RESULTS OF THE MARCH 2000 REMOTS® AND SIDE-SCAN SONAR SURVEY OF HARS REMEDIATION AREAS 1, 2, AND 3

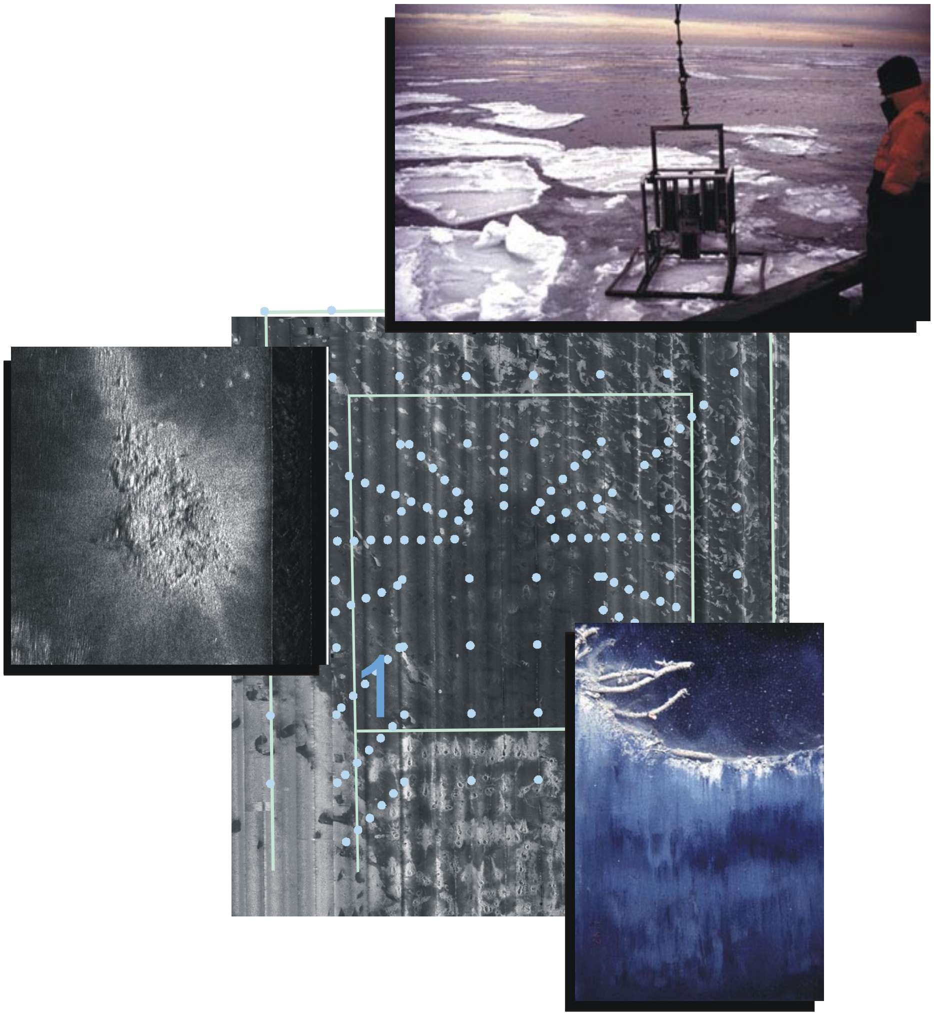

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

Page

LIST OF FIGURES

LIST OF FIGURES (continued)

Page

Page

Page

ACKNOWLEDGMENTS

This report presents the results of a survey involving side-scan sonar and REMOTS® sediment-profile imaging conducted in Priority Remediation Areas 1, 2 and 3 of the Historic Area Remediation Site (HARS). The survey was conducted in January and March 2000 by Science Applications International Corporation (SAIC) of Newport, RI, under contract to the U.S. Army Corps of Engineers - New York District (NYD). Stephen Knowles is the manager of technical activities under the NYD contract; Ray Valente was SAIC's project manager for the side-scan sonar and REMOTS® survey.

Logistical and planning support for the survey were provided by Stephen Knowles and Tim LaFontaine of the NYD.

Melissa Swanson, Heather Saffert, Jason Infantino, Ed DeAngelo, David Fischman, and Michael Cole of SAIC were responsible for mobilizing the side-scan sonar and REMOTS® equipment and conducting the survey operations aboard the Corps vessel M/V *Gelberman*.

Melissa Swanson analyzed the sediment-profile images and produced graphic data products for this report. Jason Infantino and Edward DeAngelo processed the side-scan sonar data and created the resulting graphic data products. This report was co-authored by Melissa Swanson and Jason Infantino, with technical oversight by Ray Valente and Edward DeAngelo. Tom Fox of SAIC was responsible for report production.

1.0 INTRODUCTION

1.1 Background

Dredged material from the Port of New York and New Jersey historically has been placed in and around the Mud Dump Site (MDS), located in the open waters of the New York Bight six nautical miles east of Sandy Hook, New Jersey. Based on concerns about limited site capacity and the environmental effects of past disposal, the MDS was closed on September 1, 1997. Simultaneous with the closure of the MDS, the site and surrounding areas were designated as the Historic Area Remediation Site, or HARS (Figure 1-1).

Region II of the United States Environmental Protection Agency (USEPA) and the New York District (NYD) of the United States Army Corps of Engineers (USACE) together are responsible for managing the HARS to reduce the presently elevated contamination and toxicity of surface sediments to acceptable levels. The two agencies have prepared a Site Management and Monitoring Plan (SMMP) which identifies a number of actions, provisions and practices to manage remediation activities and monitoring (USACE/USEPA 1997). Remediation consists of placing a one-meter "cap" layer of uncontaminated dredged material on top of the existing surface sediments within each of nine Priority Remediation Areas (PRAs) comprising the HARS (Figure 1-2). The material to be used for remediation is defined as dredged material that meets current Category I standards and will not cause significant undesirable effects, including through bioaccumulation.

The main objective of the HARS SMMP is to provide guidelines for monitoring the progress and effects of remediation. Toward these ends, the SMMP includes a tiered monitoring program designed to focus both on the entire HARS and on each of the nine Priority Remediation Areas. Monitoring activities may include high-resolution bathymetry, sediment profile imaging (SPI), side-scan sonar, sediment coring, sediment chemistry and toxicity testing, tissue chemistry testing, benthic community analysis, and fish/shellfish surveys. The monitoring program may also incorporate state-of-the-art technologies to determine sediment resuspension by collecting data on waves, currents and suspended particulate material using remotely installed instrumentation.

Since designation of the HARS in September 1997, placement of remediation material in Priority Remediation Areas (PRAs) 1, 2 and 3 has been on-going. Baseline surveys involving REMOTS® sediment-profile imaging and sediment planview photography were conducted in and around the HARS in 1995 and 1996 (SAIC 1996a and b). Numerous surveys involving high-resolution bathymetry and sediment-profile imaging have been conducted since 1995 to characterize baseline (i.e., pre-capping) conditions and to map the distribution of the bulk of remediation material placed, to date, on the seafloor in PRAs 1 and 2. This report presents the results of the most recent survey effort to delineate the footprint of the remediation material in PRAs 1 and 2.

1.2 Survey Objectives

The main survey objective was to obtain high-resolution side-scan sonar and sediment profile imaging data for the purpose of mapping seafloor characteristics and determining the distribution of remediation material placed within PRAs 1 and 2 since 1997, particularly in relation to the PRA boundary and buffer zone. The side-scan sonar survey also encompassed PRA 3 to provide a baseline for assessing changes in seafloor characteristics associated with future dredged material placement in this area (Figure 1-2). A secondary objective of the REMOTS® sediment profile imaging survey was to provide information on benthic recolonization and changes in benthic habitat quality associated with placement of remediation material in PRAs 1 and 2 to date.

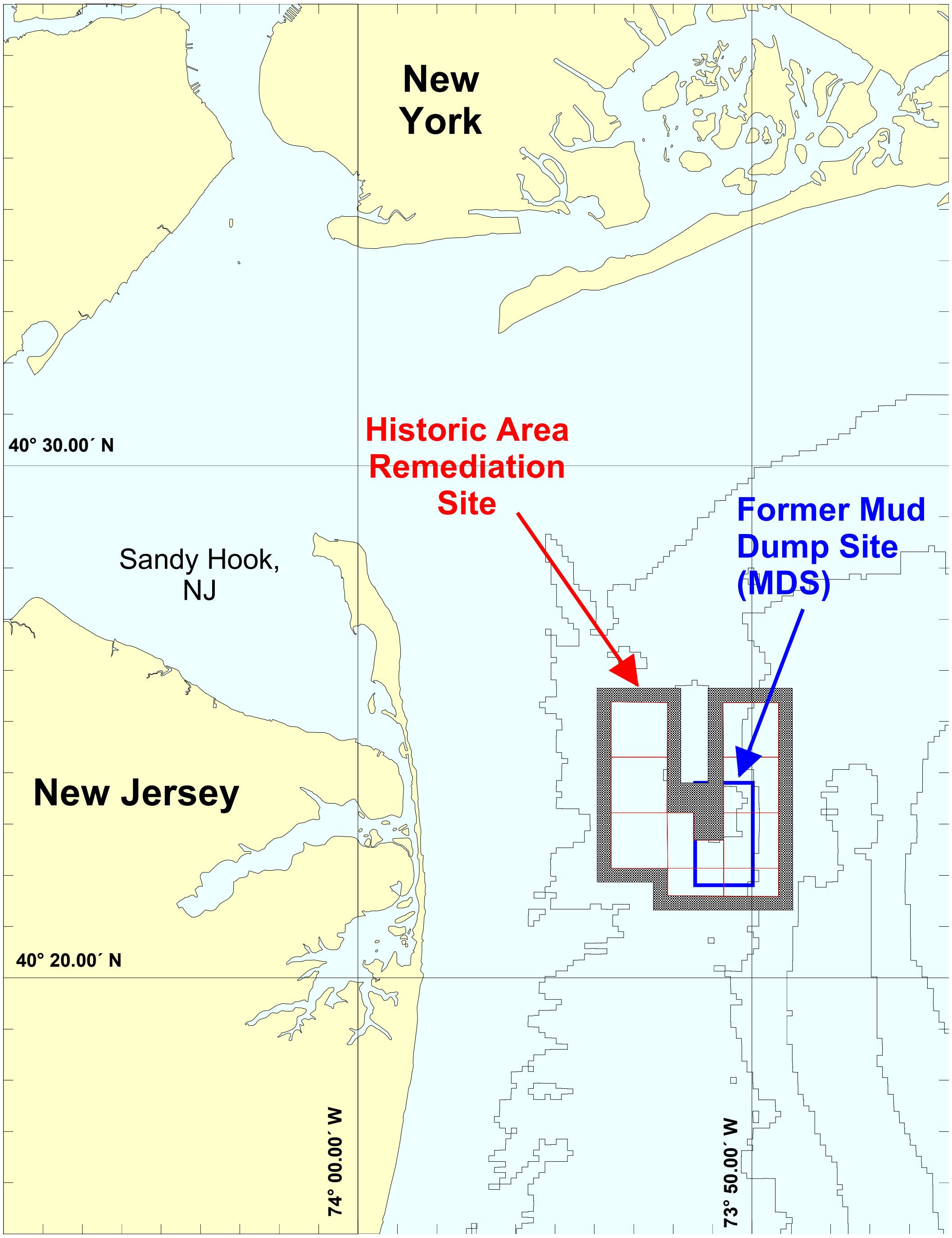


Figure 1-1. Overview map showing the locations of the Historic Area Remediation Site (HARS) and the former Mud Dump Site (MDS) in the New York Bight.

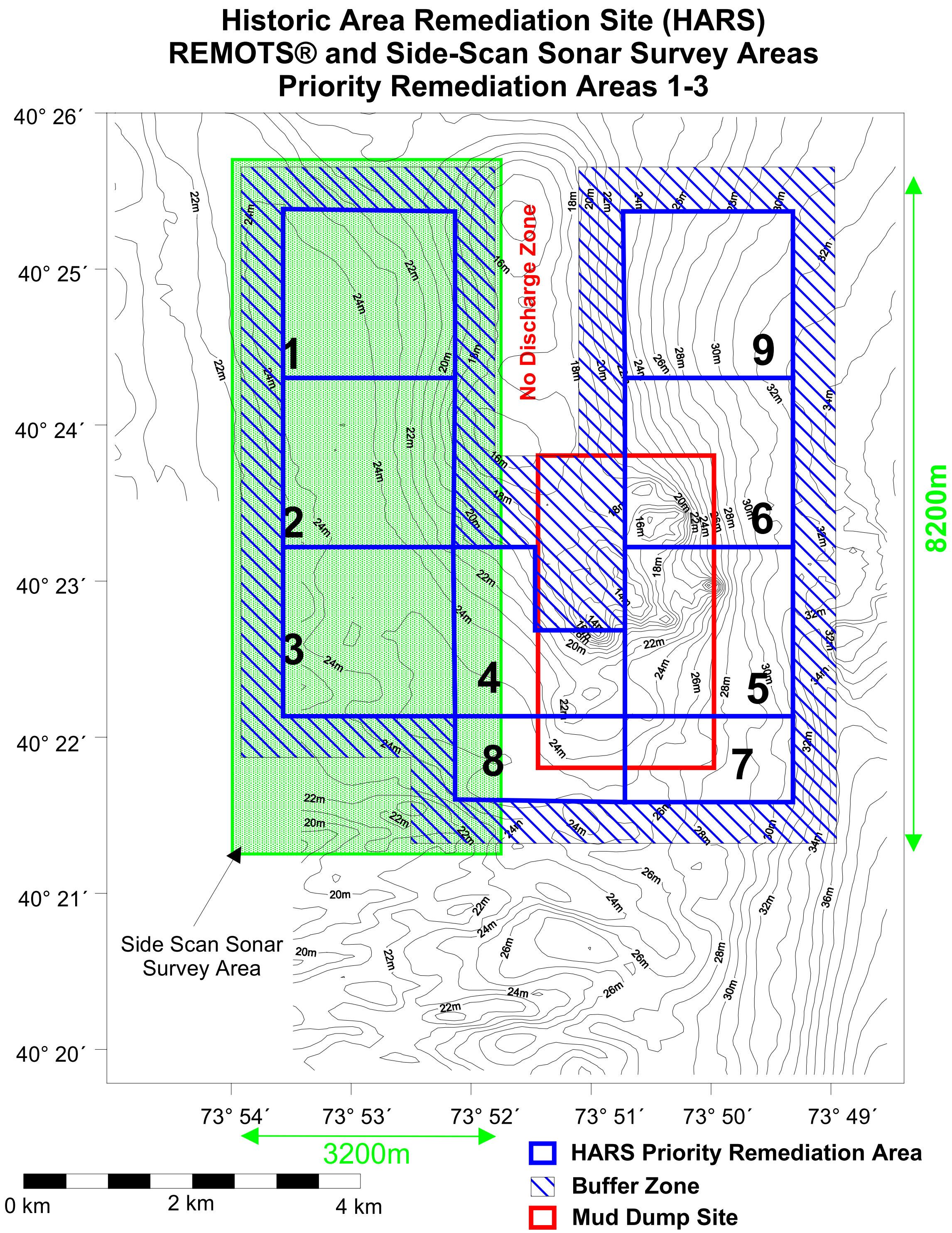


Figure 1-2. Map of the Historic Area Remediation Site (HARS), showing the former Mud Dump Site, the HARS buffer Zone, and the nine individual Priority Remediation Areas (PRAs) which comprise the HARS.

2.0 METHODS

2.1 Navigation of the Survey Vessel

For the sediment-profile imaging and side-scan sonar survey operations, SAIC installed the HYPACK® system on the survey vessel to provide navigational support for the crew and to store survey data digitally. The HYPACK® system was run on a Toshiba Satellite laptop PC with a 400 MHz processor. This system provides real-time navigation and collection of position and time data for subsequent analysis. The HYPACK® system provided the navigator and helmsman with range, bearing and offset to a selected target (e.g., the beginning and end of each side-scan survey lane or each predetermined sediment-profile imaging station), signal quality, time of day, and selected data from any operational environmental. Each fix consisted of the date and time, ship's position in latitude/longitude and the local X/Y coordinate system. HYPACK® logged all data strings at a 1-second interval and stored the files onto the hard drive.

Vessel position was determined with a Global Positioning System (GPS) receiver. One to five meter position accuracy was achieved by applying corrections acquired from a Differential GPS (DGPS) receiver to the GPS signals. The DGPS received corrections from the U.S. Coast Guard DGPS beacon located at Sandy Hook, NJ.

2.2 Side-scan Sonar

2.2.1 Side-scan Sonar Field Operations

The side-scan sonar survey operations were conducted on March 4 through 8, 2000. SAIC scientists traveled to the Army Corps of Engineers' Caven Point Facility in Jersey City, NJ and installed navigation and side-scan equipment aboard the Corps' M/V *Gelberman*. Vessel speed during the side-scan sonar survey operations was approximately 4 to 5 knots.

Side-scan sonar imagery was collected with an Edgetech DF1000 digital side-scan sonar system interfaced to a PC-based Triton-Elics ISIS™ sonar acquisition topside system. The DF1000 side-scan fish was towed behind the survey vessel by a signal cable that provided power to the subsea vehicle and two-way communication with the topside unit (Figure 2-1). The ISIS system received acoustic data from the towfish, integrated position information from the navigation system, displayed the imagery on a PC monitor, and recorded the sonar and navigation data electronically on magneto-optical disks for post-survey analysis.

Side-scan sonar systems provide an acoustic representation of the seafloor topography, bottom targets, and generalized sediment characteristics by detecting the back-scattered signals emitted from a towed transducer housed in a "towfish." The transducer operates similar to a conventional depth-sounding transducer except that the towfish has a pair of opposing transducers aimed perpendicular to and directed on either side of the vessel track. The Edgetech DF1000 is equipped with transducers capable of emitting and receiving sound waves simultaneously at frequencies of 100 and 500 kHz. Swaths of sonar imagery at specific distances

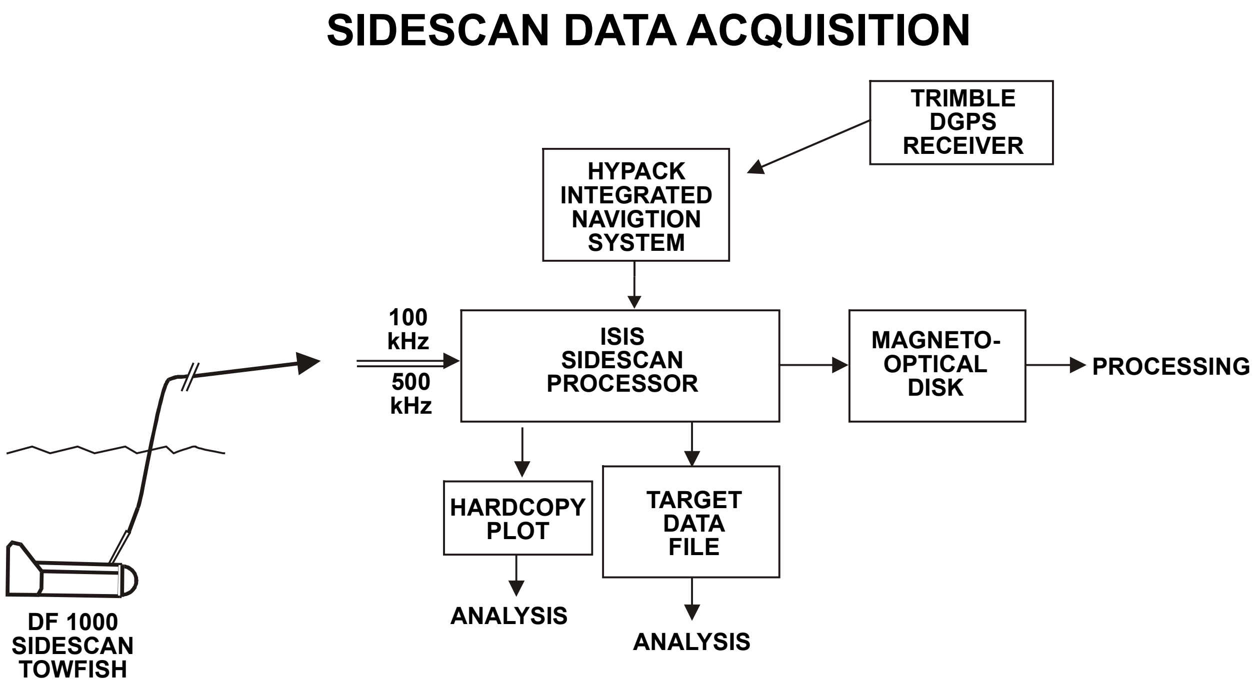


Figure 2-1. Schematic Diagram of the side-scan sonar system.

from the towfish can be acquired by adjusting the altitude over the bottom that the sensor is towed and controlling the rate at which sonar pings are emitted from the towfish. .

Side-scan sonar reveals both the size of objects and their horizontal distance from the towfish. Dense objects (e.g., metal, rocks, hard sand seafloor areas) will reflect strong signals and appear as bright areas in the example records presented in this report. Conversely, areas characterized by soft features (e.g., muddy sediments) which absorb sonar energy appear as dark areas in the digital display. It is important to note that this light/dark display pattern is the reverse of traditional hard copy side-scan records, where weak returns are represented as white (the color of the paper) and hard returns are printed as black.

The side-scan sonar survey area measured 8,200 m (north-south) by 3,200 m (east-west); it included PRAs 1, 2, 3, and the surrounding buffer zone (Figure 1-2). The survey consisted of 32 parallel survey lines spaced 100 m apart and oriented north to south. The swath of the side-scan sonar was set at the 100 m range scale providing 200% bottom coverage of the entire area of interest.

2.2.2 Side-scan Sonar Data Analysis

Using Triton Elics ISIS software, the sonar data were re-played and the signal from the water column removed to produce high-quality image for mosaic purposes. The “water column” is depicted on the side-scan records as a white gap down the center of each record. This gap corresponds with the time it takes for the acoustic signal to travel from the towfish to the seafloor below. As the towfish gains altitude above the seafloor, the time required for the signals to reach the seafloor increases, thus increasing the white gap on the side-scan data record.

Each survey line was saved as a separate filename to facilitate post-survey processing. Each line was played back in ISIS and converted to a format compatible with Delph Map, the program used to produce the mosaic. During playback, adjustments are made to the time variable gain (TVG) of the return signal. The adjustments are necessary because sound energy is attenuated as it travels through the water column. Acoustic returns from objects farther from the towfish will have a weaker signal strength than returns from objects nearer the towfish. The TVG compensates for this signal attenuation by increasing the gain applied to the acoustic returns with time. The rate of increase can be controlled by the operator to insure that a balanced sonar record is displayed and seafloor features are not obscured.

As each line was completed in ISIS, it was imported into Delph Map to check for processing accuracy during file conversion. Once all the survey lines were processed, a mosaic was generated in Delph Map and checked for coverage gaps. After the mosaic was completed, it was saved and exported as a geo-referenced TIFF (Tagged Image File Format) file. This TIFF file can be imported into the DAN-NY system as a geo- referenced data layer to be compared with various existing and future geo-spatial data sets from the HARS.

Along with the production of the mosaic, the data were used to produce the individual graphics included in this report. Selected images of targets such as wrecks, disposal mounds, lobster traps, scour marks and sand waves are included. An overall sediment characterization map of PRAs 1, 2, and 3 was prepared, as well as maps showing the relationship between Automated Disposal Surveillance System (ADISS) disposal barge tracking data and the location of apparent disposal mounds.

2.3 REMOTS® Sediment-Profile Imaging

2.3.1 Sampling Design

To address the objective of delineating the footprint of remediation dredged material, the REMOTS® survey consisted of two phases. The first phase was an initial reconnaissance of sixty-four (64) stations spaced 400 m apart; the stations were arranged in a rectangular grid pattern within PRA 1 and the northern part of PRA 2 and the associated buffer zone (Figure 2-2). These stations were occupied previously during an August 1998 REMOTS® survey to characterize "baseline" seafloor conditions in PRAs 1 and 2, prior to placement of significant volumes of remediation material (SAIC 1998a).

Each row of stations was lettered sequentially A through H, and each column was labeled in increments of 400 meters starting with zero (0) at the western boundary (roughly longitude 73° 54') and ending with 2800 at the eastern boundary (roughly longitude 73°52'; Figure 2-2). The REMOTS® images obtained in the reconnaissance survey were examined to determine the broad-scale spatial distribution of remediation dredged material. An additional 100 "footprint delineation" stations were then identified and sampled to yield more precise (i.e., finer-scale) mapping of the dredged material footprint (Figure 2-3). These stations were spaced 100 m apart and aligned in a series of transects at the known edges of the dredged material deposit (i.e., on the apron as identified in the reconnaissance survey), facilitating more precise mapping of the dredged material distribution.

The REMOTS® camera was lowered multiple times at each station in an attempt to collect at least two replicate REMOTS® images suitable for subsequent analysis. Color slide film was used and developed at the end of each field day to verify proper equipment operation and image acquisition. Overall, 565 REMOTS® images were obtained at the 164 stations within and around PRAs 1 and 2 (64 reconnaissance stations and 100 footprint delineation stations; Figure 2-4). In general, two representative images from each station were analyzed and used to prepare the maps presented in this report.

2.3.2 REMOTS® Image Acquisition

REMOTS® is a formal and standardized technique for sediment-profile imaging and analysis (Rhoads and Germano 1982; 1986). A Benthos Model 3731 Sediment Profile Camera (Benthos, Inc., North Falmouth, MA) was used in this study (Figure 2-5). 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

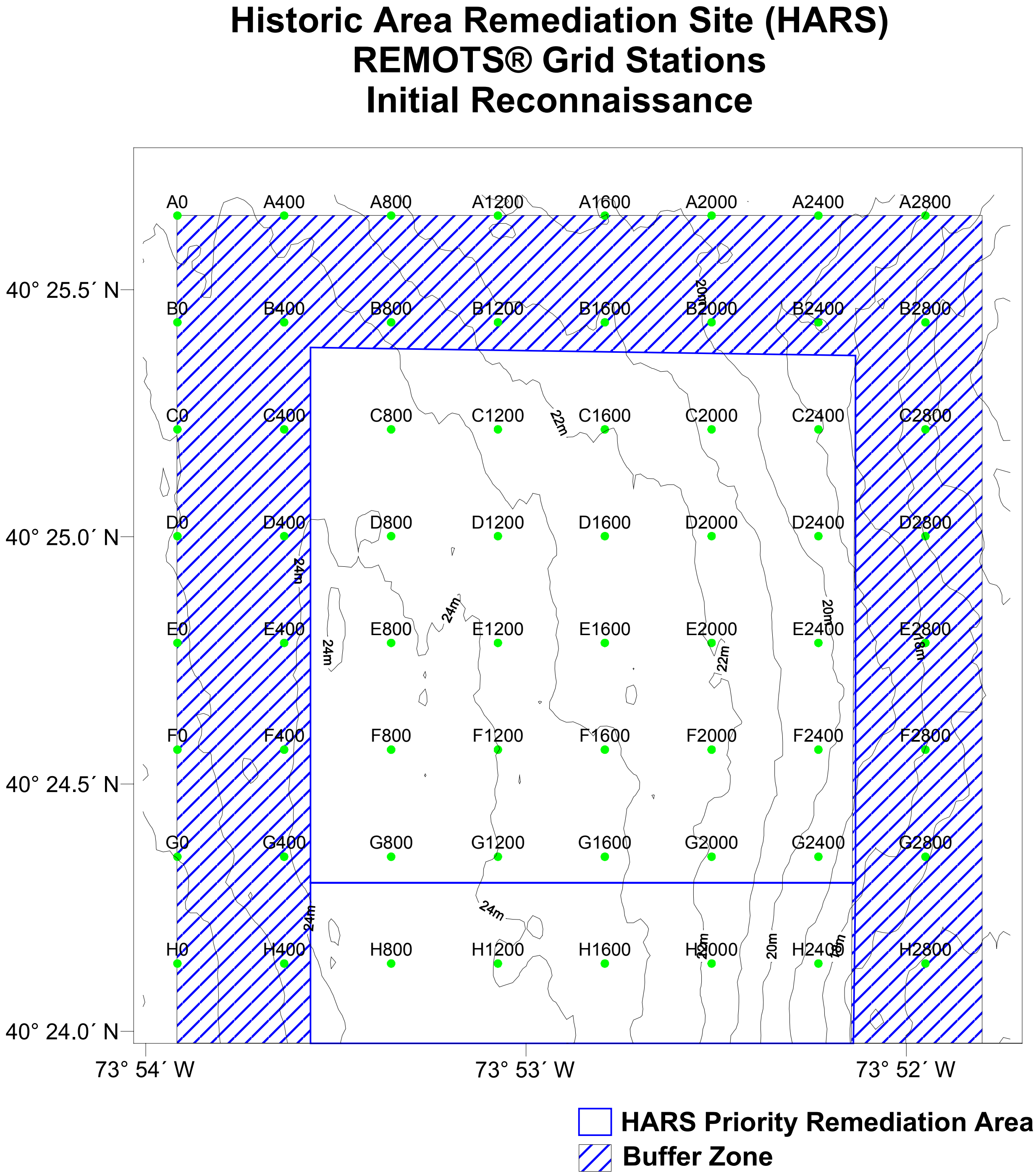


Figure 2-2. Location of 64 REMOTS® reconnaissance stations arranged in a rectangular grid pattern covering PRAs 1 and 2 and the surrounding buffer zone.

Historic Area Remediation Site (HARS)
REMOTS® Radial Stations
Footprint Delineation

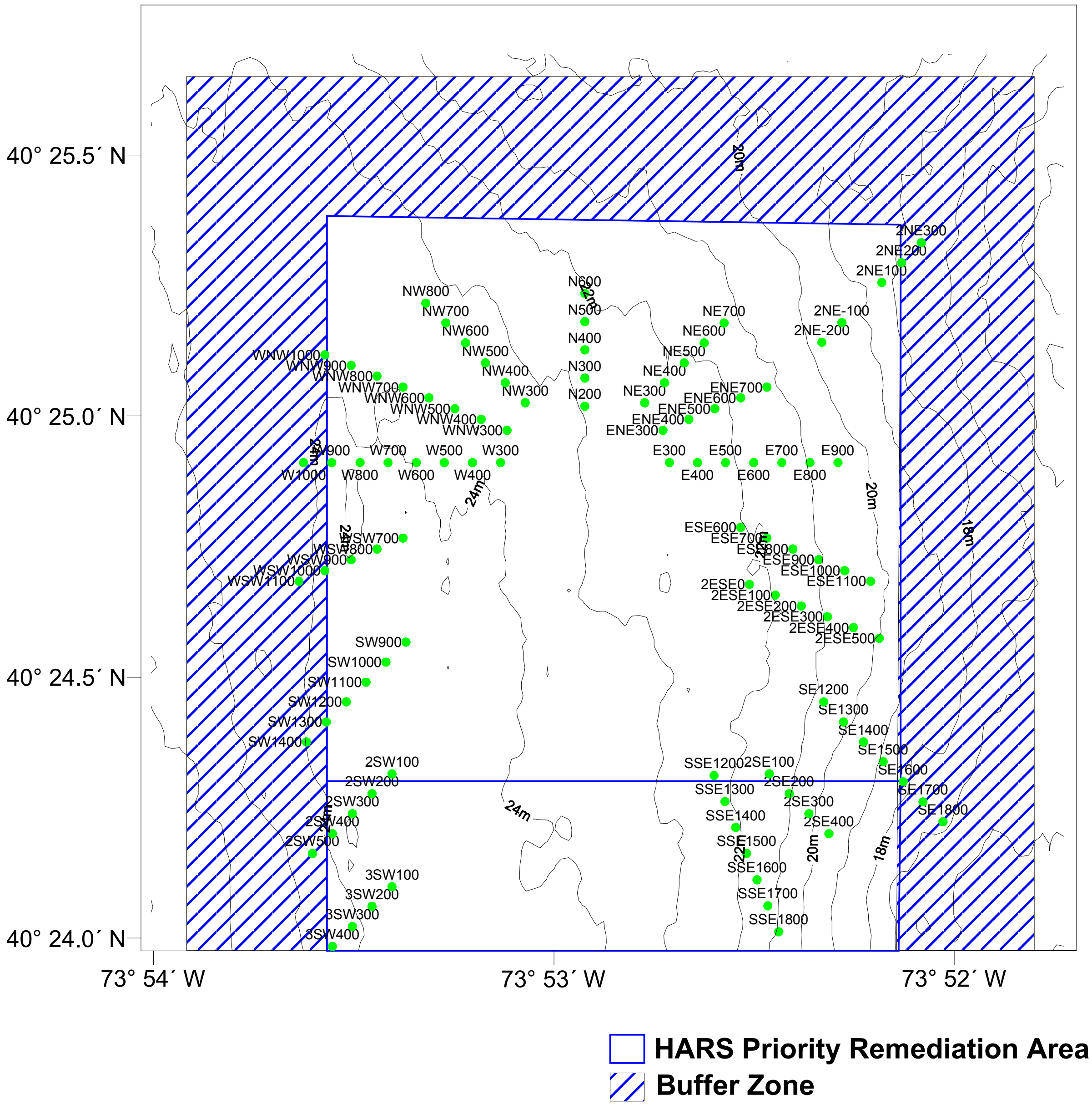


Figure 2-3. Location of 100 REMOTS® delineation stations arranged in radial transects covering PRAs 1 and 2 and the surrounding buffer zone.

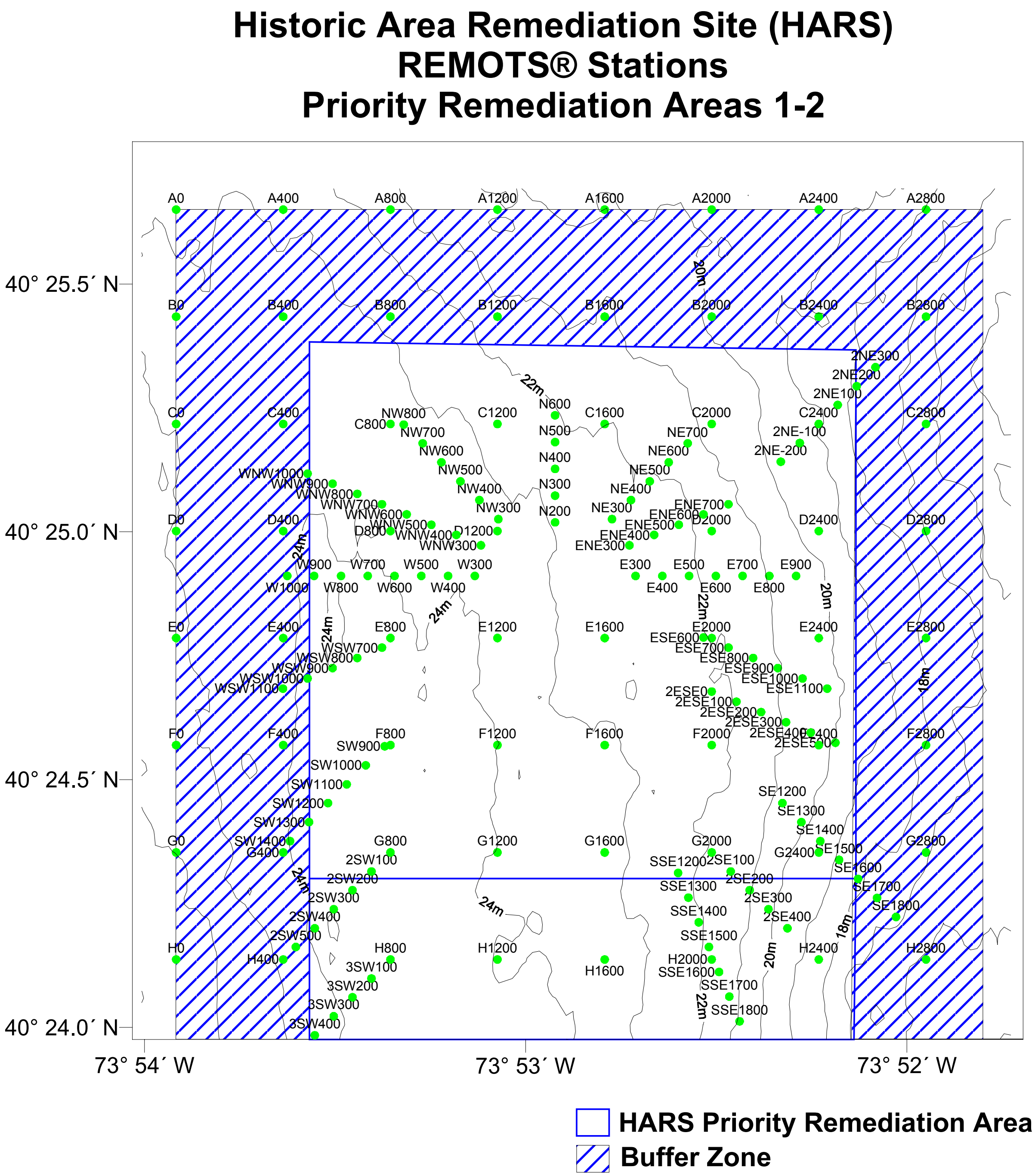


Figure 2-4. Location of all 164 REMOTS® stations covering PRAs 1 and 2 and the surrounding buffer zone.

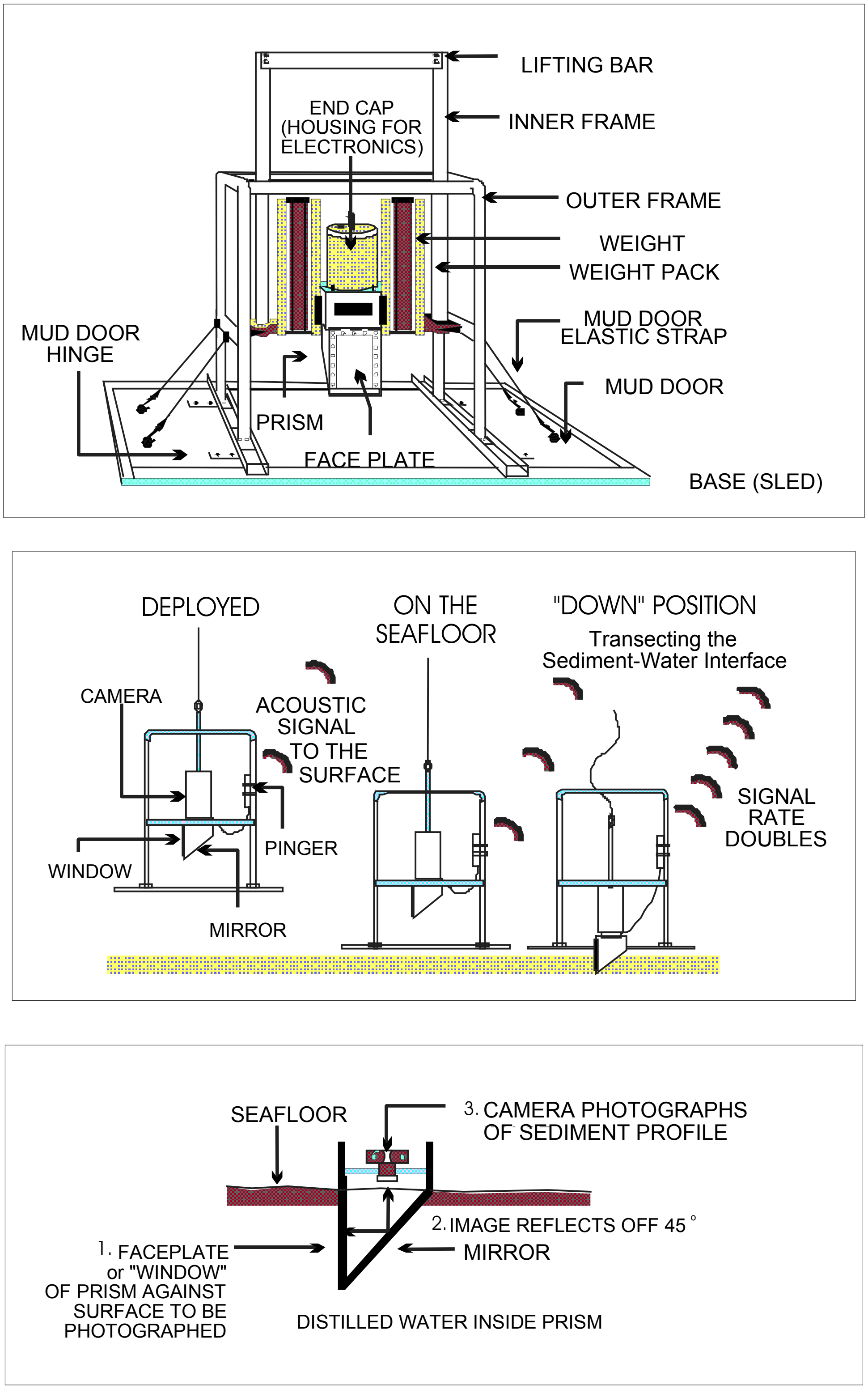


Figure 2-5. Schematic diagram of Benthos, Inc. Model 3731 sediment-profile camera and sequence of operation on deployment.

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 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 2-5). 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 deck 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.

2.3.3 REMOTS® Image Analysis

The REMOTS® images were analyzed with SAIC's full-color digital 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 color slide on the CRT while measurements of 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 data sheets for a quality assurance check by an SAIC Senior Scientist before being approved for final data synthesis, statistical analyses, and interpretation. A summary of the major categories of REMOTS® data is presented below.

Sediment Type Determination

The sediment grain size major mode and range are estimated visually from the photographs by overlaying a grain size comparator which is at 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: >4 ϕ, 4-3 ϕ, 3-2 ϕ, 2-1 ϕ, 1-0 ϕ, 0-(-1 ϕ), and <-1 ϕ. The lower limit of optical resolution of the photographic system is about 62 microns (4 ϕ), 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 those images that show layering of sand and mud, the dominant major mode assigned to a replicate therefore depends on how much area of the photograph is represented by sand versus mud. These textural assignments 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.

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 15 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.).

Optical Prism Penetration Depth

The optical prism penetrates the bottom under a static driving force imparted by the weight of the descending optical prism, camera housing, supporting mechanism, and weight packs. 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 optical prism into the bottom can be a useful parameter, because dredged and capped materials often will have different shear strengths and bearing capacities.

Mud Clasts

When fine-grained, cohesive sediments are disturbed, either by physical bottom scour or faunal activity (e.g., decapod foraging), intact clumps of sediment are often scattered about the seafloor. These mud clasts can be seen at the sediment-water interface in REMOTS® images. During analysis, the number of clasts is counted, the diameter of a typical clast is measured, and their oxidation state is assessed. Depending on their place of origin and the depth of disturbance of the sediment column, mud clasts can be reduced or oxidized. Also, once at the sediment-water interface, these sediment clumps are subject to bottom-water oxygen levels and bottom currents. Based on laboratory microcosm observations of reduced sediments placed within an aerobic environment, oxidation of reduced surface layers by diffusion alone is quite rapid, occurring within 6-12 hours (Germano 1983). Consequently, the detection of reduced mud clasts in an obviously aerobic setting suggests a recent origin. The size and shape of mud clasts, e.g., angular versus rounded, are also considered. Mud clasts may be moved about and broken by bottom currents and/or animals (macro- or meiofauna; Germano 1983). Over time, large angular clasts become small and rounded. Overall, the abundance, distribution, oxidation state, and angularity of mud clasts are used to make inferences about the recent pattern of seafloor disturbance in an area.

Measurement of Dredged Material Layers, Cap Layers or other Depositional Layers

Distinct sedimentary horizons are clearly distinguishable in sediment profile images. Typically, depositional layers at the sediment surface or sedimentary horizons at depth are distinguished on the basis of their unique texture and/or color. Depositional layers may be the result of natural processes (e.g., sediment erosion, transport, and deposition), or anthropogenic activities like dredged material placement or capping. The recognition of dredged material in REMOTS® images is usually based on the presence of anomalous sedimentary materials within an area of ambient sediment. The ability to distinguish between ambient sediment and dredged or cap material demands that the survey extend well beyond the margins of a placement site so that an accurate characterization of the ambient bottom is obtained. The distributional anomalies may be manifested in topographic roughness, differences in grain size, sorting, shell content, optical reflectance, fabric, or sediment compaction (i.e., camera prism penetration depth). Second-order anomalies may also provide information about the effects of dredged material on the benthos and benthic processes such as bioturbation (see following sections).

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) or iron oxide, producing a rust color, while reduced and muddy sediments below this oxygenated layer are darker, generally grey to black. The boundary between the colored ferric hydroxide surface sediment and underlying grey to black sediment is called the apparent redox potential discontinuity, or RPD (Revsbech et al. 1979).

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.

In sediment-profile surveys of ocean disposal sites sampled seasonally or on an annual basis throughout the New England region performed under the DAMOS (Disposal Area Monitoring System) Program for the New England Army Corps of Engineers, SAIC repeatedly has documented a drastic reduction in apparent RPD depths at disposal sites immediately after dredged material placement, followed by a progressive postdisposal apparent RPD deepening (barring further physical disturbance). Consequently, time-series RPD measurements can be a critical diagnostic element in monitoring the degree of recolonization in an area by the ambient benthos.

