Monitoring Cruise At The
Central Long Island Sound Disposal Site
July 1990

Disposal Area Monitoring System DAMOS

D A M O S

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Contribution 94
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A monitoring survey was conducted at the Central Long Island Sound Disposal Site (CLIS) from July 18 to 23, 1990 as part of the Disposal Area Monitoring System (DAMOS) Program. The objectives of the July 1990 field operations were to delineate the extent and topography of the recently deposited dredged material, to measure near-bottom and near-surface dissolved oxygen concentrations and vertical profiles of temperature and salinity at selected disposal site and reference stations, and to collect additional baseline sediment grain size and chemistry samples from the reference areas. The data included precision bathymetry, Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile photography, conductivity, temperature, and depth (CTD) measurements and dissolved oxygen information, and sediment grab samples.

The precision bathymetric survey detected disposal mounds CLIS-88, CLIS-89, and CS-90-1 formed since the 1988 survey. The dredged material did form the distinct mounds predicted at the CLIS-88 and CLIS-89 buoy locations. However, the diameter of CLIS-89 was smaller than expected, 200 versus 250 m, and the diameter of CLIS-88 was larger than expected without forming a distinct separate mound due to the proximity of CLIS-87.

At CS-90-1, material unsuitable for unconfined open water disposal was capped with clean material. Based on the dredged material footprint detected by an earlier REMOTS® survey, cap material was released at eight locations on the CS-90-1 deposit. The amount of cap material over portions of the mound flank was less than 20 cm. Additional cap material and alternate disposal patterns are recommended.

Benthic recolonization was determined from the analysis of REMOTS® photographs obtained at CLIS and at three outlying reference areas. The recolonization predictions were accurate at CLIS-89, with Stage I taxa predominating. At CS-90-1, Stage I taxa occurred 200 m southwest of the buoy location. Most of the remaining site stations and the reference stations had Stage III assemblages. Dissolved oxygen values ranged from 3.4 to 6.34 mg×l^{-1}, indicating the absence of hypoxia.

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DISPOSAL SITE
JULY 1990

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EXECUTIVE SUMMARY

A monitoring survey was conducted at the Central Long Island Sound Disposal Site (CLIS) from July 18 to 23, 1990 as part of the Disposal Area Monitoring System (DAMOS) Program. The objectives of the July 1990 field operations were to delineate the extent and topography of the recently deposited dredged material, to measure near-bottom and near-surface dissolved oxygen concentrations and vertical profiles of temperature and salinity at selected disposal site and reference stations, and to collect additional baseline sediment grain size and chemistry samples from the reference areas. The data included precision bathymetry, Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile photography, conductivity, temperature, and depth (CTD) measurements and dissolved oxygen information, and sediment grab samples. It was predicted that material disposed since 1988 would result in the formation of mounds with radii of 250-300 m at the CLIS-88 and CLIS-89 buoy locations, that benthic recolonization would be mostly Stage I on CLIS-89 and CS-90-1 mounds and Stage III on CLIS-86 and CLIS-88 mounds, and that near-bottom dissolved oxygen concentrations would be similar within the disposal site and reference areas. Sediment chemistry and grain size analytical results were incomplete at the time of the report preparation and will be incorporated into a future report.

The precision bathymetric survey detected disposal mounds CLIS-88, CLIS-89, and CS-90-1 formed since the 1988 survey. The dredged material did form the distinct mounds predicted at the CLIS-88 and CLIS-89 buoy locations. However, the diameter of CLIS-89 was smaller than expected, 200 versus 250 m, and the diameter of CLIS-88 was larger than expected without forming a distinct separate mound due to the proximity of CLIS-87. The thin layer of dredged material seen in REMOTS® photos from up to 300 m away from the disposal mounds was not detected in the bathymetric data.

At CS-90-1, material unsuitable for unconfined open water disposal was capped with clean material. Based on the dredged material footprint detected by an earlier REMOTS® survey, cap material was released at eight locations on the CS-90-1 deposit. The amount of cap material over portions of the mound flank was less than 20 cm. Additional cap material and alternate disposal patterns are recommended.

Benthic recolonization was determined from the analysis of REMOTS® photographs obtained at CLIS and at three outlying reference areas. The 66 REMOTS® stations at CLIS formed a rectangular grid with stations 100 m apart. The recolonization predictions were accurate at CLIS-89, with Stage I taxa predominating. At CS-90-1, Stage I taxa occurred 200 m southwest of the buoy location. Most of the remaining site stations and the reference stations had Stage III assemblages.

The CTD and dissolved oxygen data from CLIS and the reference areas were spatially homogeneous. Dissolved oxygen values ranged from 3.4 to 6.34 $mg \cdot l^{-1}$, indicating the absence of hypoxia.

1.0 INTRODUCTION

The Central Long Island Sound Disposal Site (CLIS) is located 5.6 nautical miles south of New Haven Harbor, Connecticut. Environmental monitoring by the US Army Corps of Engineers, New England Division (NED) has occurred at the site since 1972. A primary objective of past investigations has been to assess the environmental impact of dredged material disposal, particularly in terms of the postdisposal recovery of benthic ecosystems. A secondary historical objective has been to monitor the location of dredged material, the height and stability of individual dredged material mounds, and any postdepositional dispersion of material. Several active and inactive disposal points or mounds currently exist at CLIS. The previous monitoring survey at CLIS was conducted in July 1988 (SAIC 1990a). During the 1988/89 and 1989/90 disposal seasons, approximately 594,800 m^3 of dredged material was disposed at buoy locations CLIS–88 and CLIS-89. At location CS-90-1, 28,720 m^3 of material unsuitable for unconfined open water disposal was capped by 78,550 m^3 of clean sediment in January 1990. The July 1990 CLIS survey investigated active disposal points CLIS-88, CLIS-89, and CS-90-1 (Figure 1-1).

Science Applications International Corporation (SAIC) conducted the field operations for this report at CLIS from 18 to 23 July 1990. The field work consisted of a precision bathymetric survey, a Remote Ecological Monitoring of the Seafloor (REMOTS®) sediment-profile photographic survey, dissolved oxygen (DO) and conductivity, temperature, and depth (CTD) profiles, and sediment sampling. The objectives of this study were

- to delineate the extent and topography of the recently deposited dredged material resulting from the past two years' disposal activities through bathymetry and sediment-profile photography;
- to measure near-bottom and near-surface dissolved oxygen concentrations and vertical profiles of temperature and salinity at selected disposal site and reference stations to characterize depth gradients and assess near-bottom dissolved oxygen concentrations relative to REMOTS® benthic analysis; and
- to collect additional baseline sediment grain size and chemistry samples from the reference areas.

The 1990 monitoring scheme at CLIS investigated the following predictions:

- Sediment disposed since July 1988 would result in the formation of mounds with radii of 250-300 m at CLIS-88 and CLIS-89 buoy locations;

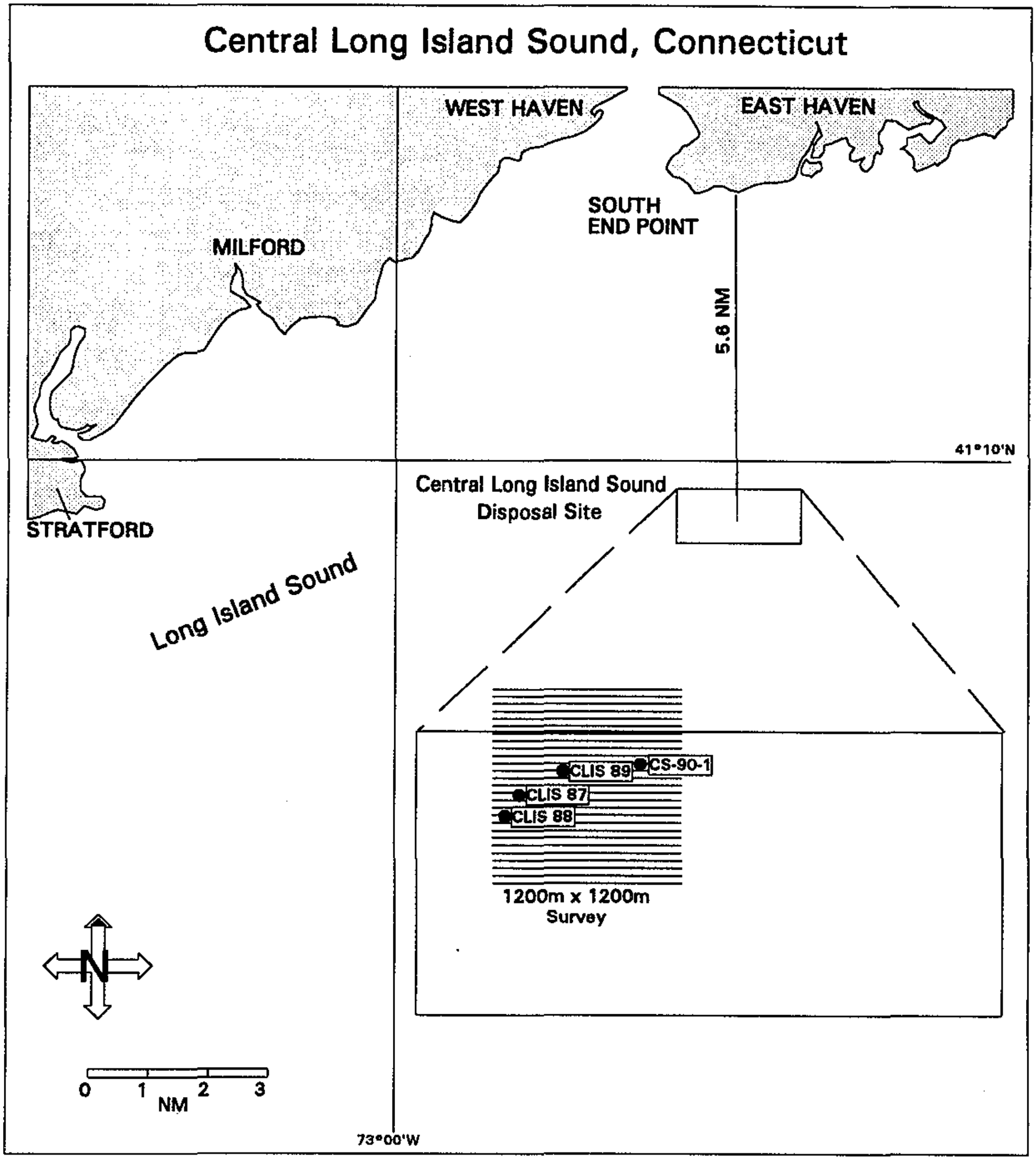


Figure 1-1. Map of bathymetric survey lanes used for the CLIS 1990 survey with the approximate locations of active and inactive disposal mounds

- Benthic recolonization at CLIS would be mostly in Stage I on CLIS-89 and CS–90-1 mounds and progressing to Stage III on CLIS-86 and CLIS-88; and

- Near-bottom dissolved oxygen concentrations would be similar within the disposal site and the reference stations.

2.0 METHODS

2.1 Bathymetry and Navigation

The SAIC Integrated Navigation and Data Acquisition System (INDAS) provided the precision navigation required for all field operations. This system used a Hewlett-Packard 9920® series computer to collect position, depth, and time data for subsequent analysis, as well as providing real-time navigation. A Del Norte Trisponder® System provided positioning to an accuracy of ±3 m. Shore stations were established in Connecticut at known benchmarks at Stratford Point (41°9.112′ N and 73°6.227′ W) and Lighthouse Point (41°14.931′ N and 72°54.255′ W). A detailed description of the navigation system and its operation can be found in DAMOS Contribution No. 60 (SAIC 1989).