The depth of the mean apparent RPD also can be affected by local erosion. The peaks of disposal mounds commonly are scoured by flow over the mound. This can result in washing away of fines, development of shell or gravel lag deposits, and very thin apparent RPD depths. During storm periods, erosion may completely remove any evidence of the apparent RPD (Fredette et al. 1988).

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.).

Sedimentary Methane

At extreme levels of organic-loading, pore-water sulphate is depleted, and methanogenesis occurs. The process of methanogenesis is detected by the appearance of methane bubbles in the sediment column. These gas-filled voids are readily discernible in REMOTS® images because of their irregular, generally circular aspect and glassy texture (due to the reflection of the strobe off the gas). If present, the number and total areal coverage of all methane pockets are measured.

Infaunal Successional Stage Designation

The mapping of successional stages, as employed in this project, 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). This 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; 1986) 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 placement, thermal effluent from power plants, bottom trawling, pollution impacts from industrial discharge, 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; 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. 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. 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 relic (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 and the presence of subsurface feeding voids, respectively; both types of assemblages may be present in the same image. Additional information on REMOTS® image interpretation can be found in Rhoads and Germano (1982, 1986).

Organism-Sediment Index (OSI)

The multi-parameter REMOTS® Organism-Sediment Index (OSI) has been constructed to characterize habitat quality. 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 deeply depressed 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 2-1. The OSI is calculated automatically by SAIC software after completion of all measurements from each REMOTS® photographic negative. The index has proven to be an excellent 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 of 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) seres. Stage III seres 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 seres following abatement of such events may take several years (Rhoads and Germano 1982). Stations that have low OSI values (+6) are indicative of recently disturbed areas and tend to have greater temporal and spatial variation in benthic habitat quality than stations with higher OSI values (> +8).

Table 2-1

Calculation of the REMOTS® Organism Sediment Index Value

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 to II	2
	Stage II	3
	Stage II to 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 - +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.

3.0 RESULTS

3.1 Side-scan Sonar Physical Characterization of PRAs 1, 2 and 3

In the side-scan sonar mosaic (Figure 3-1), darker areas represent weak acoustic returns (low reflectance) indicative of softer, lower density sediments such as muds and silts. Lighter areas in the mosaic indicate strong acoustic returns (high reflectance) from harder substrates (e.g., sand and rocks). The side-scan mosaic showing different reflectance therefore indicates several distinct sediment types within PRAs 1, 2 and 3.

One of the major areas of softer sediment occurs roughly in the center of PRA 1 (Figures 3-1 and 3-2). The area of low reflectance has a circular shape within the center of this remediation area (Figure 3-2). The low reflectance signature is due to the absorption of the sound energy by relatively soft sediments in this area. These sediments are the result of placement of fine-grained dredged material in PRA 1. Poor reflectance in the side-scan records is also characteristic of smooth surfaces with few obstructions. The remaining portions of PRA 1 are also characterized by having relatively low acoustic reflectance, reflecting the soft, fine-grained sediments with little surface relief which characterize the broad topographic depression in this area. The northeastern portion of PRA 1, as well as the northern part of the buffer zone, had patches of relatively higher reflectance. These patches may be sand waves interspersed between changing sediment types.

Within PRA 2, the majority of the area has a high reflectance and as a result, produces a lighter image on the mosaic (Figures 3-1 and 3-3). Placement of remediation material within PRA 2 has occurred throughout the past year. The placement operations have introduced a combination of sand, rock and mud to this area of the HARS. The high reflectance can be attributed to the multiple placement events and the irregular shape of the resulting dredged material deposits on the seafloor. In general, a large number of reflective surfaces produce a higher acoustical signature return, thus revealing a target or feature. To the east within PRA 2, there is a distinct difference in reflectance intensity compared to the western portion described above. The eastern portion has not been subjected to recent placement activities and represents ambient bottom. There is a mixture of high and low reflectance, with the generalized direction of the natural features running northwest to southeast. This orientation is likely the result of the prevailing bottom currents in the region. The pattern of these features suggests a soft, conforming type of sediment such as sand and mud. To the west of PRA 2, inside and outside of the buffer zone, there appears to be a large area of high reflectance. This area is predominantly sand intermixed with patches of finer-grained sediment. Sand waves are clearly visible in the side-scan images from this area.

PRA 3 can be split into three generalized areas. The northern section shows a mixture of high and low reflectance patterns (Figure 3-4). The eastern half of PRA 3 and the adjacent buffer zone exhibits low reflectance, suggesting a relatively smooth, softer bottom type. The third area comprising the western half of PRA 3 and the adjacent buffer zone to the west and south mimics the northern area, showing a mixture of high and low reflectance returns. This area is comprised of a patchy mixture of coarser-grained material (sand) and finer-grained material (silt/mud). The presence of sand waves helps to distinguish the sandy areas.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Mosaic

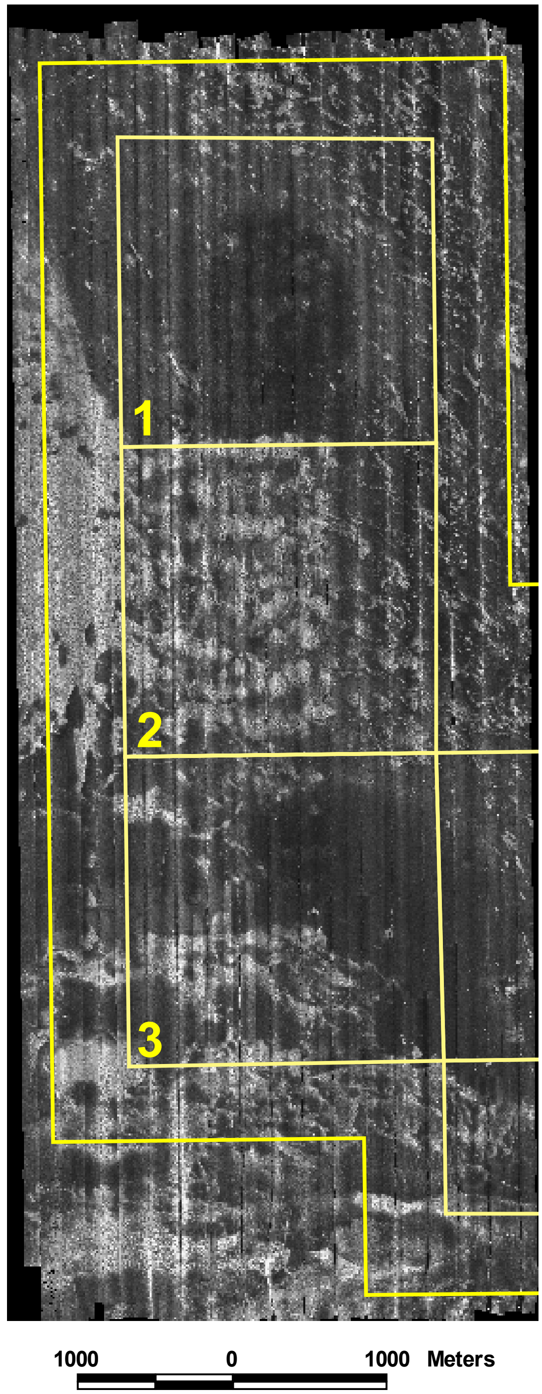


Figure 3-1. Side-scan sonar mosaic of acoustic imagery collected at the HARS during the March 2000 interim monitoring survey. The boundaries of the individual PRA's and the Buffer Zone have been plotted for reference.

HARS Priority Remediation Area 1
Side-Scan Sonar Mosaic

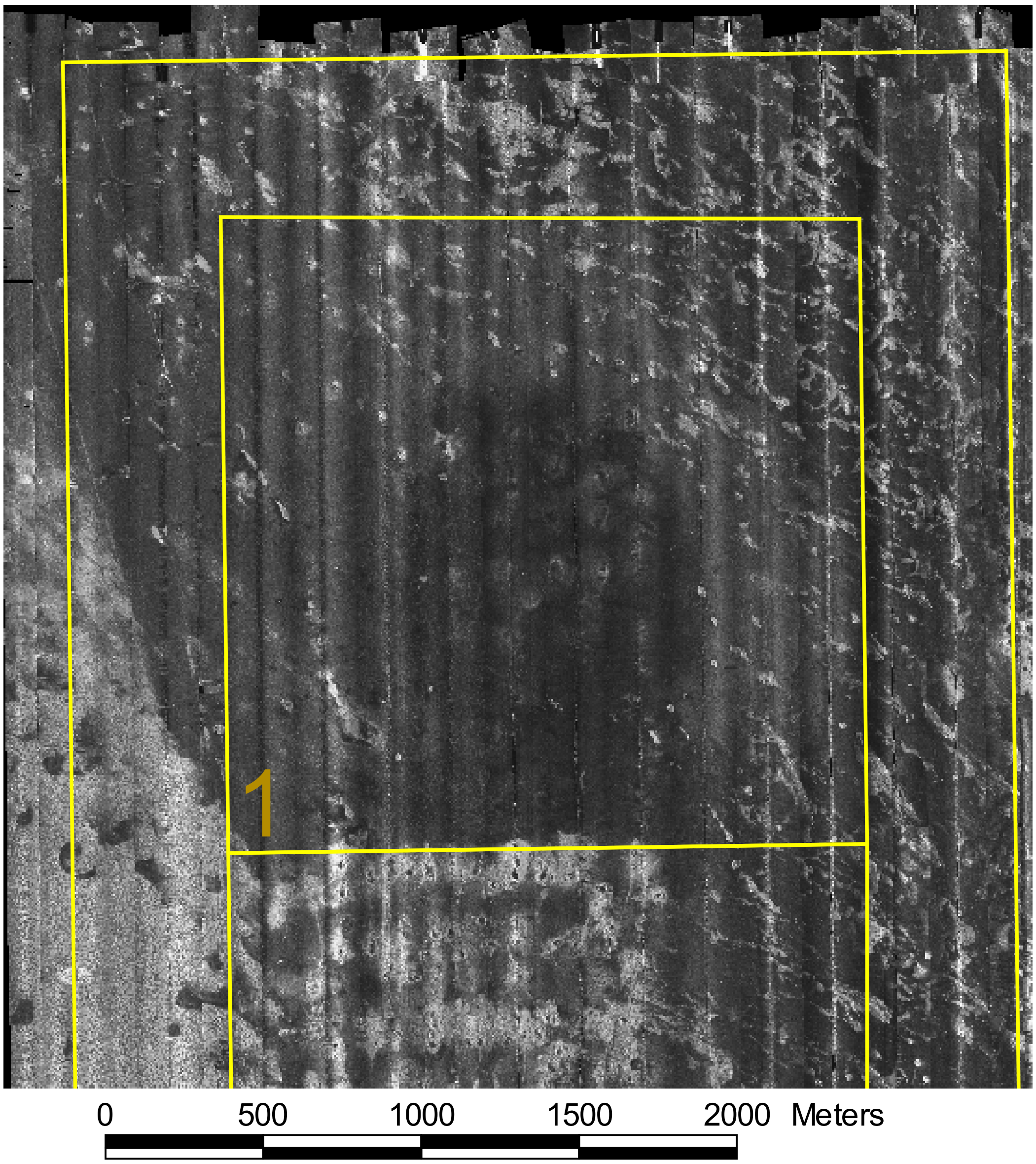


Figure 3-2. Expanded view of the side-scan mosaic within PRA 1. A circular region of low reflectance sediments was observed in the center of the cell and is consistent with dredged material placement records. The boundaries of the PRA and the HARS Buffer Zone have been plotted for reference.

HARS Priority Remediation Area 2
Side-Scan Sonar Mosaic

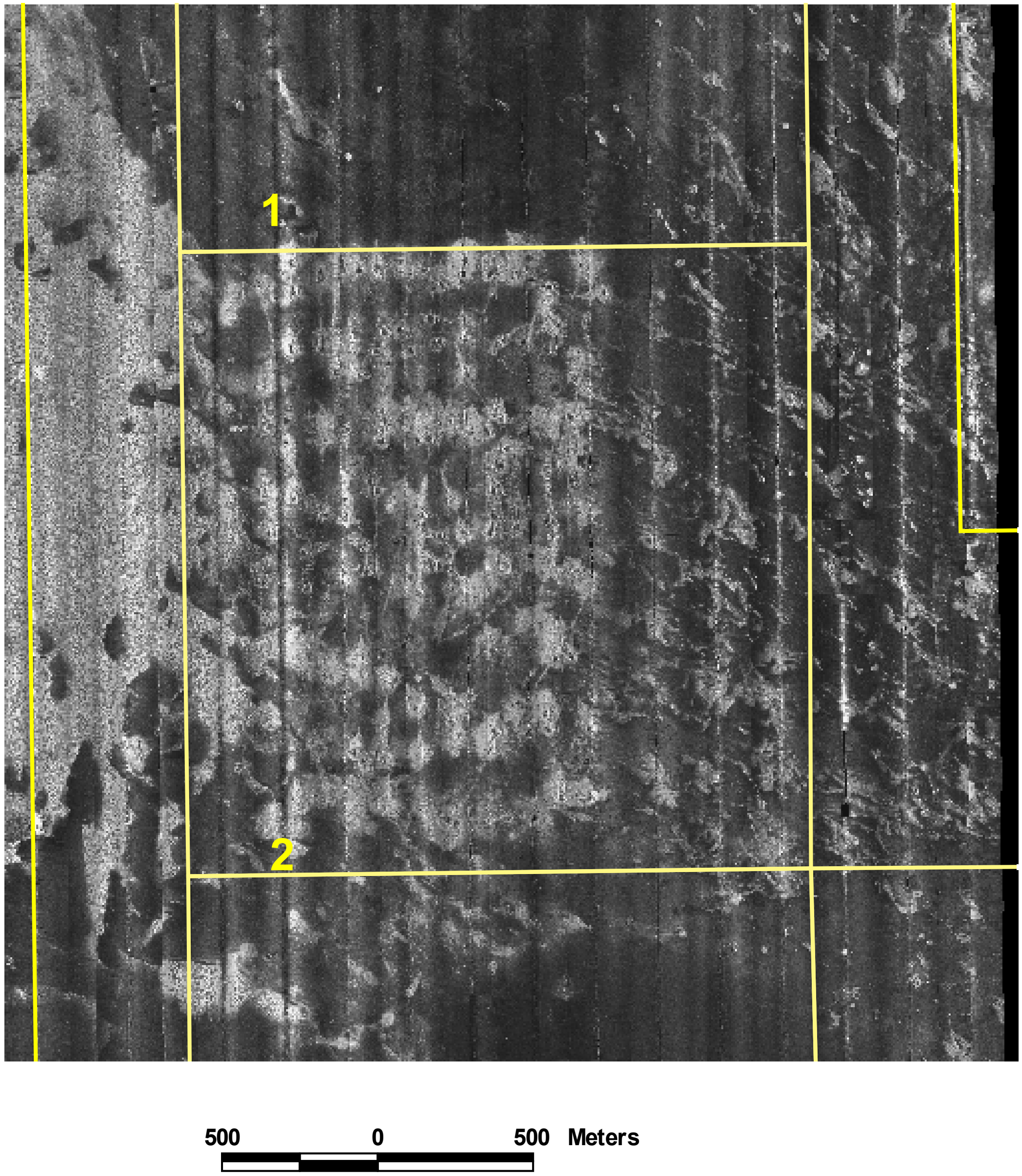


Figure 3-3. Expanded view of the side-scan mosaic within PRA 2. The mottled region in the western portion of the PRA is the result of the placement of hard material from the Kill Van Kull dredging project. The boundaries of the PRA and the HARS Buffer Zone have been plotted for reference.

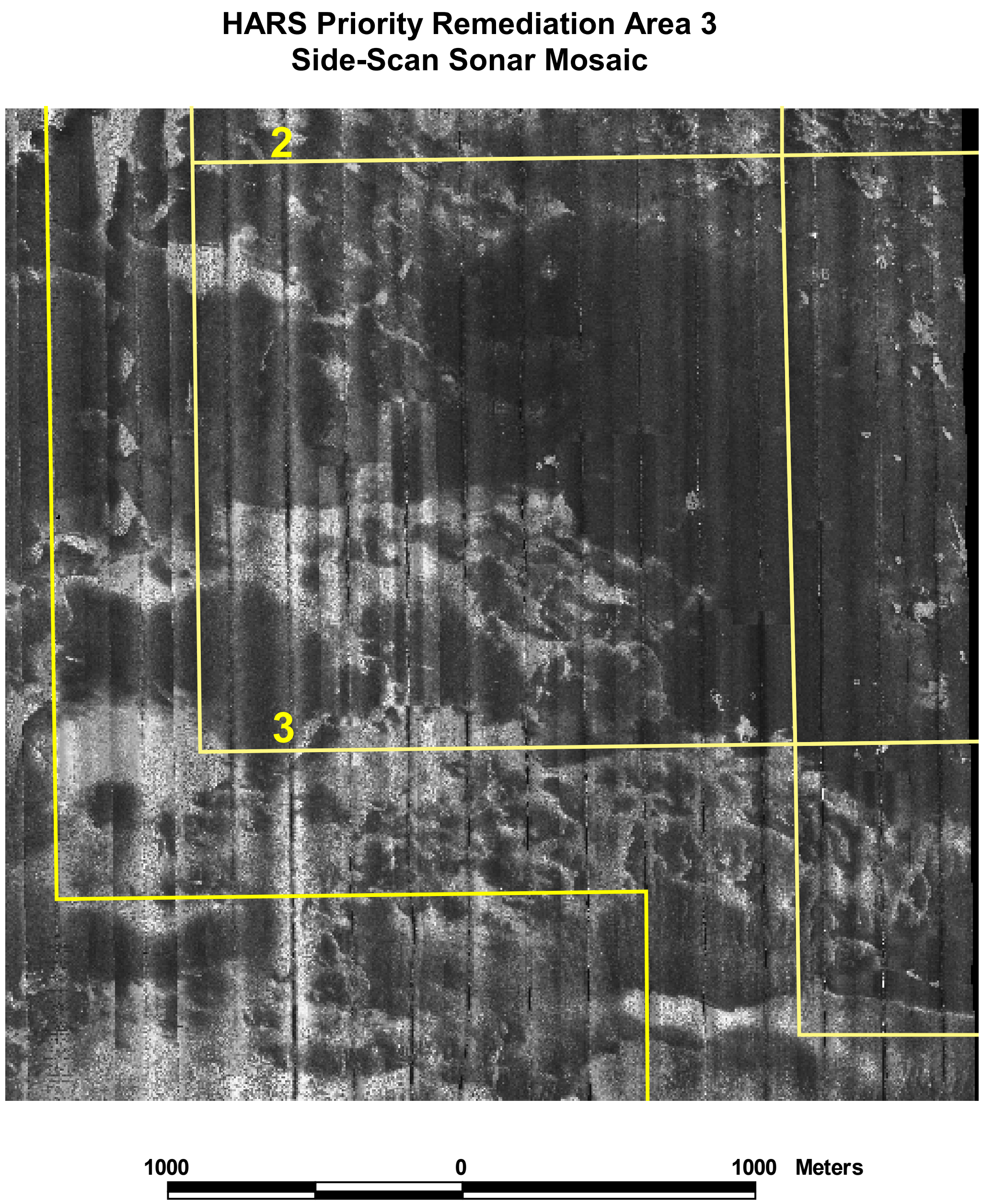


Figure 3-4. Expanded view of the side-scan mosaic within PRA 3. Low reflectance sediments were observed in the eastern portion of the PRA. Large scale sand wave features observed in the southern buffer zone exhibited higher reflectance. The boundaries of the PRA and the HARS Buffer Zone have been plotted for reference.

Overall, the mosaic of the HARS was used to create an interpretative map of major sedimentary features (Figure 3-5). This map illustrates the locations of sand wave fields, dredged material deposits, and areas containing primarily muddy sediment.

Five dredging projects have placed material at the HARS since its opening in September 1997 (Table 3-1). For each of these projects, SAIC installed the Automated Disposal Inspection Surveillance System (ADISS) aboard the disposal scows to obtain data on the actual location of each individual placement event (SAIC 1998b and c; SAIC 1999). ADISS accurately monitored scow position and draft during (1) loading at the dredging site, (2) transit, and (3) disposal within a pre-determined target grid. Data were acquired in near real-time via ARGOS satellite or during service trips to the scow(s). The ADISS data have been archived and incorporated into the DAN-NY (Disposal Analysis Network – New York), a GIS-based information management system being used by the Corps of Engineers New York District for managing the HARS.

Table 3-1

Projects and Estimated Volumes of Remediation Material Placed in PRAs 1, 2 and 3 since September 1997

Project Name	Completion Date	Recorded Log Disposals	Recorded ADISS Disposals	Total Volume (yd^3)*
ITO Passenger Ship Terminal	April 1998	134	129	481,000
Refined Sugars, Inc.	November 1998	18	18	56,000
ITO Passenger Ship Terminal	May 1999	115	94	342,000
Brooklyn Marine Terminal	December 1999	33	27	107,000
Kill Van Kull Phase II, Contract I	project is on-going as of May 2000	>350**	313**	985,522

* volumes are estimates only based on recorded disposal log information
** as of May 24, 2000 (note: numbers reflect disposal at the HARS only)

The ADISS data (showing the target grids for each project and the individual disposal events within each grid cell) was overlaid on the side-scan mosaic to examine the correlation between seafloor features and the individual disposal locations (Figure 3-6). There was a strong correlation between the ADISS disposal points and the seafloor features in the side-scan mosaic. The geodetic position of the disposal points closely agreed with the location of features identified as dredged material deposits. The disposal logs incorporated in the DAN-NY system provide valuable information about the composition and type of sediment placed at the HARS. In PRA 1, the circular area toward the center of the cell was interpreted from the sonar records as consisting of loosely consolidated silt/mud (Figure 3-7). The disposal logs suggest that most of

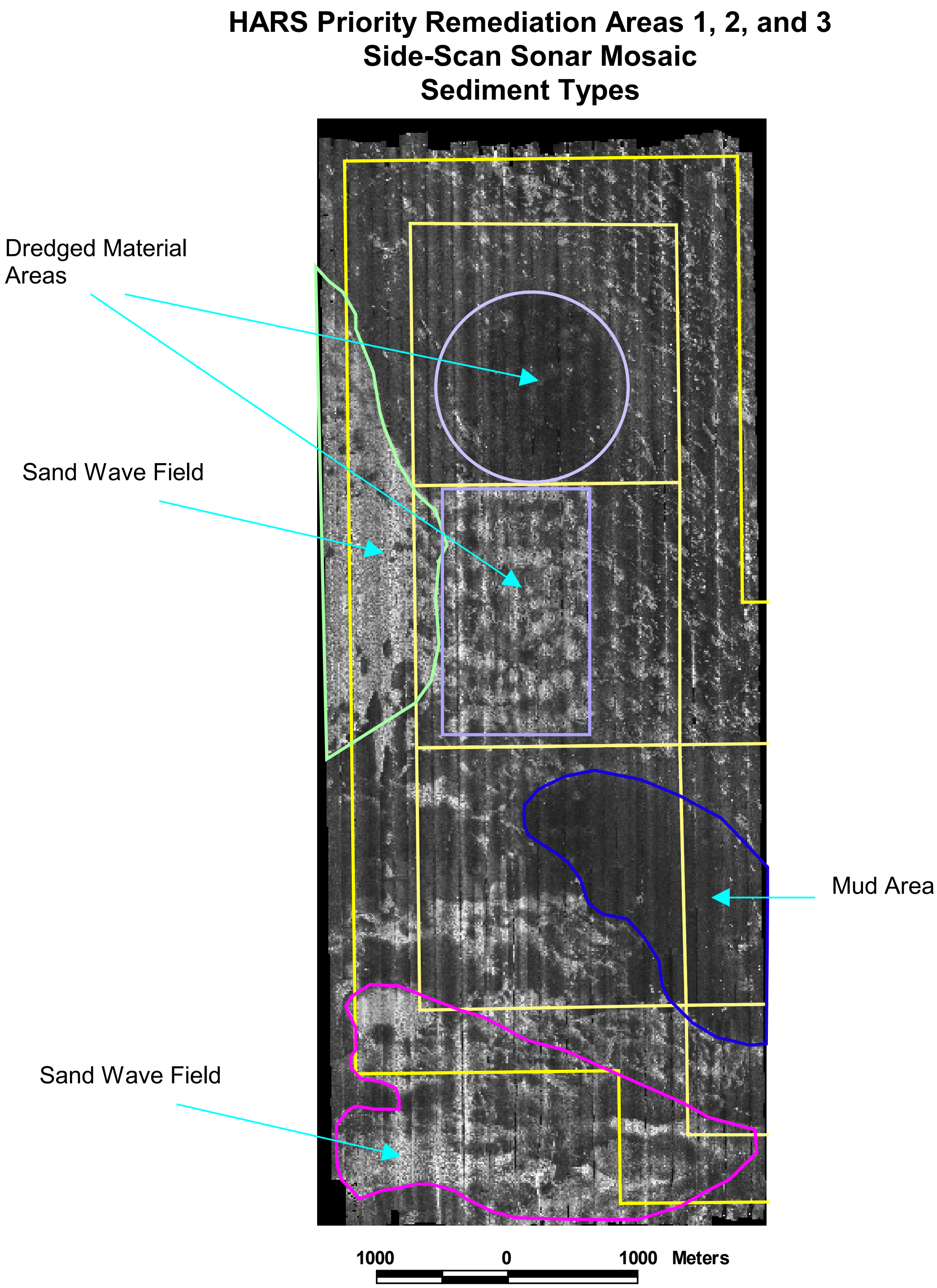


Figure 3-5. Delineation of the primary sedimentary environments of the HARS as interpreted from the side-scan mosaic. Areas covered with dredged material, sand, and fine-grained sediments have been identified. The boundaries of the individual PRAs and the HARS Buffer Zone have been plotted for reference.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Mosaic
ADISS Disposal Events

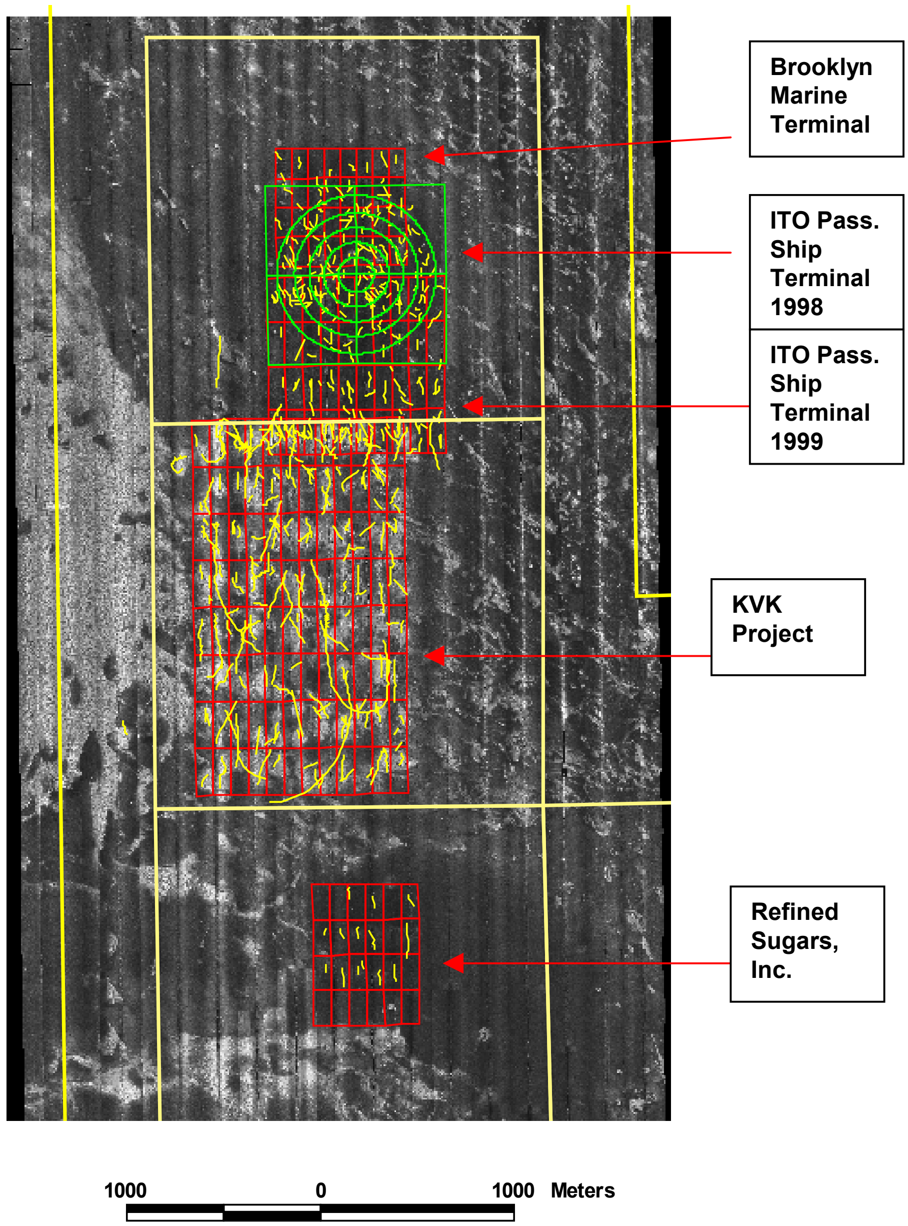


Figure 3-6. Location of individual disposal events (yellow wavy lines) as recorded by ADISS in relation to the side-scan mosaic. Disposal "target grids" used to direct the placement of dredged material for five different dredging projects (see labels) are also illustrated. The boundaries of PRAs 1, 2 and 3 and the surrounding HARS buffer zone are plotted for reference.

HARS Priority Remediation Area 1
Side-Scan Sonar Mosaic

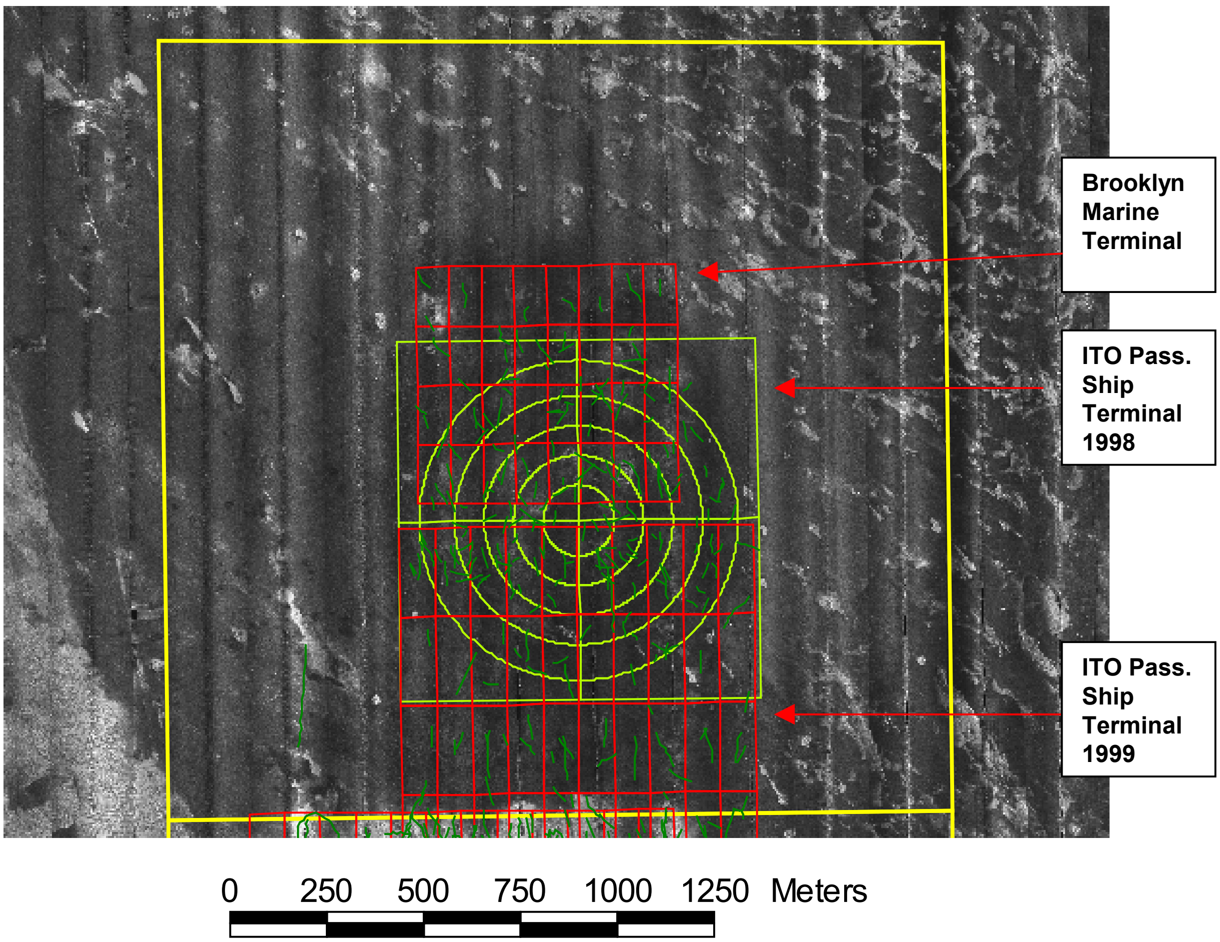


Figure 3-7. Expanded view of disposal locations from the ITO Passenger Ship Terminal and Brooklyn Marine Terminal projects in PRA 1. The boundaries of the individual PRAs and the HARS buffer zone have been plotted for reference.

the material placed in this area was from maintenance dredging; this material had a high apparent water content and high concentrations of silts and muds.

The dredged material placed in PRA 2 was comprised of a mixture of sand, mud and rock. The side-scan mosaic shows extensive patches of high reflectance (light color), suggesting harder, more compact sediment and/or higher relief relative to the surrounding bottom (Figure 3-8). Many of the light colored patches in Figure 3-8 correspond precisely with scow release points (green wavy lines), supporting the interpretation that these patches represent discrete seafloor deposits of remediation material. The eastern half of PRA 3 consisted of a broad area of low reflectance, indicating softer, more fine-grained sediment (Figure 3-9). Most of this sediment is interpreted to be relic dredged material which has accumulated over time within the topographic depression in this area. There are a few faint patches visible in the side-scan records that represents deposits of remediation material placed during the Refined Sugars, Inc. dredging project (Figure 3-9).

3.2 Individual Features Observed in the Side-scan Sonar Records

3.2.1 Wrecks

A total of 5 wrecks were identified in the side-scan records, positions for which are provided in Table 3-2. All five wrecks were located in the northern section of PRA 1 (Figure 3-10). The side-scan images of these wrecks were visible on both 100 and 500 kHz digital data. The best representation of each wreck was chosen for illustration purposes in Figures 3-11 through 3-15. A brief description of each wreck is given below.

Table 3-2
Shipwrecks observed in the side-scan sonar images of PRAs 1, 2 and 3.

Wreck No.	*Latitude*	*Longitude*	*Description*
1	40° 25.127'	73° 53.765'	Wreckage debris field
2	40° 25.358'	73° 52.823'	Intact, upright wreck
3	40° 25.439'	73° 52.200'	Large deteriorated wreck
4	40° 25.361'	73° 52.078'	Pocket barge
5	40° 25.072'	73° 51.780'	Wreckage debris field

Wreck No. 1 was observed at a depth of 24 m (78 ft) in the HARS buffer zone west of PRA 1. In the side-scan sonar images, the wreck appeared to be partially exposed, the presence of surrounding debris suggested it was not fully intact (Figure 3-11). Overall, the area covered with debris from Wreck No. 1 measured approximately 20 m by 15 m.

Wreck No. 2, located on the northern boundary of PRA 1, is a vessel approximately 20 m long by 7 m wide (Figure 3-12). Sitting flat the seafloor at a depth of about 22 m (70 ft), the bow (top) and stern (bottom) of the wreck are clearly visible in the side-scan image. There was no

HARS Priority Remediation Area 2
Side-Scan Sonar Mosaic

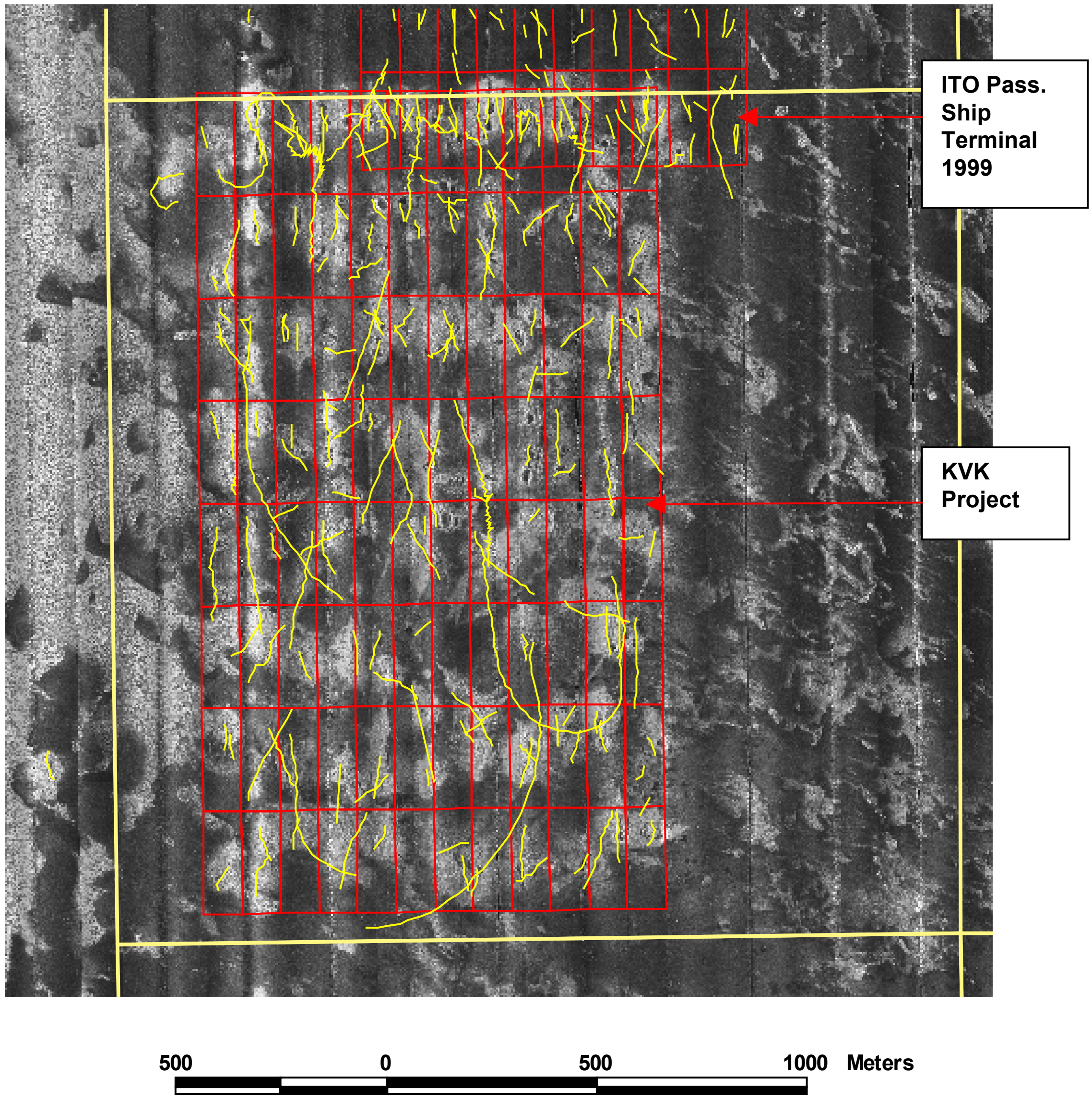


Figure 3-8. Expanded view of disposal locations from the KVK and ITO Passenger Ship Terminal dredging projects in PRA 2. The boundaries of the individual PRAs and the HARS buffer zone have been plotted for reference.

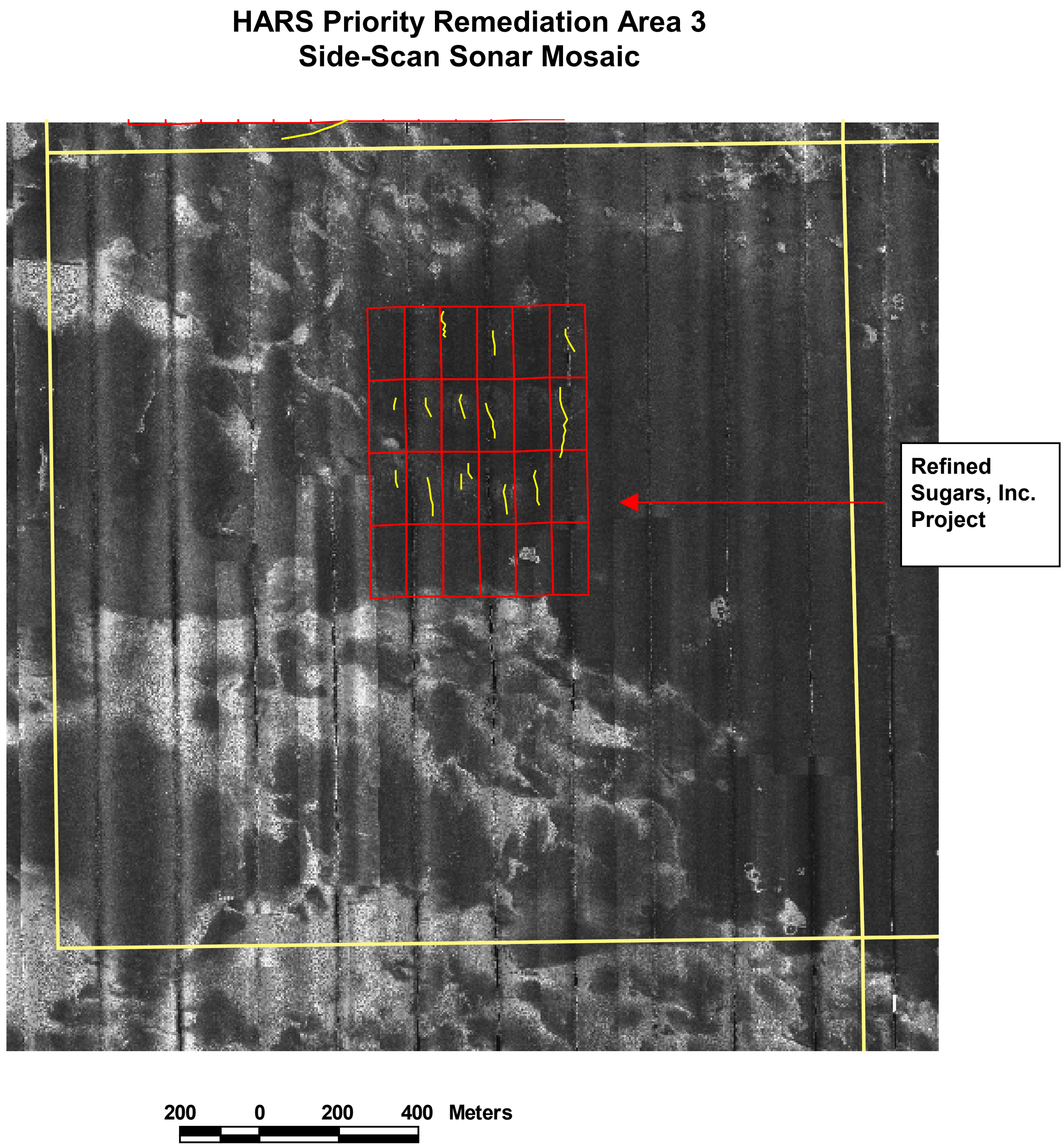


Figure 3-9. Expanded view of disposal locations from the Refined Sugars, Inc. project in PRA 3. The boundaries of the individual PRAs and the HARS buffer zone have been plotted for reference.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Shipwreck Locations

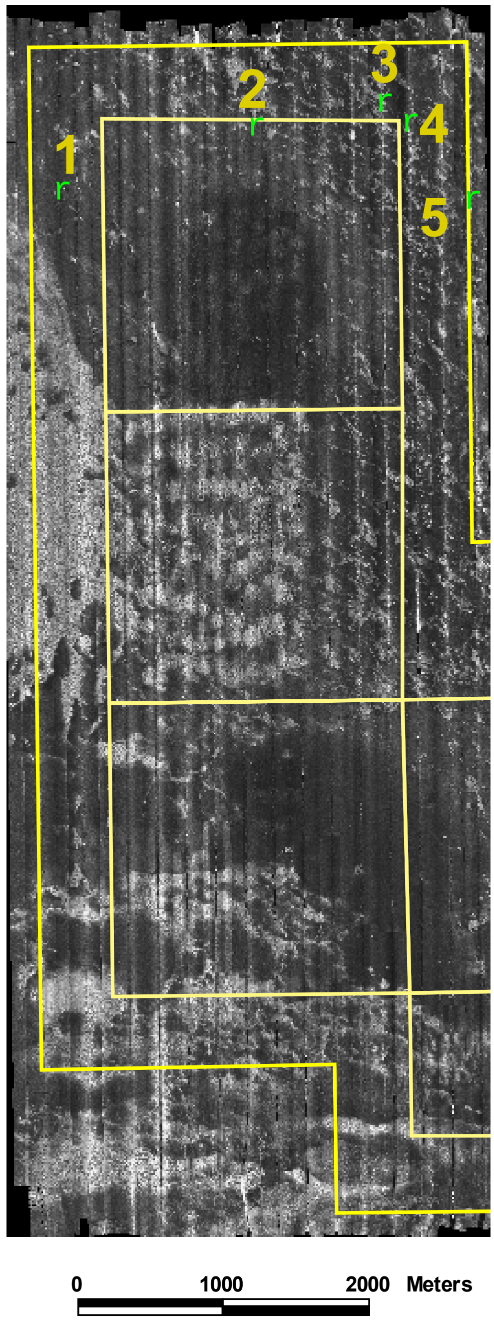


Figure 3-10. The location of five shipwrecks observed during the March 2000 side-scan sonar survey at the HARS. The boundaries of the individual PRAs and the HARS Buffer Zone have been plotted for reference.

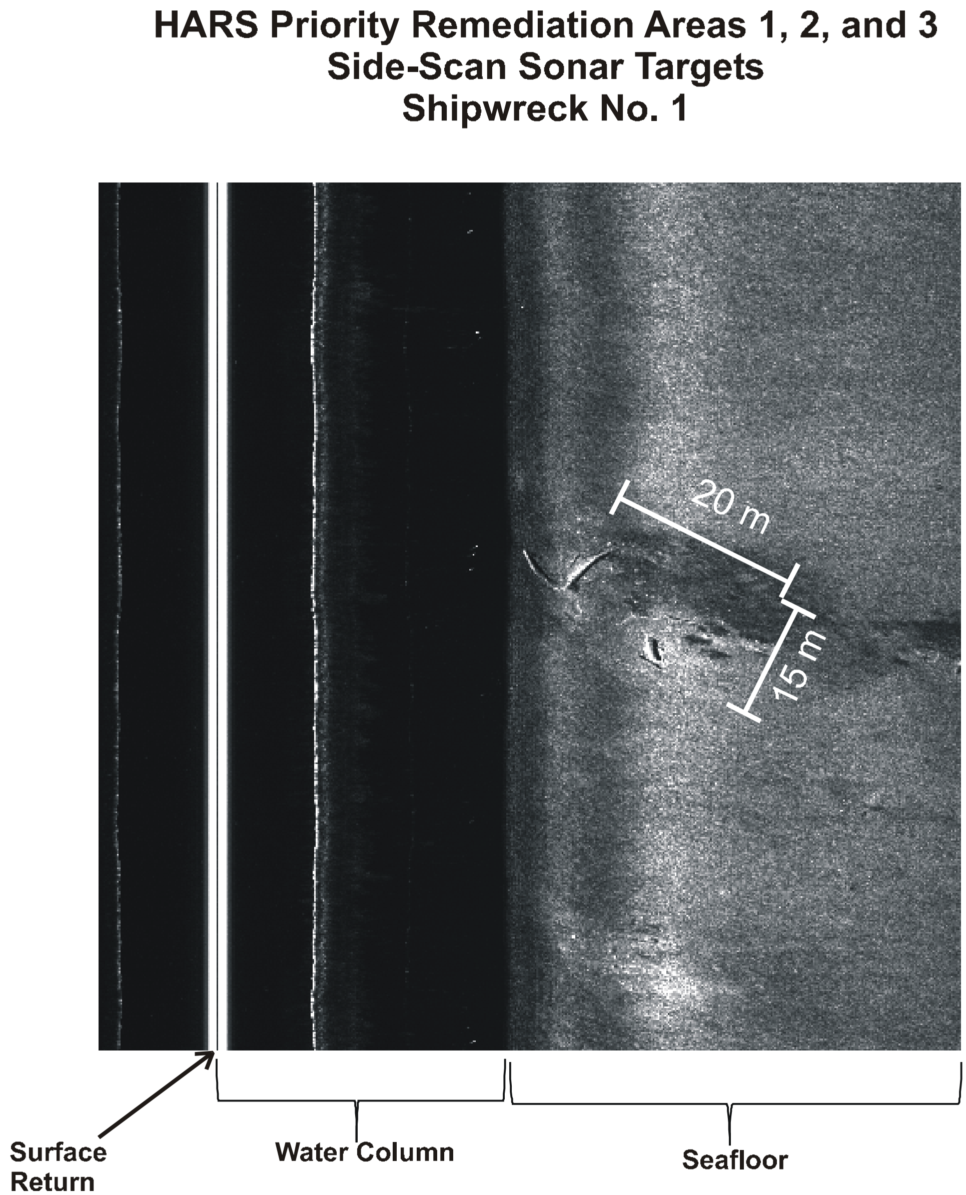


Figure 3-11. Side-scan sonar image of wreck No. 1. Located in the buffer zone west of PRA, this wreckage debris field covers a 15 × 20 m area of the seafloor.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Shipwreck No. 2

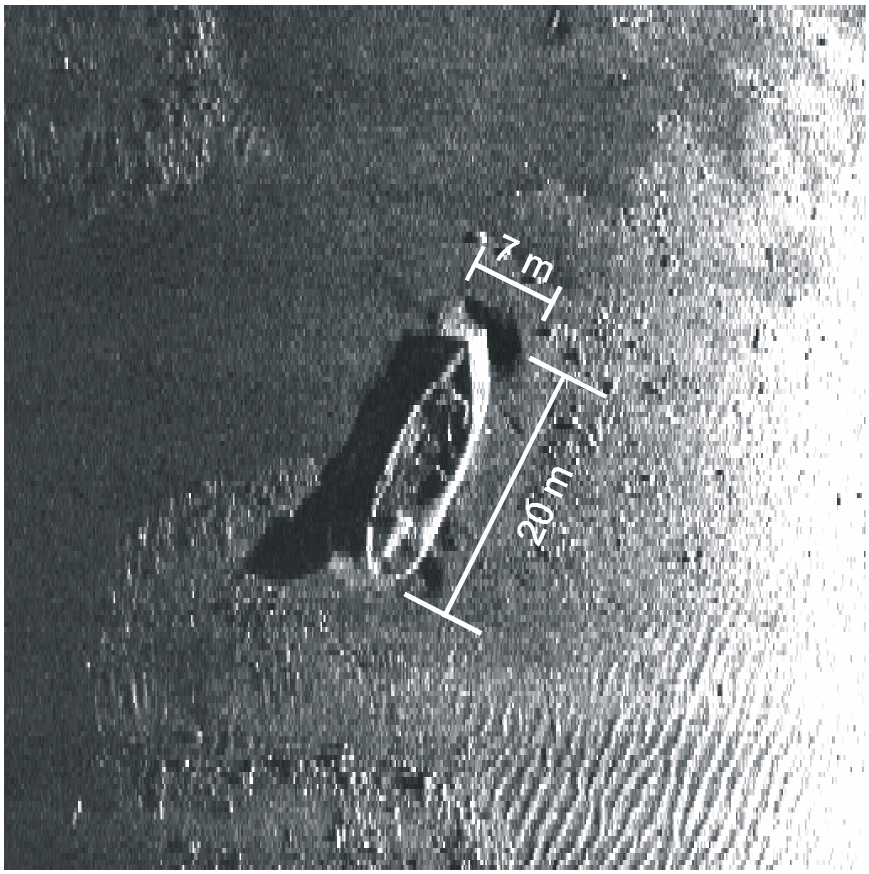


Figure 3-12. Side-scan sonar image of wreck No. 2. This intact wreck observed near the northern border of PRA 1 measures 20 m long and 7 m wide.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Shipwreck No. 3

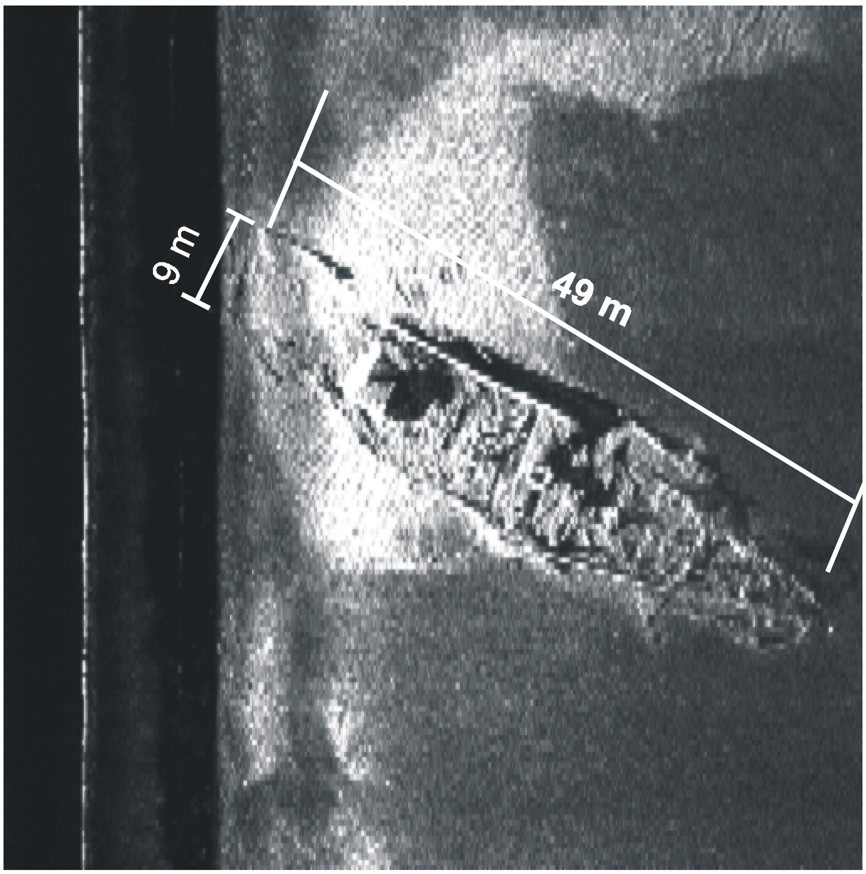


Figure 3-13. Side-scan sonar image of wreck No. 3. Located near the northeast corner of PRA 1, this clearly visible wreck measures 49 m long and 9 m wide. There is evidence of scouring and the migration of sand over the stern of this vessel.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Shipwreck No. 4

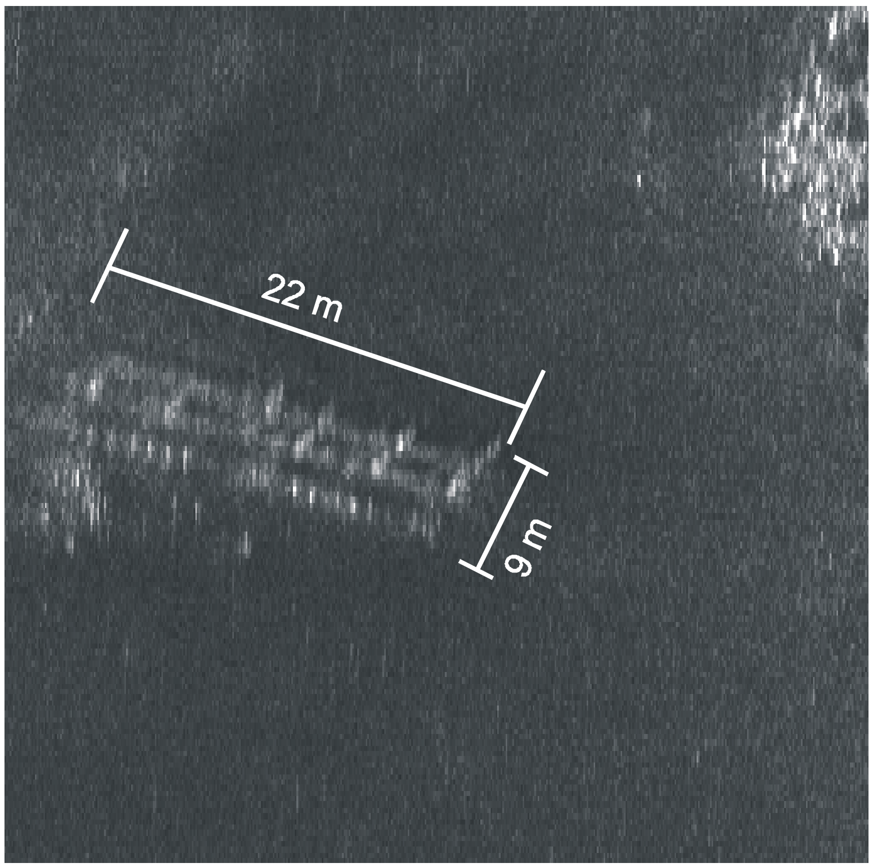


Figure 3-14. Side-scan sonar image of wreck No. 4. The remains of this pocket barge were located near the northeast corner of PRA 1. The wreck measures 22 m × 9 m and five pockets are clearly visible.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Shipwreck No. 5

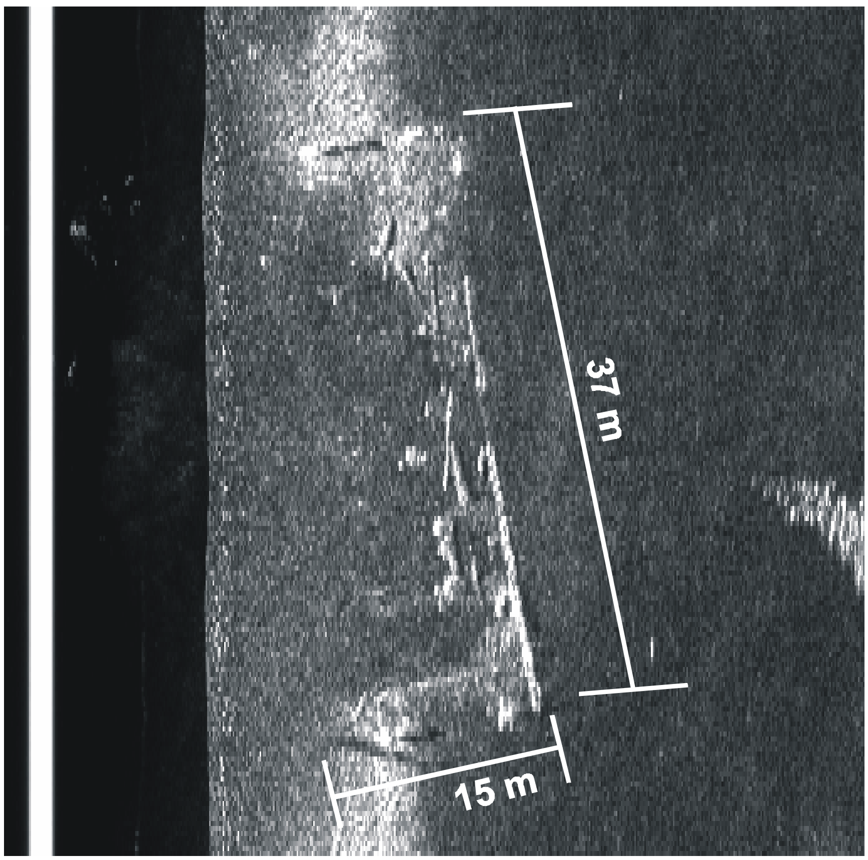


Figure 3-15. Side-scan sonar image of wreck No. 5. Located near the outer boundary of the buffer zone east of PRA 1, debris from this wreck covers an area of the seafloor measuring 37 m × 15 m.

visible debris surrounding this wreck. The black area on the left side of the wreck represents an acoustic shadow created by the hull sitting above the seafloor. The height of the wreck was calculated by measuring the length of the shadow, the horizontal distance from the towfish, and the height of the towfish above the seafloor. Based on these measurements, it was calculated that Wreck No. 2 is as high as 1.63 meters above the seafloor.

Wreck No. 3 was clearly depicted in the side-scan records. This was the largest wreck observed in the survey, measuring 49 m long by 9 m wide (Figure 3-13). The vessel sits almost flat on the seafloor in approximately 19 m (61 ft) of water. A small shadow cast to one side of the vessel indicates that it sits above the seafloor to some degree. There was evidence of scouring and the migration of sand over of the stern of this vessel.

Wreck No. 4 was located in 17.6 m (57 ft) of water and measured approximately 22 m by 9 m (Figure 3-14). The vessel appears to be the remains of a pocket barge. Five equally sized pockets running the length of barge are easily distinguished by the white outlines in the sonar image.

Wreck No. 5 was located near the outer boundary of the buffer zone; the side-scan sonar imagery suggests it was partially covered with surrounding sediment. It occurred in 50 ft of water and measured 37 m long by 15 m wide (Figure 3-15).

3.2.2 Individual Dredged Material Deposits

Individual dredged material deposits, each resulting from one or perhaps a few discrete placement events, were clearly visible in the side-scan images throughout the survey area. Representative side-scan images from PRAs 1, 2 and 3 (Figure 3-16) provide examples of the different dredged material deposit morphologies that were observed (Figures 3-17 through 3-21). In general, the shape and appearance of each deposit appears to be related to the type of dredged material that was placed. For example, the ADISS disposal logs indicate that most of the material placed in PRA 1 (see Area A in Figure 3-16) was fine-grained, predominantly silt and clay (i.e., mud). The resulting deposits on the seafloor generally had low relief and appeared dark in the side-scan records (Figures 3-17 and 3-18).

Most of the material placed in PRA 2 (see Area B in Figure 3-16) was composed of variable mixtures of clay, mud, and large rocks. The resulting deposits on the seafloor had relatively high relief and high relative reflectance in the side-scan records (Figures 3-19 and 3-20). This coarser material generally created seafloor deposits having more definition in the side-scan records, and there were also indications in some records of a slightly raised ring of sediment along the footprint of the deposit as a result of impact with the seafloor. For example, the deposit shown in Figure 3-20 is surrounded by a halo of light-colored sonar return generated by the pressure wave at the time of impact.

There was a relatively small area in PRA 3 (Area C in Figure 3-16) that received dredged material from the Refined Sugars, Inc. dredging project (see Figure 3-9). Additional dredged material deposits were observed in PRA 3 outside the Refined Sugars, Inc. disposal grid; these

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Dredged Material Placement Locations

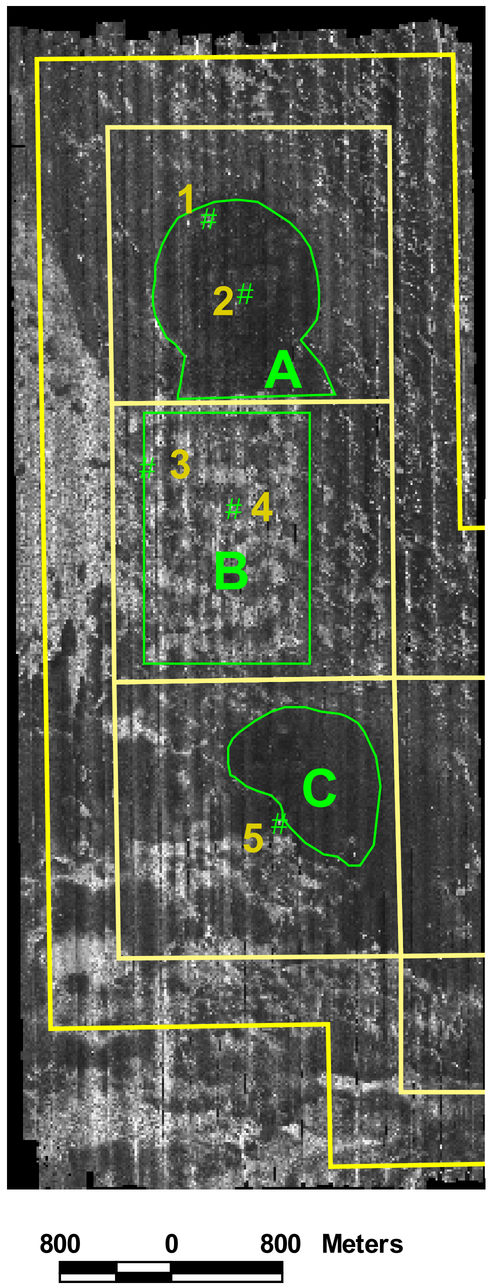


Figure 3-16. Dredged material placement has been concentrated in three areas of the HARS since its inception. The locations of five example dredged material deposits presented in the following series of figures have been plotted.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Dredged Material No. 1

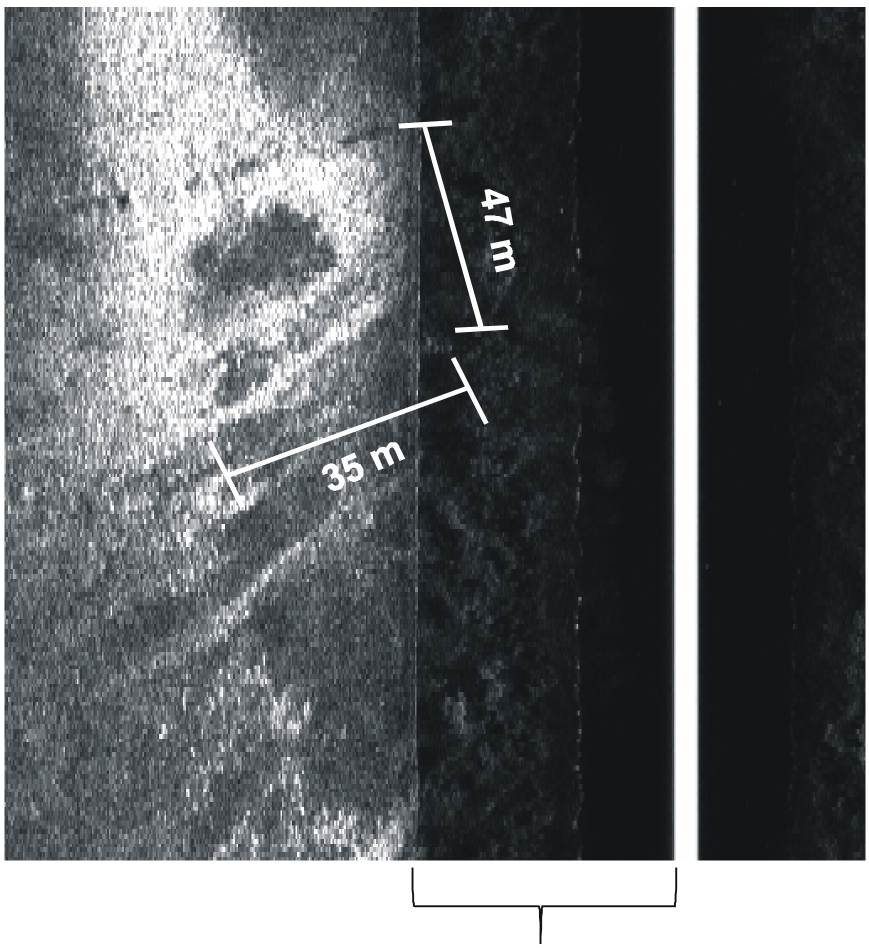


Figure 3-17. Side-scan sonar image of dredged material deposit No. 1. This low-relief disposal event of soft sediments observed in PRA 1 was placed during the ITO Passenger Ship Terminal Project. Overall, the visible spread of the disposal covers an area of the seafloor approximately 47 m × 35 m.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Dredged Material No. 2

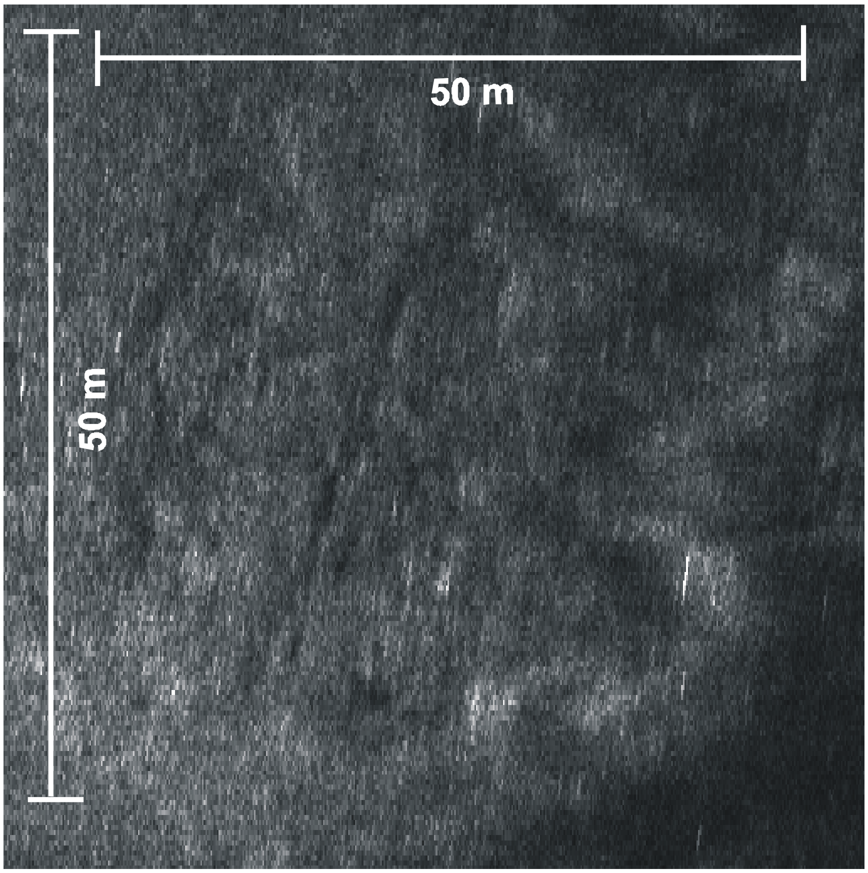


Figure 3-18. Side-scan sonar image of dredged material deposit No. 2. Another example of a low-relief, soft-sediment deposit from the ITO Passenger Ship Terminal dredging project.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Dredged Material No. 3

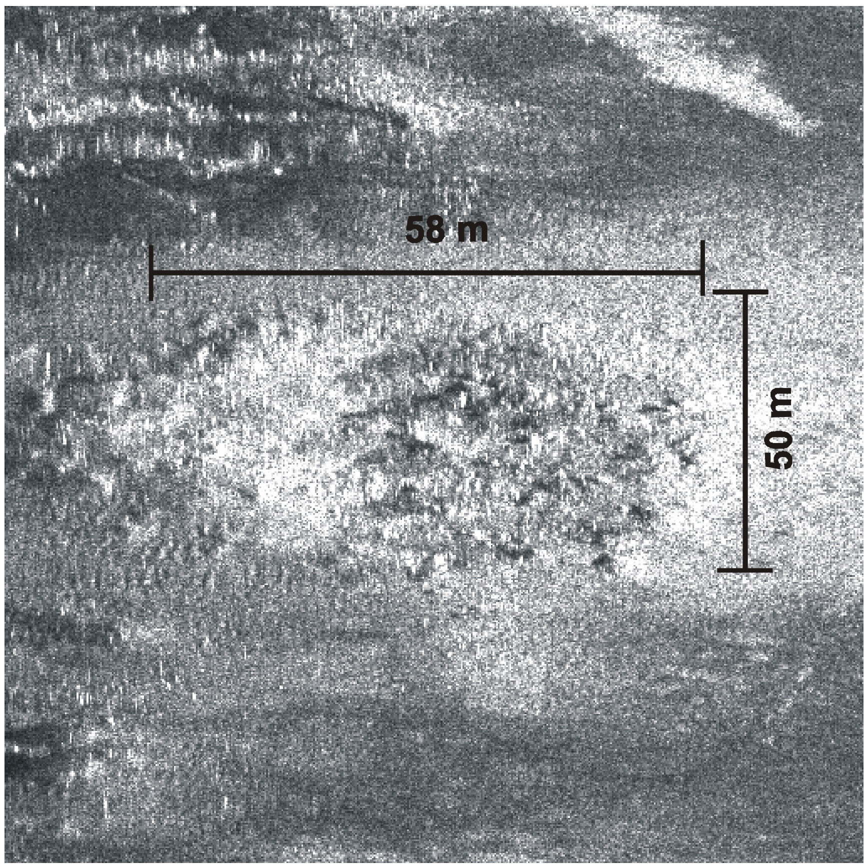


Figure 3-19. Side-scan sonar image of dredged material deposit No. 3. Example dredged material placement event observed in PRA 2 and related to the KVK dredging program. This event covered a 50 m × 58 m area of the seafloor and is composed of high-relief, rocky debris.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Dredged Material No. 4

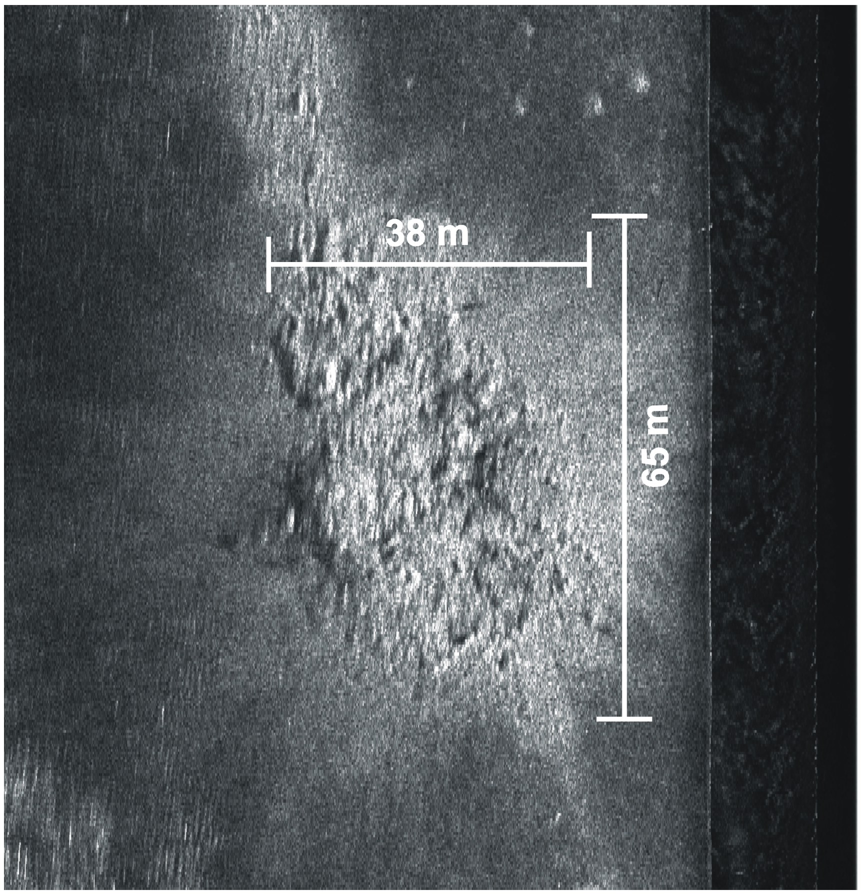


Figure 3-20. Side-scan sonar image of dredged material deposit No. 4. Also from the KVK project and located in PRA 2, this is an example of a rocky dredged material deposit placed on fine-grained ambient sediments.

are presumably related to past or historic disposal that had taken place in what is now the HARS (Figure 3-21). Other than within Area C in Figure 3-16, there did not appear to be any evidence of recent disposal activities in PRA 3.

Overall, dredged material deposits within the survey area were found in a singular, clustered, or linear pattern. The linear pattern is characteristic of split hull barges: as the barge releases material while underway, it leaves a "trail" on the seafloor. The highest concentration of dredged material deposits was in PRAs 1 and 2, reflecting the more intensive use of these areas since the opening of the HARS in September 1997. Close management of the disposal operations through the use of well-defined target grids and ADISS has resulted in an organized pattern of deposits on the seafloor, particularly within PRA 2. The seafloor pattern closely mimics the shape of the disposal grids that were created to regulate the disposal activities during the past few years.

3.2.3 Sand Waves

Sand waves were observed sporadically throughout the survey area, and two major sand wave fields were identified (Figure 3-5). Sand waves and ripples are characterized by a distinct white and black striping in the side-scan images (Figures 3-22 through 3-24). Both major areas of sand waves produced a distinctive acoustic pattern where the crests of the waves can be followed across the overlapping survey lanes. The majority of the sand waves in the two major areas ranged from 1-4 m in length. The northeast-southwest orientation of the sand ripples is consistent with the predominant northwest-southeast tidal flow in the New York Bight.

3.2.4 Trawl Scar Marks

Trawl scar marks were observed in the northern portion of the survey area, within the broad and relatively flat elongated basin in the HARS buffer zone outside PRA 1 (Figure 3-25). In general, the trawl scar features lacked much detail (Figures 3-26 and 3-27). These linear “scar” features are formed by the digging and scouring action of trawler net doors being towed along the seafloor behind a fishing vessel. It is difficult to determine the age of the observed features.

3.2.5 Lobster Traps

Lobster trap lines present in the northern half of the survey area (Figure 3-28) were observed in the sonar records (Figures 3-29 and 3-30). The lobster trap buoys could be seen on the surface of the water as the survey vessel passed by them. As the towfish passed by the traps, they appeared as small hard returns on the side-scan records. The lobster trap lines each contained multiple traps spaced fairly equally apart (Figures 3-29 and 3-30).

3.3 Sediment-Profile Imaging Survey Results

A total of 565 sediment-profile images were obtained at the 164 project area stations. At 156 of these stations (95%), 2 replicate images were analyzed for the purpose of preparing the summary table and graphics presented in this report. At 8 of the stations, up to 4 replicate images needed to be analyzed because the camera penetration was sub-optimal in some of the replicates.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Dredged Material No. 5

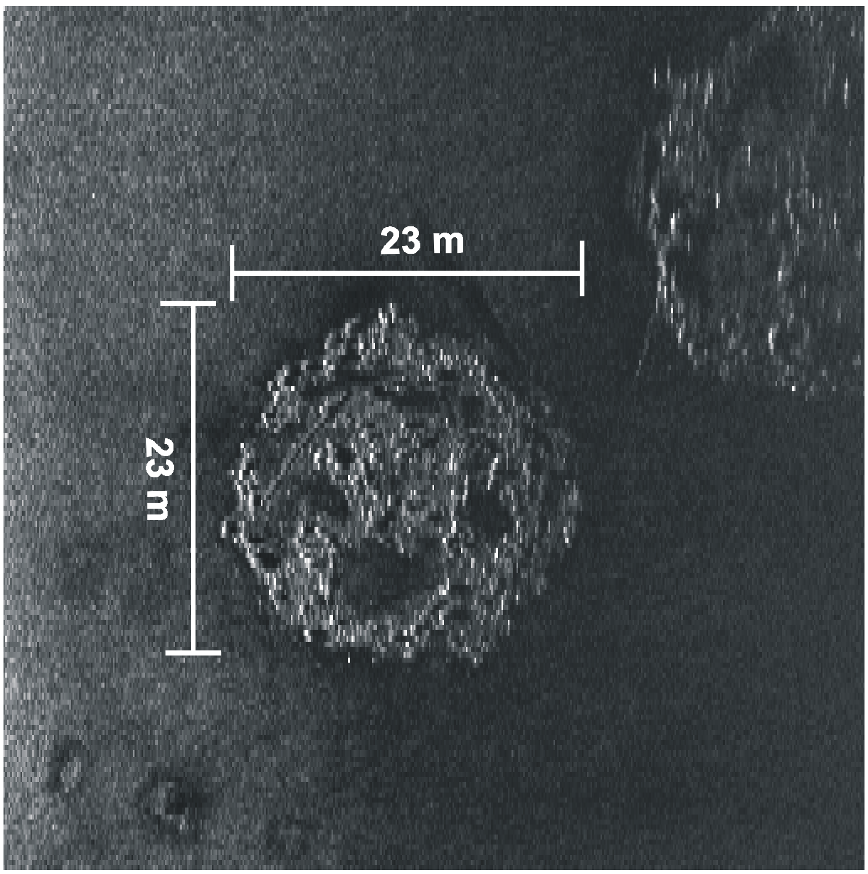


Figure 3-21. Side-scan sonar image of dredged material deposit No. 5, an example of a relic dredged material placement event observed in PRA 3.

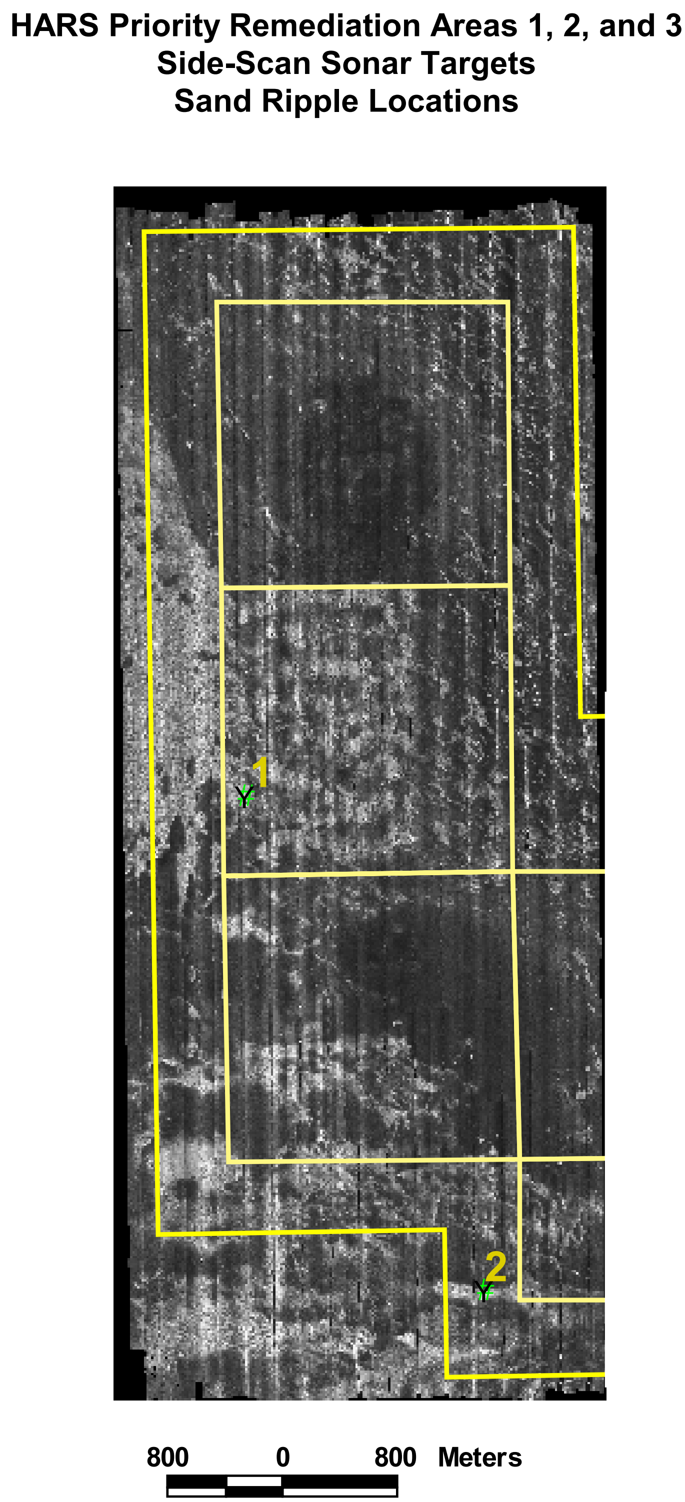


Figure 3-22. Large areas of the seafloor in the HARS were covered with hard sandy sediments. Examples of sand ripples produced by the local current regime are presented in the following two figures.

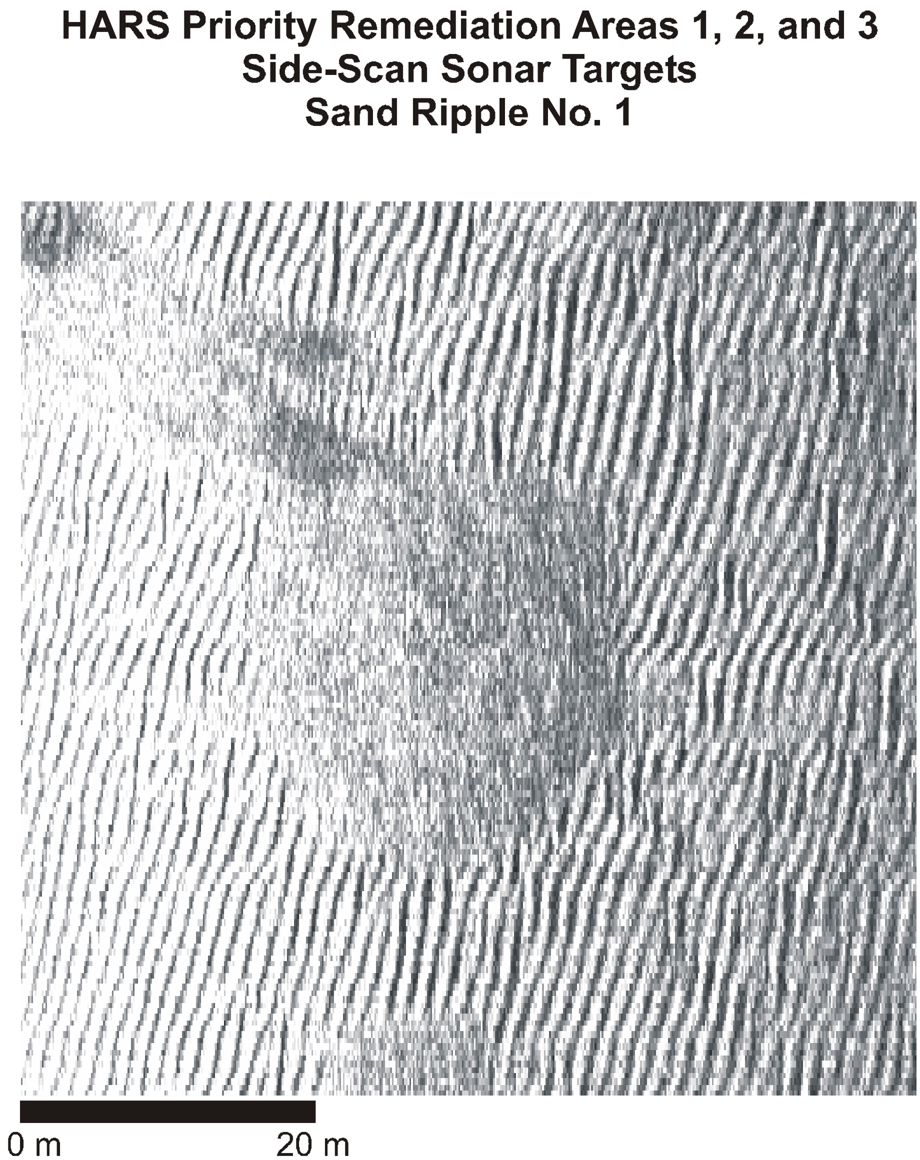


Figure 3-23. Side-scan sonar image of sand ripple area No. 1. Sand ripples located in PRA 2.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Sand Ripple No. 2

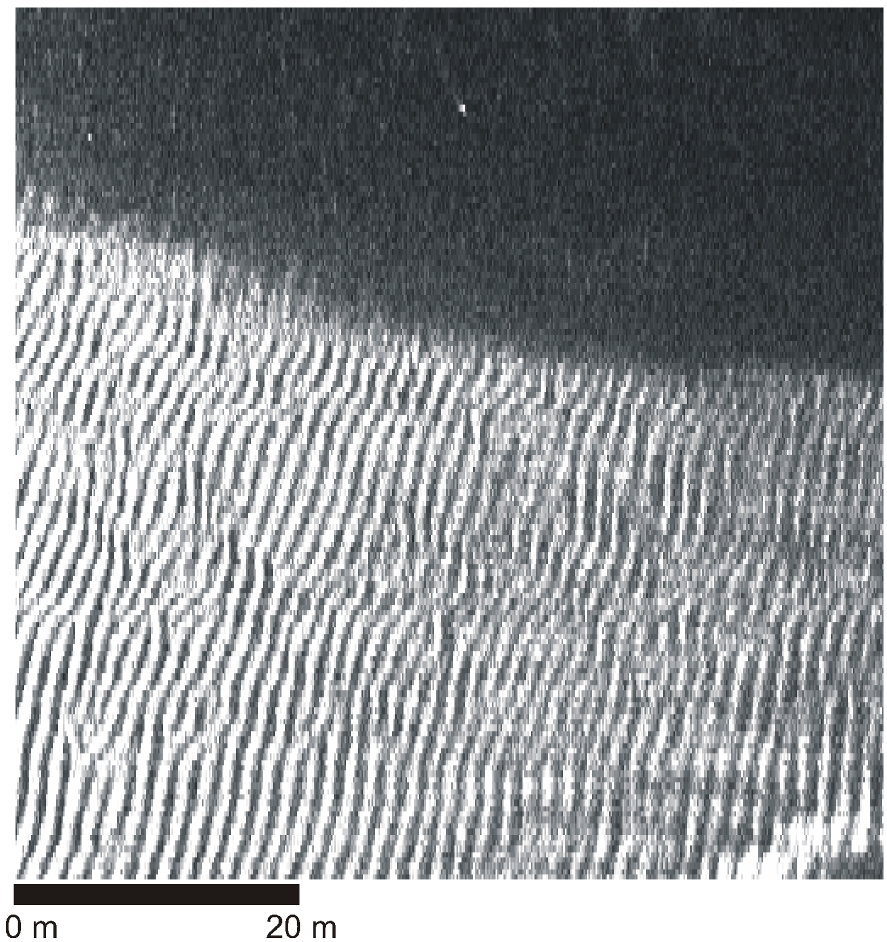


Figure 3-24. Side-scan sonar image of sand ripple area No. 2. Sand ripples located in PRA 3 in the region of the large waveforms of the Shrewsbury Rocks geological feature.