An ODOM DF3200 Echotrac® Survey Fathometer with a narrow-beam 208 kHz transducer measured individual depths to a resolution of 3.0 cm (0.1 feet). Depth values transmitted to the computer were adjusted for speed of sound and transducer depth. Prior to starting the 1990 precision bathymetric survey, an Applied Microsystems, Ltd. Model STD-12 CTD probe was used to obtain a sound velocity profile. A complete description of this instrument is given in DAMOS Contribution No. 66 (SAIC 1990b). During analysis, raw bathymetric data were standardized to Mean Low Water by correcting for changes in tidal height during the survey. A detailed discussion of the bathymetric analysis technique is given in DAMOS Contribution No. 60 (SAIC 1989).

The July 1990 bathymetric survey of the northwest corner of CLIS encompassed a 1200 × 1200 m grid centered at coordinates 41°9.260′ N and 72°53.353′ W. The survey consisted of 49 lanes run east and west at 25 m lane spacing.

2.2 REMOTS® Sediment-Profile Photography

REMOTS® photography detected the distribution of thin (1 to 20 cm) dredged material layers, mapped benthic disturbance gradients, and monitored the process of infaunal recolonization on, and adjacent to, the disposal mound. A detailed description of REMOTS® photograph acquisition, analysis, and interpretive rationale is given in DAMOS Contribution No. 60 (SAIC 1989).

The 66 REMOTS® stations occupied at CLIS in July 1990 were 100 m apart and set up in two grids east and west of the CLIS-89 disposal buoy location (Figure 2-1). Each station consisted of three replicate photographs. In addition to the stations within CLIS, three reference areas allowed a comparison between ambient and on-site conditions (Figure 2-1). The reference areas were 2500 m west (2500W), 4500 m east (4500E), and 5094 m southeast (CLIS-REF) of the CLIS-87 buoy location. Each reference area contained 13

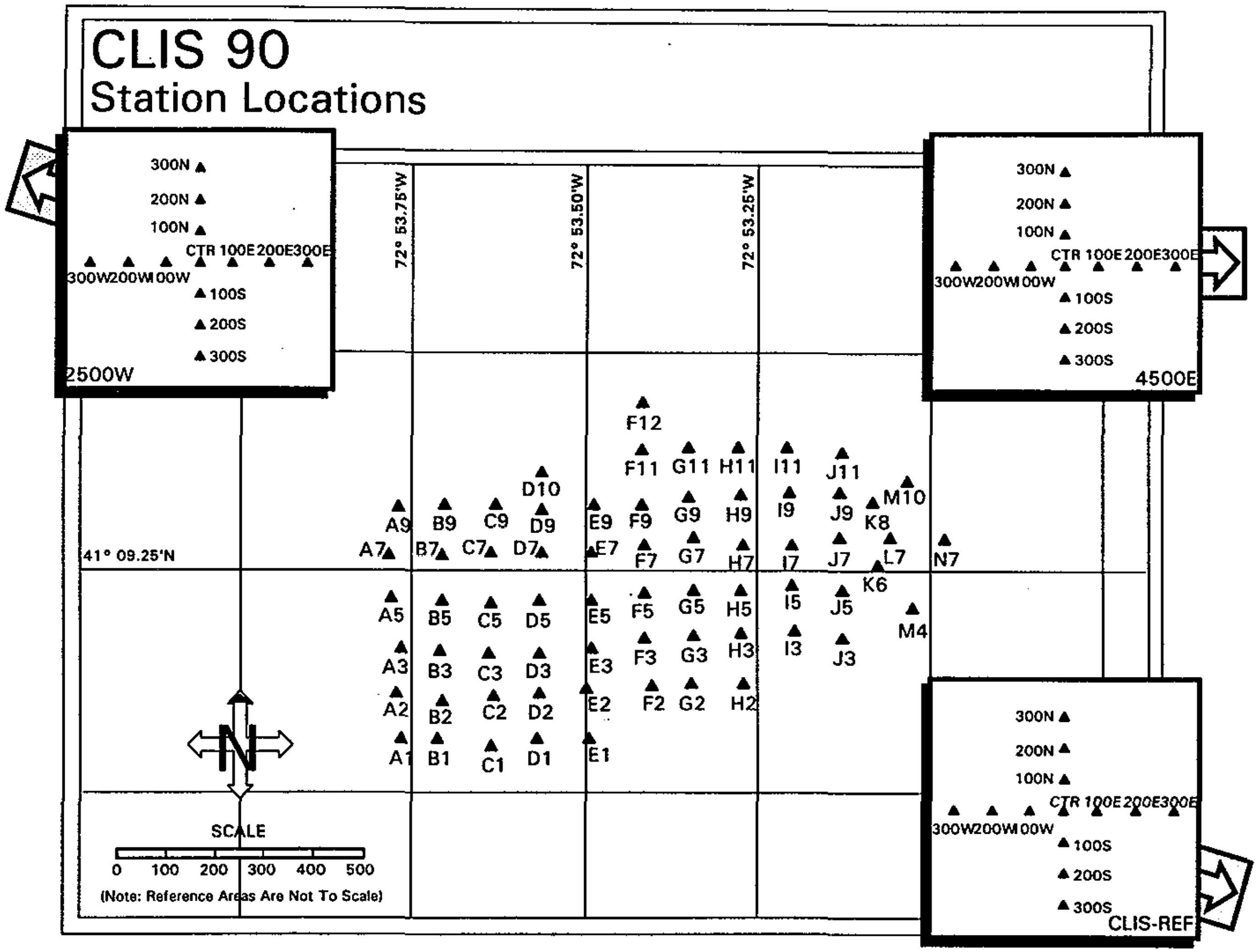


Figure 2-1. Locations and designations of REMOTS® stations (triangles) at CLIS, July 1990. Cross-shaped grids with 100 m station spacing were used at the three outlying reference stations (2500W, 4500E, and CLIS-REF).

REMOTS® stations, arranged in a cross-shaped pattern and spaced 100 m apart. Three replicate photographs were collected at each reference station.

2.3 Sediment Sampling and Analysis

A Smith-McIntyre grab sampler (0.1 m^2) was used to collect triplicate sediment samples at the center of the three reference areas: CLIS-REF, 4500E, and 2500W (Figure 2-1). At each station, four polycarbonate plastic core liners (6.5 cm ID) were pushed into the grab sample, extracting a minimum of 10 cm of sediment. Three of these cores were combined and placed into a sealed plastic bag for chemical analysis. The remaining cores from each of the triplicate grab samples were combined and sealed in plastic bags for grain size analysis. The samples were packed in ice and delivered to the NED laboratory for analysis. Analytical results were incomplete at the time of report preparation and will be included in a future report.

2.4 CTD and Dissolved Oxygen Sampling

Conductivity, temperature, and depth and DO information characterized depth gradients and assessed near-bottom dissolved oxygen concentrations relative to REMOTS® benthic analyses on and near the disposal site. CTD casts collected salinity and temperature profiles at the center of the three reference areas (2500W, 4500E, and CLIS-REF), at the CLIS-89 buoy location, and at four points 300 m north, south, east, and west of the buoy. Niskin casts at CLIS-89, CLIS-REF, 4500E, and 2500W collected water samples approximately 1 m above the bottom for dissolved oxygen analysis. A 300 ml subsample from the Niskin bottle was analyzed immediately following retrieval using a modification of the standard Winkler titration method (Strickland and Parsons 1972, Parsons et al. 1984).

3.0 RESULTS

3.1 Bathymetry

The CLIS 1990 bathymetric survey area was previously mapped in 1988 and 1986 (Figures 3-1, 3-2). Since July 1988, dredged material has been released at buoy locations CLIS-88, CLIS-89, and CS-90-1 (Figure 3-3). The July 1988 survey included the area west of 72°53.500′ W, and the July 1986 survey covered the area east of 72°53.500′ W. The disposal of dredged material at the CLIS-88 buoy (1988/89) formed a disposal mound approximately 400 m long, 200 m wide, trending northeast/southwest, and encompassing both the 1987 and 1988 disposal buoy locations. The mound height at CLIS-88 was 4.4 m (minimum water depth of 14.2 m). Disposal mound CLIS-89 (1989/90) had a diameter of approximately 200 m and a height of 3.0 m (minimum water depth of 15.6 m). At CS-90-1, the dredged material and cap material formed a mound less than 1 m high (minimum water depth of 17.7 m) and approximately 80 m across.

A visual comparison of the 400 m × 1200 m area encompassing disposal mound CLIS-88 in 1988 and 1990 showed a decrease in water depth from 18.5 m to 14 m near the CLIS-88 buoy (Figure 3-4). The depth difference map for this area (Figure 3-5) indicated an accumulation of 4.4 m of material at the CLIS-88 buoy location and smaller accumulations, from 0.2 to 0.4 m, south of the CLIS-88 disposal mound. North of the CLIS-88 and CLIS-87 disposal mounds there was an apparent loss of material ranging from 0.2 m to over 1.0 m (Figure 3-5). The net volume of material calculated from the depth difference map (Figure 3-5) was 103,466 m^3 (95% confidence limits: 92,176 m^3 to 114,755 m^3). For the same time period, 1988 to 1990, barge logs recorded releasing 336,950 m^3 in the area.

A visual comparison of the 1986 and 1990 surveys for the areas surrounding disposal mounds CLIS-89 and CS-90-1 showed disposal mound heights of approximately 3 m at CLIS-89 and 1 m at CS-90-1 (Figures 3-2 and 3-3). The depth difference map comparing the 1986 and 1990 depth matrices indicated an accumulation of material at CLIS-87 (4.6 m), CLIS-89 (3.0 m), and CS-90-1 (0.8 m) (Figure 3-6). Smaller accumulations, 0.2 to 0.4 m, occurred away from the disposal mounds. Volume calculations for the area north of 41°9.250′ N showed approximately 153,000 m^3 of dredged material deposited from July 1986 to July 1990 (95% confidence limits: 147,355 m^3 to 158,644 m^3). Barges recorded releasing 152,166 m^3 of material in the area between 1988 and 1990. These values do not include material added to CLIS-87 between 1986 and 1988 or the 211,981 m^3 of dredged material released south of 41°9.250′ N and east of 72°53.300′ W between 1988 and 1990.

3.2 REMOTS® Sediment-Profile Photography

A REMOTS® survey around the active CLIS disposal points and three reference areas detected the distribution of dredged material and assessed benthic recolonization status.