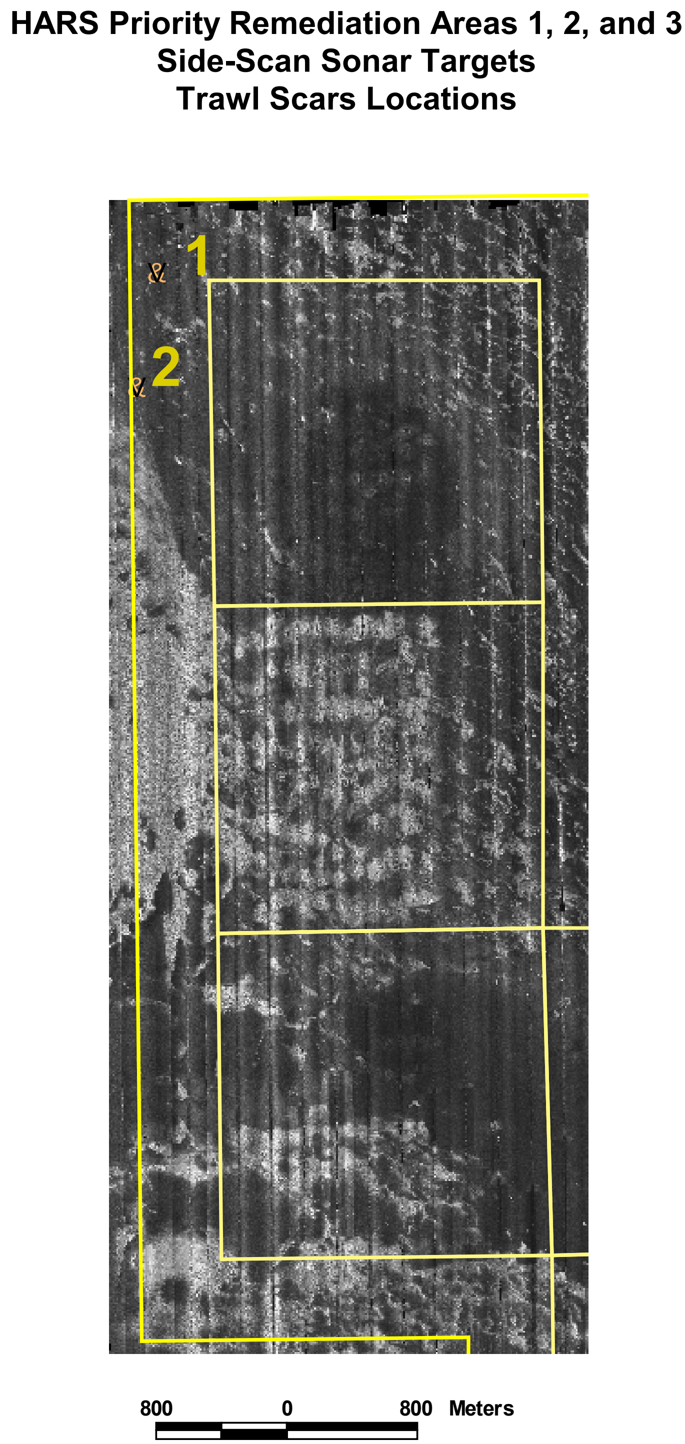


Figure 3-25. Evidence of commercial fishing activity in the vicinity of the HARS was observed in the form of trawl scars on the seafloor. Numbers 1 and 2 indicate the locations of example images shown in Figures 3-26 and 3-27.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Trawl Scars No. 1

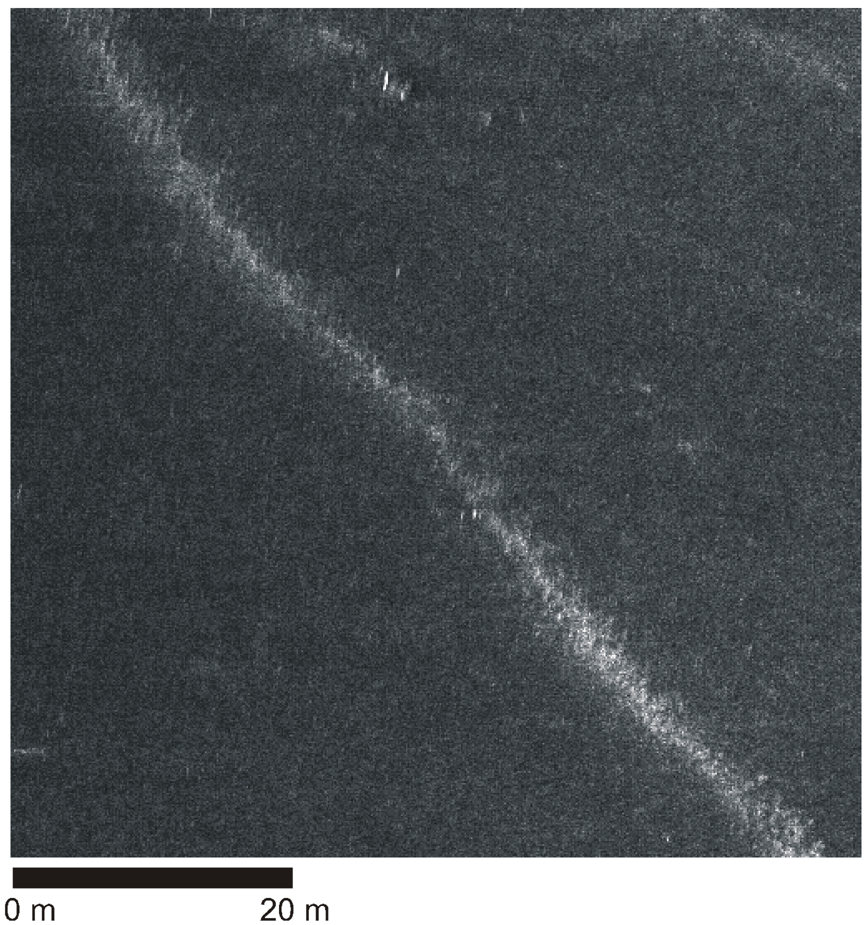


Figure 3-26. Side-scan sonar image of trawl scar No. 1. Example of a trawl scar in the buffer zone.

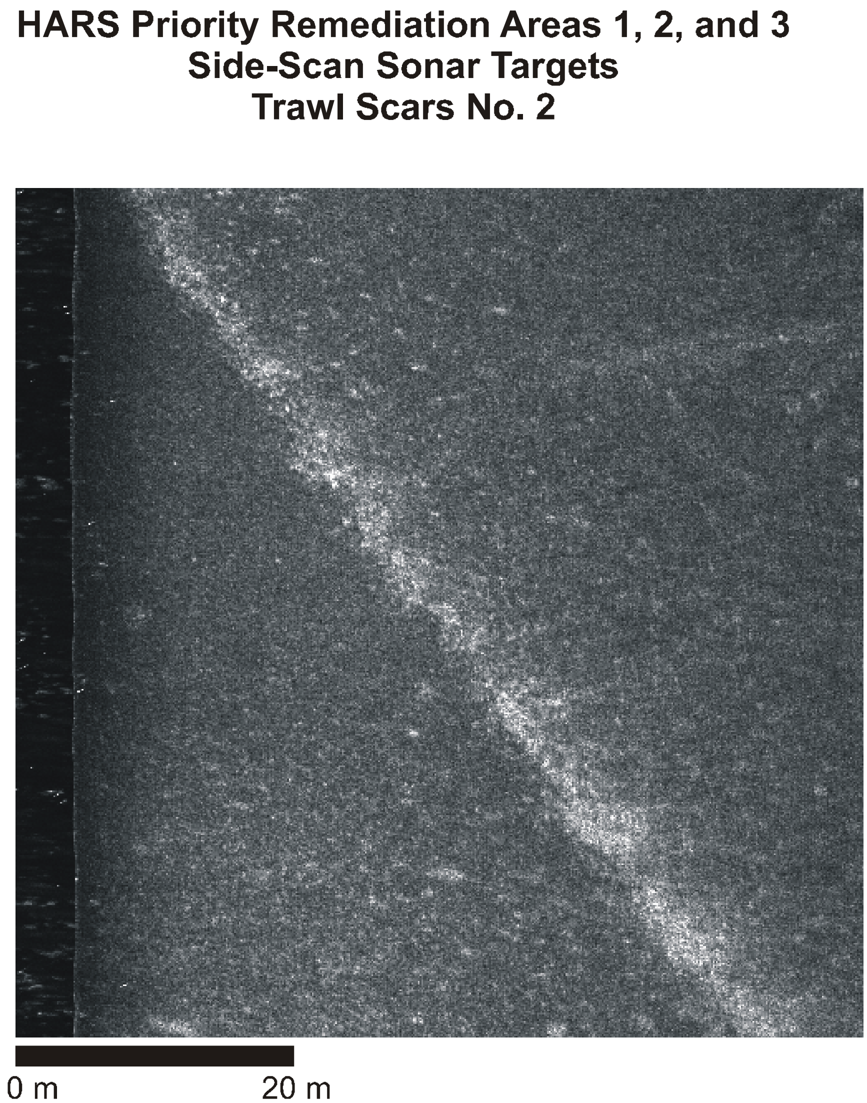


Figure 3-27. Side-scan sonar image of trawl scar No. 2. Example of a trawl scar in the buffer zone.

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Lobster Pot Locations

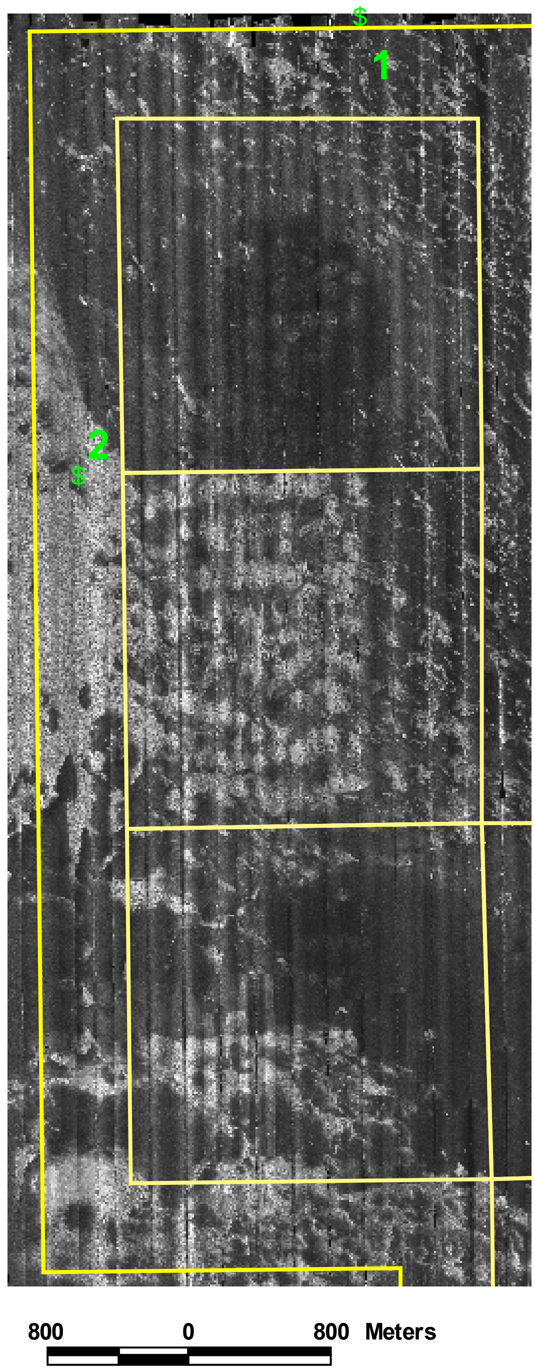


Figure 3-28. Lobster fishing gear was observed on the seafloor in the vicinity of the HARS. Individual locations are indicated by numbers 1 and 2 and illustrated in Figures 3-29 and 3-30.

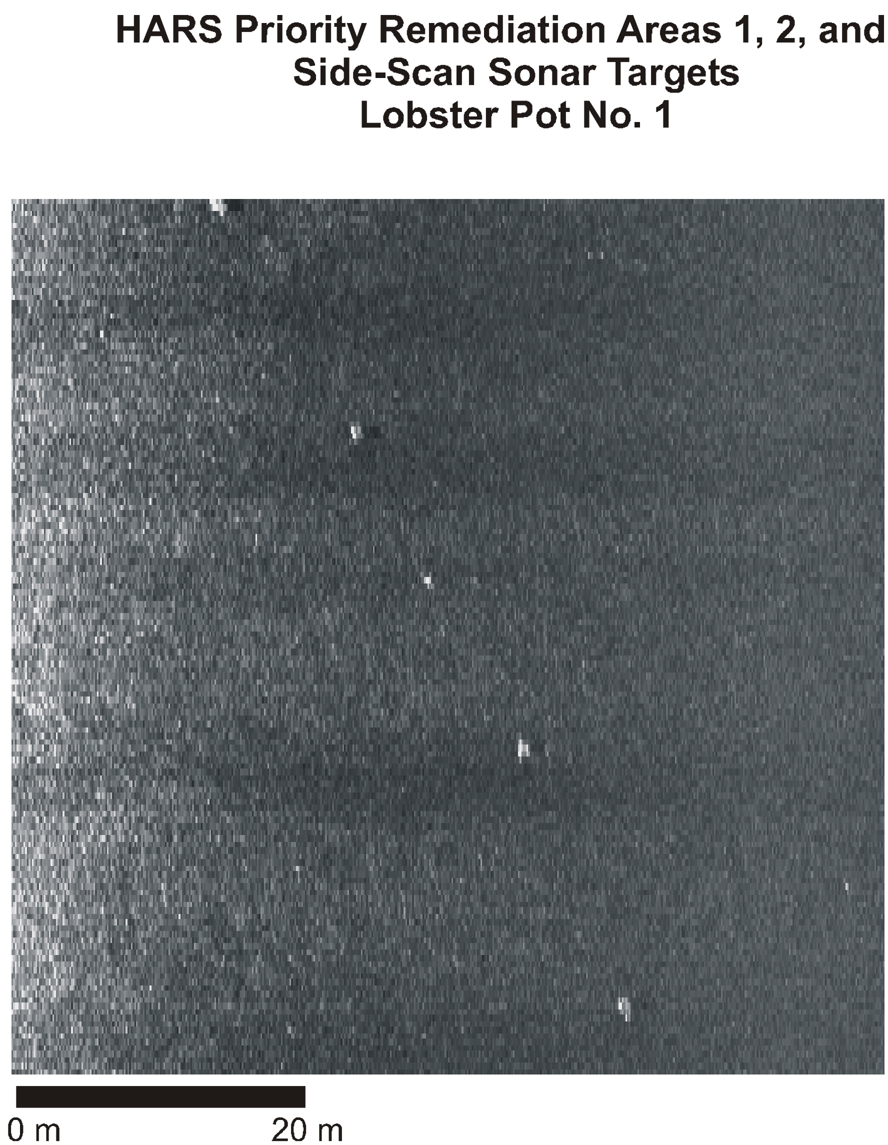


Figure 3-29. Side-scan sonar image of a line of lobster traps (No. 1 location in Figure 3-28).

HARS Priority Remediation Areas 1, 2, and 3
Side-Scan Sonar Targets
Lobster Pot No. 2

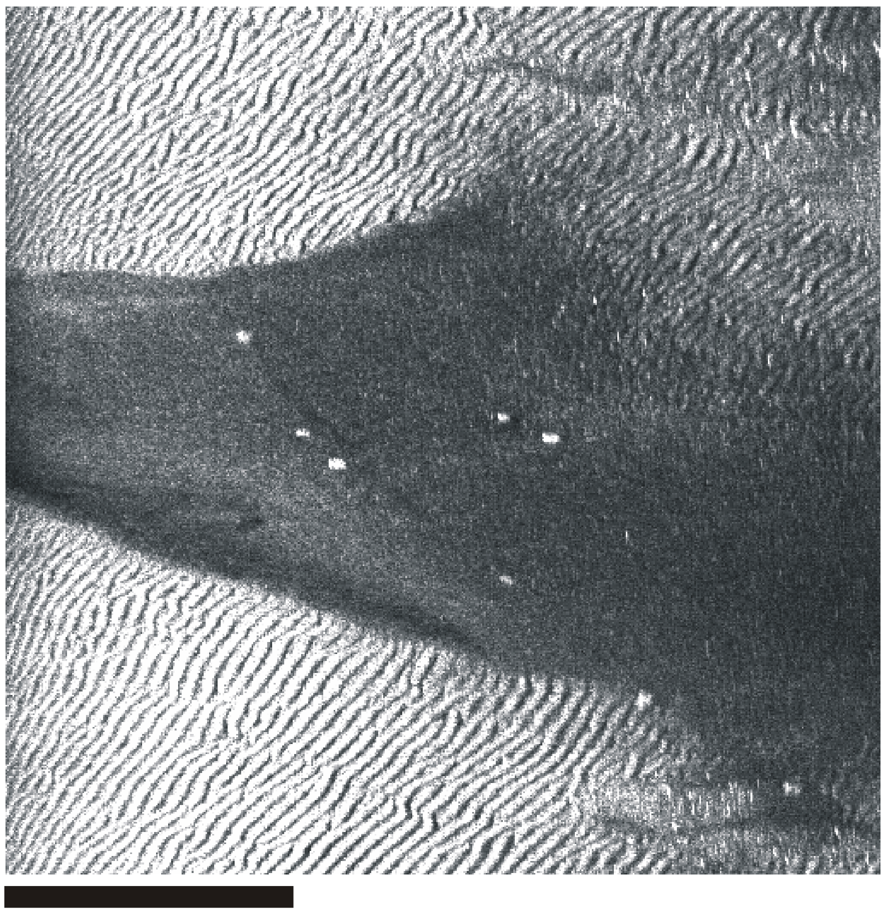


Figure 3-30. Side-scan sonar image of several lobster traps (No. 2 location in Figure 3-28).

Overall, 332 images were analyzed for this report. A summary table of the REMOTS® image analysis measurement results is presented in Appendix A.

3.3.1 Horizontal Distribution of Sediment Grain Size

Analysis of the REMOTS® images indicated a variety of sediment types were present within the surveyed area at HARS. However, while the particle size of surface sediments in the area ranged from gravel (<-1 phi) to silt-clay (>4 phi), very fine sand (4 to 3 phi) and silt-clay (>4 phi) were the two dominant grain size major modes (Figure 3-31).

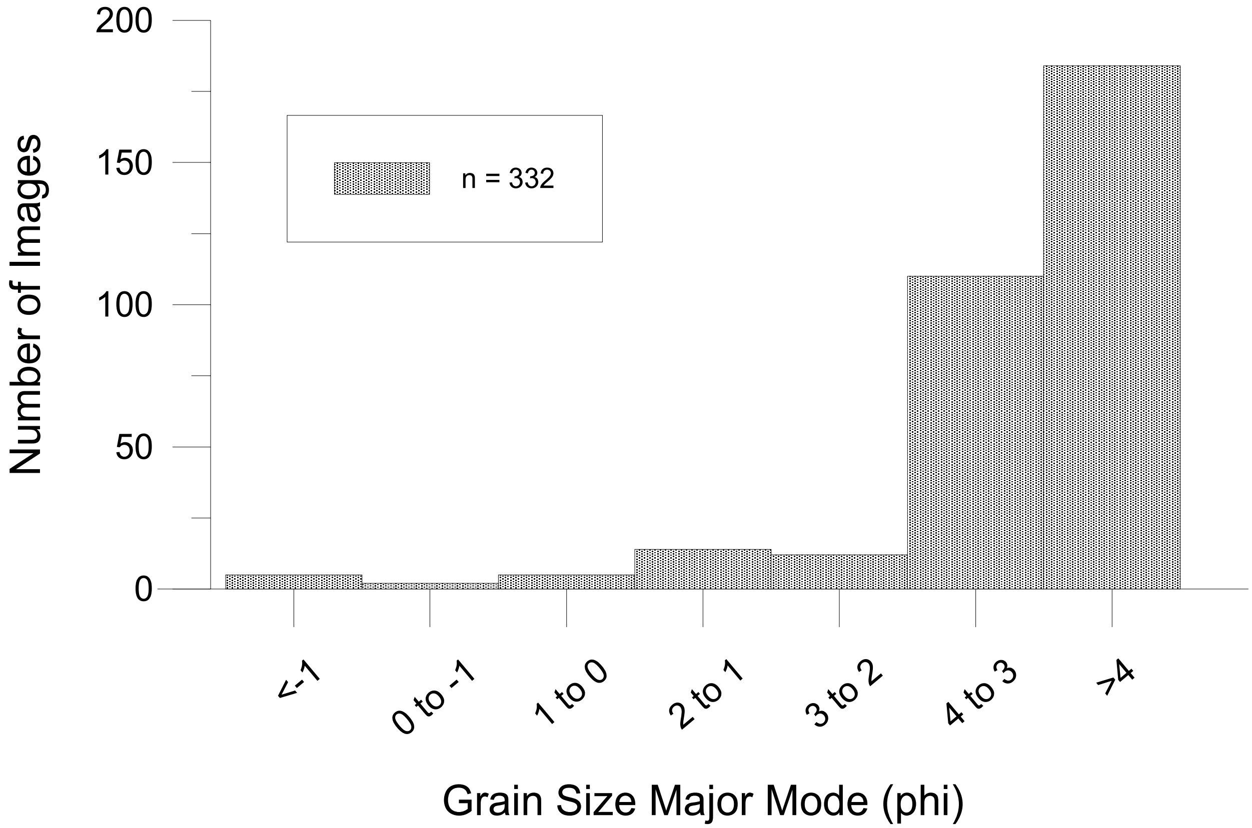
The silt-clay (>4 phi) was found primarily below the 22 m depth contour, within the elongated basin which is the dominant topographic feature of PRAs 1 and 2 (Figure 3-32). Most of this fine-grained material is the result of past dredged material placement in and around the former Mud Dump Site; the "relic" dredged material has settled within the basin and persists there. Placement of fine-grained remediation material within PRAs 1 and 2 on a regular basis since April 1998 has also contributed to the observed dominance of silt-clay on the seafloor in the surveyed area.

Sands were found on the sloping bottom representing the sides of the basin and within the HARS buffer zone (Figure 3-32). On the sloping bottom comprising the eastern and northern sides of the basin, very fine sand (4 to 3 phi) and fine sand (3 to 2 phi) were dominant (Figure 3-32). On the western side of the basin, within the buffer zone outside of PRAs 1 and 2, both medium (2 to 1 phi) and coarse (1 to 0 phi) sands were observed. Most of the sands were rippled, suggesting a slightly higher energy level associated with these shallower areas (Figure 3-33).

Scattered throughout the surveyed area were a few stations having rocks of various sizes (e.g., boulders, cobbles, pebbles having a major mode of <-1 phi). The stations in the sampling grid which had both rocks and sand present in the replicate REMOTS® images were mapped with a "variable" grain size in Figure 3-32.

3.3.2 Dredged Material Distribution

Dredged material is recognized in REMOTS® images by the presence of low optical reflectance (i.e., dark-colored) silt-clay sediments with chaotic fabrics or layered stratigraphy. An objective of this survey was to delineate the footprint of newly deposited remediation material within PRAs 1 and 2. Two distinguishable types of dredged material were observed in the REMOTS® images obtained in this survey. The first and more prevalent was relic (i.e., historic) dredged material (Figure 3-34). This material was fine-grained and distinguished primarily by its very dark color (e.g., dark gray or black) below a shallow redox layer (Figure 3-35, image A). Furthermore, the relic dredged material typically had numerous small shells or shell fragments present at the surface (Figure 3-35, images A and B). The relic dredged material appeared the same in this survey as it did in the August 1998 survey of PRAs 1, 2, and 3, prior to placement of any significant volumes of remediation material (SAIC 1998a). At most stations, the relic dredged material was observed in the profile image extending from the sediment surface to below the penetration depth of the REMOTS® camera prism (i.e., the thickness of the dredged



Phi Size	Description	Grain Size in mm
<-1	Gravel	>2.00
0 to -1	Very Coarse Sand	1.00 – 2.00
1 to 0	Coarse Sand	0.50 – 1.00
2 to 1	Medium Sand	0.250 – 0.50
3 to 2	Fine Sand	0.125 – 0.250
4 to 3	Very Fine Sand	0.0625 – 0.125
>4	Silt-Clay	<0.0625

Figure 3-31. Frequency distribution of grain size major mode for all of the replicate REMOTS® images that were analyzed.

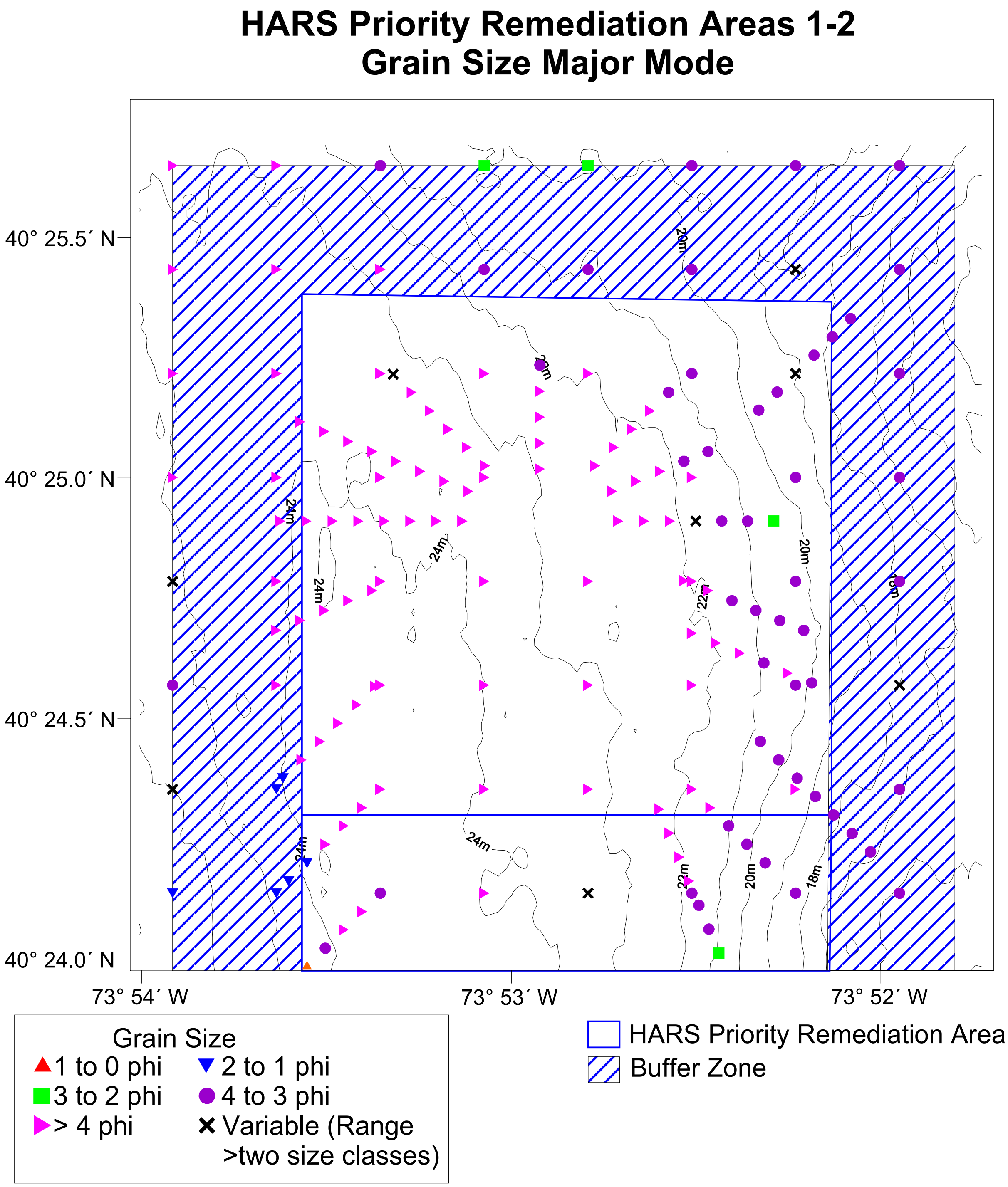


Figure 3-32. Map of grain size major mode at each station in the HARS survey area based on REMOTS® analysis.

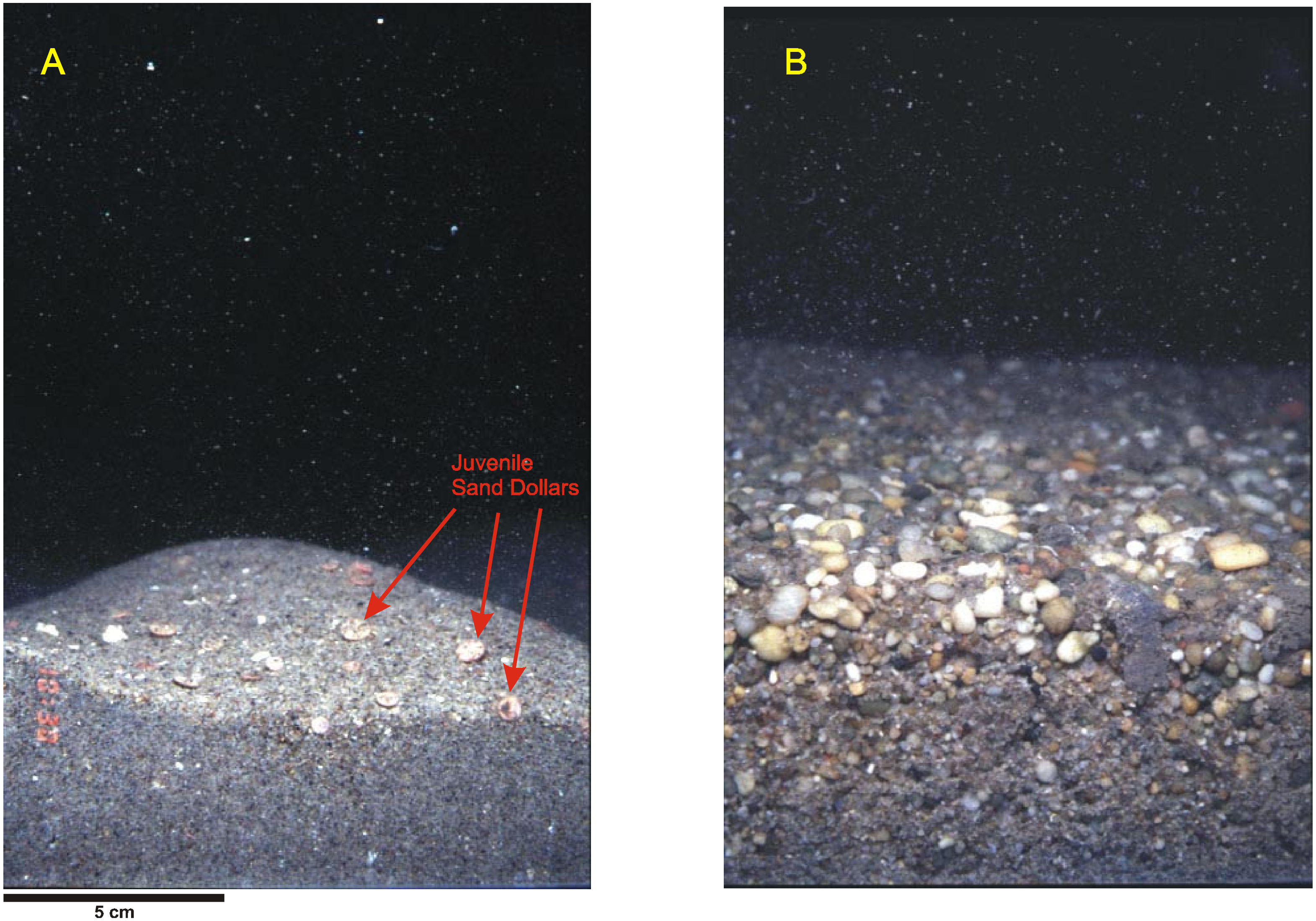


Figure 3-33. Two REMOTS® images showing sandy sediments in the surveyed area. Image A from Station C-2800 shows the rippled, very fine sand (4 to 3 phi) which characterized the sloping bottom to the east of the elongated basin. Image B from Station H-0 shows coarse sand (1 to 0 phi) observed in the HARS buffer zone along the west side of PRA 1 and 2.

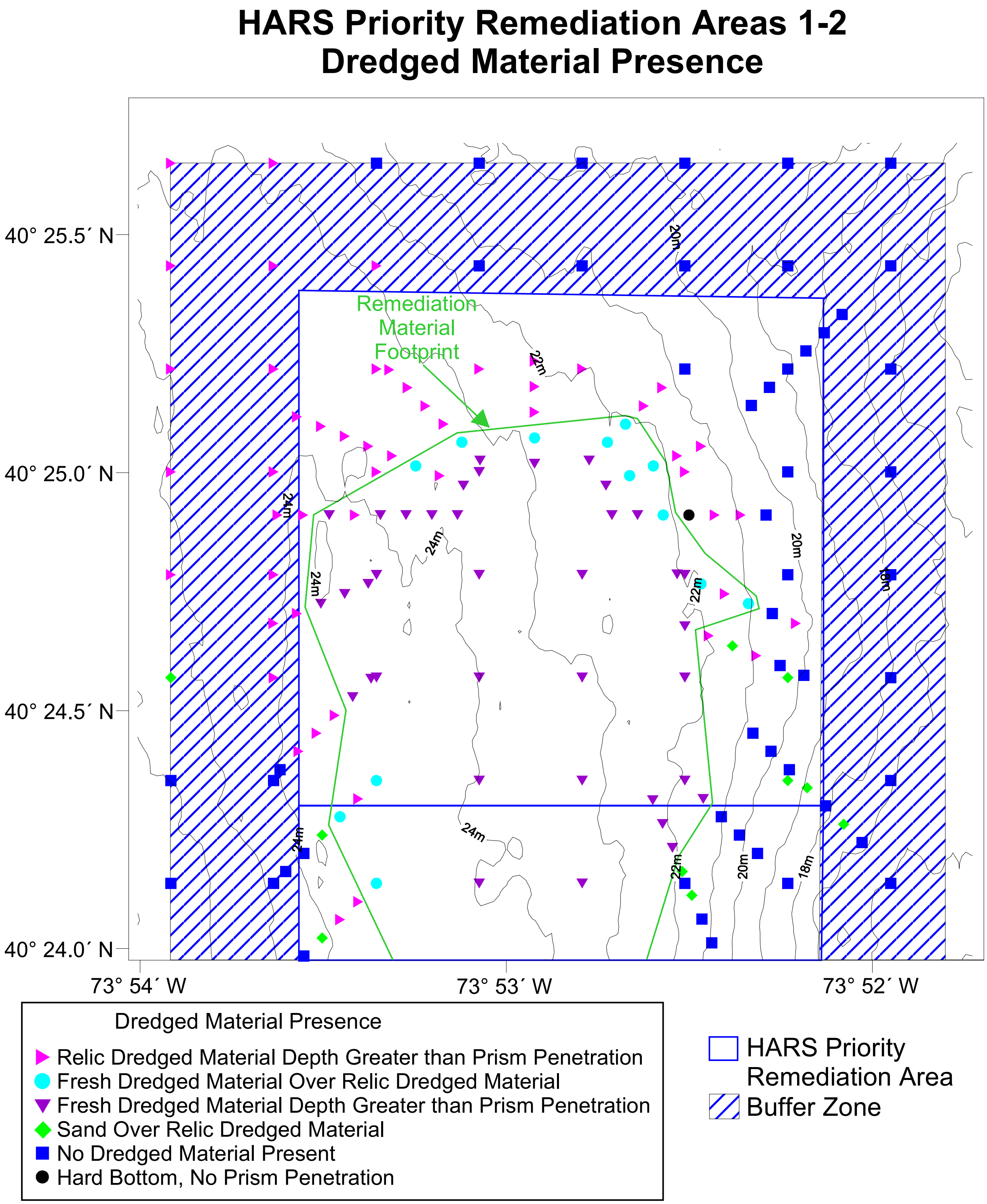


Figure 3-34. Map showing the presence of relic and fresh dredged material in the surveyed area

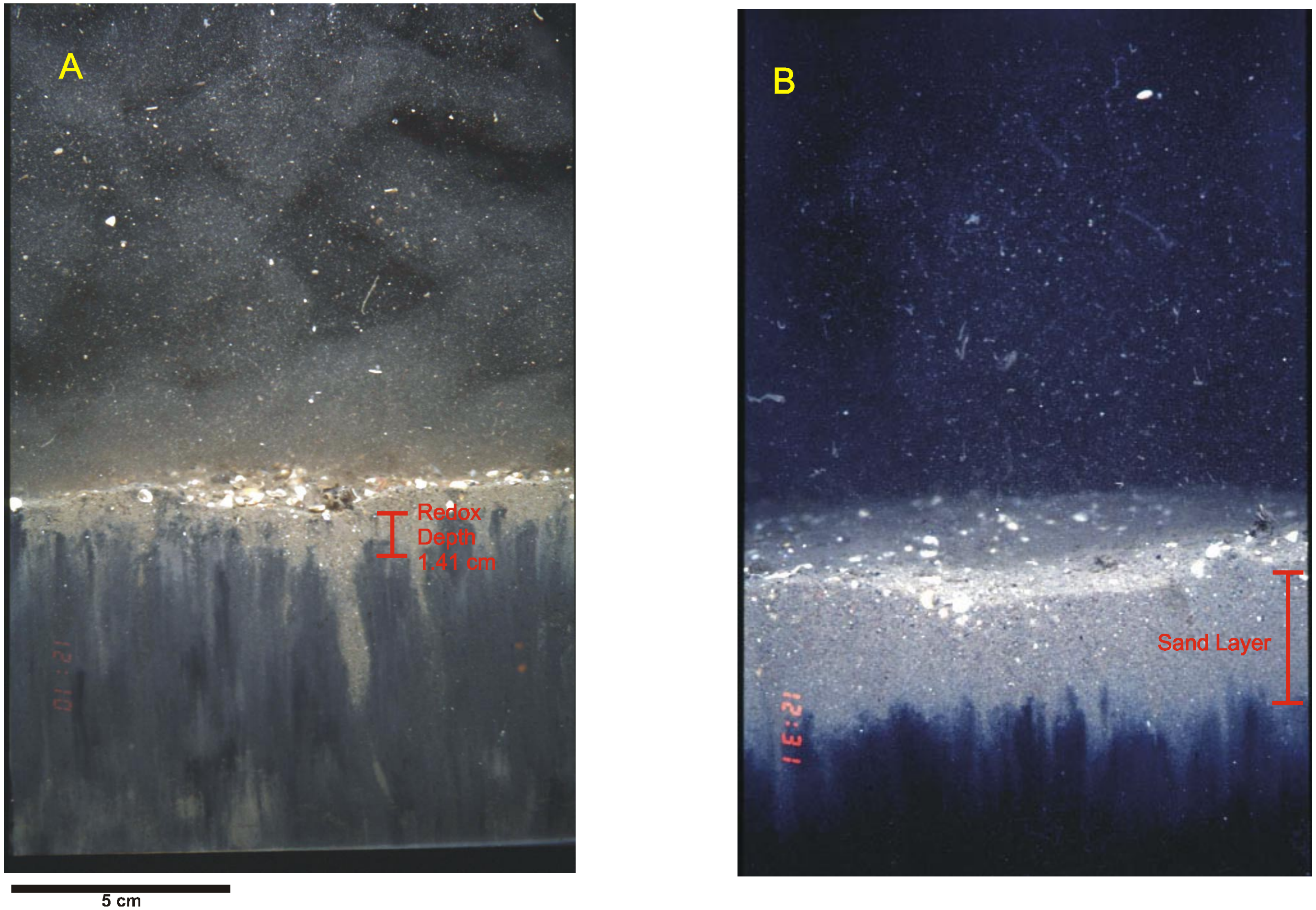


Figure 3-35. Two representative REMOTS® images illustrating the relic dredged material observed at a large number of stations outside the remediation material footprint. In image A from Station C-400, the black, relic dredged material has a shallow redox layer and extends from the sediment surface to below the camera's imaging depth. Image B from Station 2ESE-200, shows a layer of sand over black relic dredged material. Note the presence of numerous small white shells and shell fragments at the sediment surface in both images.

material layer exceeded the prism penetration depth). At a few stations, the black relic dredged material was covered by a surface layer of sand (Figure 3-35, image B).

The second type of dredged material was characterized by a light grey color and soft texture that helped make it clearly distinguishable from the black relic dredged material (Figure 3-36). The penetration of the REMOTS® camera prism in the fresh dredged material typically was greater than in the relic material, providing another diagnostic feature (e.g., comparison of Figures 3-35 and 3-36). The "fresh" dredged material was observed in the center of PRA 1 and within the northern portion of PRA 2 and represents remediation material placed in this area since April 1998 as a result of several dredging projects. The footprint of the remediation material is defined in Figure 3-34.

At stations near the center of PRAs 1 and 2, the fresh remediation dredged material extended from the sediment surface to below the camera's imaging depth. The deposit of remediation material presumably has its greatest thickness near the center of the cells. At a number of stations near the edge of the footprint defined in Figure 3-34 (i.e., the mound "apron" region), the fresh dredged material was visible as a thin, discrete layer in the sediment profile images. A series of images obtained along the NE (northeast) transect helps to illustrate the typical transition in dredged material layer thickness moving progressively from the mound center, into the apron region, and onto the ambient or pre-existing bottom (Figure 3-37). On the main mound, a relatively thick layer of newly placed material was observed (Figure 3-37, image A). Discrete layers of fresh material were observed over relic dredged material on the mound apron (Figure 3-37, images B and C), while relic dredged material representing the pre-existing or ambient bottom (Figure 3-37, image D) was observed outside the remediation material footprint.

3.3.3 Small-Scale Surface Boundary Roughness

Measurements of small-scale boundary roughness are limited by the window size of the REMOTS® camera (15 × 20 cm). When small-scale surface features predominate (e.g., sand ripples with amplitudes less than the width of the camera window), the camera can provide an accurate measure of boundary roughness. However, the camera cannot provide an accurate measurement of boundary roughness when large-scale features predominate (e.g., sand ripples with amplitudes exceeding the width of the REMOTS® camera window). Therefore, it is important to note that the REMOTS® measurements are of small-scale boundary roughness only.

Figure 3-38 shows the spatial distribution of small-scale boundary roughness in the project area; the mapped values are averages for the replicate images obtained at each station. Approximately 80% of the boundary roughness values were less than 2 cm, with the majority of values falling in the range 0.5-1.0 cm (Figure 3-39). Five of the nine stations having higher small-scale boundary roughness (between 3 and 7 cm) were located in shallower water on the eastern sloped side of the elongated basin. These stations all had rippled fine sand and may experience higher energy conditions due to the shallower water. The other four stations having relatively high boundary roughness were located on the western side of the station grid and were characterized by coarser sand.

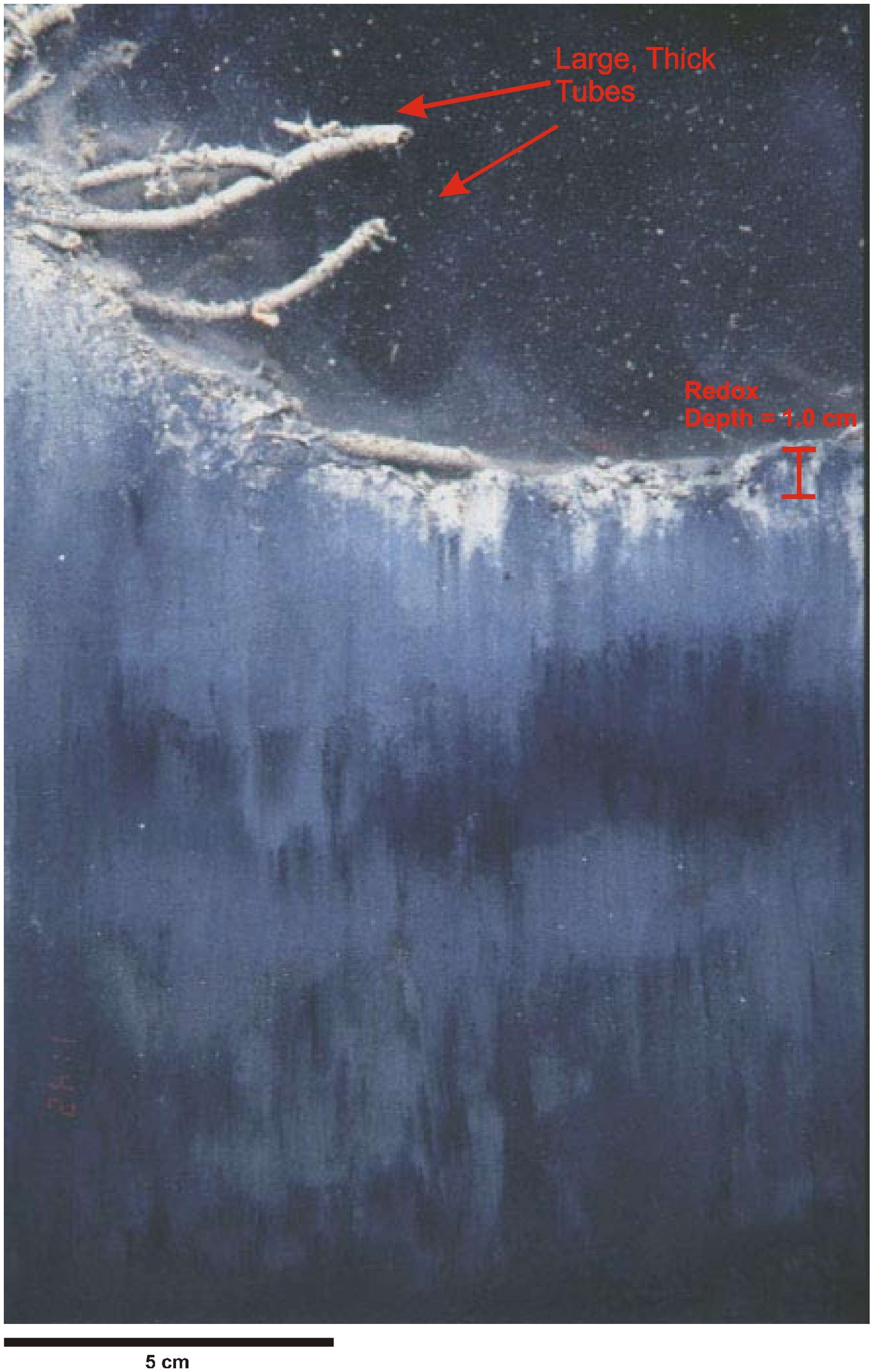


Figure 3-36. REMOTS® image showing the “fresh” dredged material found in PRA 1. This image from station F-1200 shows the lighter grey material extending from the sediment surface to below the camera’s imaging depth. Note the deeper camera penetration in this material compared to the relic dredged material shown in Figure 3-24. Several large, thick polychaete tubes are visible at the sediment surface.