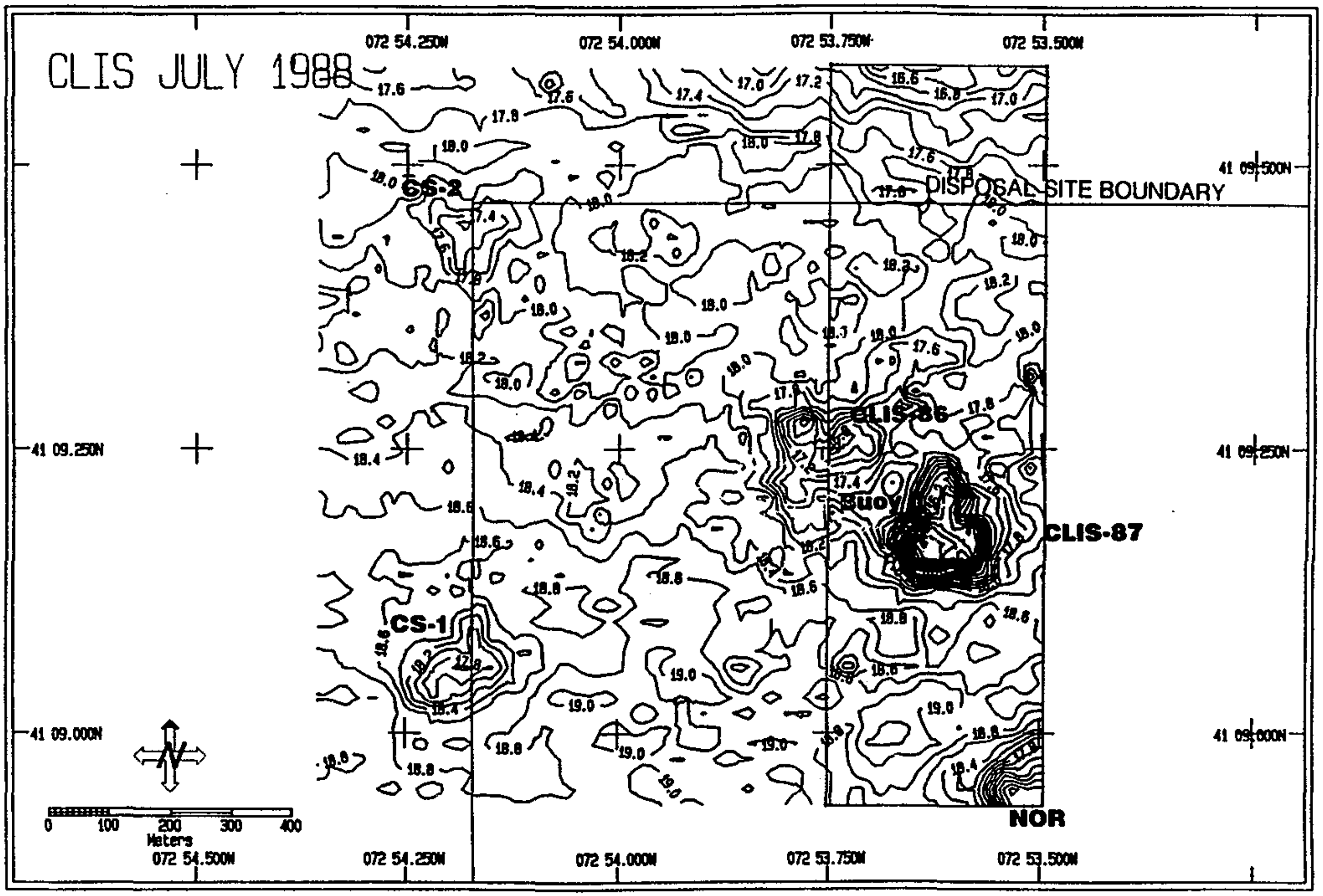


Figure 3-1. Contoured bathymetric chart (depth in meters) of CLIS, 1988. The contour interval is 0.2 m. The area outlined is shown in Figure 3-4.

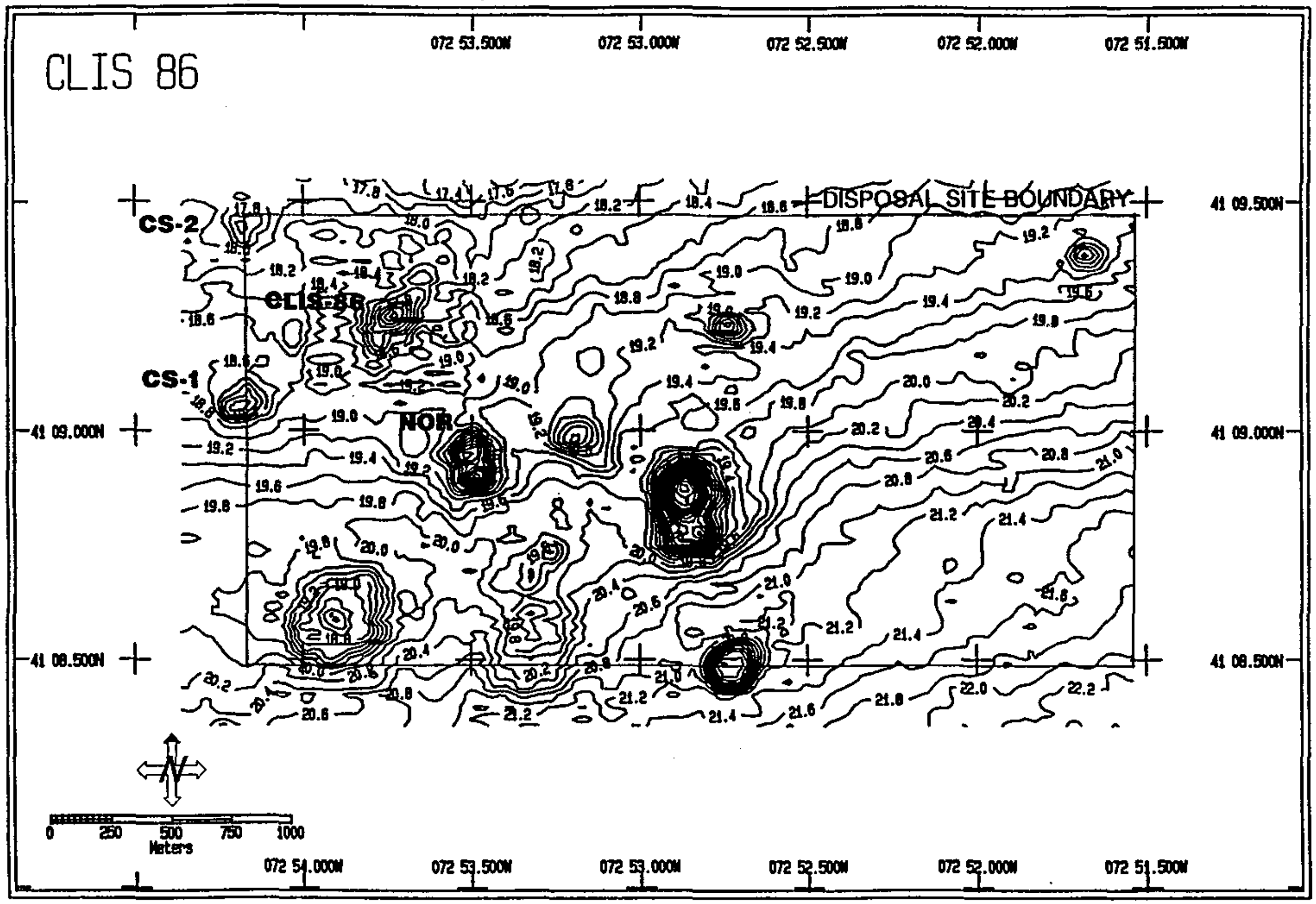


Figure 3-2. Contoured bathymetric chart (depth in meters) of CLIS, 1986. The contour interval is 0.2 m.

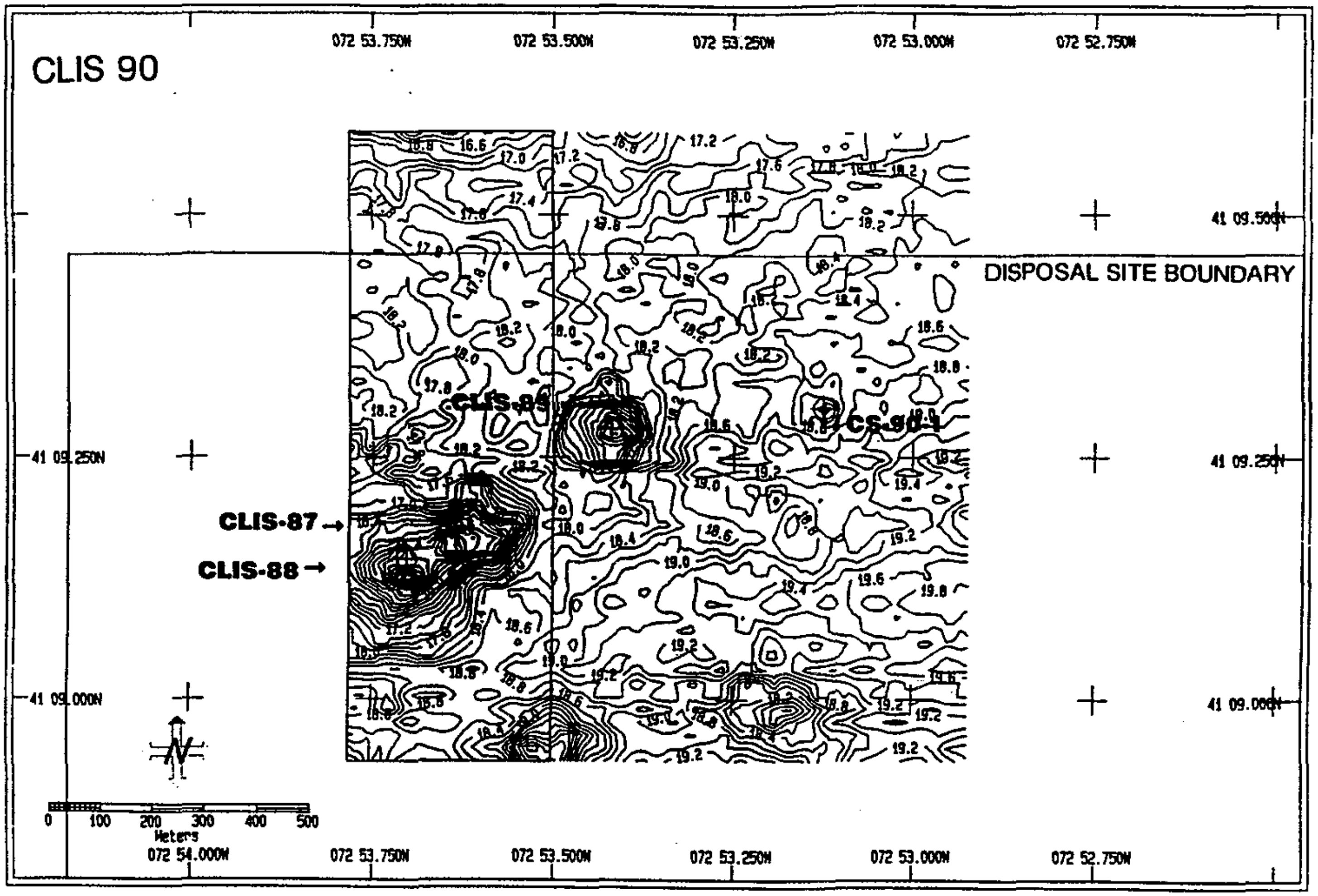


Figure 3-3. Contoured bathymetric chart (depth in meters) of CLIS, 17 and 18 July 1990. The contour interval is 0.2 m. The area outlined is shown in Figure 3-4.

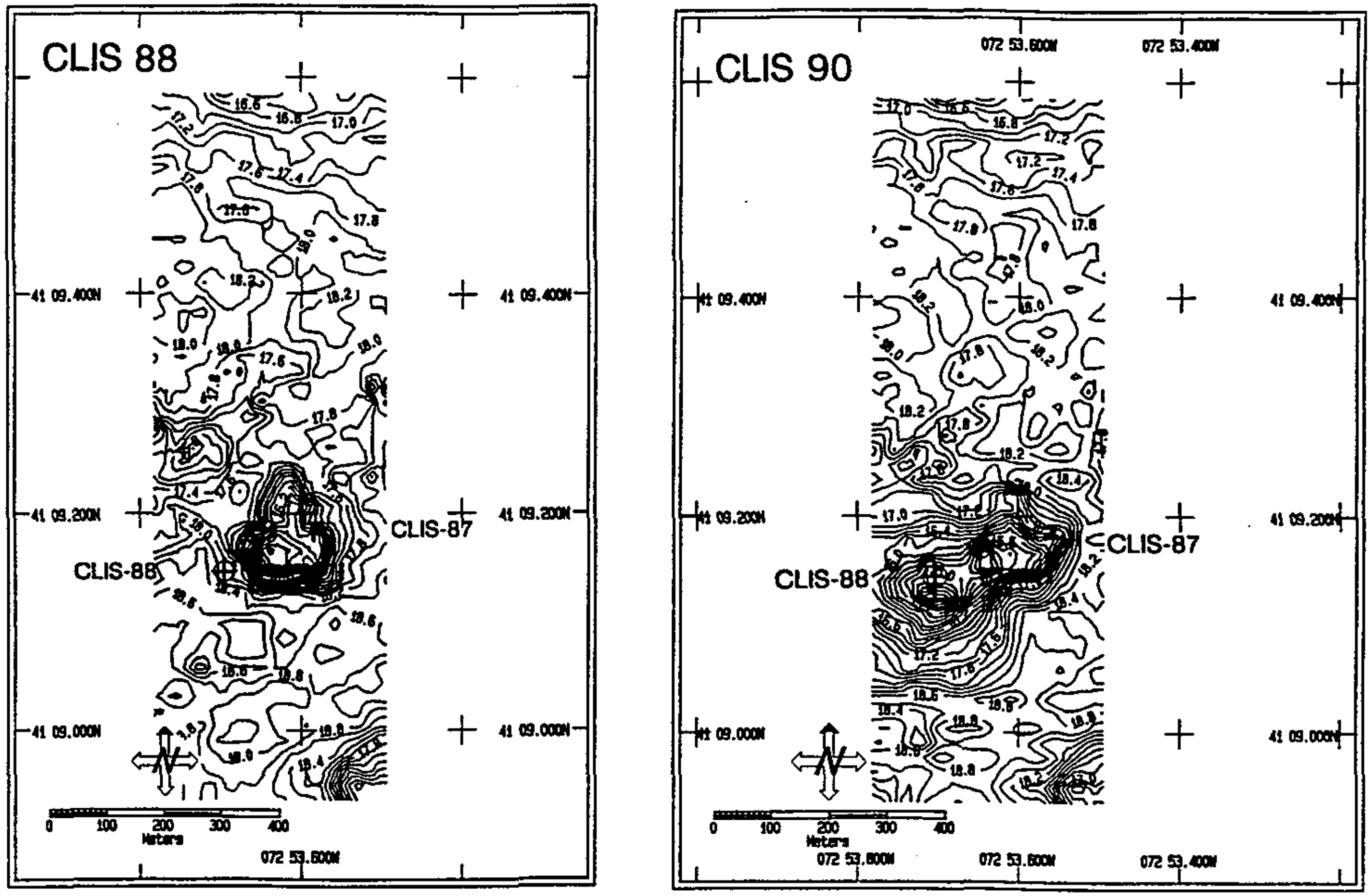


Figure 3-4. Bathymetric contour charts (depth in meters) from July 1988 and July 1990 showing the 400 × 1200 m areas outlined in Figures 3-1 and 3-3

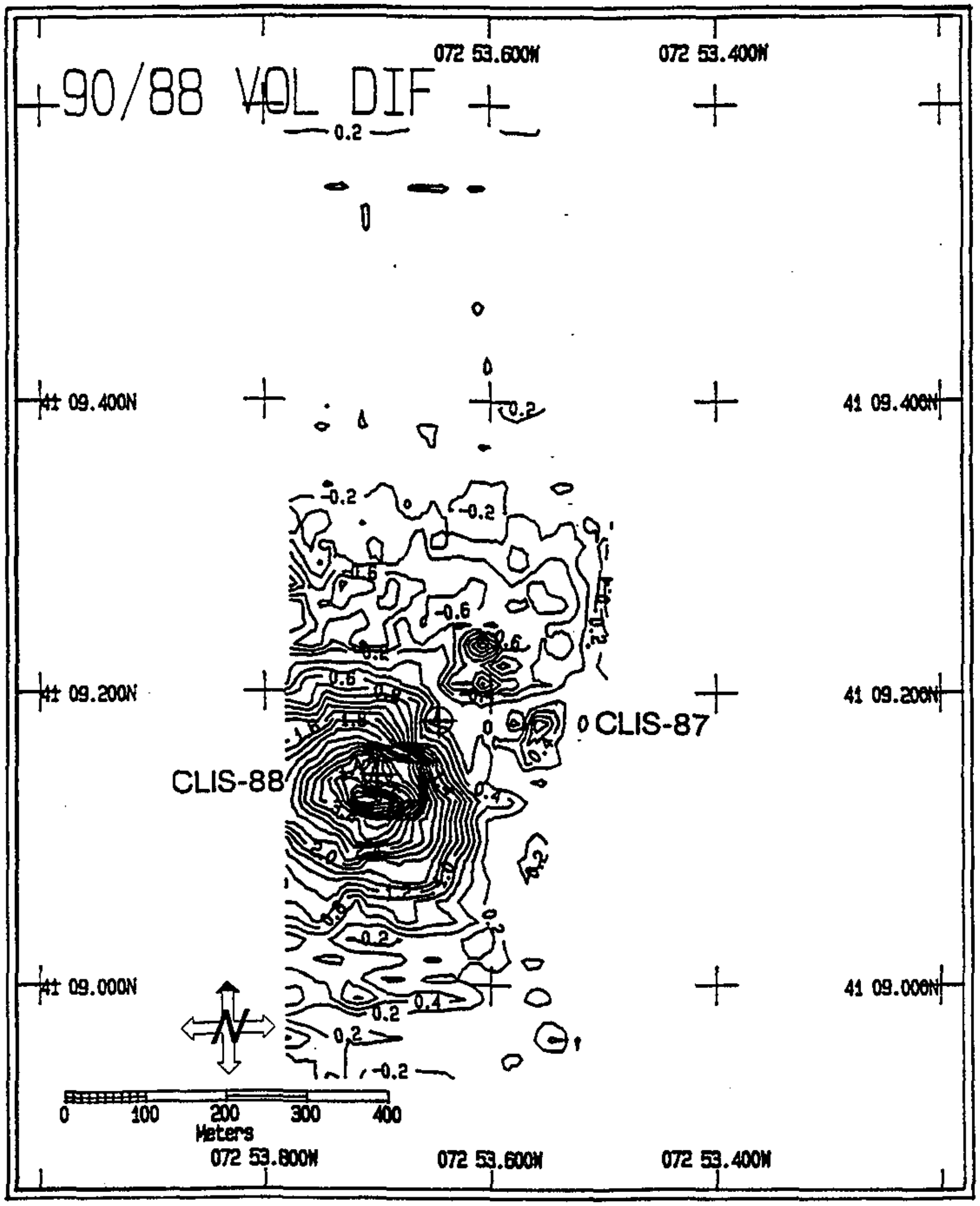


Figure 3-5. Contoured depth difference chart (meters) surrounding the CLIS-88 disposal mound. The contour interval is 0.2 m. The areas that were compared to produce this chart are presented in Figure 3-4.

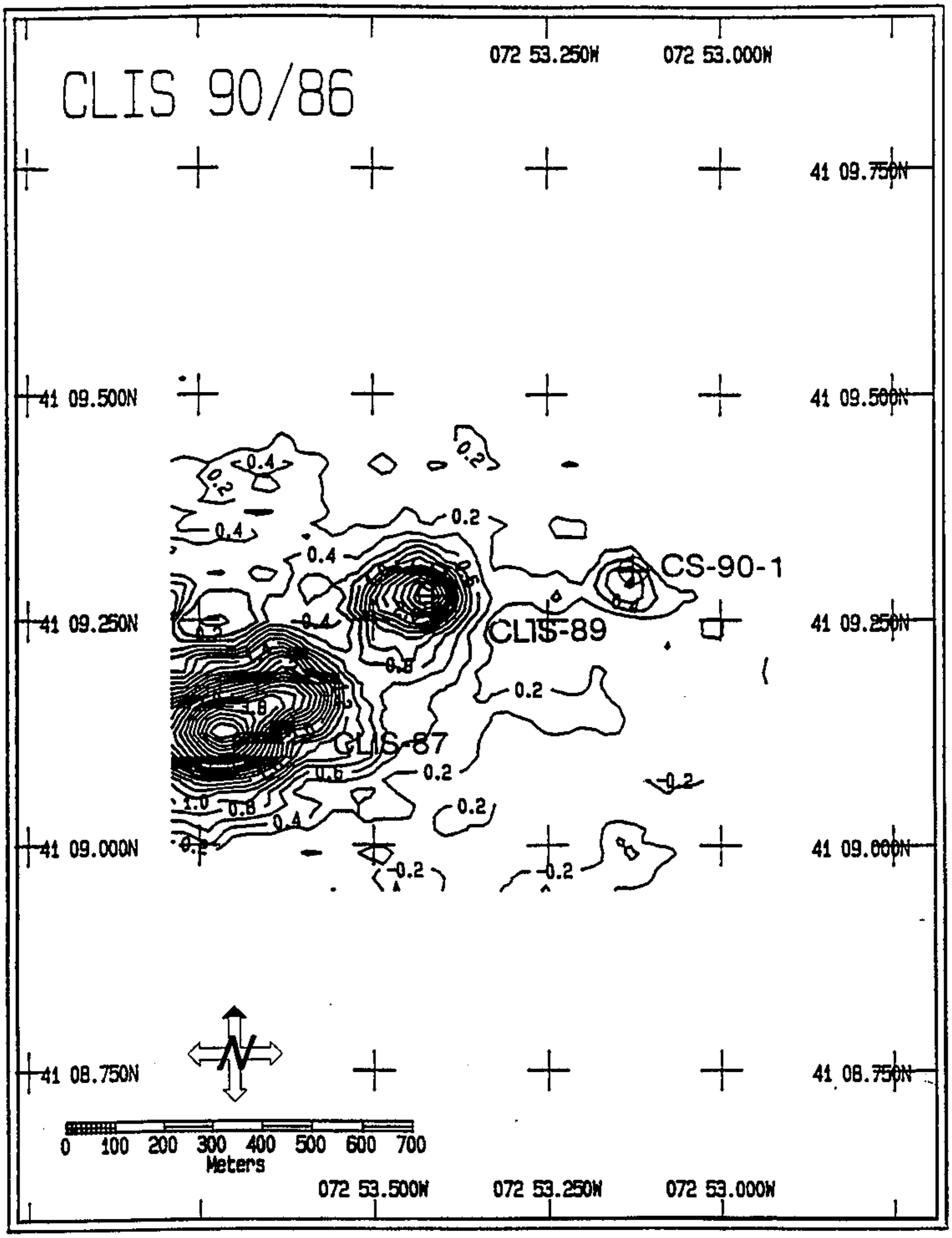


Figure 3-6. Contoured depth difference chart (meters) from 1986 to 1990 surrounding the CLIS-89 and CS-90-1 disposal mounds.