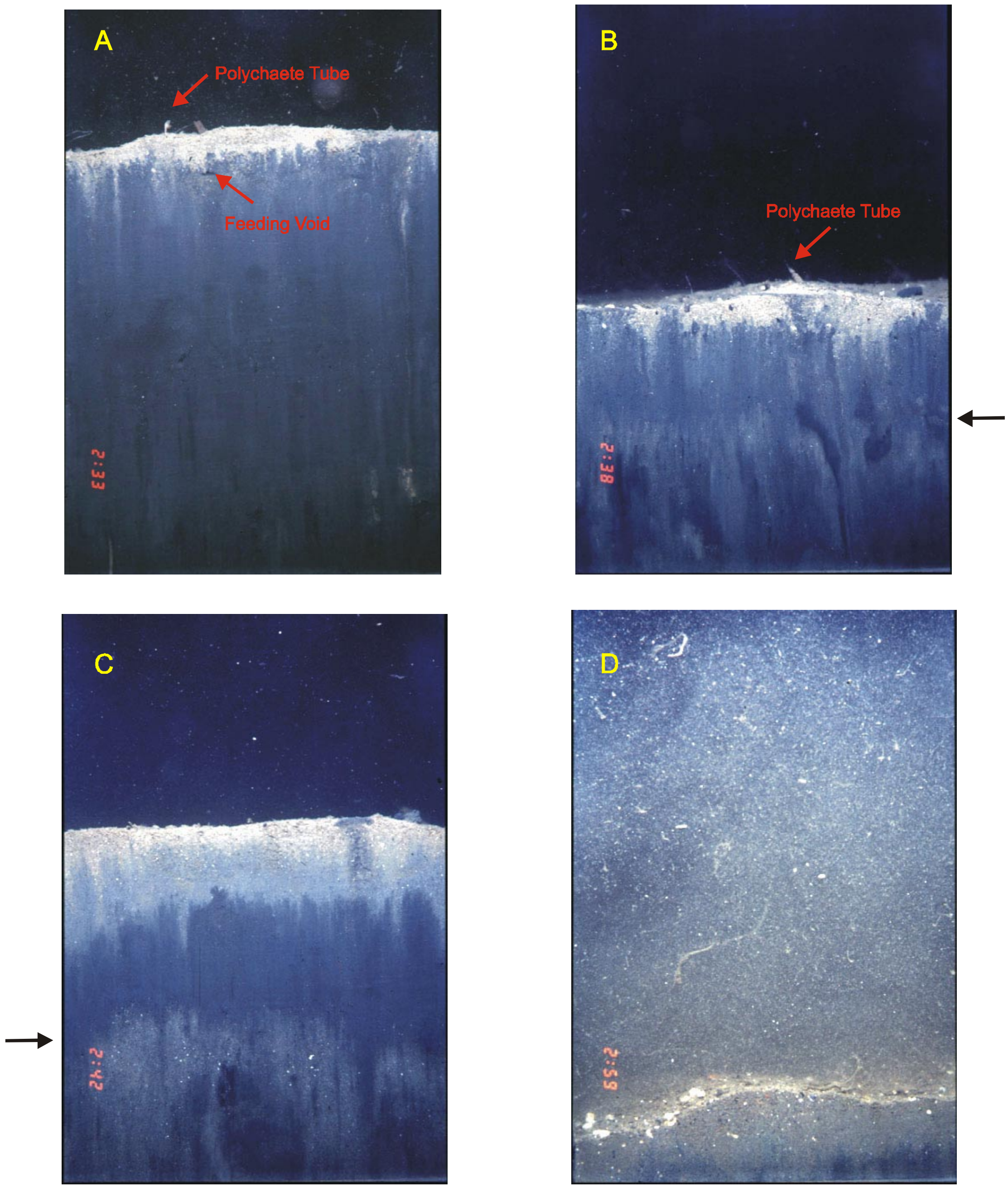


Figure 3-37. Four REMOTS® images from the NE transect. Image A, from station NE-300 shows remediation material extending from the sediment surface to below the camera's imaging depth. Images B and C, from stations NE-400 and NE-500, show discrete layers of remediation material overlying relic dredged material on the mound apron leading to the edge of the remediation material footprint (point of contact between the two layers is marked with an arrow). Image D, from station NE-600 shows "ambient" relic dredged material extending from the sediment surface to below the camera's imaging depth. In this image, the camera has not penetrated very deeply into the sediment; most of the image shows sediment which has been dispersed into the overlying water by the camera prism.

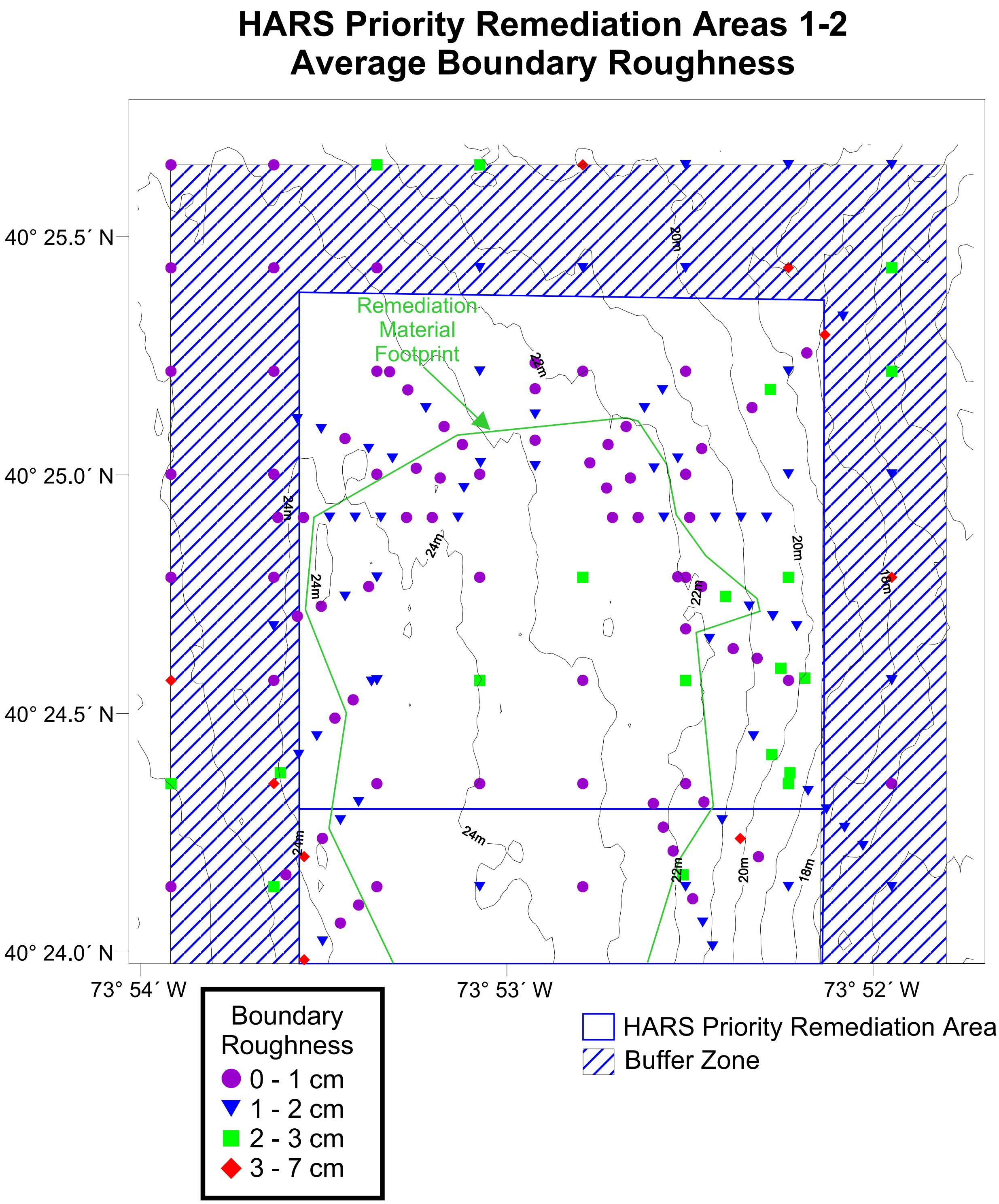


Figure 3-38. Map of average small-scale boundary roughness values at the sampled stations.

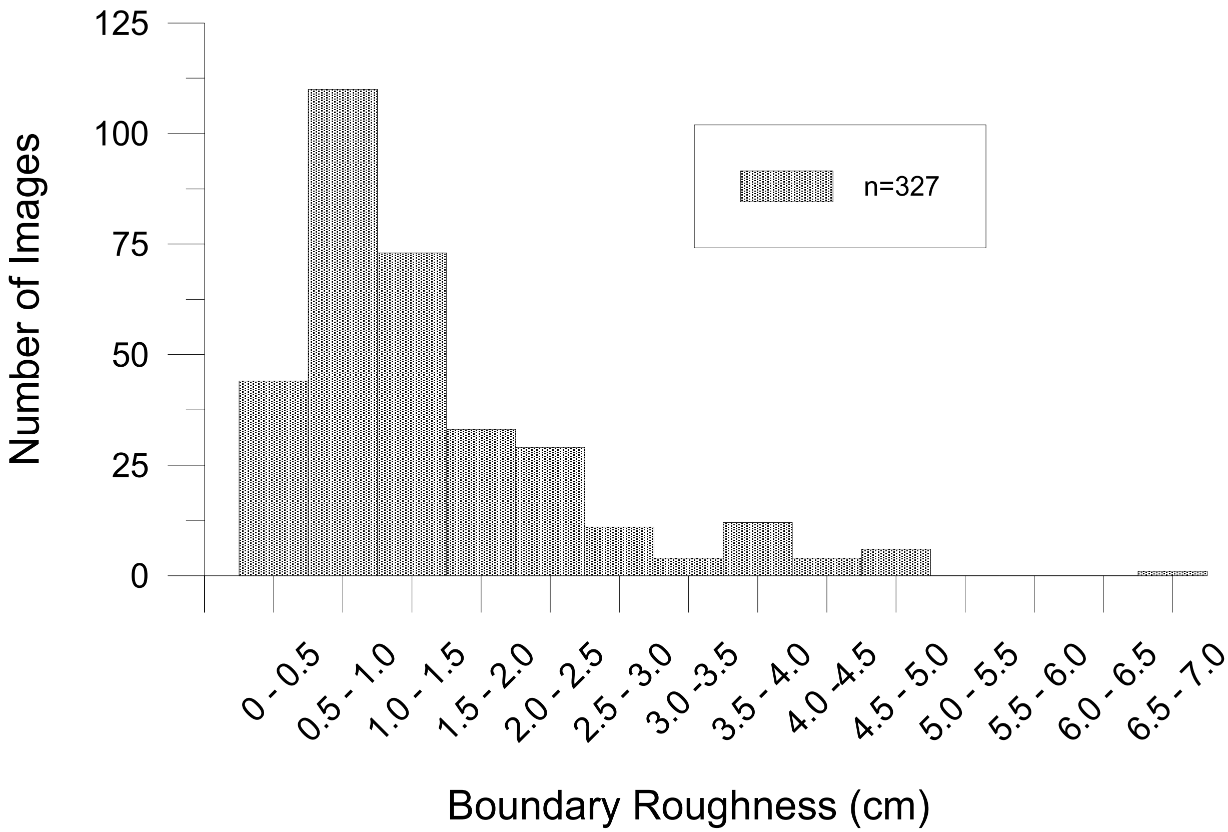


Figure 3-39. Frequency distribution of small-scale boundary roughness values for all of the replicate REMOTS® images that were analyzed.

3.3.4 Camera Prism Penetration Depth

The depth of penetration of the REMOTS® camera prism can be used to map gradients in the bearing strength (hardness) of the sediment. This hardness parameter is useful for distinguishing between a relatively thick (>20 cm) layer of sand cap material or soft bottom related to the presence of thin caps or underlying silt/clay. Freshly deposited sediments or older, highly bioturbated sediments tend to be soft, while compacted sands are hard and resist camera prism penetration. During the March 2000 survey, weight was added to or removed from the REMOTS® camera frame to optimize penetration in the diverse types of sediment encountered across the surveyed areas. Therefore, it is not possible to use camera prism penetration depth as a direct comparative measure of sediment bearing strength or density among different stations. Nevertheless, some broad qualitative comparisons of average prism penetration among stations are possible.

As might be expected, the deepest prism penetration (in the range of 10 to 20 cm) was found at the stations having "fresh" remediation dredged material in PRAs 1 and 2 (Figure 3-40). Intermediate penetration values (5 to 10 cm) generally were found at stations having relic dredged material within the basin, while the shallowest penetration was at the sandy and rocky stations located on the sloping sides of the basin (Figure 3-40).

3.3.5 Infaunal Successional Stage

At a relatively small number of stations where sand, pebbles or rocks were the dominant sediment type, the penetration of the REMOTS® camera prism was hindered and the infaunal successional stage paradigm could not be applied. An "indeterminate" successional stage designation was applied to roughly 4% of the replicate images (8 stations) obtained in the March 2000 survey.

A mixture of Stage I, Stage II and Stage III organisms occurred across the surveyed area (Figure 3-41). Stage I was the dominant successional stage, occurring in 210 (63%) of the replicate images (Figure 3-42). Stage I was observed most consistently at the sandy stations located on the eastern sloped side of the elongated basin, as well as at stations having relic dredged material (Figure 3-41). Stage I going to II was found in 49 of 332 (15%) of the replicate images, Stage II was found in 27 images (8%), while Stage I on III was found in 22 (7%) of the images (Figure 3-42). It is notable that a significant number of stations within the remediation material footprint were characterized by advanced successional stages (e.g., Stages II and III), either alone or in combination with Stage I (Figures 3-41 and 3-43). These results suggest that the remediation material has been recolonized successfully by a relatively diverse benthic community.

The evidence of Stage I consisted primarily of polychaete tubes occurring at the sediment surface (e.g., Figure 3-37, images A and B). Feeding voids at depth within the sediment provided evidence of the presence of larger, deposit-feeding, Stage III taxa. Both Stage I surface tubes and Stage III feeding voids were sometimes observed in the same image, resulting in the Stage I on III successional designation (Figure 3-43). The surface tubes were found both at sandy and silt-clay stations. At eleven stations, mostly on the east and west transects both within and outside

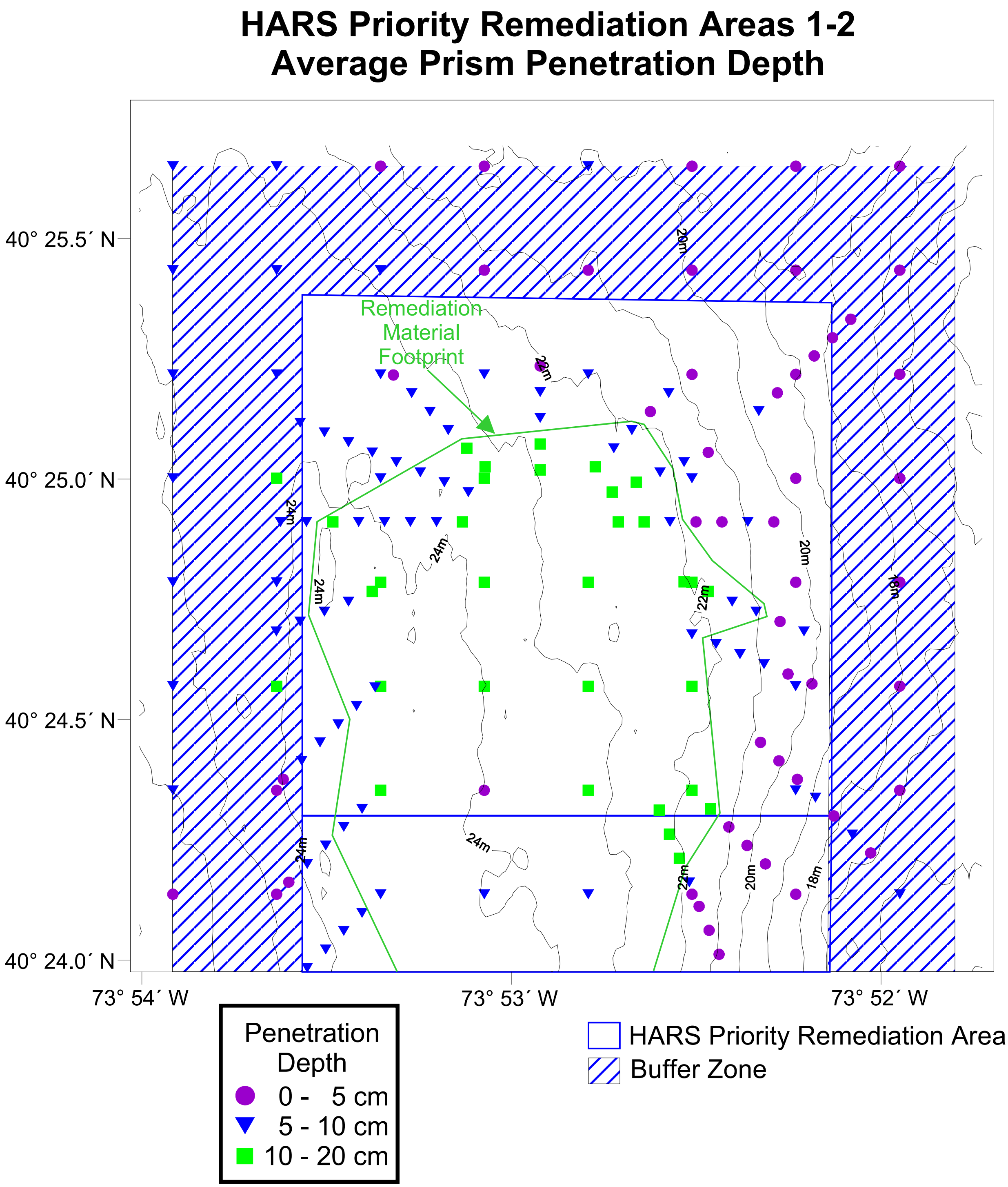


Figure 3-40. Map of average prism penetration depths in the survey area.

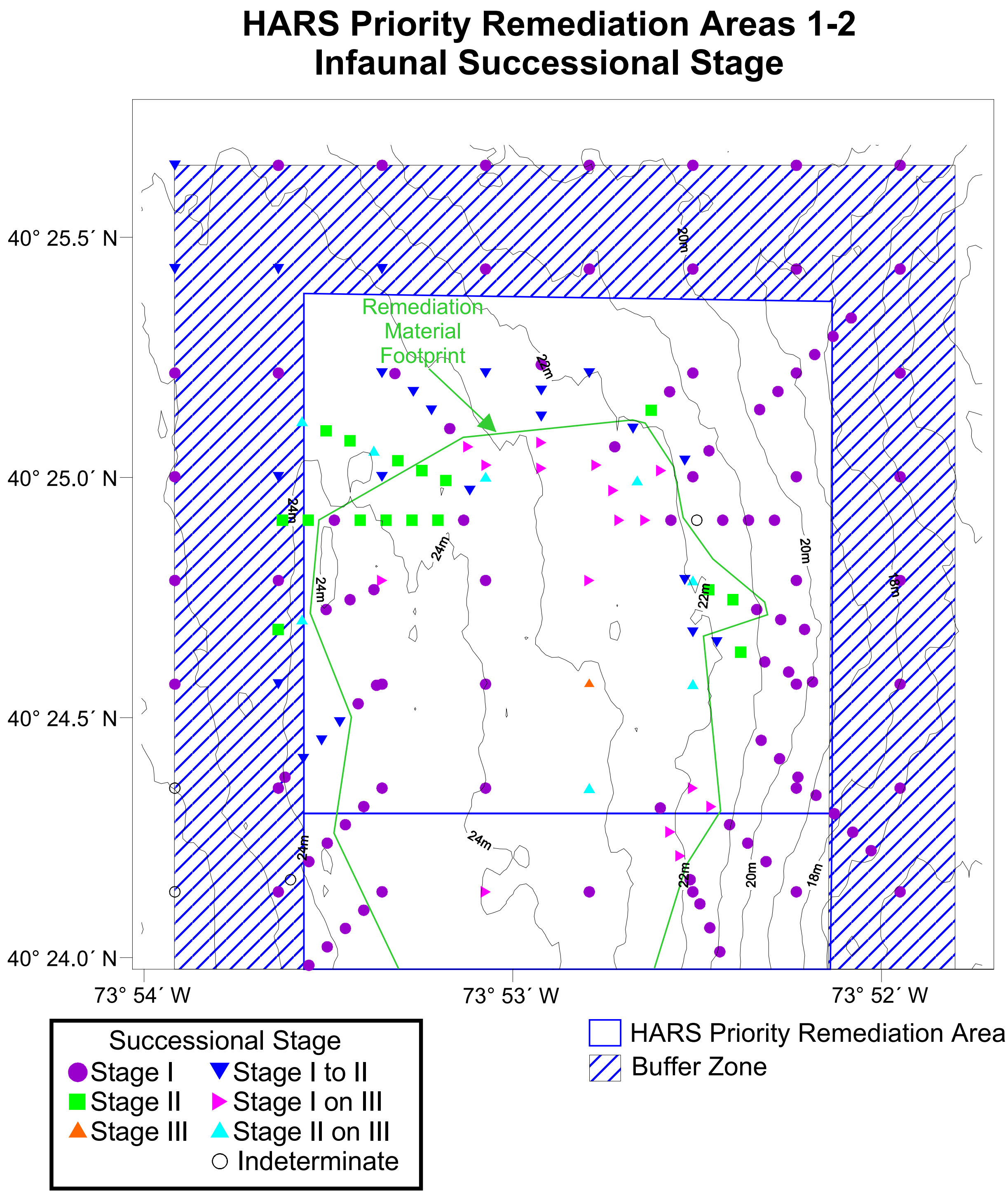


Figure 3-41. Map of infaunal successional stages in the surveyed area.

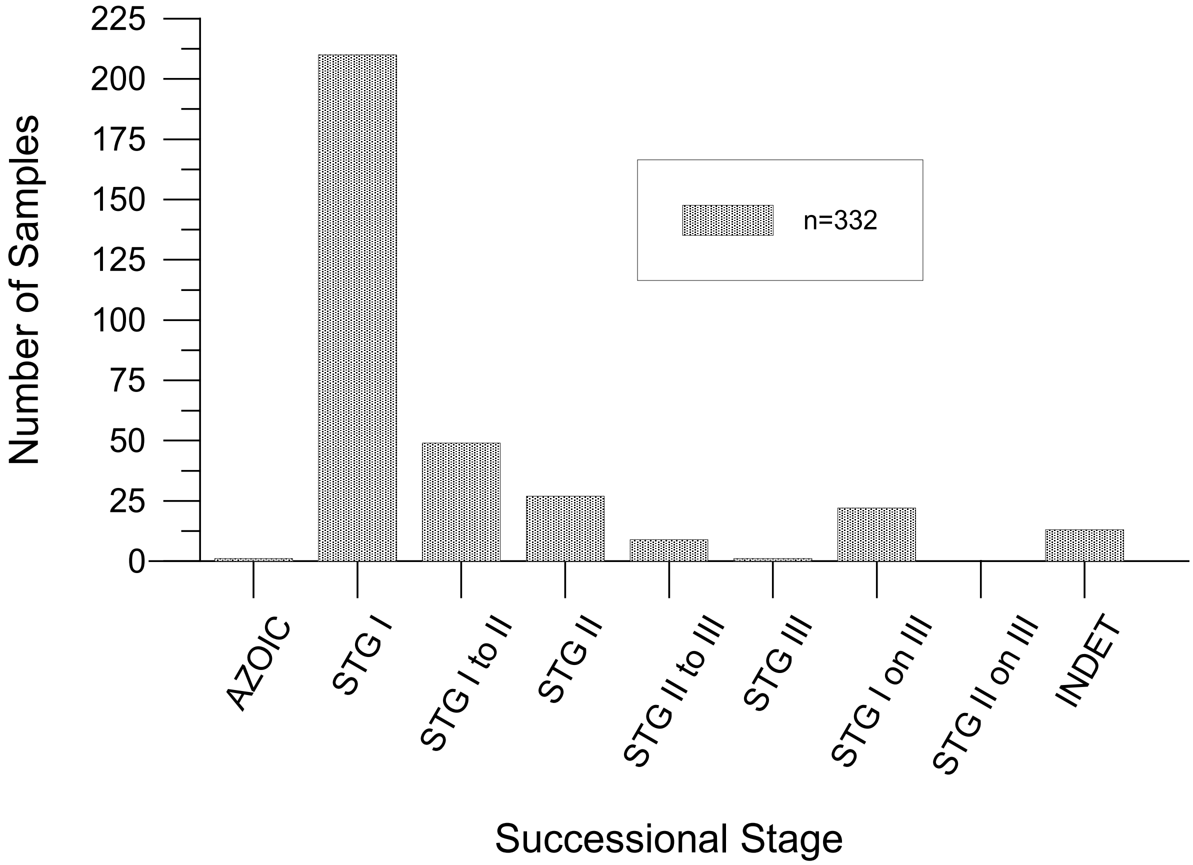


Figure 3-42. Frequency distribution of infaunal successional stages for all of the replicate REMOTS® images that were analyzed.

Figure 3-43. REMOTS® image from station ENE-300 showing fine-grained remediation material. A number of Stage I polychaete tubes are visible at the sediment surface, and Stage III feeding voids occur at depth, resulting in a Stage I on III successional designation. The redox layer (RPD) is shallow in this newly placed material.

the remediation material footprint, larger polychaete tubes were present at the sediment surface (Figure 3-36).

Small, light-colored bivalves assumed to be *Nucula proxima* (a species which is common in fine-grained sediments throughout the New York Bight region) were observed in the sediment-profile images at 55 stations (Figure 3-44). At most of these stations (46 of 55 or 84%), live *Nucula sp.* were seen in the upper 2 to 4 cm of the sediment profile (Figure 3-45, image A). There were also dense surface layers of dead *Nucula* shells observed at 27 stations (Figure 3-45, image B). The bivalve *Nucula proxima* is considered a Stage II organism.

3.3.6 Apparent RPD Depth

Sands generally are characterized by low concentrations of ferrous hydroxides and organic material and therefore tend to lack an obvious color contrast to mark the division between aerobic and anaerobic zones in the sediment column. The lack of color contrast makes it difficult to measure the depth of the apparent RPD in REMOTS® images of sand. However, it is assumed that rippled sands in the New York Bight generally are well aerated as a result of both diffusion of oxygen from the overlying water and physical mixing associated with periodic bedload transport. Therefore, in REMOTS® images of sandy sediments, the depth of apparent RPD typically is measured as being equal to or greater than the prism penetration depth. This is considered preferable to designating the RPD as "indeterminate" because such a designation would result in an indeterminate Organism-Sediment Index value as well (i.e., for each image, the RPD must be measured for the OSI to be calculated). If too many stations in an area have indeterminate RPD and OSI values, the resultant seafloor maps become greatly reduced in value.

Stations with rippled sand located in the shallower east, northeast and southwest corners of the survey area were associated with relatively deep (i.e., greater than 3 cm) apparent RPD depths (Figure 3-46). At stations having dredged material (either fresh or relic), roughly half of the average RPD depths were in the range 0 to 3 cm (Figure 3-46). There was typically a distinct color change between the light colored, oxidized sediment at the surface and the black, highly-reduced sediment at depth (e.g., Figure 3-35 image A; Figure 3-43; Figure 3-47).

Generally speaking, the observed RPD depths of less 3 cm in the dredged material (both fresh and relic) are considered shallow (i.e., indicative of poor sediment aeration). It is assumed that when this dredged material was first deposited, the entire sediment column consisted of black, highly-reduced sediment. In the fresh remediation dredged material, it is anticipated that the shallow RPD depths will gradually deepen with time, as a result of both molecular diffusion of oxygen from the overlying water and increased bioturbation by recolonizing organisms serving to mix oxygenated bottom water down into the sediment.

In the relic dredged material, the shallow RPD depths appear to be a persistent feature, having been observed in the previous survey of August 1998. It is hypothesized that the lack of significant recolonization of this material by larger-bodied, bioturbating Stage III organisms (possibly related to the elevated contaminant levels and associated toxicity of this material) is the likely explanation

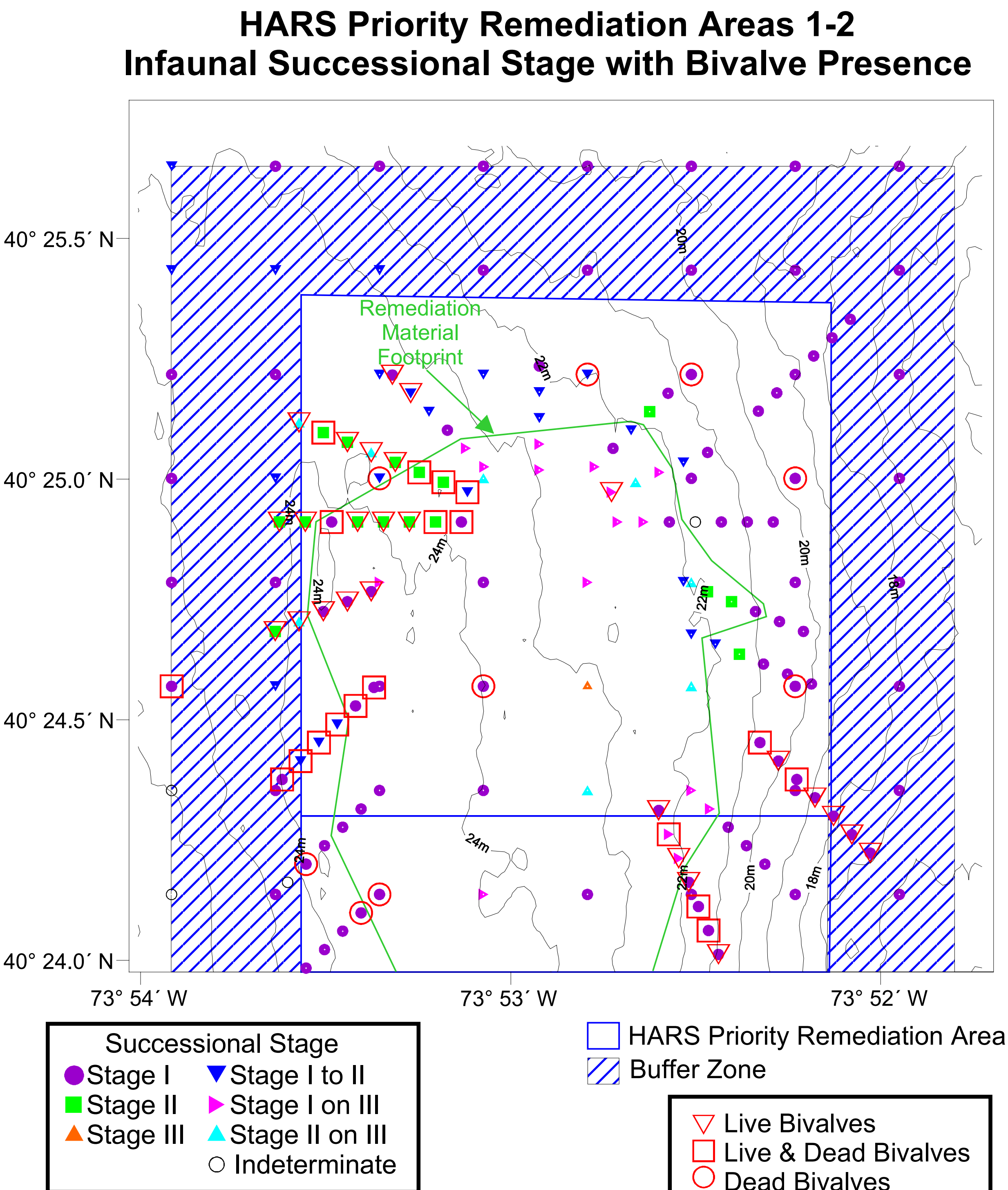


Figure 3-44. Map showing the presence of the bivalve *Nucula proxima* at stations in the surveyed area.

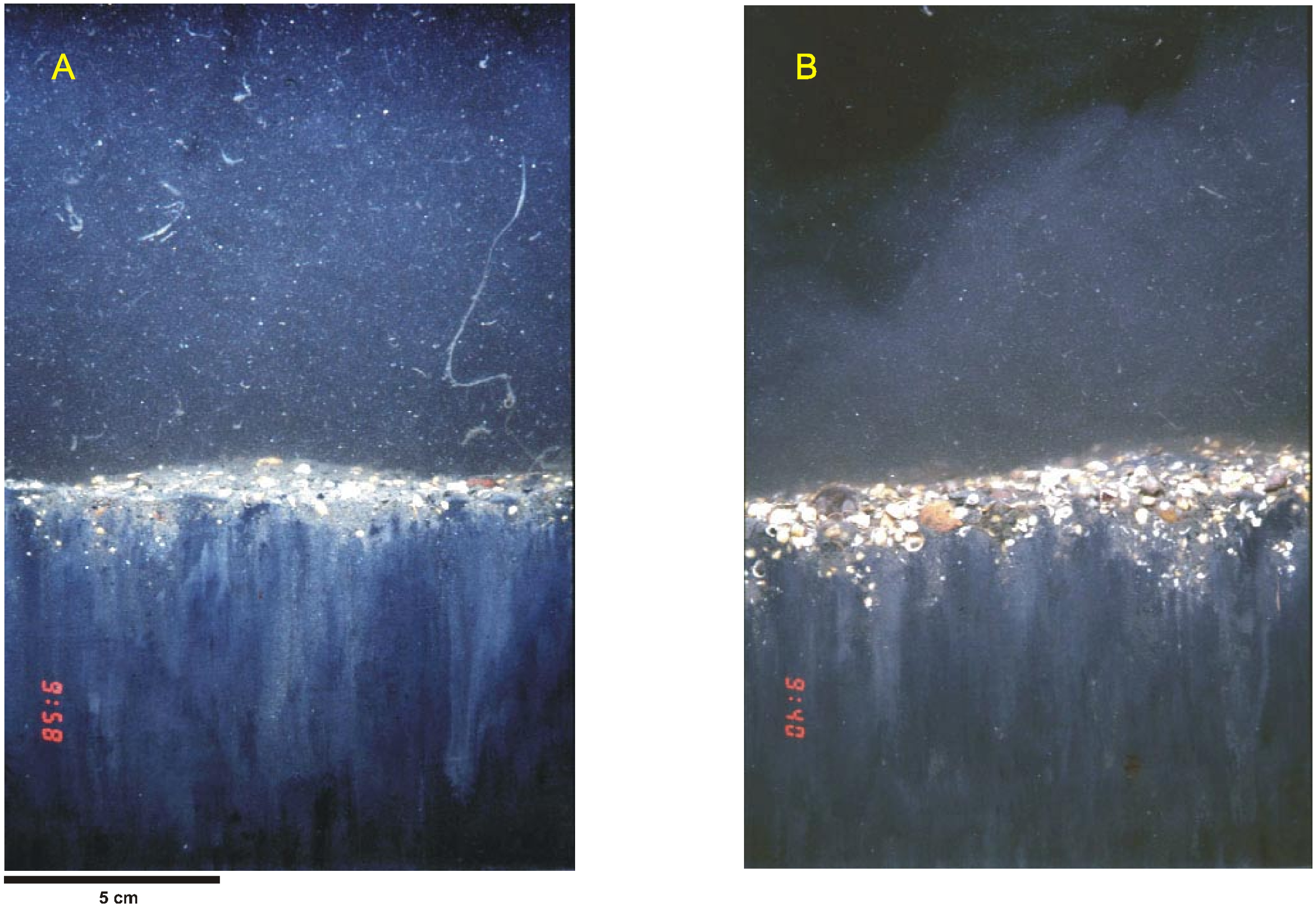


Figure 3-45. Two REMOTS® images showing the shallow surface-dwelling bivalve *Nucula proxima*. Image A, from station WSW-1000 shows a dense *Nucula* population in the upper 2 cm of the sediment column. Image B, from station SW-1100 shows a dense surface layer of dead *Nucula* shells.

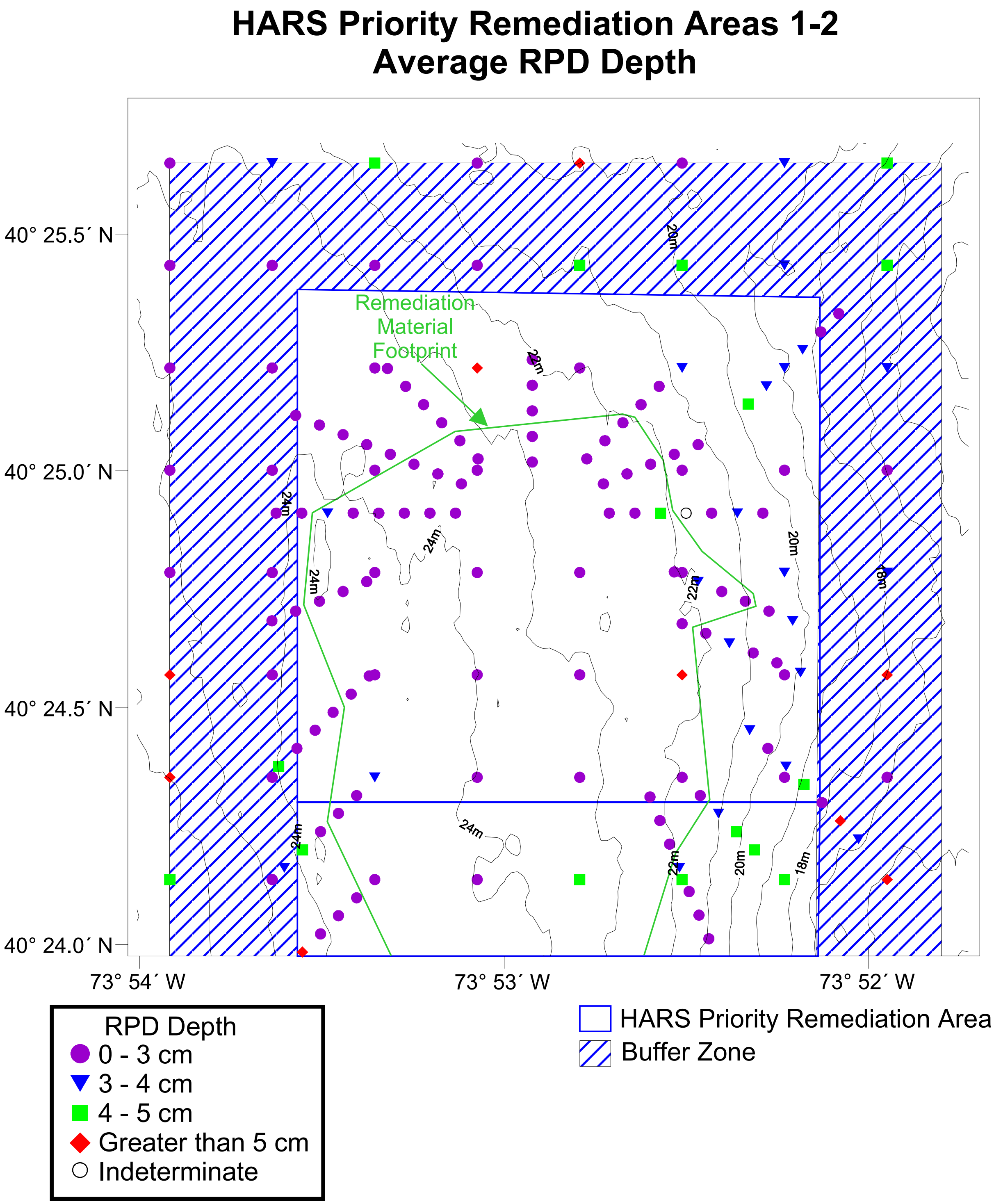


Figure 3-46. Average Redox Potential Discontinuity (RPD) depths at stations in the survey area.

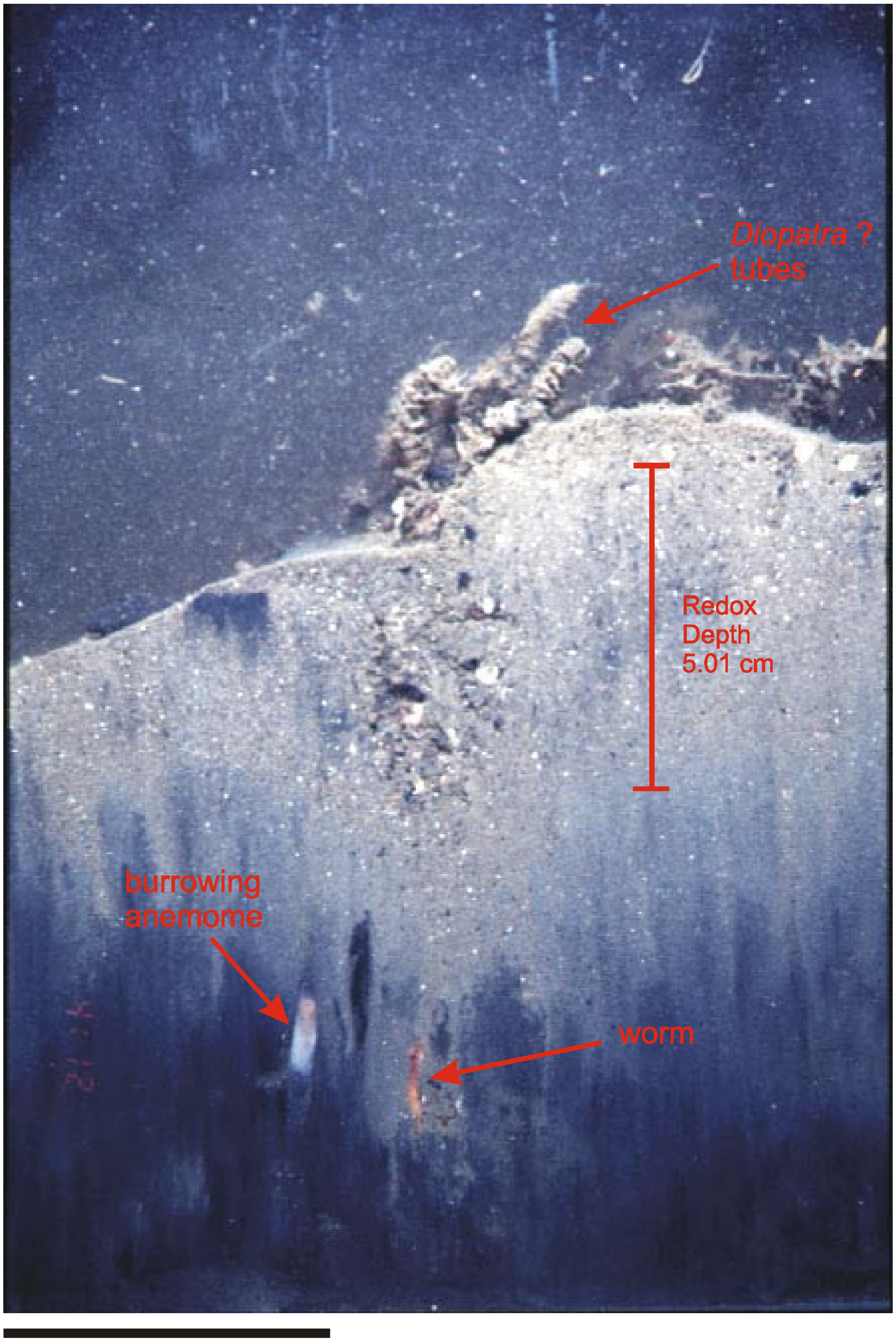


Figure 3-47. REMOTS® image from station F-2000 illustrating a distinct color change between the light colored, oxidized surface sediments and the black, reduced sediments at depth. At the sediment surface are brown Stage I worm tubes (possibly the polychaete *Diopatra* sp.), while an unidentified polychaete and a burrowing anemone (probably *Ceriantheopsis americanus*) are visible at depth.

for the persistent shallow RPD depths. The infaunal successional stage map (Figure 3-41) confirms that Stage III organisms rarely occurred at stations having relic dredged material.