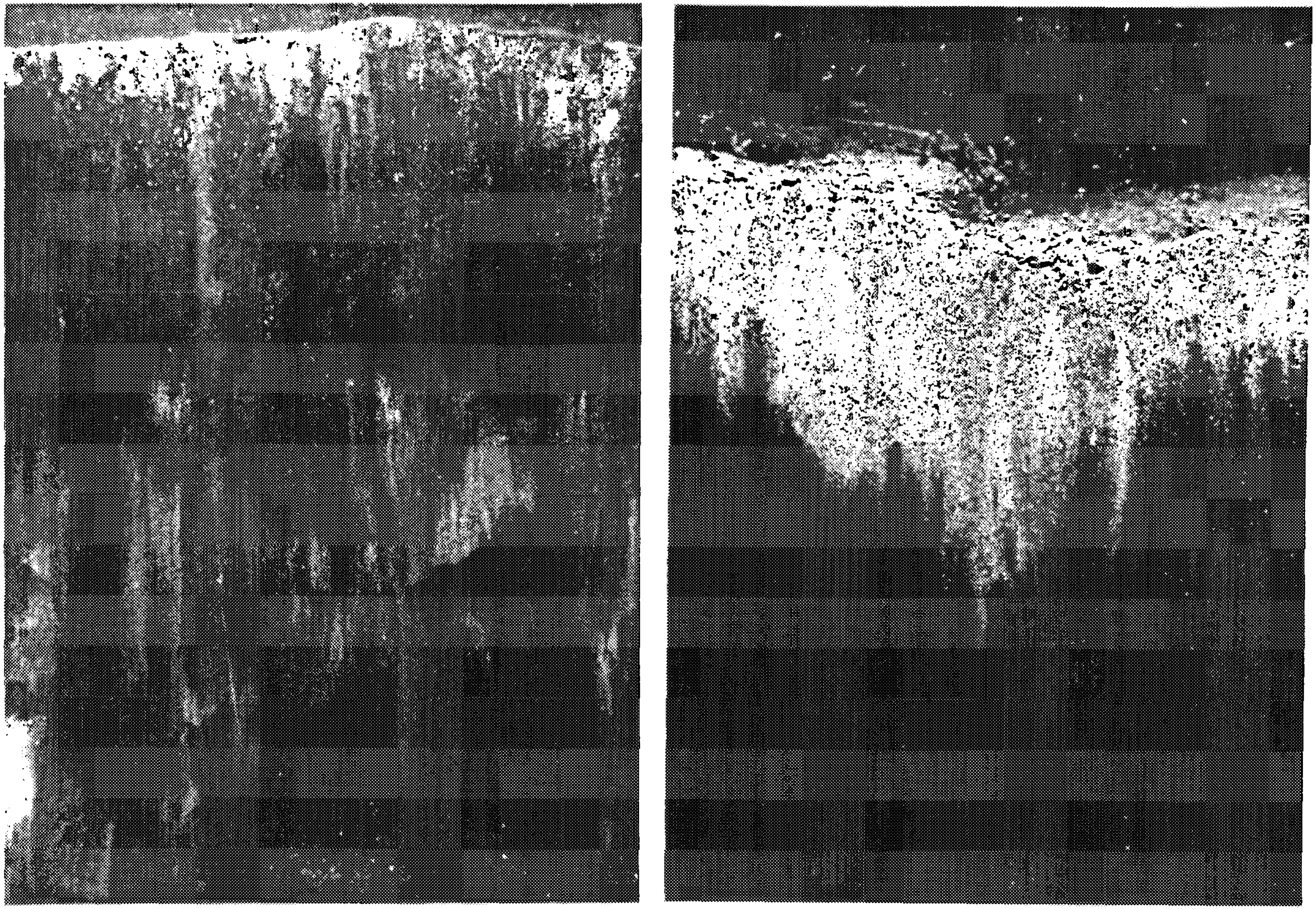
There was no dredged material detected at any of the three reference areas. Within CLIS, all REMOTS® stations showed evidence of dredged material. The dredged material was categorized as either relic or fresh dredged material based on sediment grain size, optical reflectance, and sediment fabric (SAIC 1990c) (Figures 3-7 and 3-8). Most REMOTS® stations within the disposal site contained fresh dredged material (Figure 3-9). Relic dredged material occurred at the northernmost stations and in the south central area of the survey.

The majority of REMOTS® stations in CLIS and the reference areas consisted of silt-clay and very fine sand (>4 phi and 4-3 phi, Figure 3-10). Most of the disposal site stations located near active disposal mounds exhibited finer grained sediment (>4 phi) than stations away from recent deposition (4-3 phi, 3-2 phi). At the reference stations, most REMOTS® photographs had a dominant grain size of 4-3 phi. The majority of small-scale surface boundary roughness values at the disposal site stations were in the range of 0.0 to 1.6 cm, while those at the reference stations were in the range of 0.4 to 1.2 cm. Boundary roughness values (Figure 3-11) at the disposal site stations were not significantly different from those at the reference stations (Mann-Whitney U-test, $p=.841$).

Mean apparent redox potential discontinuity (RPD) depths ranged from 1.2 cm to 6.0 cm at CLIS and from 3.4 cm to 6.6 cm at the reference areas (Figure 3-12). The frequency distribution of apparent RPD depths had a major mode at 5.0 cm for the reference areas and at 3.0 cm for the disposal site (Figure 3-13). The disposal site RPD depths were significantly shallower than those at the reference areas (Mann-Whitney U-test, $p < .001$). RPD depths less than or equal to 3.0 cm occurred in 45 out of 65 disposal site station locations. The deeper RPD values were around CS-90-1, CLIS-87, at the edges of the survey grid, and in the reference areas.

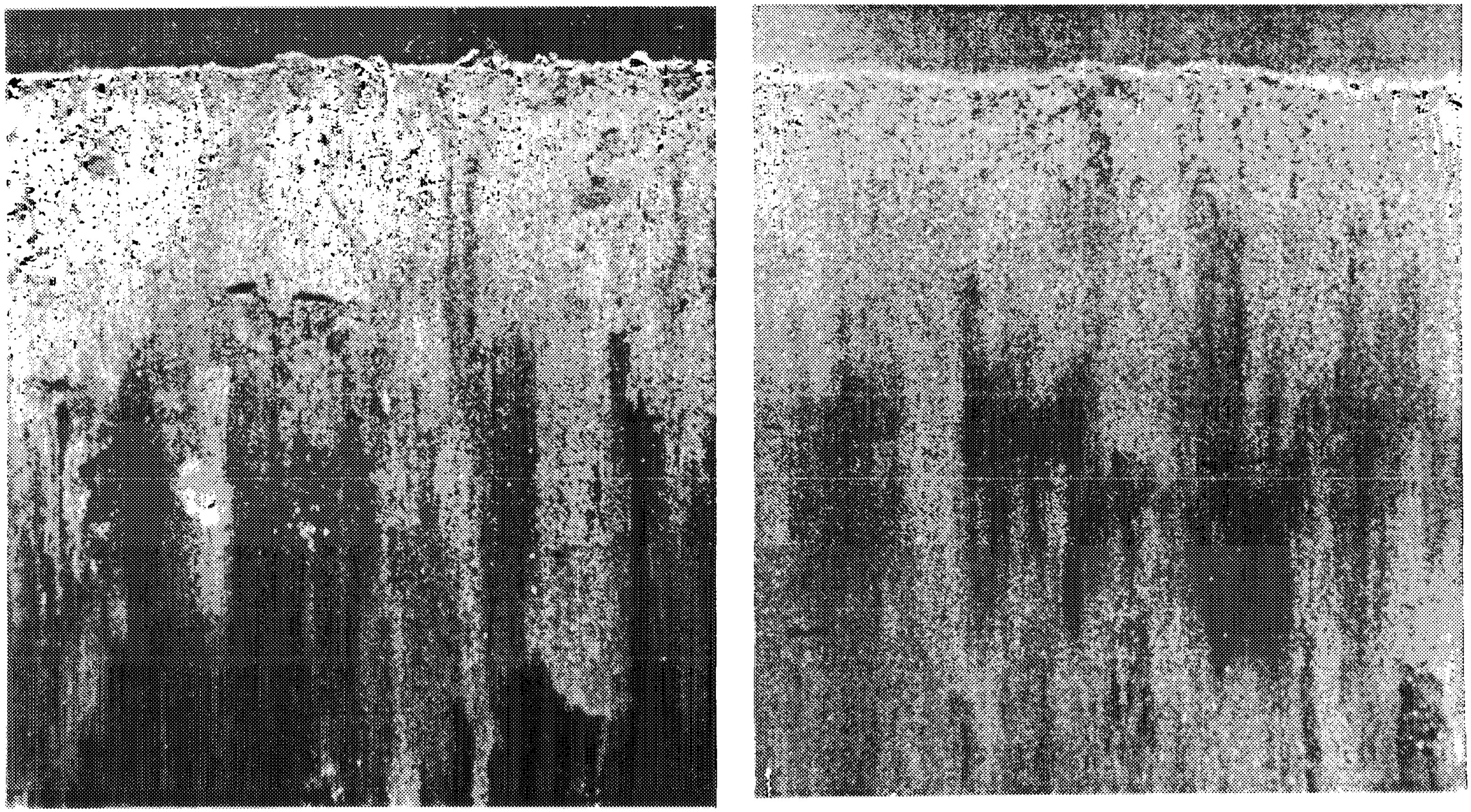
Stations with only Stage I organisms occurred at five locations: around disposal mound CLIS-89, southwest of CS-90-1, southeast of CLIS-88, one station in reference area CLIS-REF, and two stations in reference area 2500W. All other locations, both at the disposal site and reference areas, had Stage III taxa in at least one replicate REMOTS® photograph (Figure 3-14). Most of these stations had either a Stage III or Stage I on III taxa (Figure 3-15).

The multiparameter REMOTS® Organism-Sediment Index (OSI) is used to characterize habitat disturbance. The parameters used to calculate the OSI values are the mean apparent RPD depth, the presence of methane or low dissolved oxygen, and the successional stage (SAIC 1989). Based on the results of past REMOTS® surveys, OSI values of $\leq +6$ are considered indicative of chronically stressed benthic habitats and/or habitats which have experienced recent disturbance (e.g., erosion, dredged material disposal, hypoxia, demersal foraging, etc.; Rhoads and Germano 1986).



H2 F7

Figure 3-7. REMOTS® photographs from stations H2 and F7, showing "fresh" dredged material exceeding the depth of penetration of the camera prism. Scale in both photographs = 1X.



F2 F12

Figure 3-8. REMOTS® photographs from stations F2 and F12 showing bands of reduced sediment at depth representing relict dredged material. Scale in both photographs = 1X.