3.3.7 Organism-Sediment Index

Organism-Sediment Index (OSI) values could not be calculated at several of the sand and gravel stations because the successional stage and/or RPD were indeterminate; stations with indeterminate OSI values occurred primarily along the western boundary of the surveyed area (Figure 3-48). Average OSI values within the survey area generally ranged from -3 to +11, with the majority of values falling in the range +3 to +7 (Figure 3-49). Values greater than or equal to +6 typically reflect relatively deep RPD depths (>3.0 cm) and the presence of Stage II or III organisms; such values are considered indicative of benthic habitat conditions which are healthy or non-stressed. Most of the values greater than or equal to +6 were found at stations outside the remediation material footprint, where RPD depths were generally deeper (Figure 3-48). Stations with fine-grained, newly deposited remediation dredged material generally had average RPD depths less than 3 cm and only Stage I organisms present, resulting in low to intermediate OSI values between -3 and +6 (Figure 3-48). Such OSI values generally are considered indicative of benthic habitat conditions which are degraded or moderately stressed, reflecting the recent placement of the dredged material on the seafloor. It is expected that, in the absence of further placement, the RPD depths would deepen and benthic recolonization of the material would occur, resulting in higher OSI values in the future. In the relic dredged material, the OSI values indicating degraded conditions reflect the lack of colonization of this material by Stage III organisms and the persistent shallow RPD depths.

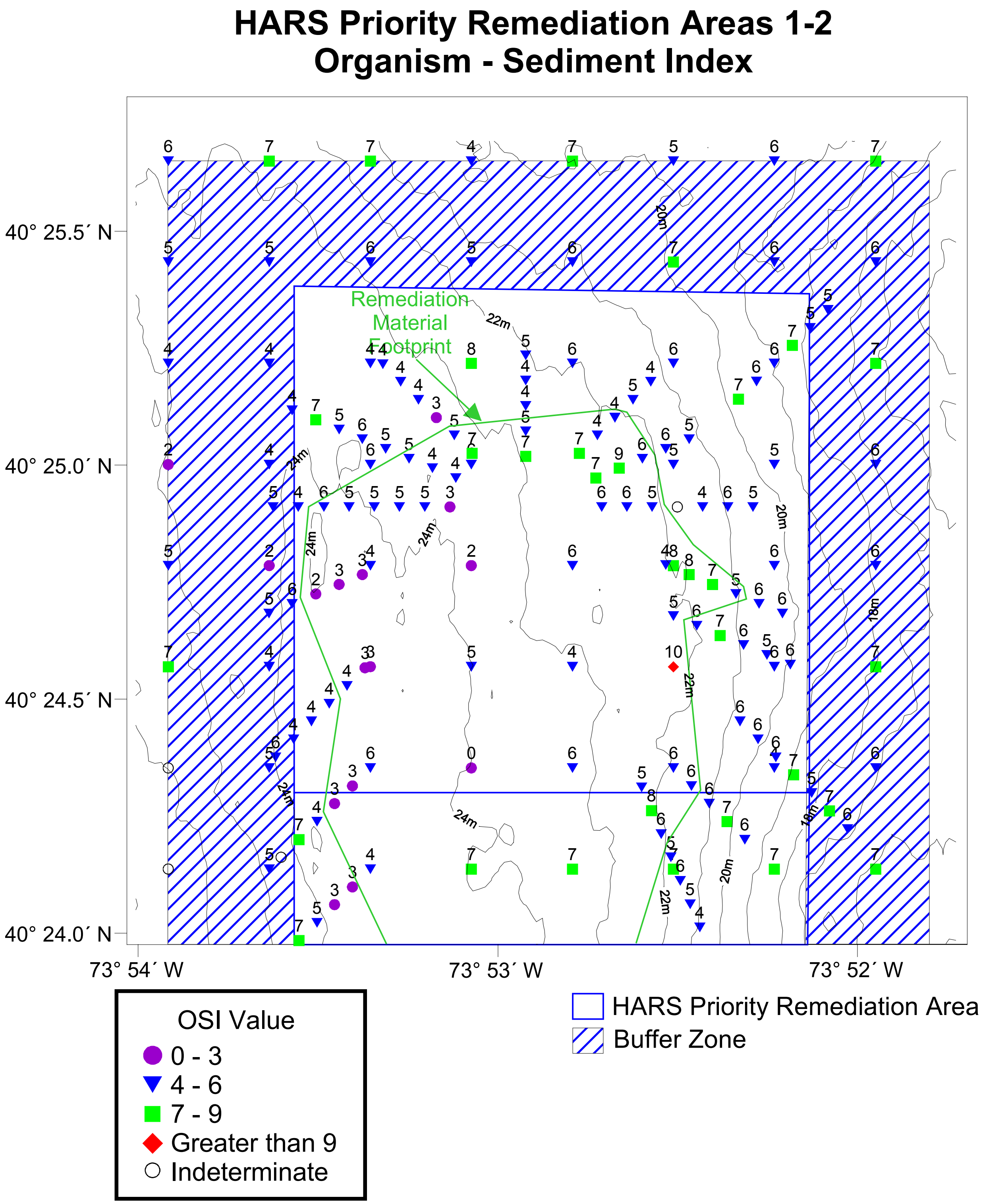


Figure 3-48. Map of average Organism Sediment Index (OSI) values at stations in the survey area.

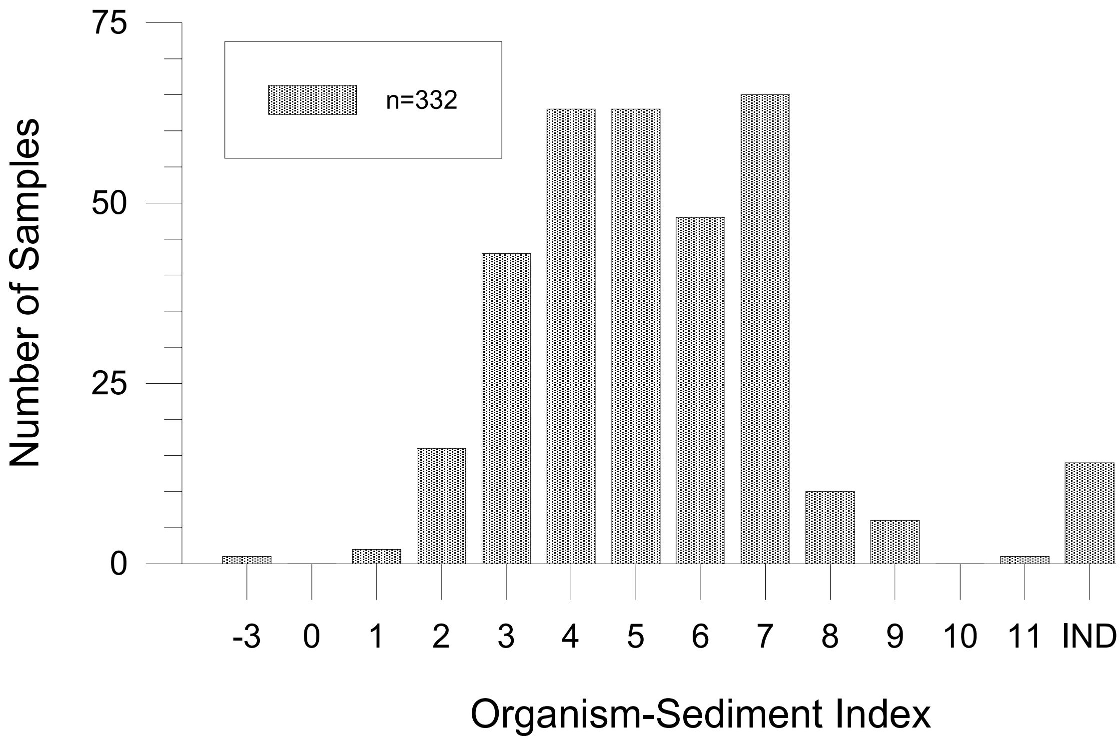


Figure 3-49. Frequency distribution of Organism-Sediment Index values for all of the replicate REMOTS® images analyzed.

4.0 DISCUSSION

In the March 2000 sediment profile imaging survey, 64 reconnaissance stations were arranged in a rectangular grid pattern to provide complete spatial coverage of PRA 1, the northern portion of PRA 2, and the surrounding buffer zone. The initial reconnaissance survey was followed by sampling at 100 stations arranged in a series of radial transects to more precisely map the footprint of the remediation material deposited since the opening of the HARS in September 1997. A secondary objective of the sediment profile imaging survey was to assess benthic recolonization of the remediation material and overall benthic habitat quality in the survey area. In addition, a side-scan sonar survey was performed to collect digital acoustic image data of seafloor characteristics within and adjacent to PRAs 1, 2 and 3.

4.1 Physical Characterization of PRAs 1, 2, and 3

Sediment profile imaging indicated three main categories of sediment present across the surveyed area. Fine-grained sediment determined to be "newly deposited" (i.e., since September 1997) remediation material was observed within the center of PRA 1 and extending south into the center of PRA 2 (Figures 3-34 and 3-36). Fine-grained, relic dredged material was found outside the newly deposited material footprint to the northwest, within the topographic depression (basin) which extends into the buffer zone west of PRA 1. Rippled fine to coarse sands, representing natural ambient sediments, were observed on the gently sloping bottom which represents the sides of the basin to the north, east and west of the remediation material footprint.

Consistent with previous sediment profile imaging surveys of this area, an association was observed in the present survey between water depth and sediment type. Rippled, fine to medium sands and some gravel were found mainly at water depths less than about 22 m (Figure 3-32). It has been hypothesized that these bottom areas above a critical depth of roughly 20 to 21 m apparently experience wave energy from periodic storm events which is high enough to cause selective winnowing of the fine-grained fraction and bedload transport of the remaining coarser grained sediments (SAIC 1998a). Areas below 21 m experience significantly less bottom energy and are generally quiescent, favoring accumulation of fine-grained sediments, as observed at stations below the 22 m depth contour (Figure 3-32).

The 64 reconnaissance grid stations used in the present survey were previously sampled in the August 1998 survey of PRAs 1, 2 and 3 (SAIC 1998a). A comparison of the two surveys indicated very little change in grain size major mode. Five stations in the northwest corner of the grid were classified as very fine sand (4 to 3 phi) in the baseline survey and as fine-grained relic dredged material (>4 phi) in this survey. The stations inside the newly placed material footprint had previously exhibited fine-grained material in the form of relic dredged material.

4.2 Distribution of Remediation Material in PRAs 1 and 2

The placement of dredged material at the former Mud Dump Site was regulated by NYD and Region II of the EPA following official designation of the site in 1984. Prior to this, placement of dredged material and construction waste had been occurring in the New York Bight for nearly a century and was poorly regulated. As a result, deposits of dredged harbor sediments and construction material (i.e., cellar dirt) can be found throughout the HARS, as documented in baseline bathymetric, REMOTS® imaging, and side-scan sonar surveys conducted in 1995 and 1996 (SAIC 1996a, b and c).

In the August 1998 sediment-profile imaging survey of PRAs 1, 2 and 3, a relatively small area of recently deposited dredged material was found in the center of PRA 1 surrounding station E-1600. The material had been placed in this area during the ITO Passenger Ship Terminal dredging project of April 1998. Since the August 1998 survey, remediation material from three additional dredging projects has been placed in PRAs 1 and 2, including the Brooklyn Marine Terminal, ITO Passenger Ship Terminal dredging of 1999, and the ongoing Kill Van Kull (KVK) project (Table 3-1 and Figure 3-6). The 64 reconnaissance sediment profile imaging stations confirmed that the newly placed material was located in the center of PRAs 1 and 2, and the 100 radial transect stations were used to successfully delineate the footprint of this material (Figure 3-34).

The remediation material varied in color from uniformly grey or dark grey (Figure 3-37, image A), or with mottled coloring consisting of alternating bands of grey and black sediment (Figure 3-36). At most of the inner radial stations, the remediation material extended from the sediment surface to below the imaging (i.e., penetration) depth of the sediment profile camera prism (Figures 3-36 and 3-37, image A). On the apron of the dredged material deposit, thinner, discrete layers of the remediation material were observed, typically overlying relic dredged material at depth (e.g., Figure 3-37, images B and C). The RPD was generally thin, indicating minimal oxidation of the reduced, recently placed remediation material (Figures 3-36 and 3-43).

4.3 Comparison of Side-scan Sonar, REMOTS®, and ADISS Monitoring Results

Side-scan sonar is capable of acquiring detailed acoustic images over large areas of the seafloor. However, as with any form of remote sensing, extracting information from the images requires some degree of interpretation. The accuracy of the interpretation is greatly improved with correlative and ground truth information. Analysis of the ADISS disposal records and REMOTS® sediment profile images both serve to strengthen the interpretations of the side-scan acoustic records and mosaic.

In the side-scan mosaic, the sediments comprising the prominent circular feature in the center of PRA 1 (Figures 3-1 and 3-2) had distinctive acoustic properties relative to surrounding sediments. Much of the acoustic energy generated by the side-scan sonar was absorbed, suggesting that the sediments were soft and fine-grained.

Examination of the disposal records indicated that primarily fine-grained, silty maintenance dredged material was placed in PRA 1. The disposal locations within PRAs 1 and 2 recorded with the ADISS (Figures 3-6 through 3-8) correlate strongly with the location of the large circular feature on the seafloor, further supporting the interpretation that this feature represents dredged material.

The sediment profile images provide data useful for ground truthing the side-scan sonar records: the sediment photographs provide the direct link between the interpretation of the side-scan acoustic images and the actual conditions on the seafloor. The images were analyzed independent of the side-scan results, and plots of the results from the two monitoring techniques are presented in Figures 4-1 and 4-2. Figure 4-1 illustrates the results of grain size analysis of the sediment-profile images relative to the side-scan mosaic. The sediments within the center of PRA 1 were primarily in the silt-clay (>4 ϕ) size class and were identified as "fresh" or recently placed dredged material (Figure 4-2). To the west and north of the PRA center, the sediment profile images indicated a transition from recently placed dredged material to relic dredged material. A similar pattern can be seen in the side-scan mosaic, where the acoustic image transitions from black, where the greatest concentration of softer (i.e., higher water content) fresh dredged material occurred, to lighter shades of grey, where the weathered, more-compact, relic dredged material was observed.

Overall, the results show how the combination of side-scan sonar, ADISS disposal records, and REMOTS® sediment profile imaging can provide an accurate and efficient method for 1) detecting dredged material, and 2) quantifying the areal coverage of dredged material on the seafloor of the HARS. Each monitoring method provides a different piece of information that when combined provide a conclusive method of monitoring remediation activity at the HARS.

4.4 Assessment of Benthic Recolonization and Habitat Quality

The sediment profile images obtained in the March 2000 survey indicate that a variety of benthic organisms, representing Stages I, II and III, had recolonized the remediation material (Figure 3-41). Stage I consisted of small, tube-dwelling polychaetes inhabiting the sediment surface (e.g., Figure 3-37, images A and B); these are typically the first organisms (pioneers) to recolonize available fine-grained substrate such as that represented by newly placed remediation material. Stage I, alone or in combination with other successional stages, was observed at 40 of the 56 stations (71%) within the remediation material footprint (Figure 3-41).

Stage II typically consists of shallow-dwelling organisms like amphipods and small, suspension feeding bivalves like *Nucula* sp. (e.g., Figure 3-45, image A). Stage II, alone or in combination with other successional stages, was observed at 16 of the 56 stations (28%) within the remediation material footprint (Figure 3-41). Stage II typically consisted of the bivalve *Nucula proxima*, which is known to be common in fine-grained sediments in the New York Bight region (Chang et al. 1992). This bivalve was observed most consistently at a cluster of stations on the W and WNW transects, near the central part of the basin (Figure 3-44).

Stage III is characterized by the presence of larger-bodied, infaunal deposit-feeders. Feeding voids visible at depth in sediment profile images provide evidence of the presence of Stage III organisms (Figure 3-43). Stage III, alone or in combination with other stages (e.g., Figure 3-43), was observed at 22 of the 56 stations (39%) within the remediation material footprint. It is notable that Stage III occurred most consistently at a cluster of stations in the northeast quadrant of the remediation material footprint (Figure 3-41). This is the general placement location for the

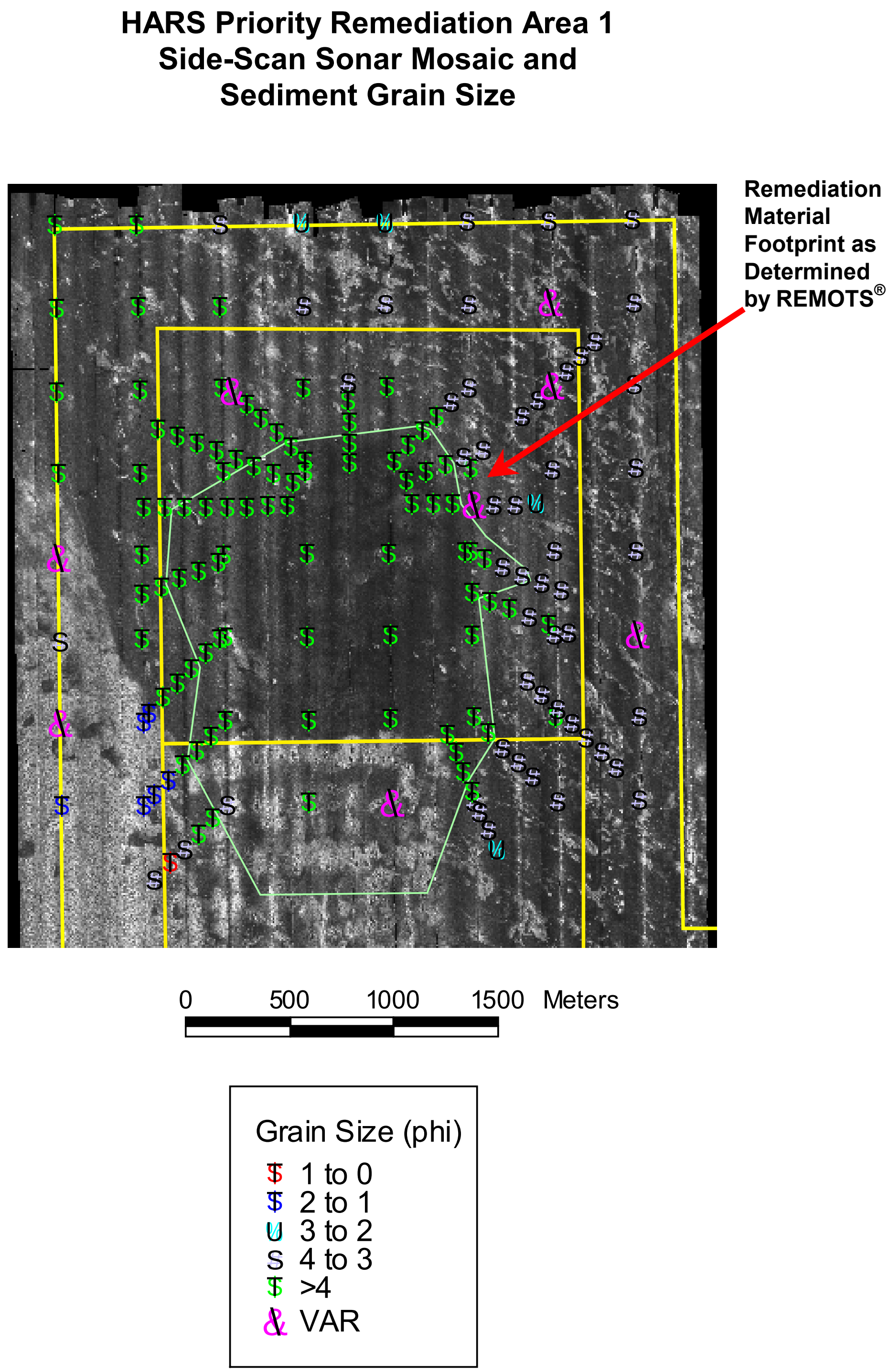


Figure 4-1. REMOTS® sediment grain size results plotted over the side-scan sonar mosaic.

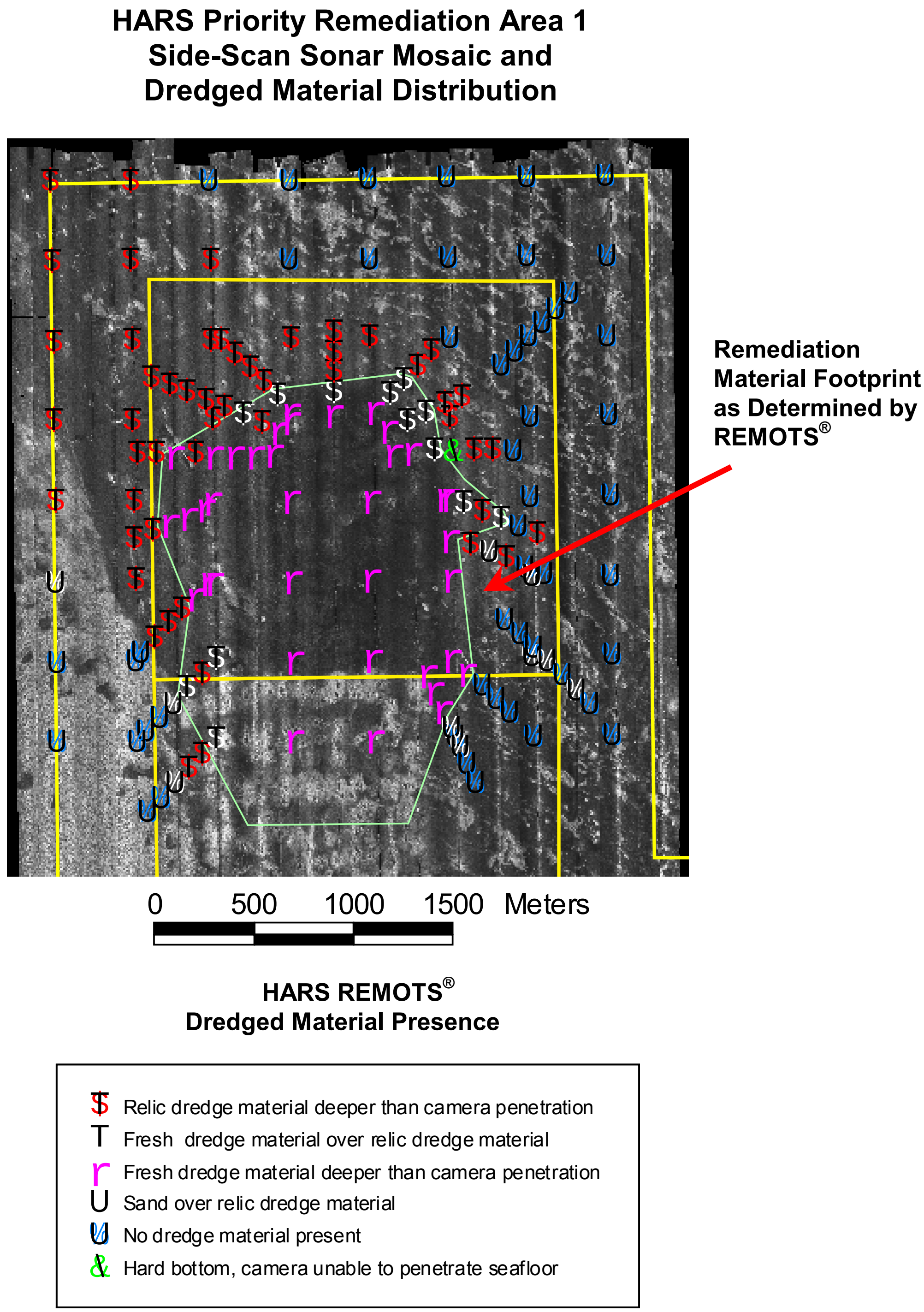


Figure 4-2. REMOTS® dredged material distribution results plotted over the side-scan sonar mosaic.

April 1998 ITO Passenger Ship Terminal dredging project, the very first project to be placed at the HARS (Figure 3-7). Long-term REMOTS® monitoring at the Mud Dump Site has shown that Stage III organisms typically become well-established in organic-rich, fine-grained dredged material within a few years of its placement. The ITO Passenger Ship Terminal material had been in place on the seafloor for a little under two years at the time of the March 2000 survey, and, in accordance with past experience (and the REMOTS® successional model), the successional sequence apparently had resulted in the establishment of a "climax" Stage III community. It is expected that the recolonization process will proceed similarly in nearby areas having remediation material. At the time of the March 2000 survey, this material had been in place for less than two years and was still in earlier stages of succession (Stages I and II).

Outside the remediation material footprint, in areas having relic dredged material, Stage I and II organisms continued to be the dominant successional types (Figure 3-41). The continued absence of Stage III organisms in the relic dredged material of the basin indicates an anomalous pattern whereby the expected succession from Stage I to Stage III has not occurred. In studies performed in support of the Environmental Impact Statement for the HARS designation, sediments collected at several stations within and near the elongated basin were found to have both elevated chemical contaminant levels and significant toxicity in the standard 10-day amphipod test (U.S. EPA 1997). Therefore, the most likely explanation for the persistent, anomalous benthic successional pattern is the continuing elevated levels of chemical contaminants in the relic dredged material and concomitant toxicity to resident benthic organisms.

It has been hypothesized that Stage I and II organisms are able to maintain sporadic populations on the relic dredged material because they are mainly surface-dwelling suspension feeders which do not have extensive exposure to the underlying contaminated sediments. These organisms inhabit a relatively narrow, oxygenated zone at the sediment surface and feed primarily on suspended material in the overlying water. Infaunal organisms having intimate contact with the sediment, particularly head-down, deposit-feeding Stage III taxa, apparently are not able to maintain viable populations within the as-yet-unremediated contaminated relic dredged material of the basin. It is notable that in the March 2000 survey, dead shells of the bivalve *Nucula proxima* (and perhaps other bivalve species) continued to be observed at stations having relic dredged material (e.g., Figure 3-45, image B). These "death assemblages" may represent the remains of populations which were able to become established only for limited periods of time before experiencing contaminant-related mortality.

The REMOTS® Organism Sediment Index (OSI) is designed to provide an overall summary of benthic habitat quality. Experience has shown that OSI values greater than or equal to +6 are indicative of relatively healthy or unstressed benthic habitat quality. In the March 2000 survey, the highest benthic habitat quality was found most consistently at stations comprising the northern and eastern portions of the surveyed area (Figure 3-48). Most of these stations were located on the sloping bottom representing the eastern side of the elongated basin, above the 22 m depth contour, where rippled sand was the dominant sediment type. These stations were generally devoid of any dredged material within the measurable sediment depth. The high OSI values reflect relatively deep RPD depths (>3.75 cm) and the presence of surface worm tubes (Stage I organisms).

A significant number of stations on the eastern side of the remediation material deposit had OSI values of +7 or greater, indicating healthy benthic habitat quality. Many of these stations, particularly those within the 1998 ITO Passenger Ship Terminal placement area, had Stage III organisms in combination with somewhat shallow RPD depths. It is hypothesized that RPD depths within the remediation material footprint in general have not yet had a chance to deepen fully as a result of the bioturbation activity of the Stage III organisms, but such deepening is expected in the future. To the west of the remediation material footprint, within the elongated basin, intermediate OSI values ranging from 2 to 6 suggest moderately stressed or degraded benthic habitat quality. These values reflect the apparent anomalous successional pattern (persistent dominance of Stage I and II organisms only) and relatively shallow RPD depths potentially related to the continued presence of contaminated relic dredged material in this area.

5.0 SUMMARY

The primary objective of the March 2000 survey was to use the combination of sediment-profile imaging and side-scan sonar to map seafloor characteristics and determine the spatial distribution of remediation material placed primarily within PRAs 1 and 2 since 1997. The side-scan sonar survey also encompassed PRA 3 to provide a baseline for assessing changes in seafloor characteristics associated with future dredged material placement in this area. A secondary objective of the REMOTS® sediment-profile imaging survey was to provide information on benthic recolonization and changes in benthic habitat quality associated with placement of remediation material in PRAs 1 and 2 to date.

The side-scan sonar survey showed that remediation material occurred primarily in PRAs 1 and 2. In PRA 1, the material was predominantly fine-grained and occupied a circular area near the center of the cell. In PRA 2, the material consisted of a variable mixture of clay, mud and large rocks. Individual dredged material deposits associated with single disposal events (i.e., one scow load) were clearly visible in the side-scan records. These deposits had variable morphology, depending on the type of constituent dredged material. Large-scale sand wave fields were found to the west of PRAs 1 and 2 and south of PRA 3. A large-scale mud area, comprised of both recent and historic dredged material, was observed in the eastern half of PRA 3. Shipwrecks, trawl scars and lobster pots were also observed in the side-scan records at various locations in the survey area.

The sediment-profile imaging survey was used to delineate more precisely the footprint of the remediation material in PRA 1 and the northern portion of PRA 2. The survey results served to confirm the side-scan sonar interpretation in showing that the remediation material footprint comprised a roughly circular area near the center of PRA 1 and extending into PRA 2. The sediment-profile images showed that the remediation material in PRA 1 was predominantly fine-grained. Relic dredged material was found in PRA 1 outside of the remediation material footprint, within the elongated basin which is the main topographic feature of PRAs 1, 2 and 3. As in previous surveys, rippled fine to coarse sands were found to be the predominant sediment types on the sloping sides of this basin.

There was excellent agreement between the March 2000 survey results and the ADISS results showing the actual location of individual disposal events. The overall footprint of the remediation material and the locations of individual dredged material deposits on the seafloor corresponded closely with the ADISS target grid cells and the corresponding data showing the exact position of each disposal scow while releasing material.

The sediment profile images obtained in the March 2000 survey indicate that a variety of benthic organisms, representing Stages I, II and III, had recolonized the remediation material. Outside the remediation material footprint, in areas having relic dredged material, Stage I and II organisms continued to be the dominant successional types. The continued absence of Stage III organisms in the relic dredged material indicates an anomalous successional pattern possibly related to the elevated contaminant levels and associated toxicity of this material.

The highest benthic habitat quality was found at stations located on the sandy, sloping bottoms representing the sides of the elongated basin within PRAs 1 and 2 and the associated HARS buffer zone. These stations were generally devoid of any dredged material within the measurable sediment depth. Relatively high Organism-Sediment Index values (> +6) at these stations reflected deep RPD depths (>3.75 cm) and the presence of surface worm tubes (Stage I organisms).

A significant number of stations on the eastern side of the remediation material deposit within PRA 1 had OSI values of +7 or greater, indicating healthy benthic habitat quality. Most of these stations had Stage III organisms in combination with somewhat shallow RPD depths, which are expected to deepen in the future as a result of bioturbation by the organisms. Within the elongated basin to the west of the remediation material footprint, intermediate OSI values ranging from 2 to 6 suggested moderately stressed or degraded benthic habitat quality, attributed to the apparent anomalous successional pattern and relatively shallow RPD depths.

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APPENDIX: A

REMOTS® IMAGE ANALYSIS RESULTS

<u>Abbreviations</u>:

STAT = station
REPL = replicate
DATE = date
TIME = time
AYST = Analyst
LAT = station latitude
LONG = station longitude
SS = successional stage
GSMX = maximum grain size (phi units)
GSMN = minimum grain size (phi units)
GSMM = grain size major mode (phi units)
MDCNT = mud clast count
MDAVG = mud clast average depth
PNMN = penetration minimum depth (cm)
PNMX = penetration maximum depth (cm)
PNRNG = penetration range (boundary roughness, in cm)
PENMEAN = mean penetration (cm)
DMMEAN = mean thickness of dredged material (cm)
RPDMEAN = mean RPD depth (cm)
METMEAN = mean depth of methane bubbles (cm)
OSI = Organism-Sediment Index (99 = indeterminate)
SURF = origin of boundary roughness (biogenic or physical)
FULL CMNT = full comment

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
2ESE0	A	3/14/80	12:42	MCS	40 24.671N	073 52.506W	ST_I_TO_II	2	>4	>4	0	0	7.9	8.13	0.23	8.01	0	2.81	0	6
2ESE0	B	3/14/80	12:42	MCS	40 24.674N	073 52.509W	ST_I_TO_II	3	>4	>4	0	0	8.58	9.55	0.97	9.06	0	2.05	0	5
2ESE0	C	3/14/80	12:43	MCS	40 24.677N	073 52.510W	ST_I_TO_II	2	>4	>4	0	0	11.6	11.94	0.34	11.77	0	2.12	0	5
2ESE100	A	3/14/80	12:35	MCS	40 24.661N	073 52.455W	ST_I_TO_II	2	>4	>4	0	0	7.16	8.3	1.14	7.73	0	1.95	0	5
2ESE100	C	3/14/80	12:39	MCS	40 24.661N	073 52.444W	ST_I_TO_II	2	>4	>4	0	0	6.76	7.73	0.97	7.24	0	2.6	0	6
2ESE200	B	3/14/80	12:31	MCS	40 24.637N	073 52.389W	ST_I_TO_II	2	>4	>4	0	0	6.65	7.61	0.97	7.13	0	2.85	0	6
2ESE200	C	3/14/80	12:32	MCS	40 24.637N	073 52.395W	ST_II	2	>4	4 to 3	0	0	6.08	6.48	0.4	6.28	0	3.39	0	8
2ESE300	C	3/14/80	12:15	MCS	40 24.607N	073 52.315W	ST_I	2	>4	4 to 3	0	0	4.89	5.63	0.74	5.26	0	2.9	0	5
2ESE300	D	3/14/80	12:15	MCS	40 24.609N	073 52.315W	ST_I	2	>4	4 to 3	0	0	7.16	7.95	0.8	7.56	0	3.09	0	6
2ESE400	A	3/14/80	12:04	MCS	40 24.591N	073 52.254W	ST_I	2	4	4 to 3	0	0	2.78	4.77	1.99	3.78	0	2.57	0	5
2ESE400	C	3/14/80	12:06	MCS	40 24.602N	073 52.255W	ST_I	3	>4	>4	0	0	0.52	4.15	3.63	2.33	0	1.68	0	4
2ESE500	A	3/14/80	12:01	MCS	40 24.573N	073 52.186W	ST_I	2	4	4 to 3	0	0	1.7	5.85	4.15	3.78	0	3.5	0	6
2ESE500	B	3/14/80	12:01	MCS	40 24.575N	073 52.185W	ST_I	2	4	4 to 3	0	0	3.98	4.66	0.68	4.32	0	3.07	0	6
2NE100	A	3/14/80	14:08	MCS	40 25.258N	073 52.180W	ST_I	2	4	4 to 3	0	0	4.63	5.09	0.46	4.86	0	4.76	0	7
2NE100	C	3/14/80	14:09	MCS	40 25.264N	073 52.177W	ST_I	2	4	4 to 3	0	0	2.34	3.83	1.48	3.09	0	3.2	0	6
2NE-100	A	3/14/80	14:04	MCS	40 25.177N	073 52.275W	ST_I	2	4	4 to 3	0	0	3.71	6.8	3.09	5.26	0	4.61	0	7
2NE-100	B	3/14/80	14:04	MCS	40 25.179N	073 52.272W	ST_I	2	4	4 to 3	0	0	1.66	2.57	0.91	2.11	0	1.89	0	4
2NE200	B	3/14/80	14:12	MCS	40 25.296N	073 52.123W	ST_I	2	4	4 to 3	0	0	0.86	3.54	2.69	2.2	0	1.93	0	4
2NE200	C	3/14/80	14:13	MCS	40 25.301N	073 52.118W	ST_I	2	4	4 to 3	0	0	2.29	6.23	3.94	4.26	0	3.45	0	6
2NE-200	A	3/14/80	14:00	MCS	40 25.145N	073 52.332W	ST_I	2	4	4 to 3	0	0	7.6	8	0.4	7.8	0	4.46	0	7
2NE-200	B	3/14/80	14:01	MCS	40 25.145N	073 52.333W	ST_I	2	4	4 to 3	0	0	4.17	4.63	0.46	4.4	0	3.93	0	7
2NE300	A	3/14/80	14:15	MCS	40 25.331N	073 52.083W	ST_I	2	4	4 to 3	0	0	1.31	2.91	1.6	2.11	0	2.2	0	4
2NE300	B	3/14/80	14:15	MCS	40 25.335N	073 52.081W	ST_I	2	4	4 to 3	0	0	2.29	4	1.71	3.14	0	3.31	0	6
2SE100	A	3/14/80	11:08	MCS	40 24.315N	073 52.477W	ST_I_ON_III	3	>4	>4	0	0	11.7	12.16	0.45	11.93	0	0.97	0	7
2SE100	B	3/14/80	11:09	MCS	40 24.317N	073 52.468W	ST_I	3	>4	>4	0	0	12.39	12.95	0.57	12.67	0	1.67	0	4
2SE200	B	3/14/80	11:05	MCS	40 24.269N	073 52.413W	ST_I	2	4	4 to 3	0	0	3.52	4.49	0.97	4.01	0	4.02	0	7
2SE200	C	3/14/80	11:06	MCS	40 24.267N	073 52.412W	ST_I	2	4	4 to 3	0	0	1.19	3.47	2.27	2.33	0	2.75	0	5
2SE300	A	3/14/80	11:01	MCS	40 24.239N	073 52.368W	ST_I	2	4	4 to 3	0	0	4.26	6.02	1.76	5.14	0	5.08	0	7
2SE300	B	3/14/80	11:02	MCS	40 24.239N	073 52.374W	ST_I	2	4	4 to 3	0	0	1.36	5.63	4.26	3.49	0	3.72	0	6
2SE400	A	3/14/80	10:58	MCS	40 24.203N	073 52.317W	ST_I	2	4	4 to 3	0	0	4.94	5.34	0.4	5.14	0	5.07	0	7
2SE400	B	3/14/80	10:58	MCS	40 24.200N	073 52.317W	ST_I	2	4	4 to 3	0	0	2.73	4.03	1.31	3.38	0	2.93	0	5
2SW100	A	3/14/80	9:11	MCS	40 24.308N	073 53.415W	ST_I	2	>4	>4	0	0	7.02	9.16	2.13	8.09	0	1.01	0	3
2SW100	B	3/14/80	9:12	MCS	40 24.307N	073 53.412W	ST_I	2	>4	>4	0	0	7.92	8.37	0.45	8.15	0	0.63	0	2
2SW200	B	3/14/80	9:06	MCS	40 24.281N	073 53.443W	ST_I	2	>4	>4	0	0	9.27	11.35	2.08	10.31	0	1.08	0	3
2SW200	C	3/14/80	9:06	MCS	40 24.279N	073 53.435W	ST_I	2	>4	>4	0	0	8.88	9.78	0.9	9.33	0	0.45	0	2
2SW300	A	3/14/80	9:01	MCS	40 24.236N	073 53.514W	ST_I	2	>4	4 to 3	0	0	2.53	3.26	0.73	2.89	0	1.96	0	4
2SW300	C	3/14/80	9:02	MCS	40 24.227N	073 53.507W	ST_I	2	>4	>4	0	0	7.25	7.81	0.56	7.53	0	1.27	0	3
2SW400	A	3/14/80	8:58	MCS	40 24.204N	073 53.565W	ST_I	0	3	1 to 0	0	0	2.08	8.76	6.69	5.42	0	4.96	0	7
2SW400	B	3/14/80	8:58	MCS	40 24.202N	073 53.561W	ST_I	0	3	2 to 1	0	0	3.26	6.29	3.03	4.78	0	4.41	0	7
2SW500	B	3/14/80	8:55	MCS	40 24.158N	073 53.597W	INDET	0	3	2 to 1	0	0	1.97	3.09	1.12	2.53	0	2.29	0	99
2SW500	C	3/14/80	8:55	MCS	40 24.155N	073 53.594W	INDET	-1	3	1 to 0	0	0	5.17	5.79	0.62	5.48	0	5.14	0	99
3SW100	A	3/14/80	8:46	MCS	40 24.098N	073 53.405W	ST_I	3	>4	>4	0	0	8.03	9.44	1.4	8.74	0	0.8	0	3
3SW100	B	3/14/80	8:47	MCS	40 24.092N	073 53.395W	ST_I	2	>4	>4	0	0	7.25	7.75	0.51	7.5	0	1.29	0	3
3SW200	A	3/14/80	8:42	MCS	40 24.054N	073 53.456W	ST_I	2	>4	>4	0	0	7.81	8.43	0.62	8.12	0	1.33	0	3
3SW200	B	3/14/80	8:43	MCS	40 24.057N	073 53.441W	ST_I	2	>4	>4	0	0	7.81	8.2	0.39	8.01	0	1.42	0	3
3SW300	A	3/14/80	8:39	MCS	40 24.025N	073 53.503W	ST_I	2	>4	4 to 3	4	0.42	4.1	6.24	2.13	5.17	0	2.15	0	4
3SW300	B	3/14/80	8:39	MCS	40 24.021N	073 53.500W	ST_I	2	>4	4 to 3	0	0	9.16	10.62	1.46	9.89	0	2.65	0	5
3SW400	B	3/14/80	8:22	MCS	40 23.984N	073 53.553W	ST_I	-1	4	1 to 0	0	0	5.28	7.53	2.25	6.4	0	6.42	0	7
3SW400	E	3/14/80	8:33	MCS	40 23.983N	073 53.539W	ST_I	0	4	1 to 0	0	0	7.36	11.63	4.27	9.49	0	9.28	0	7
3SW500	A	3/14/80	8:17	MCS	40 23.947N	073 53.606W	ST_I	2	>4	4 to 3	0	0	3.09	4.38	1.29	3.74	0	1.42	0	3
3SW500	B	3/14/80	8:17	MCS	40 23.950N	073 53.603W	ST_I	2	4	4 to 3	0	0	3.48	4.55	1.07	4.02	0	1.68	0	4
A0	A	1/29/80	8:37	MCS	40 25.649N	073 53.909W	ST_I_TO_II	2	>4	>4	0	0	8.91	9.38	0.47	9.15	0	3.34	0	7