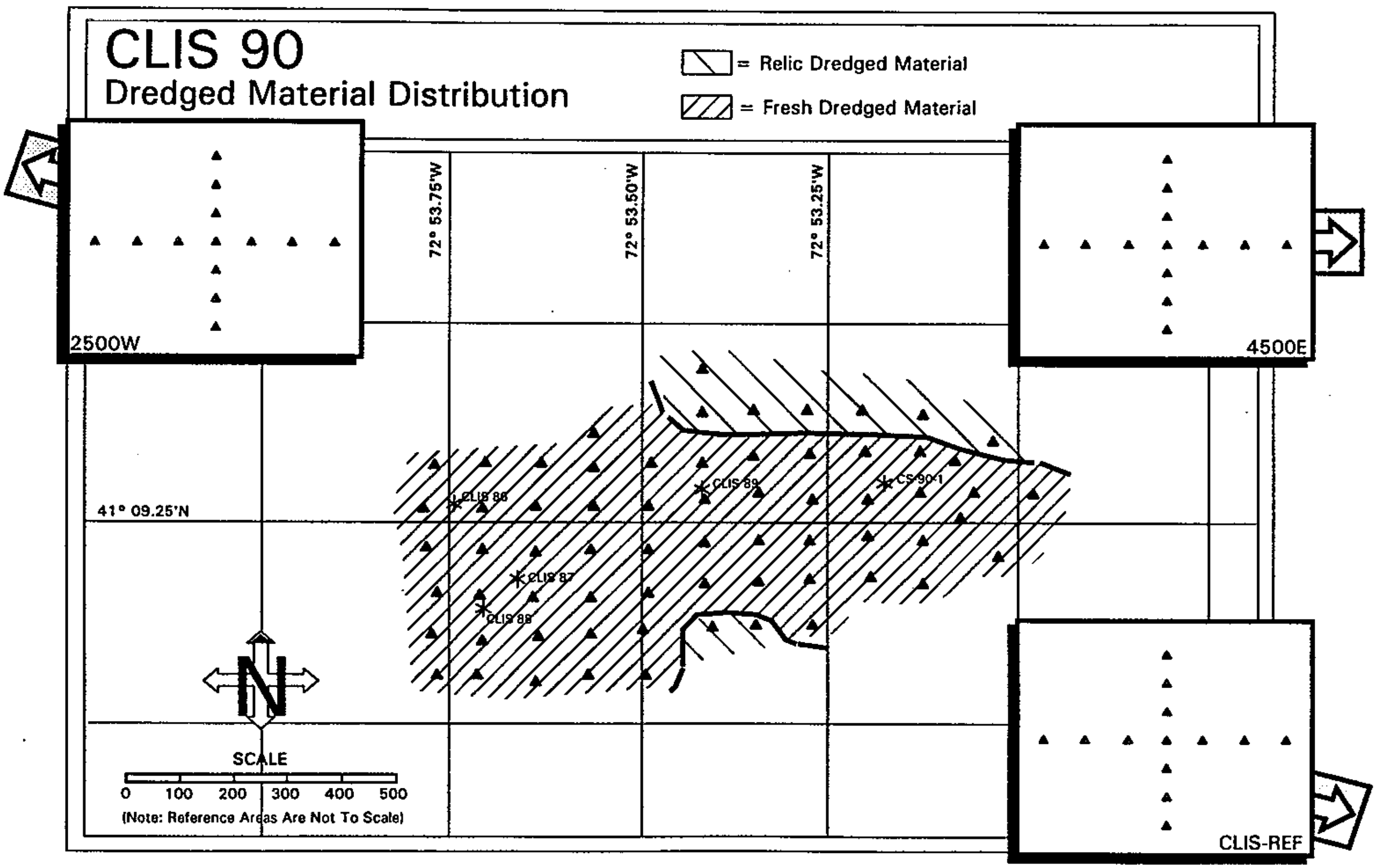


Figure 3-9. Distribution of dredged material at CLIS, July 1990.

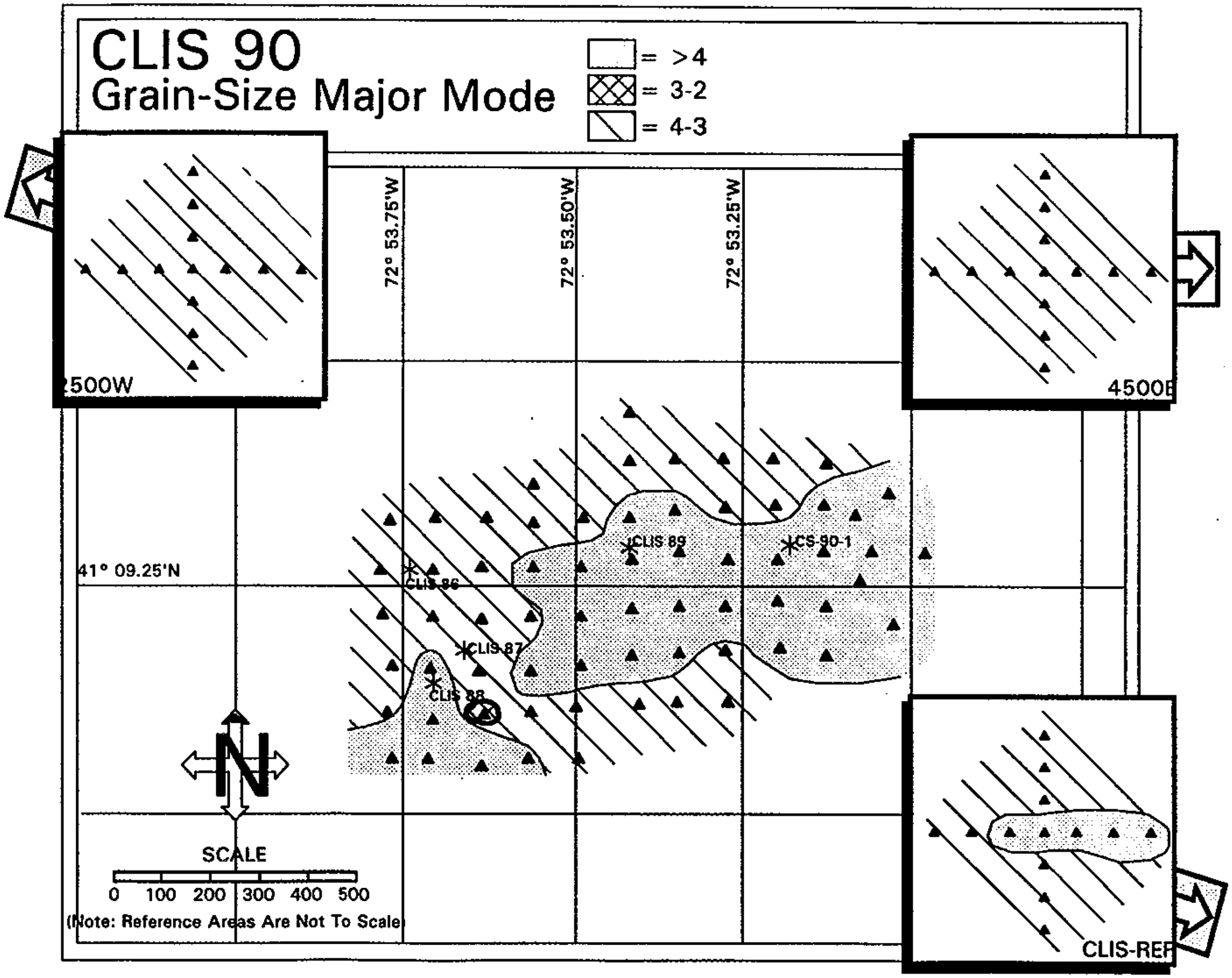
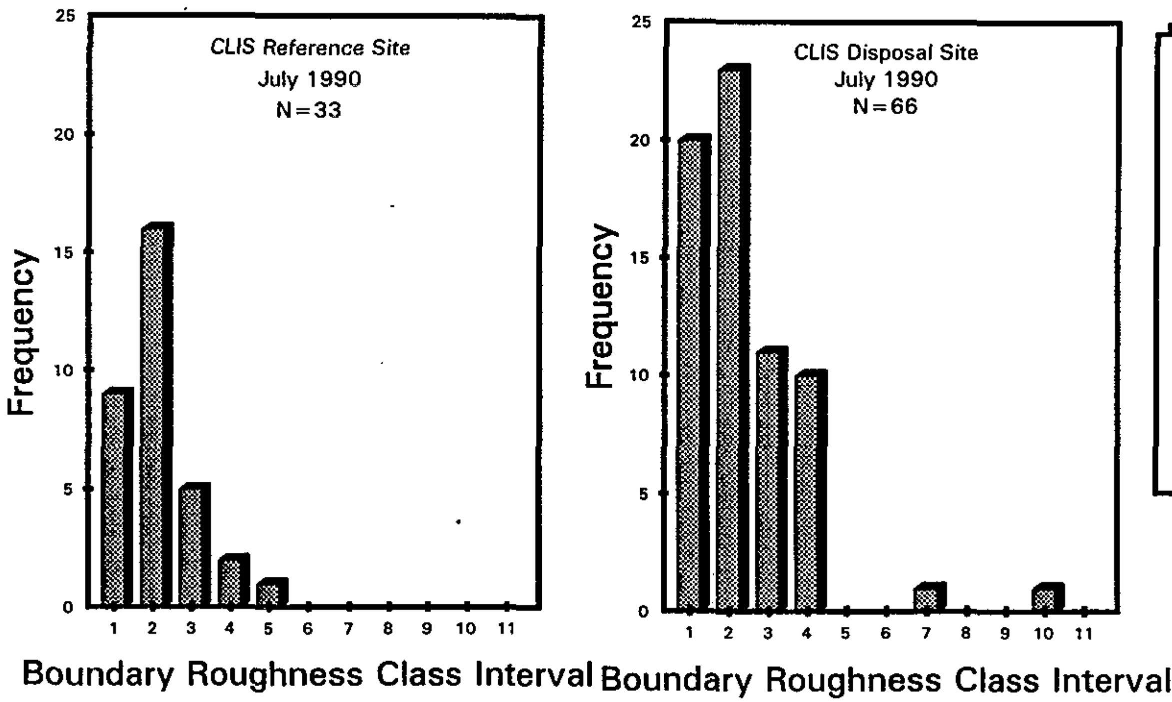


Figure 3-10. Map of sediment grain size major mode (in phi units) at CLIS, July 1990.



KEY

CLASS INTERVAL	RANGE OF VALUES (CM)
1	0.0 - 0.6
2	0.6 - 1.0
3	1.0 - 1.4
4	1.4 - 1.8
5	1.8 - 2.2
6	2.2 - 2.6
7	2.6 - 3.0
8	3.0 - 3.4
9	3.4 - 3.8
10	3.8 - 4.2
11	4.2 - 4.6

Figure 3-11. Frequency distribution of small-scale surface boundary roughness values for all stations at both the reference areas and CLIS, July 1990.