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
A0	B	1/29/80	8:38	MCS	40 25.648N	073 53.903W	ST_I_TO_II	2	>4	>4	0	0	6.42	7.93	1.5	7.18	0	1.7	0	5
A1200	B	1/29/80	13:00	MCS	40 25.646N	073 53.086W	INDET	-1	3	0 TO -1	0	0	1.39	3.9	2.51	2.65	0	2.8	0	99
A1200	D	1/30/80	7:24	MCS	40 25.652N	073 53.070W	ST_I	0	4	3 to 2	0	0	0.43	2.94	2.51	1.68	0	1.91	0	4
A1600	A	1/29/80	13:56	MCS	40 25.650N	073 52.795W	INDET	2	3	3 to 2	0	0	3.09	7.7	4.61	5.39	0	5.72	0	99
A1600	C	1/29/80	13:57	MCS	40 25.652N	073 52.794W	ST_I	2	4	3 to 2	0	0	4.5	5.97	1.47	5.24	0	5.44	0	7
A2000	B	1/29/80	15:37	MCS	40 25.650N	073 52.510W	ST_I	2	4	4 to 3	0	0	2.41	3.96	1.55	3.18	0	3.22	0	6
A2000	C	1/29/80	15:37	MCS	40 25.649N	073 52.510W	ST_I	2	4	4 to 3	0	0	1.83	2.77	0.94	2.3	0	2.24	0	4
A2400	B	1/29/80	16:27	MCS	40 25.648N	073 52.227W	ST_I	2	4	4 to 3	0	0	2.88	3.46	0.58	3.17	0	3.08	0	6
A2400	C	1/29/80	16:27	MCS	40 25.648N	073 52.226W	ST_I	2	4	4 to 3	0	0	1.94	4.71	2.77	3.32	0	3.1	0	6
A2800	C	1/30/80	10:17	MCS	40 25.645N	073 51.962W	ST_I	2	4	4 to 3	0	0	3.09	4.73	1.65	3.91	0	3.84	0	7
A2800	D	1/30/80	10:18	MCS	40 25.647N	073 51.951W	ST_I	2	4	4 to 3	0	0	4.15	4.63	0.48	4.39	0	4.26	0	7
A400	B	1/29/80	9:59	MCS	40 25.647N	073 53.635W	ST_I	2	>4	>4	0	0	8.31	8.68	0.37	8.49	0	3.09	0	6
A400	C	1/29/80	10:00	MCS	40 25.646N	073 53.636W	ST_I	2	>4	>4	2	0.22	10.26	10.79	0.53	10.53	0	4.18	0	7
A800	B	1/29/80	11:58	MCS	40 25.650N	073 53.360W	ST_I	2	>4	4 to 3	0	0	4.26	6.81	2.55	5.53	0	5.37	0	7
A800	C	1/29/80	11:59	MCS	40 25.649N	073 53.362W	ST_I	2	4	4 to 3	0	0	1.97	4.73	2.77	3.35	0	3.14	0	6
B0	B	1/29/80	8:51	MCS	40 25.430N	073 53.918W	ST_I_TO_II	2	>4	>4	0	0	7.31	7.82	0.52	7.56	0	1.71	0	5
B0	C	1/29/80	8:51	MCS	40 25.428N	073 53.922W	ST_I_TO_II	2	>4	>4	0	0	7.62	8.24	0.62	7.93	0	1.1	0	4
B1200	A	1/29/80	13:15	MCS	40 25.435N	073 53.072W	ST_I	2	>4	4 to 3	0	0	1.88	2.93	1.05	2.41	0	2.39	0	5
B1200	C	1/29/80	13:17	MCS	40 25.434N	073 53.074W	ST_I	2	>4	4 to 3	0	0	2.14	3.48	1.34	2.81	0	3	0	5
B1600	B	1/29/80	14:03	MCS	40 25.433N	073 52.789W	ST_I	2	>4	4 to 3	0	0	1.88	3.66	1.78	2.77	0	2.96	0	5
B1600	C	1/29/80	14:03	MCS	40 25.433N	073 52.788W	ST_I	2	4	4 to 3	0	0	6.34	7.23	0.89	6.78	0	6.68	0	7
B2000	A	1/29/80	15:43	MCS	40 25.432N	073 52.511W	ST_I	2	4	4 to 3	0	0	3.09	5.13	2.04	4.11	0	3.88	0	7
B2000	C	1/29/80	15:44	MCS	40 25.430N	073 52.516W	ST_I	2	4	4 to 3	0	0	3.61	5.29	1.68	4.45	0	4.53	0	7
B2400	B	1/29/80	16:34	MCS	40 25.433N	073 52.227W	ST_I	2	4	4 to 3	0	0	0.63	4.5	3.87	2.57	0	2.92	0	5
B2400	C	1/29/80	16:35	MCS	40 25.432N	073 52.228W	ST_I	-1	3	2 to 1	0	0	2.83	7.7	4.87	5.26	0	4.4	0	7
B2800	B	1/30/80	10:23	MCS	40 25.431N	073 51.951W	ST_I	2	4	4 to 3	0	0	4.79	7.13	2.34	5.96	0	5.89	0	7
B2800	C	1/30/80	10:24	MCS	40 25.431N	073 51.952W	ST_I	2	4	4 to 3	0	0	2.18	4.63	2.45	3.4	0	2.98	0	5
B400	A	1/29/80	10:11	MCS	40 25.433N	073 53.634W	ST_I_TO_II	2	>4	>4	0	0	6.83	7.35	0.53	7.09	0	1.33	0	4
B400	C	1/29/80	10:13	MCS	40 25.432N	073 53.634W	ST_I_TO_II	2	>4	>4	0	0	6.61	6.98	0.37	6.8	0	1.86	0	5
B800	A	1/29/80	12:03	MCS	40 25.434N	073 53.355W	ST_I_TO_II	2	>4	>4	0	0	8.35	8.88	0.53	8.62	0	3.14	0	7
B800	C	1/29/80	12:05	MCS	40 25.433N	073 53.356W	ST_I_TO_II	2	>4	>4	0	0	6.86	7.34	0.48	7.1	0	2.13	0	5
C0	A	1/29/80	8:56	MCS	40 25.213N	073 53.912W	ST_I	2	>4	>4	0	0	8.6	8.91	0.31	8.76	0	1	0	3
C0	B	1/29/80	8:58	MCS	40 25.216N	073 53.913W	ST_I	2	>4	>4	0	0	8.65	9.53	0.88	9.09	0	1.69	0	4
C1200	A	1/29/80	13:22	MCS	40 25.216N	073 53.070W	ST_I_TO_II	2	>4	>4	0	0	8.48	9.95	1.47	9.21	0	4.51	0	8
C1200	B	1/29/80	13:23	MCS	40 25.217N	073 53.069W	ST_I_TO_II	2	>4	>4	0	0	7.8	8.95	1.15	8.38	0	6.03	0	8
C1600	A	1/29/80	14:09	MCS	40 25.217N	073 52.794W	ST_I_TO_II	2	>4	>4	0	0	5.13	5.65	0.52	5.39	0	2.98	0	6
C1600	B	1/29/80	14:10	MCS	40 25.217N	073 52.794W	ST_I_TO_II	2	>4	>4	0	0	6.28	6.6	0.31	6.44	0	1.87	0	5
C2000	B	1/29/80	15:49	MCS	40 25.212N	073 52.519W	ST_I	2	>4	4 to 3	0	0	2.41	2.98	0.58	2.7	0	2.84	0	5
C2000	C	1/29/80	15:50	MCS	40 25.213N	073 52.521W	ST_I	2	>4	4 to 3	0	0	2.83	3.61	0.79	3.22	0	3.2	0	6
C2400	A	1/29/80	16:40	MCS	40 25.215N	073 52.231W	ST_I	0	>4	2 to 1	0	0	3.46	3.83	0.37	3.64	0	3.56	0	6
C2400	B	1/29/80	16:40	MCS	40 25.215N	073 52.233W	ST_I	1	3	2 to 1	0	0	8.03	10.32	2.29	9.18	0	4.21	0	7
C2400	C	1/29/80	16:41	MCS	40 25.215N	073 52.235W	ST_I	4	>4	>4	0	0	0.53	2.13	1.6	1.33	0	1.8	0	4
C2800	A	1/30/80	10:29	MCS	40 25.214N	073 51.951W	ST_I	2	4	4 to 3	0	0	2.55	4.95	2.39	3.75	0	3.82	0	7
C2800	B	1/30/80	10:30	MCS	40 25.213N	073 51.956W	ST_I	2	4	4 to 3	0	0	3.83	5.48	1.65	4.65	0	4.01	0	7
C400	A	1/29/80	10:19	MCS	40 25.219N	073 53.641W	ST_I	2	>4	>4	0	0	8.2	8.73	0.53	8.47	0	2.27	0	5
C400	B	1/29/80	10:19	MCS	40 25.219N	073 53.641W	ST_I	2	>4	>4	0	0	6.83	7.35	0.53	7.09	0	1.41	0	3
C800	B	1/29/80	12:10	MCS	40 25.218N	073 53.352W	ST_I	2	>4	>4	0	0	7.85	8.48	0.63	8.17	0	0.88	0	3
C800	C	1/29/80	12:11	MCS	40 25.214N	073 53.355W	ST_I_TO_II	2	>4	>4	0	0	9.11	9.69	0.58	9.4	0	1.57	0	5
D0	A	1/29/80	9:04	MCS	40 25.000N	073 53.912W	ST_I	2	>4	>4	0	0	9.07	9.79	0.73	9.43	0	0.3	0	2
D0	B	1/29/80	9:04	MCS	40 24.999N	073 53.912W	ST_I	2	>4	>4	0	0	8.76	9.12	0.36	8.94	0	0.01	0	2
D1200	B	1/29/80	13:28	MCS	40 25.003N	073 53.072W	ST_II_ON_III	2	>4	>4	0	0	18.12	19.37	1.26	18.74	0	1.7	0	8
D1200	C	1/29/80	13:29	MCS	40 25.003N	073 53.072W	ST_I	2	>4	>4	0	0	17.64	18.17	0.52	17.91	0	1.33	0	3

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
D2000	B	1/29/80	15:57	MCS	40 24.998N	073 52.516W	ST_I	2	>4	>4	0	0	6.65	7.02	0.37	6.83	0	2.38	0	5
D2000	C	1/29/80	15:57	MCS	40 24.997N	073 52.517W	ST_I	2	>4	>4	0	0	2.72	3.66	0.94	3.19	0	2.12	0	4
D2400	A	1/29/80	16:50	MCS	40 24.999N	073 52.226W	ST_I	2	4	4 to 3	0	0	2.51	3.16	0.64	2.83	0	2.75	0	5
D2400	C	1/29/80	16:51	MCS	40 24.998N	073 52.225W	ST_I	2	>4	4 to 3	0	0	1.76	4.26	2.5	3.01	0	2.66	0	5
D2800	B	1/30/80	10:37	MCS	40 24.999N	073 51.947W	ST_I	0	4	4 to 3	0	0	1.76	4.04	2.29	2.9	0	3.19	0	6
D2800	C	1/30/80	10:38	MCS	40 24.998N	073 51.948W	ST_I	2	>4	4 to 3	0	0	1.81	3.3	1.49	2.55	0	2.5	0	5
D400	A	1/29/80	10:28	MCS	40 25.000N	073 53.640W	ST_I_TO_II	2	>4	>4	0	0	10.48	11.22	0.74	10.85	0	0.9	0	4
D400	B	1/29/80	10:29	MCS	40 25.000N	073 53.640W	ST_I_TO_II	2	>4	>4	0	0	9.1	9.74	0.63	9.42	0	1.05	0	4
D800	A	1/29/80	12:21	MCS	40 25.003N	073 53.361W	ST_I_TO_II	2	>4	>4	0	0	8.59	9.53	0.94	9.06	0	2.15	0	5
D800	B	1/29/80	12:22	MCS	40 24.999N	073 53.364W	ST_I_TO_II	2	>4	>4	0	0	9.69	10.31	0.63	10	0	2.35	0	6
E0	A	1/29/80	9:10	MCS	40 24.784N	073 53.921W	ST_I	2	>4	3 to 2	0	0	6.58	6.89	0.31	6.74	0	2.18	0	4
E0	B	1/29/80	9:11	MCS	40 24.785N	073 53.921W	ST_I	2	>4	>4	0	0	8.34	8.6	0.26	8.47	0	2.39	0	5
E1200	D	1/30/80	8:06	MCS	40 24.786N	073 53.071W	ST_I	2	>4	>4	0	0	18.64	19.9	1.26	19.27	0	1.15	16.41	1
E1200	E	1/30/80	8:07	MCS	40 24.785N	073 53.073W	ST_I	2	>4	>4	0	0	19.74	19.95	0.21	19.84	0	1.02	0	3
E1600	H	3/24/80	8:31	MCS	40 24.778N	073 52.790W	ST_I_ON_III	2	>4	>4	0	0	14.6	15.11	0.51	14.86	0	2.49	0	9
E1600	K	3/24/80	8:33	MCS	40 24.776N	073 52.791W	ST_I	3	>4	>4	0	0	8.86	12.39	3.52	10.63	0	0.75	0	2
E2000	A	1/29/80	16:06	MCS	40 24.786N	073 52.514W	ST_I_TO_II	2	>4	>4	0	0	17.28	17.43	0.16	17.36	0	2.56	0	6
E2000	C	1/29/80	16:07	MCS	40 24.787N	073 52.515W	ST_II_ON_III	2	>4	>4	4	0.61	17.38	18.32	0.94	17.85	0	2.54	0	9
E2400	A	1/29/80	16:57	MCS	40 24.781N	073 52.233W	ST_I	2	4	4 to 3	0	0	2.61	4.73	2.13	3.67	0	3.42	0	6
E2400	C	1/29/80	16:59	MCS	40 24.782N	073 52.239W	ST_I	2	4	4 to 3	0	0	1.49	5.05	3.56	3.27	0	2.84	0	5
E2800	A	1/30/80	10:47	MCS	40 24.785N	073 51.954W	ST_I	2	4	4 to 3	0	0	2.02	7.02	5	4.52	0	4.51	0	7
E2800	D	1/30/80	10:49	MCS	40 24.784N	073 51.951W	ST_I	2	4	4 to 3	0	0	1.86	4.15	2.29	3.01	0	2.94	0	5
E300	A	3/24/80	9:33	MCS	40 24.909N	073 52.721W	ST_I_ON_III	2	>4	>4	12	0.18	17.84	18.41	0.57	18.13	0	0.66	0	6
E300	B	3/24/80	9:33	MCS	40 24.908N	073 52.721W	ST_I_ON_III	2	>4	>4	0	0	17.5	18.92	1.42	18.21	0	0.51	0	6
E400	A	3/24/80	9:28	MCS	40 24.907N	073 52.643W	ST_I	2	>4	>4	0	0	14.09	14.94	0.85	14.52	0	1.37	0	3
E400	B	1/29/80	10:58	MCS	40 24.780N	073 53.637W	ST_I	2	>4	>4	0	0	8.89	9.95	1.06	9.42	0	0.5	0	2
E400	C	1/29/80	10:58	MCS	40 24.781N	073 53.637W	ST_I	2	>4	>4	0	0	9.41	10.16	0.74	9.79	0	0.01	0	2
E400	C	3/24/80	9:29	MCS	40 24.908N	073 52.645W	ST_I_ON_III	2	>4	>4	0	0	15.74	16.76	1.02	16.25	0	2.6	0	9
E500	A	3/24/80	9:16	MCS	40 24.912N	073 52.577W	ST_I	2	>4	>4	0	0	6.48	7.1	0.63	6.79	4.59	1.44	0	3
E500	B	3/24/80	9:17	MCS	40 24.913N	073 52.581W	ST_I	3	>4	>4	5	0.31	10.28	11.88	1.59	11.08	0	7.13	0	7
E600	A	3/24/80	9:12	MCS	40 24.912N	073 52.503W	INDET	-1	-1	<-1	0	0	0.06	0.06	0	0.06	0	NA	0	99
E600	C	3/24/80	9:13	MCS	40 24.911N	073 52.501W	INDET	-1	-1	<-1	0	0	0.06	0.06	0	0.06	0	NA	0	99
E700	B	3/24/80	9:08	MCS	40 24.906N	073 52.425W	ST_I	2	>4	4 to 3	0	0	6.19	7.39	1.19	6.79	0	2.82	0	5
E700	C	3/24/80	9:08	MCS	40 24.908N	073 52.426W	ST_I	2	>4	4 to 3	0	0	1.88	3.3	1.42	2.59	0	1.14	0	3
E800	A	1/29/80	12:35	MCS	40 24.786N	073 53.357W	ST_I	2	>4	>4	0	0	11.41	12.3	0.89	11.86	0	0.4	0	2
E800	A	3/24/80	9:01	MCS	40 24.904N	073 52.366W	ST_I	2	>4	4 to 3	0	0	7.44	8.3	0.85	7.87	0	3.77	0	7
E800	B	1/29/80	12:36	MCS	40 24.786N	073 53.357W	ST_I_ON_III	2	>4	>4	0	0	10.52	11.68	1.15	11.1	0	0.5	0	6
E800	B	3/24/80	9:01	MCS	40 24.902N	073 52.369W	ST_I	2	>4	4 to 3	0	0	3.41	5	1.59	4.2	0	2.76	0	5
E900	A	3/24/80	8:55	MCS	40 24.914N	073 52.292W	ST_I	2	4	3 to 2	0	0	3.69	4.6	0.91	4.15	0	2.52	0	5
E900	B	3/24/80	8:55	MCS	40 24.913N	073 52.296W	ST_I	2	>4	3 to 2	0	0	3.3	5.45	2.16	4.38	0	1.79	0	4
ENE300	B	3/14/80	13:20	MCS	40 24.979N	073 52.743W	ST_I_ON_III	2	>4	>4	0	0	20	20.4	0.4	20.2	0	1.42	0	7
ENE300	C	3/14/80	13:23	MCS	40 24.976N	073 52.720W	ST_I_ON_III	2	>4	>4	0	0	17.43	18.51	1.09	17.97	0	1.27	0	7
ENE400	A	3/14/80	13:44	MCS	40 24.995N	073 52.655W	ST_II_ON_III	3	>4	>4	0	0	11.77	12.57	0.8	12.17	8.25	2.02	0	8
ENE400	B	3/14/80	13:44	MCS	40 24.998N	073 52.655W	ST_II_ON_III	3	>4	>4	0	0	11.66	12.29	0.63	11.97	9.2	2.93	0	9
ENE500	D	3/24/80	9:39	MCS	40 25.009N	073 52.594W	ST_I	2	>4	>4	5	0.37	3.64	4.89	1.25	4.26	0	1.15	0	3
ENE500	E	3/24/80	9:40	MCS	40 25.004N	073 52.596W	ST_I_ON_III	2	>4	>4	6	0.35	8.76	10.11	1.36	9.44	5.37	1.53	0	8
ENE500	F	3/24/80	9:42	MCS	40 25.008N	073 52.607W	ST_I_TO_II	2	>4	>4	0	0	7.16	8.69	1.53	7.93	0	2.31	0	6
ENE600	A	3/14/80	13:51	MCS	40 25.037N	073 52.533W	ST_I	2	>4	4 to 3	0	0	8.17	9.2	1.03	8.69	0	3.82	0	7
ENE600	B	3/14/80	13:52	MCS	40 25.041N	073 52.531W	ST_I_TO_II	2	>4	4 to 3	0	0	1.54	3.83	2.29	2.69	0	1.73	0	5
ENE700	B	3/14/80	13:56	MCS	40 25.061N	073 52.458W	ST_I	2	>4	4 to 3	0	0	4	4.74	0.74	4.37	0	1.71	0	4
ENE700	C	3/14/80	13:56	MCS	40 25.063N	073 52.456W	ST_I	2	>4	4 to 3	0	0	2.69	3.54	0.86	3.11	0	2.39	0	5
ESE100	G	3/24/80	8:48	MCS	40 24.698N	073 52.283W	ST_I	2	4	4 to 3	0	0	1.82	3.3	1.48	2.56	0	2.57	0	5

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
ESE100	H	3/24/80	8:49	MCS	40 24.696N	073 52.286W	ST_I	2	4	4 to 3	0	0	2.5	3.86	1.36	3.18	0	3.16	0	6
ESE1100	B	3/14/80	12:50	MCS	40 24.676N	073 52.211W	ST_I	2	>4	4 to 3	0	0	6.76	7.84	1.08	7.3	0	2.86	0	5
ESE1100	C	3/14/80	12:51	MCS	40 24.681N	073 52.208W	ST_I	2	>4	4 to 3	0	0	6.76	8.18	1.42	7.47	0	3.3	0	6
ESE600	B	3/14/80	13:14	MCS	40 24.791N	073 52.533W	ST_I_TO_II	2	>4	>4	0	0	12.23	13.2	0.97	12.71	0	1.77	0	5
ESE600	C	3/14/80	13:15	MCS	40 24.792N	073 52.531W	ST_I	2	>4	>4	0	0	11.26	11.83	0.57	11.54	0	1.4	0	3
ESE700	A	3/14/80	13:09	MCS	40 24.764N	073 52.471W	ST_II	2	>4	>4	0	0	7.37	8.34	0.97	7.86	0	2.61	0	7
ESE700	B	3/14/80	13:09	MCS	40 24.769N	073 52.472W	ST_II	3	>4	>4	0	0	14.17	14.86	0.69	14.51	0	4.6	0	9
ESE800	A	3/14/80	13:05	MCS	40 24.742N	073 52.409W	ST_II	2	>4	4 to 3	0	0	6.51	7.54	1.03	7.03	0	2.06	0	6
ESE800	C	3/14/80	13:06	MCS	40 24.746N	073 52.405W	ST_II	2	>4	4 to 3	0	0	3.77	7.71	3.94	5.74	0	2.75	0	7
ESE900	A	3/14/80	12:58	MCS	40 24.727N	073 52.343W	ST_I	2	>4	4 to 3	0	0	4.49	6.7	2.22	5.6	0	3.03	0	6
ESE900	B	3/14/80	12:59	MCS	40 24.730N	073 52.342W	ST_I	2	4	4 to 3	0	0	4.97	5.94	0.97	5.46	0	3.58	0	6
ESE900	C	3/14/80	13:00	MCS	40 24.730N	073 52.342W	ST_I	2	>4	>4	0	0	7.63	8.76	1.13	8.19	5.51	1.77	0	4
F0	B	1/29/80	9:18	MCS	40 24.571N	073 53.924W	ST_I	2	>4	4 to 3	0	0	7.15	10.88	3.73	9.02	0	8.27	0	7
F0	C	1/29/80	9:18	MCS	40 24.570N	073 53.924W	ST_I	1	3	3 to 2	0	0	3.6	6.24	2.65	4.92	0	4.64	0	7
F1200	A	1/29/80	13:41	MCS	40 24.787N	073 53.075W	ST_I	2	>4	>4	0	0	18.43	19.84	1.41	19.14	0	4.03	0	7
F1200	C	1/29/80	13:42	MCS	40 24.570N	073 53.071W	ST_I	2	>4	>4	0	0	12.88	17.43	4.55	15.16	0	1	0	3
F1600	D	1/30/80	8:16	MCS	40 24.568N	073 52.793W	ST_I	2	>4	>4	0	0	11.78	12.46	0.68	12.12	0	1.19	0	3
F1600	G	1/30/80	8:18	MCS	40 24.569N	073 52.794W	ST_I	2	>4	>4	0	0	18.8	19.27	0.47	19.03	0	2.17	0	4
F1600	H	3/24/80	8:24	MCS	40 24.565N	073 52.793W	ST_I	3	>4	>4	0	0	5.28	6.42	1.14	5.85	0	0.49	0	2
F1600	K	3/24/80	8:25	MCS	40 24.565N	073 52.807W	ST_III	3	>4	>4	0	0	4.49	6.19	1.7	5.34	0	0.73	0	6
F2000	B	1/29/80	16:12	MCS	40 24.567N	073 52.507W	ST_II_ON_III	2	>4	>4	0	0	10	13.93	3.93	11.96	0	5.01	0	11
F2000	C	1/29/80	16:13	MCS	40 24.565N	073 52.513W	ST_II	2	>4	>4	0	0	13.87	15.39	1.52	14.63	0	7.74	0	9
F2400	A	1/30/80	9:52	MCS	40 24.567N	073 52.230W	ST_I	2	4	4 to 3	0	0	5.74	6.44	0.69	6.09	0	3.4	0	6
F2400	B	1/30/80	9:52	MCS	40 24.567N	073 52.229W	ST_I	2	4	4 to 3	0	0	5.16	6.01	0.85	5.59	0	2.42	0	5
F2800	B	1/30/80	10:55	MCS	40 24.568N	073 51.950W	ST_I	-1	3	<-1	0	0	0.05	0.05	0	0.05	0	NA	0	99
F2800	D	1/30/80	10:56	MCS	40 24.561N	073 51.961W	ST_I	0	3	2 to 1	0	0	6.81	10.59	3.78	8.7	0	8.23	0	7
F400	A	1/29/80	11:08	MCS	40 24.567N	073 53.638W	ST_I_TO_II	2	>4	>4	0	0	11.38	11.65	0.27	11.52	0	0.75	0	3
F400	B	1/29/80	11:08	MCS	40 24.568N	073 53.637W	ST_I_TO_II	2	>4	>4	0	0	12.45	13.14	0.69	12.79	0	0.9	0	4
F800	A	1/29/80	12:45	MCS	40 24.569N	073 53.357W	ST_I	2	>4	>4	0	0	11.26	13.04	1.78	12.15	0	1.31	0	3
F800	B	1/29/80	12:45	MCS	40 24.568N	073 53.358W	ST_I	2	>4	>4	0	0	14.76	15.97	1.2	15.37	0	0.75	0	2
G0	A	1/29/80	9:27	MCS	40 24.351N	073 53.914W	INDET	-1	>4	0 TO -1	0	0	1.16	2.43	1.27	1.8	0	1.86	0	99
G0	B	1/29/80	9:27	MCS	40 24.352N	073 53.915W	INDET	0	3	2 to 1	0	0	7.35	11.38	4.02	9.37	0	8.52	0	99
G1200	H	3/24/80	8:13	MCS	40 23.349N	073 53.081W	ST_I	3	>4	>4	20	0.18	3.64	4.94	1.31	4.29	0	0.5	0	2
G1200	I	3/24/80	8:13	MCS	40 24.348N	073 53.084W	AZOIC	3	>4	>4	0	0	5.28	5.68	0.4	5.48	0	0.25	0	-3
G1600	B	1/30/80	9:15	MCS	40 24.352N	073 52.790W	ST_I	2	>4	>4	0	0	19.1	19.89	0.8	19.49	0	2.22	0	4
G1600	C	1/30/80	9:16	MCS	40 24.352N	073 52.789W	ST_II_ON_III	2	>4	>4	0	0	17.93	18.4	0.48	18.17	0	2.09	0	8
G2000	A	1/30/80	9:21	MCS	40 24.353N	073 52.511W	ST_I	2	>4	>4	0	0	11.28	13.03	1.76	12.15	0	2.03	0	4
G2000	B	1/30/80	9:21	MCS	40 24.353N	073 52.507W	ST_I_ON_III	2	>4	>4	0	0	10.69	10.85	0.16	10.77	0	0.79	0	7
G2400	B	1/30/80	9:44	MCS	40 24.352N	073 52.230W	ST_I	2	>4	>4	0	0	5.96	9.47	3.51	7.71	0	2.01	0	4
G2400	D	1/30/80	9:45	MCS	40 24.350N	073 52.229W	ST_I	2	>4	4 to 3	0	0	1.91	3.99	2.07	2.95	0	1.57	0	4
G2800	A	1/30/80	11:01	MCS	40 24.351N	073 51.951W	ST_I	2	4	4 to 3	0	0	3.51	4.36	0.85	3.94	0	3.77	0	7
G2800	B	1/30/80	11:02	MCS	40 24.347N	073 51.954W	ST_I	1	4	4 to 3	0	0	1.76	2.71	0.96	2.23	0	1.93	0	4
G400	A	1/29/80	11:33	MCS	40 24.352N	073 53.635W	ST_I	-1	4	2 to 1	0	0	3.78	8.35	4.57	6.06	0	2.72	0	5
G400	C	1/29/80	11:34	MCS	40 24.352N	073 53.638W	ST_I	-1	4	2 to 1	0	0	1.22	5.96	4.73	3.59	0	2.88	0	5
G800	A	1/30/80	8:26	MCS	40 24.353N	073 53.356W	ST_I	2	>4	>4	0	0	16.22	16.44	0.21	16.33	8.12	1.92	0	4
G800	B	1/30/80	8:26	MCS	40 24.353N	073 53.356W	ST_I	2	>4	>4	0	0	18.88	20.21	1.33	19.55	8.49	4.28	0	7
H0	B	1/29/80	9:36	MCS	40 24.134N	073 53.916W	INDET	-1	3	2 to 1	0	0	6.46	7.51	1.06	6.98	0	6.2	0	99
H0	C	1/29/80	9:37	MCS	40 24.135N	073 53.917W	INDET	-1	4	2 to 1	0	0	2.17	2.96	0.79	2.57	0	2.29	0	99
H1200	A	1/30/80	8:59	MCS	40 24.135N	073 53.072W	ST_I_ON_III	1	>4	>4	0	0	11.6	12.29	0.69	11.94	0	1.71	0	8
H1200	D	1/30/80	9:00	MCS	40 24.134N	073 53.073W	ST_I	<-1	>4	4 to 3	0	0	2.61	4.04	1.44	3.32	0	3.25	0	6
H1600	C	1/30/80	9:07	MCS	40 24.135N	073 52.782W	ST_I	<-1	>4	4 to 3	0	0	11.49	12.77	1.28	12.13	0	4.38	0	7
H1600	D	1/30/80	9:08	MCS	40 24.137N	073 52.782W	INDET	-1	-1	<-1	0	0	0.05	0.05	0	0.05	0	NA	0	99

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
H2000	A	1/30/80	9:29	MCS	40 24.136N	073 52.508W	ST_I	2	4	4 to 3	0	0	3.99	6.54	2.55	5.27	0	5.21	0	7
H2000	C	1/30/80	9:30	MCS	40 24.132N	073 52.503W	ST_I	2	4	4 to 3	0	0	2.34	3.67	1.33	3.01	0	3.17	0	6
H2400	A	1/30/80	9:36	MCS	40 24.135N	073 52.232W	ST_I	2	4	4 to 3	0	0	4.2	5.32	1.12	4.76	0	5.02	0	7
H2400	B	1/30/80	9:36	MCS	40 24.134N	073 52.230W	ST_I	2	4	4 to 3	0	0	3.19	5.59	2.39	4.39	0	4.44	0	7
H2800	A	1/30/80	11:09	MCS	40 24.133N	073 51.951W	ST_I	2	4	4 to 3	0	0	6.6	8.99	2.39	7.79	0	6.97	0	7
H2800	D	1/30/80	11:16	MCS	40 24.131N	073 51.936W	ST_I	0	4	3 to 2	0	0	7.5	8.35	0.85	7.93	0	8.08	0	7
H400	A	1/29/80	11:40	MCS	40 24.139N	073 53.641W	ST_I	-1	>4	2 to 1	0	0	0.16	3.19	3.03	1.68	0	2.33	0	5
H400	B	1/29/80	11:40	MCS	40 24.134N	073 53.643W	ST_I	-1	>4	2 to 1	0	0	1.6	3.35	1.76	2.47	0	1.75	0	4
H800	C	1/30/80	8:45	MCS	40 24.135N	073 53.357W	ST_I	1	>4	4 to 3	0	0	4.89	5.8	0.9	5.35	0	1.25	0	3
H800	D	1/30/80	8:46	MCS	40 24.135N	073 53.357W	ST_I	1	>4	4 to 3	0	0	6.01	6.49	0.48	6.25	0	2.05	0	4
N200	A	3/14/80	15:12	MCS	40 25.021N	073 52.919W	ST_I_ON_III	3	>4	>4	0	0	13.71	16.69	2.97	15.2	0	0.53	0	6
N200	B	3/14/80	15:13	MCS	40 25.020N	073 52.914W	ST_I_ON_III	3	>4	>4	0	0	16.17	16.74	0.57	16.46	0	1.03	0	7
N300	B	3/14/80	13:16	MCS	40 25.076N	073 52.911W	ST_I_ON_III	3	>4	>4	0	0	10.74	11.66	0.91	11.2	0	0.66	0	6
N300	C	3/14/80	13:17	MCS	40 25.080N	073 52.910W	ST_I	3	>4	>4	0	0	10.29	10.57	0.29	10.43	7.18	0.96	0	3
N400	B	3/14/80	15:21	MCS	40 25.131N	073 52.932W	ST_I	3	>4	>4	0	0	8.34	9.31	0.97	8.83	0	1.41	0	3
N400	C	3/14/80	15:21	MCS	40 25.132N	073 52.922W	ST_I_TO_II	3	>4	>4	0	0	6.91	8.17	1.26	7.54	0	0.89	0	4
N500	A	3/14/80	15:24	MCS	40 25.180N	073 52.911W	ST_I_TO_II	2	>4	>4	0	0	7.66	7.94	0.29	7.8	0	0.95	0	4
N500	B	3/14/80	15:25	MCS	40 25.178N	073 52.911W	ST_I_TO_II	3	>4	>4	0	0	7.6	8.29	0.69	7.94	0	1.1	0	4
N600	A	3/14/80	15:33	MCS	40 25.235N	073 52.911W	ST_I	2	>4	4 to 3	0	0	3.77	4.29	0.51	4.03	0	1.7	0	4
N600	B	3/14/80	15:36	MCS	40 25.240N	073 52.921W	ST_I	2	>4	4 to 3	0	0	2.06	3.09	1.03	2.57	0	2.35	0	5
NE300	A	3/14/80	14:33	MCS	40 25.034N	073 52.772W	ST_I_ON_III	2	>4	>4	0	0	15.71	16.69	0.97	16.2	0	0.72	0	6
NE300	C	3/14/80	14:35	MCS	40 25.033N	073 52.771W	ST_I_ON_III	2	>4	>4	0	0	14.34	15.26	0.91	14.8	0	1.25	0	7
NE400	B	3/14/80	14:37	MCS	40 25.068N	073 52.722W	ST_I	2	>4	>4	0	0	9.71	9.83	0.11	9.77	0	2.5	0	5
NE400	C	3/14/80	14:38	MCS	40 25.071N	073 52.720W	ST_I	2	>4	>4	0	0	9.6	10.17	0.57	9.89	5.78	0.95	0	3
NE500	A	3/14/80	14:40	MCS	40 25.101N	073 52.676W	ST_I_TO_II	2	>4	4 to 3	0	0	5.31	5.89	0.57	5.6	0	1.44	0	4
NE500	C	3/14/80	14:42	MCS	40 25.108N	073 52.670W	ST_I	2	>4	>4	0	0	12.63	12.97	0.34	12.8	7.71	0.93	0	3
NE600	B	3/14/80	14:59	MCS	40 25.145N	073 52.614W	ST_I	3	>4	>4	0	0	1.66	3.31	1.66	2.49	0	1.45	0	3
NE600	C	3/14/80	15:00	MCS	40 25.147N	073 52.619W	ST_II	2	>4	4 to 3	0	0	1.89	3.03	1.14	2.46	0	1.66	0	6
NE700	B	3/14/80	15:04	MCS	40 25.188N	073 52.570W	ST_I	2	>4	4 to 3	0	0	1.83	3.49	1.66	2.66	0	1.27	0	3
NE700	C	3/14/80	15:05	MCS	40 25.189N	073 52.567W	ST_I	2	>4	4 to 3	0	0	7.54	9.54	2	8.54	0	1.93	0	4
NW300	A	3/14/80	15:44	MCS	40 25.032N	073 53.066W	ST_I_ON_III	2	>4	>4	0	0	17.77	19.2	1.43	18.49	0	1.26	0	7
NW300	B	3/14/80	15:45	MCS	40 25.032N	073 53.060W	ST_I_ON_III	2	>4	>4	0	0	16.63	17.2	0.57	16.91	0	0.76	0	7
NW400	A	3/14/80	15:48	MCS	40 25.067N	073 53.113W	ST_I_ON_III	2	>4	>4	0	0	11.71	12.51	0.8	12.11	7.84	1.02	0	7
NW400	B	3/14/80	15:49	MCS	40 25.071N	073 53.109W	ST_I	2	>4	>4	0	0	8.86	9.83	0.97	9.34	5.86	1.25	0	3
NW500	A	3/14/80	15:53	MCS	40 25.106N	073 53.163W	ST_I	3	>4	>4	0	0	6.4	7.09	0.69	6.74	0	0.67	0	2
NW500	C	3/14/80	15:54	MCS	40 25.110N	073 53.159W	ST_I	2	>4	>4	0	0	6.46	7.2	0.74	6.83	0	1.17	0	3
NW600	A	3/24/80	11:20	MCS	40 25.138N	073 53.218W	ST_I_TO_II	3	>4	>4	0	0	6.93	7.73	0.8	7.33	0	0.76	0	4
NW600	B	3/24/80	11:20	MCS	40 25.136N	073 53.217W	ST_I_TO_II	3	>4	>4	0	0	6.48	7.9	1.42	7.19	0	0.8	0	4
NW700	A	3/24/80	11:25	MCS	40 25.174N	073 53.265W	ST_I_TO_II	3	>4	>4	0	0	6.99	7.56	0.57	7.27	0	1.17	0	4
NW700	B	3/24/80	11:26	MCS	40 25.174N	073 53.263W	ST_I_TO_II	3	>4	>4	0	0	7.16	7.61	0.45	7.39	0	0.82	0	4
NW800	A	3/24/80	11:31	MCS	40 25.217N	073 53.318W	ST_I	3	>4	>4	0	0	5.06	6.25	1.19	5.65	0	1.68	0	4
NW800	C	3/24/80	11:32	MCS	40 25.215N	073 53.316W	INDET	-1	-1	<-1	0	0	0.06	0.06	0	0.06	0	NA	0	99
SE1200	A	3/14/80	11:13	MCS	40 24.450N	073 52.322W	ST_I	2	4	4 to 3	0	0	1.53	3.13	1.59	2.33	0	2.17	0	4
SE1200	C	3/14/80	11:15	MCS	40 24.444N	073 52.320W	ST_I	2	4	4 to 3	0	0	3.86	6.08	2.22	4.97	0	4.74	0	7
SE1300	A	3/14/80	11:56	MCS	40 24.414N	073 52.272W	ST_I	2	4	4 to 3	0	0	3.18	4.72	1.53	3.95	0	3.8	0	7
SE1300	C	3/14/80	11:57	MCS	40 24.420N	073 52.274W	ST_I	2	4	4 to 3	0	0	0.45	4.26	3.81	2.36	0	2.01	0	4
SE1400	A	3/14/80	11:52	MCS	40 24.370N	073 52.223W	ST_I	2	4	4 to 3	0	0	2.16	5.68	3.52	3.92	0	3.01	0	6
SE1400	C	3/14/80	11:53	MCS	40 24.376N	073 52.222W	ST_I	2	4	4 to 3	0	0	2.95	4.38	1.42	3.66	0	3.3	0	6
SE1500	A	3/14/80	11:44	MCS	40 24.338N	073 52.182W	ST_I	1	>4	3 to 2	0	0	7.56	8.75	1.19	8.15	0	4.11	0	7
SE1500	B	3/14/80	11:45	MCS	40 24.348N	073 52.189W	ST_I	2	4	4 to 3	0	0	3.86	6.31	2.44	5.09	0	4.93	0	7
SE1600	A	3/14/80	11:41	MCS	40 24.295N	073 52.128W	ST_I	2	4	4 to 3	0	0	1.99	4.03	2.05	3.01	0	2.64	0	5
SE1600	B	3/14/80	11:41	MCS	40 24.296N	073 52.128W	ST_I	2	4	4 to 3	0	0	2.1	3.69	1.59	2.9	0	2.83	0	5

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
SE1700	A	3/14/80	11:37	MCS	40 24.258N	073 52.086W	INDET	2	>4	4 to 3	0	0	7.84	8.81	0.97	8.32	0	5.42	0	99
SE1700	C	3/14/80	11:39	MCS	40 24.267N	073 52.093W	ST_I	2	>4	4 to 3	0	0	5.11	7.1	1.99	6.11	0	4.74	0	7
SE1800	A	3/14/80	11:34	MCS	40 24.223N	073 52.036W	ST_I	1	4	3 to 2	0	0	2.27	3.3	1.02	2.78	0	2.71	0	5
SE1800	C	3/14/80	11:35	MCS	40 24.228N	073 52.030W	ST_I	2	4	4 to 3	0	0	2.44	4.66	2.22	3.55	0	3.65	0	6
SSE1200	A	3/14/80	10:51	MCS	40 24.313N	073 52.605W	ST_I	3	>4	>4	0	0	12.9	13.35	0.45	13.13	0	2.7	0	5
SSE1200	C	3/14/80	10:52	MCS	40 24.310N	073 52.608W	ST_I	3	>4	>4	0	0	12.95	14.09	1.14	13.52	0	1.73	0	4
SSE1300	B	3/14/80	10:48	MCS	40 24.254N	073 52.573W	ST_I_ON_III	3	>4	>4	0	0	11.36	11.99	0.63	11.68	0	2	0	8
SSE1300	C	3/14/80	10:48	MCS	40 24.254N	073 52.572W	ST_I_ON_III	3	>4	>4	0	0	12.95	14.2	1.25	13.58	0	0.96	0	7
SSE1400	B	3/14/80	10:44	MCS	40 24.209N	073 52.544W	ST_I	3	>4	>4	0	0	8.69	10.11	1.42	9.4	0	1.41	0	3
SSE1400	C	3/14/80	10:45	MCS	40 24.210N	073 52.545W	ST_I_ON_III	3	>4	>4	0	0	11.82	12.39	0.57	12.1	0	1.59	0	8
SSE1500	A	3/14/80	10:40	MCS	40 24.168N	073 52.530W	ST_I	2	4	4 to 3	0	0	4.66	7.39	2.73	6.02	0	6.46	0	7
SSE1500	B	3/14/80	10:40	MCS	40 24.168N	073 52.530W	ST_I	2	>4	>4	0	0	7.73	9.15	1.42	8.44	0	1.41	0	3
SSE1600	A	3/14/80	10:36	MCS	40 24.114N	073 52.496W	ST_I	2	>4	4 to 3	0	0	5.34	6.42	1.08	5.88	0	2.4	0	5
SSE1600	C	3/14/80	10:37	MCS	40 24.112N	073 52.494W	ST_I	2	>4	4 to 3	0	0	3.35	4.09	0.74	3.72	0	3.13	0	6
SSE1700	B	3/14/80	10:33	MCS	40 24.056N	073 52.470W	ST_I	2	4	4 to 3	0	0	2.16	3.24	1.08	2.7	0	2.59	0	5
SSE1700	C	3/14/80	10:33	MCS	40 24.057N	073 52.470W	ST_I	2	4	4 to 3	0	0	1.99	3.47	1.48	2.73	0	2.96	0	5
SSE1800	A	3/14/80	10:27	MCS	40 24.011N	073 52.452W	ST_I	0	3	3 to 2	0	0	3.64	5.34	1.7	4.49	0	1.53	0	4
SSE1800	B	3/14/80	10:27	MCS	40 24.009N	073 52.451W	ST_I	1	4	3 to 2	0	0	1.53	2.44	0.91	1.99	0	1.68	0	4
SW1000	A	3/14/80	9:42	MCS	40 24.529N	073 53.424W	ST_I	3	>4	>4	0	0	8.65	9.33	0.67	8.99	0	1.02	0	3
SW1000	C	3/14/80	9:44	MCS	40 24.521N	073 53.415W	ST_I	3	>4	>4	0	0	8.26	9.44	1.18	8.85	0	1.75	0	4
SW1100	B	3/14/80	9:40	MCS	40 24.492N	073 53.468W	ST_I_TO_II	2	>4	>4	0	0	8.65	9.55	0.9	9.1	0	0.7	0	3
SW1100	C	3/14/80	9:40	MCS	40 24.492N	073 53.459W	ST_I_TO_II	3	>4	>4	0	0	7.81	8.76	0.96	8.29	0	1.06	0	4
SW1200	A	3/14/80	9:36	MCS	40 24.463N	073 53.520W	ST_I_TO_II	2	>4	>4	0	0	8.54	9.38	0.84	8.96	0	0.95	0	4
SW1200	C	3/14/80	9:37	MCS	40 24.461N	073 53.511W	ST_I_TO_II	2	>4	>4	0	0	8.93	10.34	1.4	9.63	0	0.82	0	4
SW1300	A	3/14/80	9:32	MCS	40 24.416N	073 53.580W	ST_I_TO_II	2	>4	>4	0	0	7.58	8.88	1.29	8.23	0	0.79	0	4
SW1300	C	3/14/80	9:33	MCS	40 24.402N	073 53.581W	ST_I_TO_II	2	>4	>4	0	0	9.33	10.34	1.01	9.83	0	1.35	0	4
SW1400	A	3/14/80	9:28	MCS	40 24.377N	073 53.625W	ST_I	0	3	1 to 0	0	0	0.73	2.81	2.08	1.77	0	1.58	0	4
SW1400	B	3/14/80	9:28	MCS	40 24.374N	073 53.618W	ST_I	1	4	2 to 1	0	0	5.06	8.15	3.09	6.6	0	6.6	0	7
SW900	A	3/14/80	9:46	MCS	40 24.577N	073 53.371W	ST_I	2	>4	>4	0	0	4.83	5.9	1.07	5.37	0	0.89	0	3
SW900	B	3/14/80	9:47	MCS	40 24.578N	073 53.368W	ST_I	3	>4	>4	0	0	6.35	8.26	1.91	7.3	0	0.82	0	3
W1000	A	3/24/80	10:21	MCS	40 24.911N	073 53.629W	ST_II	3	>4	>4	0	0	7.84	8.58	0.74	8.21	0	0.8	0	5
W1000	D	3/24/80	10:24	MCS	40 24.908N	073 53.628W	ST_II	3	>4	>4	0	0	7.27	8.24	0.97	7.76	0	0.61	0	4
W300	B	3/24/80	9:50	MCS	40 24.921N	073 53.607W	ST_I	3	>4	>4	12	0.52	10.91	13.81	2.9	12.36	0	1.05	0	3
W300	C	3/24/80	9:50	MCS	40 24.922N	073 53.140W	ST_I	2	>4	>4	4	0.34	14.55	15	0.45	14.77	0	1.37	0	3
W400	A	3/24/80	9:55	MCS	40 24.913N	073 53.210W	ST_II	3	>4	>4	12	0.27	7.56	7.9	0.34	7.73	0	1.09	0	5
W400	C	3/24/80	9:56	MCS	40 24.918N	073 53.211W	ST_II	3	>4	>4	3	0.18	7.27	8.92	1.65	8.1	0	0.92	0	5
W500	A	3/24/80	9:59	MCS	40 24.909N	073 53.280W	ST_II	3	>4	>4	0	0	6.82	7.56	0.74	7.19	0	1.31	0	5
W500	B	3/24/80	10:00	MCS	40 24.910N	073 53.283W	ST_II	3	>4	>4	0	0	10.28	11.14	0.85	10.71	0	1.38	0	5
W600	A	3/24/80	10:04	MCS	40 24.914N	073 53.346W	ST_I_TO_II	3	>4	>4	0	0	6.82	8.92	2.1	7.87	0	0.76	0	4
W600	C	3/24/80	10:06	MCS	40 24.916N	073 53.356W	ST_II	3	>4	>4	0	0	8.92	9.66	0.74	9.29	0	1.17	0	5
W700	A	3/24/80	10:09	MCS	40 24.913N	073 53.418W	ST_II	3	>4	>4	0	0	8.35	10.45	2.1	9.4	0	1.95	0	6
W700	C	3/24/80	10:10	MCS	40 24.910N	073 53.418W	ST_I_TO_II	3	>4	>4	0	0	9.15	10.51	1.36	9.83	0	1.41	0	4
W800	B	3/24/80	10:13	MCS	40 24.915N	073 53.490W	ST_I	3	>4	>4	0	0	15.17	16.88	1.7	16.02	0	4.99	0	7
W800	C	3/24/80	10:14	MCS	40 24.917N	073 53.488W	ST_I	2	>4	>4	0	0	18.92	20.85	1.93	19.89	10.04	2.69	0	5
W900	A	3/24/80	10:17	MCS	40 24.914N	073 53.553W	ST_II	3	>4	>4	6	0.28	8.3	9.49	1.19	8.89	0	0.96	0	5
W900	B	3/24/80	10:18	MCS	40 24.912N	073 53.555W	ST_I_TO_II	3	>4	>4	0	0	9.55	10.17	0.63	9.86	0	0.25	0	3
WNW100	A	3/24/80	11:11	MCS	40 25.119N	073 53.569W	ST_I	3	>4	>4	0	0	6.08	8.35	2.27	7.22	0	0.68	0	2
WNW100	C	3/24/80	11:13	MCS	40 25.116N	073 53.579W	ST_II_ON_III	3	>4	>4	0	0	7.39	8.18	0.8	7.78	0	0.59	0	6
WNW300	B	3/24/80	10:37	MCS	40 24.970N	073 53.117W	ST_I_TO_II	2	>4	>4	0	0	6.02	7.61	1.59	6.82	0	2.02	0	5
WNW300	C	3/24/80	10:38	MCS	40 24.969N	073 53.119W	ST_I	3	>4	>4	0	0	7.22	8.81	1.59	8.01	0	0.25	0	2
WNW400	A	3/24/80	10:41	MCS	40 24.995N	073 53.181W	ST_II	3	>4	>4	0	0	7.78	8.13	0.34	7.95	0	0.67	0	4
WNW400	B	3/24/80	10:42	MCS	40 24.994N	073 53.182W	ST_II	3	>4	>4	0	0	7.22	7.9	0.68	7.56	0	0.5	0	4

STAT	REPL	DATE	TIME	AYST	LAT	LONG	SS	GSMX	GSMN	GSMM	MDCNT	MDAVG	PNMN	PNMX	PNRNG	PENMEAN	DMMEAN	RPDMEAN	METMEAN	OSI
WNW500	A	3/24/80	10:46	MCS	40 25.011N	073 53.250W	ST_II	3	>4	>4	0	0	7.33	7.67	0.34	7.5	0	1.35	0	5
WNW500	B	3/24/80	10:47	MCS	40 25.011N	073 53.252W	ST_II	3	>4	>4	0	0	7.39	8.3	0.91	7.84	0	0.75	0	4
WNW600	A	3/24/80	10:51	MCS	40 25.034N	073 53.311W	ST_II	3	>4	>4	0	0	6.42	7.33	0.91	6.88	0	0.97	0	5
WNW600	B	3/24/80	10:51	MCS	40 25.034N	073 53.312W	ST_II	3	>4	>4	0	0	6.53	7.9	1.36	7.22	0	0.43	0	4
WNW700	A	3/24/80	10:55	MCS	40 25.054N	073 53.376W	ST_II	2	>4	>4	0	0	7.9	8.98	1.08	8.44	0	1.79	0	6
WNW700	C	3/24/80	10:57	MCS	40 25.050N	073 53.379W	ST_II_ON_III	2	>4	>4	0	0	7.95	9.26	1.31	8.61	0	0.65	0	6
WNW800	A	3/24/80	11:01	MCS	40 25.075N	073 53.445W	ST_I_TO_II	3	>4	>4	0	0	7.33	8.07	0.74	7.7	0	1	0	4
WNW800	C	3/24/80	11:02	MCS	40 25.076N	073 53.445W	ST_II	2	>4	>4	0	0	8.24	9.2	0.97	8.72	0	1.32	0	5
WNW900	A	3/24/80	11:06	MCS	40 25.100N	073 53.508W	ST_I_TO_II	2	>4	>4	0	0	7.44	9.77	2.33	8.61	0	2.4	0	6
WNW900	C	3/24/80	11:07	MCS	40 25.098N	073 53.512W	ST_II	3	>4	>4	0	0	8.52	9.89	1.36	9.2	0	2.6	0	7
WSW1000	A	3/14/80	9:57	MCS	40 24.704N	073 53.575W	ST_II_ON_III	3	>4	>4	0	0	8.65	9.61	0.96	9.13	0	0.9	0	7
WSW1000	C	3/14/80	9:58	MCS	40 24.700N	073 53.572W	ST_II	3	>4	>4	0	0	8.71	9.04	0.34	8.88	0	1.03	0	5
WSW1100	A	3/14/80	9:53	MCS	40 24.681N	073 53.634W	ST_II	3	>4	>4	0	0	6.07	7.19	1.12	6.63	0	2.53	0	7
WSW1100	C	3/14/80	9:55	MCS	40 24.679N	073 53.632W	ST_I	3	>4	>4	0	0	7.92	9.16	1.24	8.54	0	0.97	0	3
WSW700	A	3/14/80	10:08	MCS	40 24.768N	073 53.378W	ST_I	3	>4	>4	0	0	14.05	14.66	0.62	14.35	0	1.1	8.31	1
WSW700	B	3/14/80	10:08	MCS	40 24.768N	073 53.376W	ST_I	3	>4	>4	1	1.19	14.55	15	0.45	14.78	0	1.9	0	4
WSW800	A	3/14/80	10:04	MCS	40 24.745N	073 53.436W	ST_I	3	>4	>4	0	0	6.91	8.43	1.52	7.67	0	1.08	0	3
WSW800	B	3/14/80	10:05	MCS	40 24.741N	073 53.439W	ST_I	3	>4	>4	0	0	8.99	9.83	0.84	9.41	0	0.78	0	3
WSW900	A	3/14/80	10:00	MCS	40 24.733N	073 53.506W	ST_I	3	>4	>4	0	0	9.49	10.06	0.56	9.78	0	0.59	0	2
WSW900	C	3/14/80	10:02	MCS	40 24.732N	073 53.505W	ST_I	2	>4	>4	3	0.45	8.48	9.16	0.67	8.82	0	0.53	0	2

STAT	REPL	SURF	FULL CMNT
2ESE0	A	BIOGENIC	V FINE SANDY RELIC DM>P;NUCULA;TUBES
2ESE0	B	PHYSICAL	RELIC DM>P;NUCULA;TUBE;FIBEROUS ORG MATTER;WORM @ Z
2ESE0	C	PHYSICAL	FRESH DM>P;NUCULA;TUBES;BURROWING ANENOME @ Z
2ESE100	A	BIOGENIC	V FINE SANDY RELIC DM>P;NUCULA;RIPPLED
2ESE100	C	BIOGENIC	V FINE SANDY RELIC DM;TUBES;DENSE NUCULA & NUCULA SHELLS
2ESE200	B	PHYSICAL	V FINE S=RELIC DM;RPD=S LAYER;NUCULA & NUCULA SHELLS;TUBE;V REDUCED @ Z
2ESE200	C	PHYSICAL	V FINE S=RELIC DM;RPD=S LAYER;NUCULA & NUCULA SHELLS
2ESE300	C	PHYSICAL	V FINE SANDY RELIC DM>P;RIPPLED;TUBES
2ESE300	D	PHYSICAL	V FINE SANDY RELIC DM>P;RIPPLED;MANY SHELLS
2ESE400	A	PHYSICAL	V FINE S>P;RIPPLED;RPD=LIGHT COLORED S;SNAIL SHELL IN FARFIELD
2ESE400	C	BIOGENIC	RELIC DM>P;LOTS FIBEROUS ORG MATTER
2ESE500	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED
2ESE500	B	PHYSICAL	FINE S>P;RIPPLED;ORG MATTER IN FARFIELD;TUBES IN FARFIELD
2NE100	A	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;MANY JUVENILE SAND $S IN FARFIELD
2NE100	C	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;MANY JUVENILE SAND $S;SHELL BITS
2NE-100	A	PHYSICAL	FINE S>P;RIPPLED;RPD=P;TUBE;JUVENILE SAND $ IN FARFIELD
2NE-100	B	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;MULTIPLE JUVENILE SAND $S
2NE200	B	PHYSICAL	V FINE S>P;RIPPLED;RPD=P
2NE200	C	PHYSICAL	FINE S>P;RPD=P;RIPPLED;JUVENILE SAND $S;ORG FLOC
2NE-200	A	PHYSICAL	MUDDY S>P;RIPPLED;FINE SHELL BITS @ SURF & Z
2NE-200	B	PHYSICAL	FINE S>P;RPD=P;RIPPLED;SHELL BITS IN FARFIELD;REDUCED SPOT=ARTIFACT
2NE300	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED;JUVENILE SAND $S;GRN FIBEROUS ORG MATTER
2NE300	B	PHYSICAL	FINE S>P;RIPPLED;RPD=P
2SE100	A	PHYSICAL	FRESH DM>P;SM VOIDS;TUBE STALKS
2SE100	B	PHYSICAL	FRESH DM>P;WELL SORTED;CHAOTIC FABRIC
2SE200	B	PHYSICAL	FINE S>P;RPD=P;RIPPLED;TUBES;ORG MATTER
2SE200	C	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;TUBE;ORG FLOC
2SE300	A	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;3 SAND $S PARTLY BURIED;ORG MATTER
2SE300	B	PHYSICAL	FINE S>P;RPD=P;RIPPLED;ORG MATTER IN FARFIELD
2SE400	A	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;JUVENILE SAND $-MORE IN FARFIELD
2SE400	B	PHYSICAL	V FINE S>P;RIPPLED;RPD=P;FIBEROUS ORG MATTER;JUVENILE SAND $ @ Z;SHELL BITS
2SW100	A	PHYSICAL	RELIC DM>P;NUCULA DETH ASSEMBLAGE;WORMS @Z;WIPER CLSTS;REDUCED;THIN RPD
2SW100	B	PHYSICAL	RELIC DM>P;ORG MATTER @ SURF;DEAD NUCULA;REDUCED;THIN RPD
2SW200	B	PHYSICAL	POSS FRESH DM>P;WIPER CLASTS/SMEARS;WORM @ Z;REDUCED @ Z
2SW200	C	PHYSICAL	RELIC DM>P;ORG MATTER;REDUCED; THIN RPD
2SW300	A	PHYSICAL	V FINE S/RELIC DM;NUCULA SHELLS;SHELL BITS;ORG MATTER
2SW300	C	PHYSICAL	RELIC DM>P;BRICK BITS;SHELL BITS;REDUCED @ Z
2SW400	A	PHYSICAL	COARSE S>P;RPD=P;RIPPLED;POORLY SORTED
2SW400	B	PHYSICAL	MED-COARSE S>P;RPD=P;RIPPLED;PEBBLE
2SW500	B	INDET	MED-COARSE S>P;RPD=P
2SW500	C	PHYSICAL	COARSE S>P;RPD=P;POORLY SORTED;RIPPLED;BRICK BITS
3SW100	A	PHYSICAL	RELIC DM>P;STG I TUBES;WELL SORTED;REDUCED @ Z
3SW100	B	PHYSICAL	MED S/RELIC DM;WIPER CLAST/SMEAR;WORMS @ Z
3SW200	A	PHYSICAL	RELIC DM>P;SHELLS & SHELL PIECES;WORM @ Z;ORG FLOC/MATTER @ SURF
3SW200	B	PHYSICAL	RELIC DM>P;ORG FLOC/MATER @ SURF;SHELLS/SHELL PIECES;WIPER CLAST/SMEAR
3SW300	A	PHYSICAL	V FINE MUDDY S>P;REDUCED @ Z;RIPPLED;RED. MUD CLASTS
3SW300	B	PHYSICAL	V FINE S/RELIC DM;RIPPLED
3SW400	B	PHYSICAL	MED-COARSE S>P;RPD=P;RIPPLED
3SW400	E	PHYSICAL	MED-COARSE S>P;RPD=P;RIPPLED
3SW500	A	PHYSICAL	FINE SAND/HIST DM;RIPPLED;SHELL BITS
3SW500	B	PHYSICAL	MED-FINE S>P;ORG FLOC IN FARFIELD
A0	A	PHYSICAL	HIST DM>P;NUCULA

STAT	REPL	SURF	FULL CMNT
A0	B	PHYSICAL	HIST DM>P;NUCULA;SHELL BITS IN FARFIELD
A1200	B	PHYSICAL	COARSE-MED S>P;RPD=P;PEBBLES & GRAVEL;WIPER SMEAR;MANY BRICK FRAGS
A1200	D	PHYSICAL	S>P;RPD=P;TUBE;ORG FLOC;RIPPLED;MOD SORTED
A1600	A	PHYSICAL	MED-FINE S>P;RPD=P;RIPPLED;SHELL HASH
A1600	C	PHYSICAL	MED-FINE S>P;RPD=P;SEA STAR;TUBES;RIPPLED
A2000	B	PHYSICAL	V FINE S>P;RPD=P;TUBE;JUVENILE SAND DOLLARS;WELL SORTED SAND
A2000	C	PHYSICAL	V FINE S>P;RPD=P;TUBES;8 JUVENILE SAND $S;SM SHELL;RIPPLED;WELL SORTED
A2400	B	PHYSICAL	V FINE S>P;RPD=P;3 JUVENILE SAND $S;RIPPLED;WELL SORTED
A2400	C	PHYSICAL	V FINE S>P;RPD=P;FEW SHELL BITS;RIPPLED;WELL SORTED
A2800	C	PHYSICAL	FINE S>P;RPD=P;HERMIT CRAB;RIPPLED;SHELLS IN FARFIELD;WELL SORTED
A2800	D	PHYSICAL	FINE S>P;RPD=P;SAND $;HERMIT CRAB IN FARFIELD;RIPPLED;WELL SORTED
A400	B	PHYSICAL	HIST DM>P;DENSE ST I WORMS RESUSPENDED
A400	C	PHYSICAL	HIST DM>P; TUBES
A800	B	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;SHELL IN FARFIELD;SM SHELL BITS;ORG FLOC;WELL SORTED
A800	C	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;TUBE;TUBE STALK IN FARFIELD;WELL SORTED
B0	B	PHYSICAL	HIST DM>P;NUCULA;WIPER CLAST;DEAD NUCULA SHELLS
B0	C	PHYSICAL	HIST DM>P;NUCULA;WIPER CLAST/SMEAR;BURROWING ANENOME @ Z
B1200	A	PHYSICAL	FINE S>P;RPD=P;AMPHIPOD TUBE STALKS;SM SHELL BITS IN FARFIELD;ORG FLOC;WELL SORTED
B1200	C	PHYSICAL	FINE S>P;RPD=P;ORG FLOC;SHELL BITS;RIPPLED
B1600	B	PHYSICAL	V FINE S>P;RPD=P;TUBES;SHELL BITS
B1600	C	PHYSICAL	V FINE S>P;RPD=P;TUBES;SM RIPPLES;WELL SORTED
B2000	A	PHYSICAL	V FINE S>P;RPD=P;7 JUVENILE SAND $S;RIPPLED;WELL SORTED
B2000	C	PHYSICAL	V FINE S>P;RPD=P;TUBES;7 JUVENILE SAND $S;SHELL BITS
B2400	B	PHYSICAL	V FINE S>P;RPD=P;SHELL BITS;RIPPLED
B2400	C	PHYSICAL	COARSE-MED S>P;RPD=P;PEBBLES;BRICK PEBBLES;RIPPLED
B2800	B	PHYSICAL	FINE S>P;RPD=P;12 JUVENILE SAND $S;RIPPLED;WELL SORTED
B2800	C	PHYSICAL	FINE S>P;RPD=P;RIPPLED;ST I TUBES
B400	A	PHYSICAL	HIST DM>P;NUCULA;TUBES;BURROWING ANENOME @ Z; SHELL BITS; BRICK FRAG IN FARFIELD
B400	C	PHYSICAL	HIST DM>P;NUCULA;WORM @ Z
B800	A	PHYSICAL	HIST DM>P;NUCULA;TUBES
B800	C	PHYSICAL	HIST DM>P;NUCULA;TUBES;SHELL FRAGS
C0	A	PHYSICAL	HIST DM>P;BRICK FRAGS AND SHELL BITS IN FARFIELD
C0	B	PHYSICAL	HIST DM>P;SHELL BITS @ SURF;BURROWING ANENOME @ Z
C1200	A	PHYSICAL	HIST DM>P;NUCULA
C1200	B	PHYSICAL	HIST DM>P;NUCULA;TUBES;RIPPLED
C1600	A	PHYSICAL	HIST DM>P;NUCULA;TUBES;SM WORM @ Z
C1600	B	PHYSICAL	HIST DM>P;NUCULA ARE DEAD & ALIVE
C2000	B	BIOGENIC	V FINE SILTY-S>P;RPD=P;MANY SM TUBES;SHELL BITS MIXED IN SAND;ORG FLOC
C2000	C	BIOGENIC	MUDDY FINE S>P;RPD=P;TUBES;SHELL HASH;ORG FLOC;SHELLS IN FARFIELD
C2400	A	PHYSICAL	MED S>P;RPD=PEN;ORG FLOC DRAGDOWN;PEBBLES
C2400	B	PHYSICAL	COARSE-MED S>P;RPD=P;RIPPLED
C2400	C	PHYSICAL	THIN LAYER RELIC DM>P;RPD=P;POSS RELIC DM PUDDLE IN AREA;AMBIENT COARSE SAND IN FARFIELD
C2800	A	PHYSICAL	FINE S>P;RPD=P;SHELLS & JUVENILE SAND $S IN FARFIELD;RIPPLED;WELL SORTED
C2800	B	PHYSICAL	FINE S>P;RPD=P;MANY MANY JUVENILE SAND $S;RIPPLED;WELL SORTED
C400	A	PHYSICAL	HIST DM>P
C400	B	PHYSICAL	HIST DM>P;TUBE;WIPER CLAST/SMEAR;NUCULA DEATH ASSEMBLAGE
C800	B	PHYSICAL	HIST DM>P;NUCULA DEATH ASSEMBLAGE
C800	C	BIOGENIC	HIST DM>P;NUCULA;TUBES; WIPER CLASTS/SMEARS; FECAL MOUND
D0	A	PHYSICAL	HIST DM>P;2 WORMS @ Z;DENSE NUCULA DEATH ASSEMBLAGE;SHALLOW RPD
D0	B	PHYSICAL	HIST DM>P;REDUCED SED @ SURF;DENSE NUCULA DEATH ASSEMBLAGE
D1200	B	PHYSICAL	FRESH DM>P;NUCULA;VOID;WORM @ Z;WIPER CLASTS/SMEARS
D1200	C	PHYSICAL	FRESH DM>P;SURFACE TUBES;WIPER CLASTS/SMEARS

STAT	REPL	SURF	FULL CMNT
D2000	B	PHYSICAL	HIST DM>P;TUBES;RIPPLES; ORG FLOC
D2000	C	PHYSICAL	HIST DM>P;RPD=P;MANY BRICK FRAGS
D2400	A	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;WELL SORTED
D2400	C	PHYSICAL	FINE S>P;RPD=P;RIPPLED;MANY MANY JUVENILE SAND $S
D2800	B	PHYSICAL	FINE S>P;RPD=P;RIPPLED;MOD SORTED
D2800	C	PHYSICAL	FINE S>P;RPD=P;RIPPLED;ORG FLOC;WELL SORTED
D400	A	PHYSICAL	HIST DM>P;NUCULA
D400	B	PHYSICAL	HIST DM>P;NUCULA;WIPER CLASTS
D800	A	PHYSICAL	HIST DM>P;NUCULA;TUBES;STALK STRUCTURE;GREEN BLOB @ Z
D800	B	PHYSICAL	HIST DM>P;WIPER CLASTS/SMEAR;NUCULA ARE DEAD & ALIVE
E0	A	PHYSICAL	S/HIST DM;RPD INCL SAND;PEBBLES;SM BRICK FRAGS
E0	B	PHYSICAL	HIST DM>P;PEBBLES;WOOD/ORG FRAG;SHELL BITS;BRICK BITS
E1200	D	PHYSICAL	FRESH DM>P;TUBES;METHANE BUBBLES
E1200	E	PHYSICAL	FRESH DM>P;TUBE
E1600	H	PHYSICAL	FRESH DM>P;VOIDS
E1600	K	PHYSICAL	FRESH DM>P;DISTURBED SURF;WIPER CLASTS;SHELL?
E2000	A	PHYSICAL	FRESH DM>P;NUCULA;WORM @ Z;SHELLS @ SURF
E2000	C	PHYSICAL	FRESH DM>P;NUCULA @ SURF;VOID;MUD CLASTS;WIPER CLASTS TOO
E2400	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED;TUBE? IN FARFIELD;WELL SORTED
E2400	C	PHYSICAL	FINE S>P;RIPPLED;TUBES;WELL SORTED
E2800	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED;WELL SORTED
E2800	D	PHYSICAL	FINE S>P;RPD=P;RIPPLED;WELL SORTED
E300	A	PHYSICAL	FRESH DM>P;AMPHIPOD TUBE STALKS;VOID;SM OX & RED MUD CLASTS
E300	B	PHYSICAL	FRESH DM>P;VOID;WIPER CLASTS/SMEARS
E400	A	PHYSICAL	FRESH DM>P;RIPPLED
E400	B	PHYSICAL	HIST DM>P;WIPER CLASTS/SMEARS;SHELL PIECES;SHALLOW RPD
E400	C	BIOGENIC	HIST DM>P;DEAD NUCULA;WORMS @ Z;FECAL MOUNDS;BRICK FRAGS;REDUCED SED @ SURF
E400	C	PHYSICAL	FRESH DM>P;VOID;WIPER CLASTS
E500	A	PHYSICAL	FRESH DM/RELIC DM;RIPPLED;TUBES;ORG MATTER;SHELL HASH
E500	B	PHYSICAL	FRESH SANDY DM>P;RIPPLED;OX MUD CLASTS;POORLY SORTED
E600	A	INDET	HARD BOT;NO PEN;ROCKS;EPIFAUNA;SHELL BITS
E600	C	INDET	HARD BOT;NO PEN;ROCKS;EPIFAUNA
E700	B	PHYSICAL	SANDY RELIC DM>P;SHELL PIECES;LG TUBES;NUCULA DEATH ASSEMBLAGE?;RIPPLED
E700	C	PHYSICAL	SANDY RELIC DM>P;RIPPLED;SHELL BITS/HASH;TUBES
E800	A	BIOGENIC	FRESH DM>P;FIBEROUS ORG MAT @ SURF;SHELL HASH @ NEAR SURF;REDUCED SED @ SURF
E800	A	PHYSICAL	SANDY RELIC DM>P;RIPPLED;SHELL BITS;DIOPATRA TUBE IN FARFIELD
E800	B	PHYSICAL	FRESH DM>P;VOID;TUBE;WIPER CLASTS/SMEARS;ORG FLUFF IN FARFIELD;REDUCED SED @ SURF
E800	B	PHYSICAL	SANDY RELIC DM>P;RIPPLED;LG DIOPATRA? TUBES;SHELL BITS
E900	A	PHYSICAL	S>P;RPD=LT COLORED S;TUBES;SHELL HASH;RIPPLED;REDUCED @ Z
E900	B	PHYSICAL	S/SANDY RELIC DM;RPD=LT COLORED S;RIPPLED;SHELL BITS
ENE300	B	PHYSICAL	FRESH DM>P;VOIDS;WIPER CLASTS/SMEAR
ENE300	C	PHYSICAL	FRESH DM>P;MANY VOIDS;TUBES
ENE400	A	PHYSICAL	FRESH DM/RELIC DM;VOID;NUCULA;TUBES;TUBE STALK
ENE400	B	PHYSICAL	FRESH DM/RELIC DM;VOID;NUCULA;TUBE STALK;WIPER CLASTS
ENE500	D	PHYSICAL	SANDY FRESH DM>P;TUBE STALK;RIPPLED;OX MUD CLASTS;TUBES
ENE500	E	PHYSICAL	FRESH DM/RELIC DM;OX & REDUCED MUD CLASTS;WIPER SMEAR;BOT OF ORG MATTER WOOD?
ENE500	F	PHYSICAL	SANDY RELIC DM>P;RIPPLED;NUCULA;LG TUBES;BRICK PIECE
ENE600	A	PHYSICAL	SANDY RELIC DM>P;TUBES
ENE600	B	PHYSICAL	SANDY RELIC DM>P;NUCULA;TUBES
ENE700	B	PHYSICAL	SANDY RELIC DM>P;TUBES;SHELL BITS;DIOPATRA? TUBES
ENE700	C	PHYSICAL	SANDY RELIC DM>P;RIPPLED;TUBES;SHELL BITS;POSS SHRIMP
ESE100	G	PHYSICAL	S>P;RPD=P;RIPPLED;SHELL BITS/HASH

STAT	REPL	SURF	FULL CMNT
ESE100	H	PHYSICAL	S>P;RPD=P;RIPPLED;ORG MATTER @ SURF;SHELL BITS
ESE1100	B	PHYSICAL	V FINE SANDY RELIC DM>P;RIPPLED;SM BRICK BITS
ESE1100	C	PHYSICAL	V FINE SANDY RELIC DM>P;RIPPLED;TUBES
ESE600	B	PHYSICAL	FRESH DM>P;NUCULA;TUBES;WIPER CLASTS
ESE600	C	PHYSICAL	FRESH DM>P;TUBE;WIPER SMEAR
ESE700	A	BIOGENIC	SANDY RELIC DM>P;NUCULA;ORG MATTER
ESE700	B	PHYSICAL	SANDY FRESH DM>P;NUCULA;BURROW;POSS PASSENGER SHIP TERMINAL DM
ESE800	A	BIOGENIC	SANDY RELIC DM>P;NUCULA;FINE BRICK BITS
ESE800	C	BIOGENIC	SANDY RELIC DM>P;RIPPLED;NUCULA;BRICK BITS;BURROWS;SHELL
ESE900	A	PHYSICAL	V FINE SANDY RELIC DM>P;RIPPLED;HERMIT CRAB;TUBES;FINE BRICK BITS
ESE900	B	PHYSICAL	FINE S>P;RIPPLED;BURROW;LG TUBES
ESE900	C	PHYSICAL	FRESH DM/RELIC DM;DIOPATRA TUBE?;GRN ORG DETRITUS
F0	B	PHYSICAL	S/HIST DM;RPD=S;BIG WORM @ Z;RIPPLED
F0	C	PHYSICAL	RIPPLED S>P;RPD=P;WIPER SMEAR;PEBBLES;RIPPLED
F1200	A	BIOGENIC	FRESH DM>P;MANY BIG THICK TUBES;ORG FLOC
F1200	C	BIOGENIC	FRESH DM>P;MANY BIG THICK TUBES
F1600	D	BIOGENIC	FRESH DM>P;MANY BIG THICK TUBES; SHELL ON L;WIPER CLASTS
F1600	G	BIOGENIC	FRESH DM>P;BIG THICK TUBES;WIPER CLASTS/SMEAR;SM WORM @ Z
F1600	H	PHYSICAL	FRESH DM>P;ORG MATTER IN FARFIELD;V THIN RPD;REDUCED
F1600	K	PHYSICAL	FRESH DM>P;VOIDS;WIPER CLASTS/SMEAR
F2000	B	BIOGENIC	FRESH DM>P;NUCULA;BIG THICK TUBES;BURROWING ANENOME @ Z;BURROW OPENING;WIPER CLAST
F2000	C	BIOGENIC	FRESH DM>P;MANY BIG THICK TUBES;NUCULA
F2400	A	PHYSICAL	S/HIST DM;RIPPLED;WELL SORTED SAND;OWENID TUBES
F2400	B	PHYSICAL	S/HIST DM;RIPPLED;WELL SORTED
F2800	B	PHYSICAL	NO PEN;ROCKS;BRICK FRAGS;COARSE SAND
F2800	D	PHYSICAL	COARSE-MED S>P;RPD=P;RIPPLED;BRICK FRAGS;SHELL FRAGS;POORLY SORTED
F400	A	PHYSICAL	HIST DM>P;NUCULA;NUCULA ARE DEAD & ALIVE
F400	B	PHYSICAL	HIST DM>P;NUCULA ARE DEAD & ALIVE;SM WORMS @ Z;TUBES;BRICK FRAG
F800	A	BIOGENIC	FRESH DM>P;TUBES;BURROW OPENING;2 BURROWING ANENOMES @ Z;ORG FLOC @ SURF
F800	B	PHYSICAL	FRESH DM>P;TUBES;WIPER CLASTS
G0	A	PHYSICAL	PEBBLES>P;RPD=P;GRAVEL;PEBBLES
G0	B	PHYSICAL	MEDIUM S>P;RPD=P;PEBBLES;RIPPLED
G1200	H	PHYSICAL	FRESH DM>P;RIPPLED;MANY REDUCED MUD CLASTS
G1200	I	PHYSICAL	FRESH DM>P;WIPER CLASTS/SMEARS
G1600	B	PHYSICAL	FRESH DM>P;SURF TUBES;NUCULA
G1600	C	PHYSICAL	FRESH DM>P;NUCULA;VOID
G2000	A	PHYSICAL	FRESH DM>P;HIGH SOD
G2000	B	PHYSICAL	FRESH DM>P;WORM @ Z;TUBES;VOID;WIPER CLASTS/SMEARS
G2400	B	PHYSICAL	S/RELIC DM;RPD=S;RIPPLED
G2400	D	PHYSICAL	S/RELIC DM;RPD=S;BRICK IN FARFIELD
G2800	A	PHYSICAL	FINE S>P;RPD=P.RIPPLED;6 JUVENILE SAND $S;WELL SORTED
G2800	B	PHYSICAL	FINE S>P;RPD=P;RIPPLED;6 JUVENILE SAND $S;SHELL BITS;WELL SORTED
G400	A	PHYSICAL	COARSE-MED S>P;PEBBLES;BRICK FRAGS
G400	C	PHYSICAL	COARSE-MED S>P;RPD=P;RIPPLED;ORG FLOC;PEBBLES;POOR SORTING;BRICK FRAGS
G800	A	PHYSICAL	FRESH DM LAYER/HIST DM>P;TUBES;BURROWING ANENOME @ Z
G800	B	PHYSICAL	FRESH DM LAYER/HIST DM;BURROW @ Z;TUBES
H0	B	PHYSICAL	COARSE-MED S>P;RPD=P;PEBBLES;GRAVEL
H0	C	PHYSICAL	COARSE-MED S>P;PEBBLES;GRAVEL;BLK STUFF?;SHELL PIECE
H1200	A	PHYSICAL	FRESH SANDY DM>P,POORLY CONSOLIDATED,POOR SORTING,CHAOTIC FABRIC
H1200	D	PHYSICAL	FRESH DM>P;RPD=P;SM ROCKS;BRICK FRAGS;LOOSE CONSOLIDATION;POORLY SORTED
H1600	C	PHYSICAL	FRESH SANDY DM>P;ROCKS;PVC PIPE?;POORLY SORTED
H1600	D	INDET	NO PEN;LG ROCKS

STAT	REPL	SURF	FULL CMNT
H2000	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED;WELL SORTED
H2000	C	PHYSICAL	FINE S>P;RPD=P;RIPPLED;TUBES;WELL SORTED
H2400	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED;2 JUVENILE SAND $S;WELL SORTED
H2400	B	PHYSICAL	FINE S>P;RPD=P;RIPPLED;5 JUVENILE SAND $S;WELL SORTED
H2800	A	PHYSICAL	FINE S>P;RPD=P;RIPPLED
H2800	D	PHYSICAL	MED-FINE S>P;RPD=P;RIPPLED;MOD SORTING
H400	A	PHYSICAL	S>P;RPD=P;ORG FLOC;WOOD BITS;WOOD PIECE;PEBBLES;POOR SORTING
H400	B	PHYSICAL	COARSE-MED S>P;ORG FLOC;REDUCED SED=HIST DM?;POOR SORTING
H800	C	PHYSICAL	SANDY FRESH DM>P;ORG MATTER @ SURF;SHELLS;PEBBLES;POORLY SORTED
H800	D	PHYSICAL	SANDY FRESH DM>P;WORMS @ Z;ORG MATTER @ SURF;PEBBLES;POORLY SORTED
N200	A	PHYSICAL	FRESH DM>P;VOIDS;BURROW
N200	B	PHYSICAL	FRESH DM>P;VOID;WIPER CLAST
N300	B	PHYSICAL	FRESH DM>P;VOID;TUBES
N300	C	PHYSICAL	FRESH DM/RELIC DM;TUBES;WIPER CLASTS/SMEAR
N400	B	PHYSICAL	RELIC DM>P;TUBE;SHELLS;BURROWING ANENOME @ Z;NUCULA
N400	C	BIOGENIC	RELIC DM>P;NUCULA & DEAD NUCULA;TUBE STALKS;WIPER CLASTS/SMEAR
N500	A	BIOGENIC	RELIC DM>P;NUCULA;TUBE STALKS;WIPER CLASTS/SMEARS
N500	B	PHYSICAL	RELIC DM>P;NUCULA;BURROWING ANENOME @ Z;WIPER CLASTS/SMEAR
N600	A	PHYSICAL	SANDY RELIC DM>P;RIPPLED;SHELL BITS;DEAD NUCULA
N600	B	PHYSICAL	SANDY RELIC DM>P;RIPPLED;DEAD NUCULA SHELLS;TUBES
NE300	A	PHYSICAL	FRESH DM>P;VOIDS;WORM@Z
NE300	C	PHYSICAL	FRESH DM>P;VOID
NE400	B	PHYSICAL	FRESH DM>P;TUBES;WIPER SMEAR
NE400	C	PHYSICAL	FRESH SANDY DM/RELIC DM;TUBE STALKS;WIPER CLAST/SMEAR
NE500	A	PHYSICAL	SANDY RELIC DM>P;NUCULA;TUBE STALKS;WIPER CLAST
NE500	C	PHYSICAL	FRESH DM/RELIC DM
NE600	B	PHYSICAL	SANDY RELIC DM>P;RIPPLED;FIBEROUS ORG MATTER;SHELL BITS
NE600	C	PHYSICAL	SANDY RELIC DM>P;NUCULA
NE700	B	PHYSICAL	SANDY RELIC DM>P;RIPPLED;TUBES;ORG FLOC
NE700	C	PHYSICAL	SANDY RELIC DM>P;RIPPLED;SHELL PIECES;TUBES;WORM @ Z
NW300	A	BIOGENIC	FRESH DM>P;TUBE STALKS;MANY VOIDS;BURROWS;BURROW OPENING
NW300	B	PHYSICAL	FRESH DM>P;VOID;WIPER CLASTS
NW400	A	PHYSICAL	FRESH DM/RELIC DM;VOID
NW400	B	PHYSICAL	FRESH DM/RELIC DM;TUBES
NW500	A	PHYSICAL	RELIC DM>P;DEAD NUCULA
NW500	C	BIOGENIC	RELIC DM>P;NUCULA DEATH ASSEMBLEGE;WIPER CLASTS/SMEARS
NW600	A	BIOGENIC	RELIC DM>P;NUCULA & NUCULA SHELLS;BURROW OPENING?;BRICK BITS
NW600	B	BIOGENIC	RELIC DM>P;NUCULA&NUCULA SHELLS;TUBES;FILTER FEEDER IN FARFIELD;WORM@Z
NW700	A	BIOGENIC	RELIC DM>P;NUCULA;TUBES;BRICK BITS;BURROW OPENING?;WORM @ Z
NW700	B	PHYSICAL	RELIC DM>P;NUCULA;AMPHIPOD TUBE STALKS;WORM @ Z;WIPER SMEARS
NW800	A	PHYSICAL	SANDY RELIC DM>P;LG CRAB SHELL
NW800	C	INDET	HARD BOT;NO PEN;ROCKS;EPIFAUNA
SE1200	A	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;ORG MATTER
SE1200	C	PHYSICAL	FINE S>P;RPD=P;RIPPLED;ORG MATTER
SE1300	A	PHYSICAL	V FINE S>P;RIPPLED;RPD=P
SE1300	C	PHYSICAL	V FINE S>P;RIPPLED;RPD=P;TUBES
SE1400	A	PHYSICAL	V FINE S>P;RIPPLED;RPD=P;SAND $S IN FARFIELD;ORG MATTER
SE1400	C	PHYSICAL	V FINE S>P;RIPPLED;RPD=P;JUVENILE SAND $S;SHELL BITS
SE1500	A	PHYSICAL	MED S/RELIC DM;RIPPLED;RPD=S LAYER INCL DM SMEARDOWN;TUBE
SE1500	B	PHYSICAL	V FINE S>P;RIPPLED;RPD=P;6 JUVENILE SAND $S;WIPER SMEARS
SE1600	A	PHYSICAL	V FINE S>P;RIPPLED;RPD=P;FIBEROUS ORG MATTER
SE1600	B	INDET	V FINE S>P;RIPPLED;RPD=P;ORG MATTER

STAT	REPL	SURF	FULL CMNT
SE1700	A	PHYSICAL	FINE S/RELIC DM;RIPPLED;RPD=S LAYER
SE1700	C	PHYSICAL	FINE S/RELIC DM;RIPPLED;RPD=P;ORG FLOC
SE1800	A	PHYSICAL	MED-COARSE S>P;RPD=P;RIPPLED;MANY SM BRICK BITS
SE1800	C	PHYSICAL	FINE S>P;RIPPLED;RPD=P
SSE1200	A	PHYSICAL	FRESH DM>P;BURROWING ANENOME @ Z;FIBEROUS ORG MATTER?
SSE1200	C	PHYSICAL	FRESH DM>P;FIBEROUS ORG MATTER
SSE1300	B	PHYSICAL	FRESH DM>P;BURROW;VOIDS;TUBES;FIBEROUS ORG MATTER
SSE1300	C	PHYSICAL	FRESH DM>P;VOID
SSE1400	B	PHYSICAL	FRESH DM>P;LG TUBE;WELL SORTED
SSE1400	C	PHYSICAL	FRESH DM>P;VOID;WIPER CLASTS/SMEAR;FIBEROUS ORG MATTER
SSE1500	A	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;TUBES
SSE1500	B	PHYSICAL	V FINE S/DM;RIPPLED;RPD=S LAYER;TUBES;POSS FRESH DM?
SSE1600	A	PHYSICAL	V FINE S/DM;RIPPLED;FIBEROUS ORG MATTER
SSE1600	C	PHYSICAL	V FINE S/DM;RPD=S LAYER;RIPPLED;TUBES;ORG FLOC/MATTER
SSE1700	B	PHYSICAL	V FINE S>P;RPD=P;FIBEROUS ORG MATTER;TUBES;RIPPLED
SSE1700	C	PHYSICAL	V FINE S>P;RPD=P;RIPPLED;ORG MATTER IN FARFIELD;WORM IN FARFIELD?
SSE1800	A	PHYSICAL	FINE-MED S>P;ORG FLOC;POSS BRICK BITS SUBSURF;MOD SORTING
SSE1800	B	PHYSICAL	FINE-MED S>P;RPD=P;ORG FLOC;SHELL BITS
SW1000	A	PHYSICAL	FRESH DM>P;WIPER CLASTS/SMEAR;ORG MATTER
SW1000	C	PHYSICAL	FRESH DM>P;TUBE STALKS;BURROW OPENING;WORM @ Z;WIPER SMEARS
SW1100	B	PHYSICAL	RELIC DM>P;NUCULA & NUCULA SHELLS;TUBE STALK;REDUCED;THIN RPD
SW1100	C	BIOGENIC	RELIC DM>P;NUCULA & DENSE NUCULA DEATH ASSEMBLEGE;REDUCED;THIN RPD
SW1200	A	BIOGENIC	RELIC DM>P;NUCULA & NUCULA DEATH ASSEMBLAGE
SW1200	C	BIOGENIC	RELIC DM>P;NUCULA & NUCULA DEATH ASSEMBLAGE;WORM @ Z;REDUCED;THIN RPD
SW1300	A	BIOGENIC	RELIC DM>P;LIVE NUCULA & DEATH ASSEMBLGE;MANY LG TUBES;REDUCED;THIN RPD
SW1300	C	BIOGENIC	RELIC DM>P;NUCULA & NUCULA DEATH ASSEMBLAGE;LG TUBES
SW1400	A	PHYSICAL	COARSE S>P;RPD=P;RIPPLED
SW1400	B	PHYSICAL	MED-COARSE S>P;RPD=P;RIPPLED
SW900	A	PHYSICAL	POSS FRESH DM>P;BRICK BITS;WORMS @ Z
SW900	B	PHYSICAL	FRESH DM>P;TUBE STALK;IRREGULAR SURF;WORMS @ Z;THIN RPD
W1000	A	BIOGENIC	RELIC DM>P;NUCULA;POSS DIOPATRA TUBE ON LEFT
W1000	D	BIOGENIC	RELIC DM>P;NUCULA & DENSE NUCULA SHELLS;WIPER SMEARS
W300	B	PHYSICAL	FRESH DM>P;MANY OX & RED MUD CLASTS;POSS BURROW
W300	C	PHYSICAL	FRESH DM>P;WIPER CLAST ON RT;OX & RED MUD CLASTS
W400	A	PHYSICAL	FRESH? DM>P;NUCULA;REDUCED MUD CLASTS;BURROWING ANENOME @ Z
W400	C	PHYSICAL	FRESH DM>P;NUCULA;WORMS @ Z;REDUCED MUD CLASTS;WIPER CLASTS/SMEAR
W500	A	PHYSICAL	FRESH? DM>P;NUCULA;TUBES
W500	B	PHYSICAL	FRESH? DM>P;NUCULA;RIPPLED
W600	A	PHYSICAL	FRESH? DM>P;RIPPLED;NUCULA;BURROW OPENING;TUBES
W600	C	PHYSICAL	FRESH? DM>P;NUCULA;WIPER CLAST/SMEAR
W700	A	PHYSICAL	RELIC DM>P;NUCULA & NUCULA SHELLS;WIPER CLASTS;BURROWING ANENOME @ Z?
W700	C	PHYSICAL	RELIC DM>P;RIPPLED;NUCULA;LG WORM @ Z
W800	B	PHYSICAL	FRESH DM>P;DISTURBED SURF;WIPER CLAST;WORMS @ Z
W800	C	PHYSICAL	FRESH DM/RELIC DM;DISTUBED SURF;WIPER CLASTS;WORMS @ Z
W900	A	BIOGENIC	RELIC DM>P;NUCULA;WORMS & BURROWING ANENOME @ Z;REDUCED MUD CLASTS
W900	B	BIOGENIC	RELIC DM>P;WIPER CLASTS/SMEARS;LG DIOPATRA? TUBES;NUCULA;THIN RPD
WNW100	A	PHYSICAL	RELIC DM>P;CRAB;DIOPATRA TUBE;WIPER CLASTS/SMEAR;UNEVEN SURF
WNW100	C	BIOGENIC	RELIC DM>P;NUCULA;VOID
WNW300	B	PHYSICAL	FRESH DM>P;LG TUBE;NUCULA;WIPER CLASTS/SMEARS
WNW300	C	PHYSICAL	FRESH DM>P;SHELL BITS
WNW400	A	BIOGENIC	RELIC DM>P;NUCULA & NUCULA SHELLS
WNW400	B	BIOGENIC	RELIC DM>P;NUCULA & SHELLS;WIPER CLASTS/SMEARS;WORMS @Z;DIOPATRA TUBES?

STAT	REPL	SURF	FULL CMNT
WNW500	A	PHYSICAL	POSS FRESH DM>P;NUCULA
WNW500	B	BIOGENIC	RELIC DM>P;NUCULA;WIPER CLASTS/SMEARS;WORM @ Z
WNW600	A	BIOGENIC	RELIC DM>P;DENSE NUCULA
WNW600	B	BIOGENIC	RELIC DM>P;NUCULA;WIPER CLASTS/SMEARS;BURROWING ANENOME @ Z
WNW700	A	PHYSICAL	RELIC DM>P;NUCULA
WNW700	C	BIOGENIC	RELIC DM>P;NUCULA;SM VOIDS;LG DIOPATRA TUBES;ORG MATTER;WORM @ Z
WNW800	A	PHYSICAL	RELIC DM>P;NUCULA & NUCULA SHELLS;TUBE
WNW800	C	BIOGENIC	RELIC DM>P;NUCULA;TUBE STALKS
WNW900	A	BIOGENIC	RELIC DM>P;NUCULA;MANY LG TUBES;UNEVEN SURF
WNW900	C	PHYSICAL	RELIC DM>P;NUCULA;WIPER CLASTS/SMEARS;UNEVEN SURF
WSW1000	A	BIOGENIC	HIST DM>P;VOID;NUCULA;ORG MATTER;WORM @ Z;REDUCED;THIN RPD
WSW1000	C	PHYSICAL	HIST DM>P;NUCULA;REDUCED;THIN RPD
WSW1100	A	BIOGENIC	HIST DM>P;NUCULA & NUCULA DEATH ASSEMBLEGE;ORG MATTER
WSW1100	C	BIOGENIC	HIST DM>P;NUCULA DEATH ASSEMBLEGE;REDUCED;THIN RPD
WSW700	A	PHYSICAL	FRESH DM>P;LG TUBES;3 CH4 BUBBLES
WSW700	B	PHYSICAL	FRESH DM>P;WIPER CLASTS/SMEARS;OX MUD CLAST;TUBES
WSW800	A	PHYSICAL	FRESH DM>P;TUBE;ORG MATTER IN FARFIELD;REDUCED;THIN RPD
WSW800	B	PHYSICAL	FRESH DM>P;LG TUBE;REDUCED;THIN RPD
WSW900	A	PHYSICAL	FRESH DM>P;WIPER CLAST
WSW900	C	PHYSICAL	FRESH DM>P;WORMS @ Z;REDUCED;THIN RPD