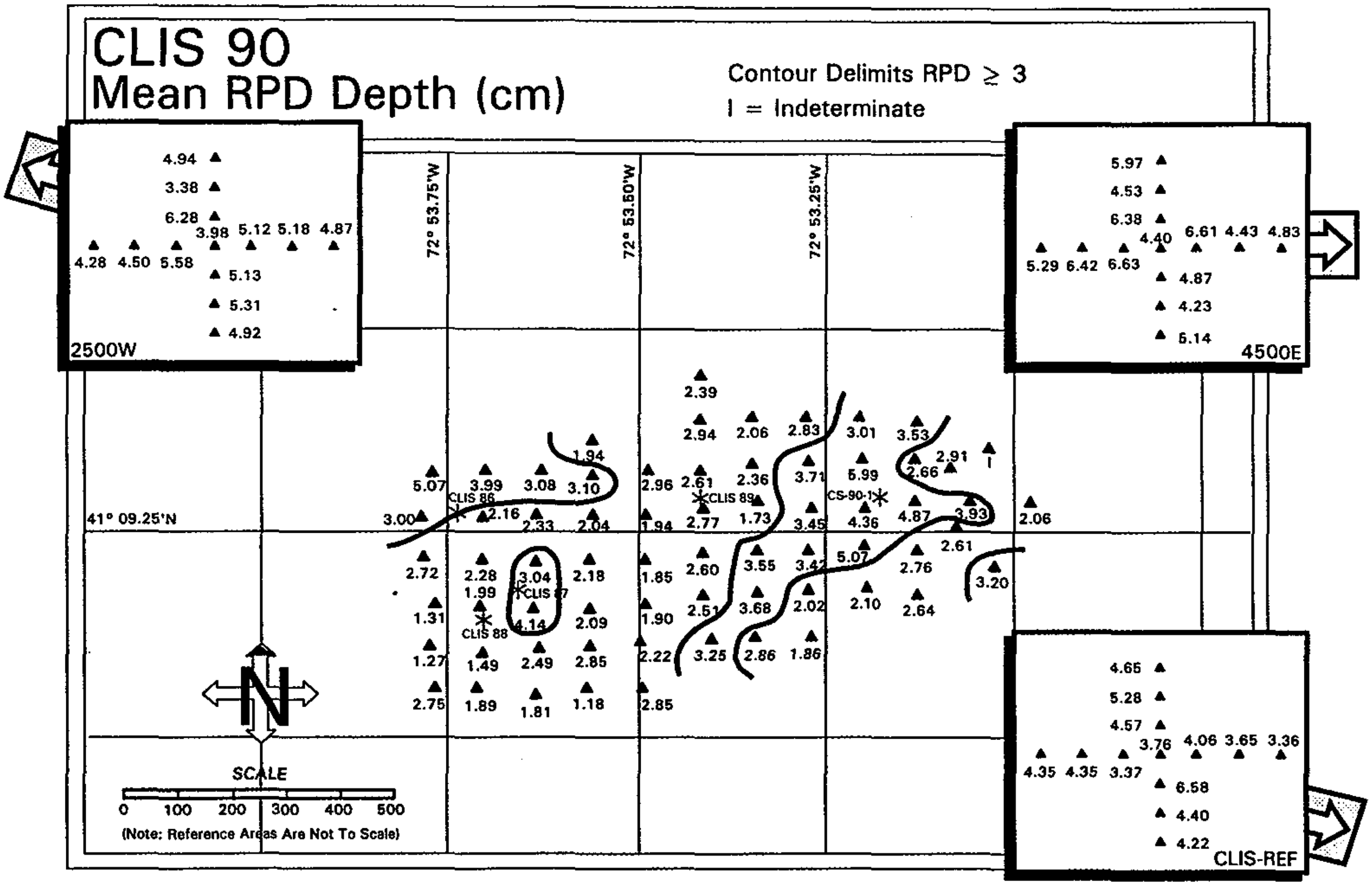


Figure 3-12. The mapped distribution of apparent RPD depths (cm), averaged by station, at CLIS in July 1990.

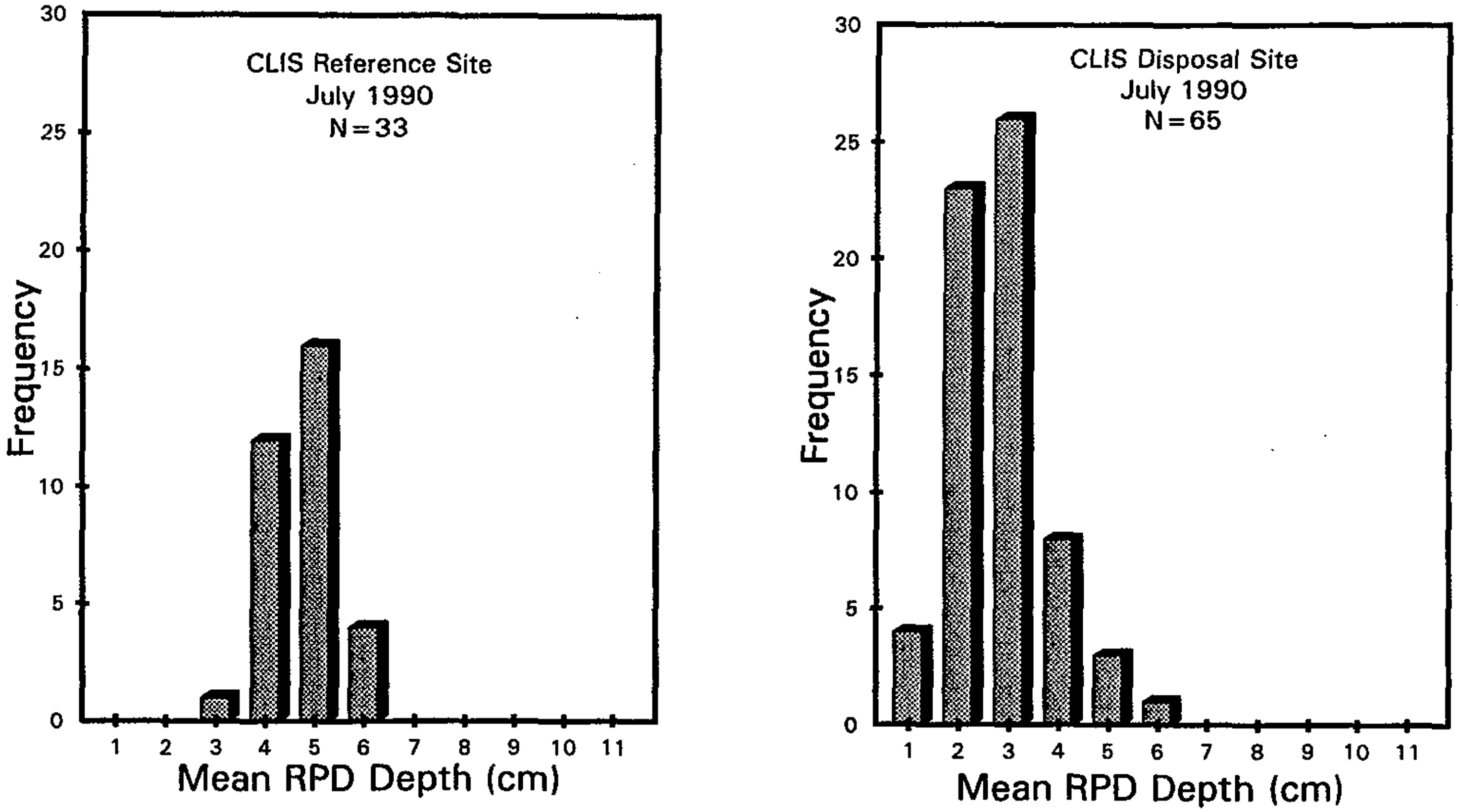


Figure 3-13. Frequency distribution of apparent RPD depths for all reference and disposal site stations at CLIS, July 1990.

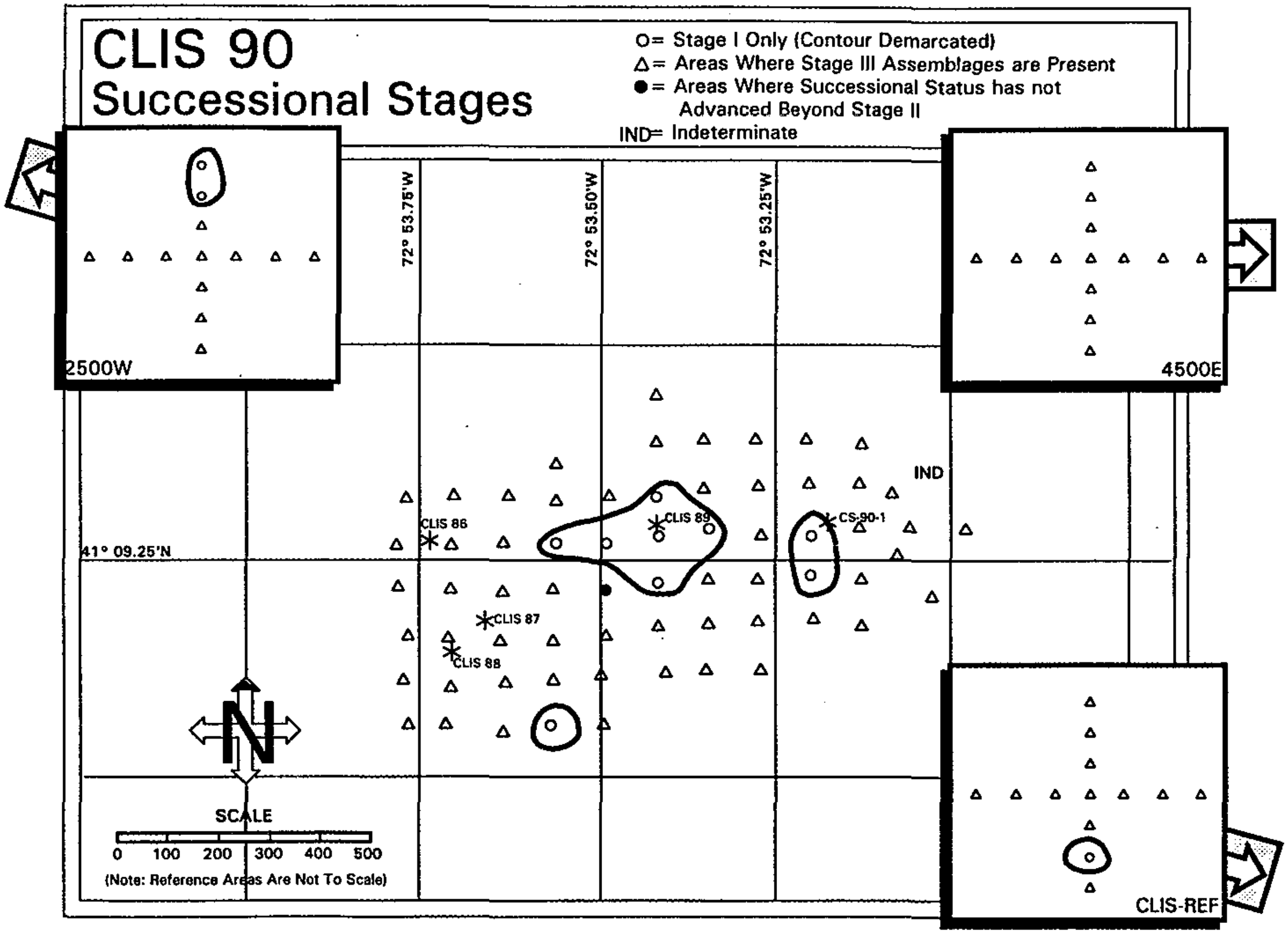


Figure 3-14. The mapped distribution of infaunal successional stages at CLIS, July 1990.

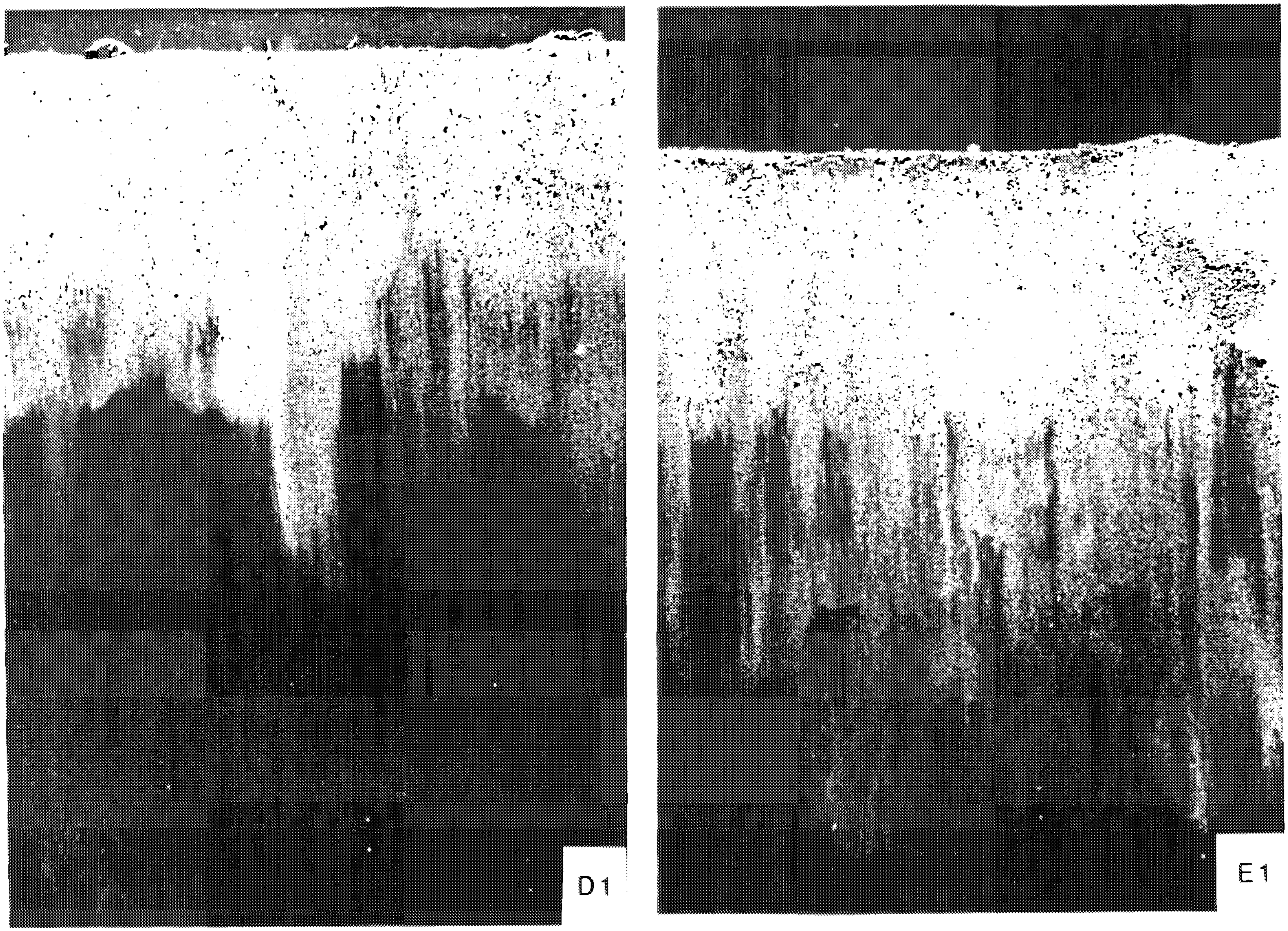


Figure 3-15. REMOTS® photographs from stations D1 and E1 showing infaunal successional stages I and I/III. Scale in both photographs = 1X.

Sixteen out of 65 stations in CLIS had mean OSI values of $\leq +6$ (Figure 3-16). These values reflected shallow RPD depths (<3 cm), the presence of Stage I organisms, and, at one station, the presence of methane (Figure 3-17). Eleven of the stations with mean OSI values of $\leq +6$ were near the CLIS-89 disposal buoy. Low OSI values at the remaining five stations resulted from the absence of Stage III taxa in one or more replicate REMOTS® photographs combined with relatively shallow RPD depths. Mean OSI values exceeded +6 at the remaining disposal site stations and at all three reference areas.

The frequency distribution of reference station OSI values had a major mode at 11, while the distribution of OSI values at all 65 stations within the CLIS boundary had major modes at 7 and 9 (Figure 3-18). There was a significant difference in OSI values at the disposal site stations versus the pooled reference stations (Mann-Whitney U-test, $p < .001$).

3.3 CTD and Dissolved Oxygen Sampling

CTD profiles obtained at the center of each reference area and at the CLIS-89 buoy location (center and 300 m north, south, east, and west) all had a distinct layer of water with high temperature, low sigma-t, and low salinity to a depth of approximately 7 m (Figures 3-19 and 3-20). Below 7 m the temperature and salinity remained constant to depth. This was consistent with CTD profiles from previous CLIS surveys (SAIC 1990a).

Dissolved oxygen concentrations for water samples 1 m above the bottom ranged from 4.02 to 4.33 $mg \cdot l^{-1}$ around the CLIS-89 buoy location and from 3.4 to 6.34 $mg \cdot l^{-1}$ at the center of the three reference stations (Table 3-1).

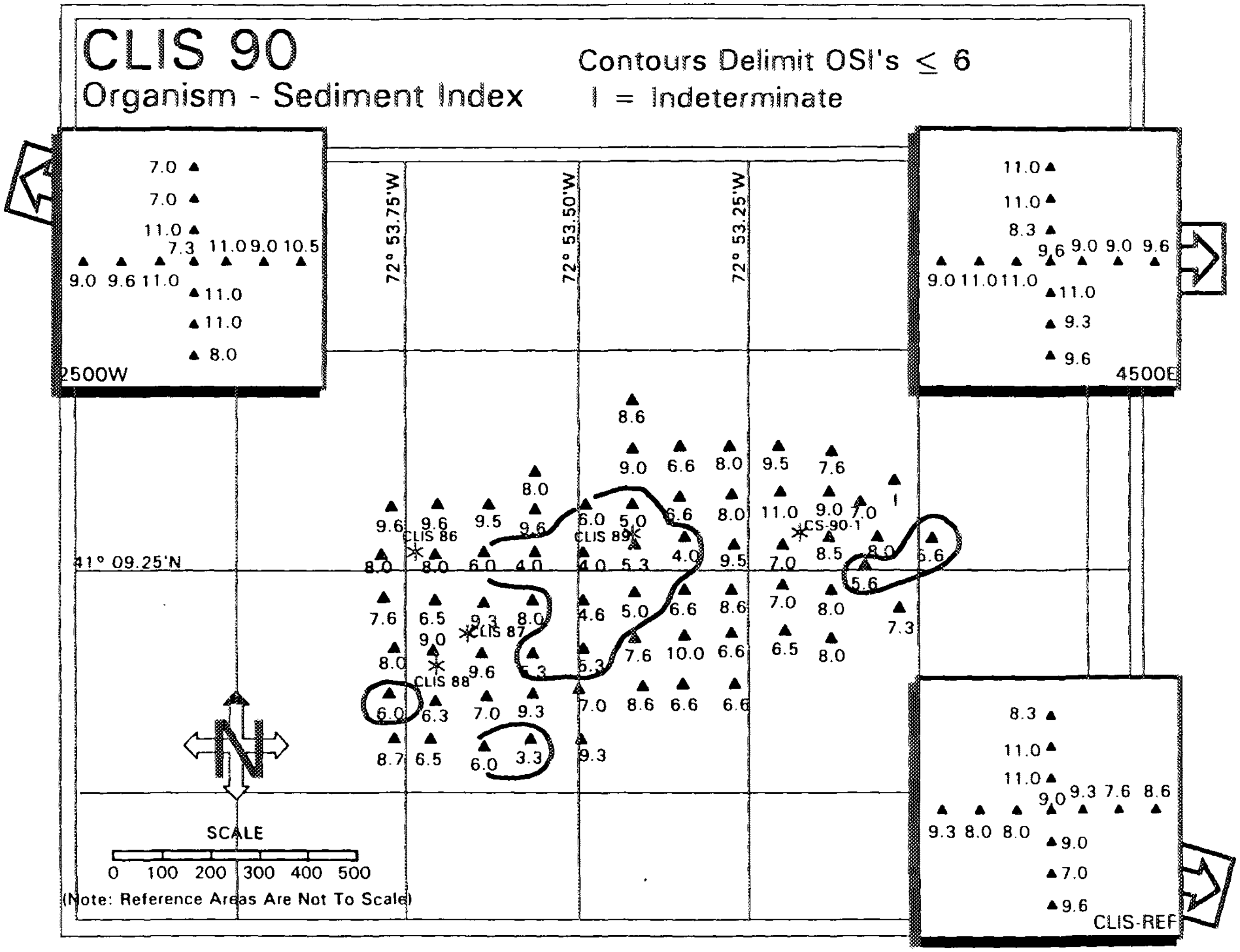
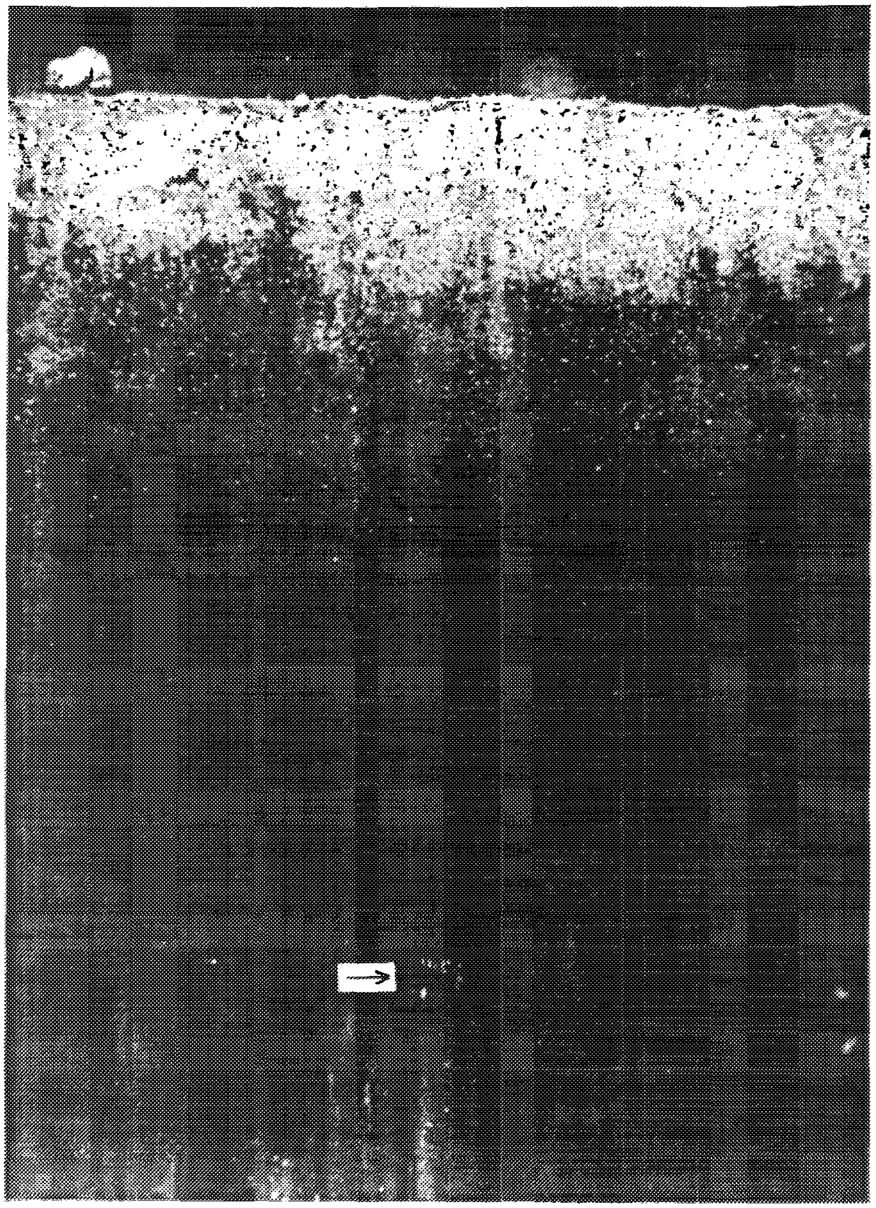


Figure 3-16. The distribution of Organism-Sediment Indices, averaged by station, at CLIS in July 1990



E9

Figure 3-17. REMOTS® photograph from Station E9 showing methane. Scale in photograph = 1X.

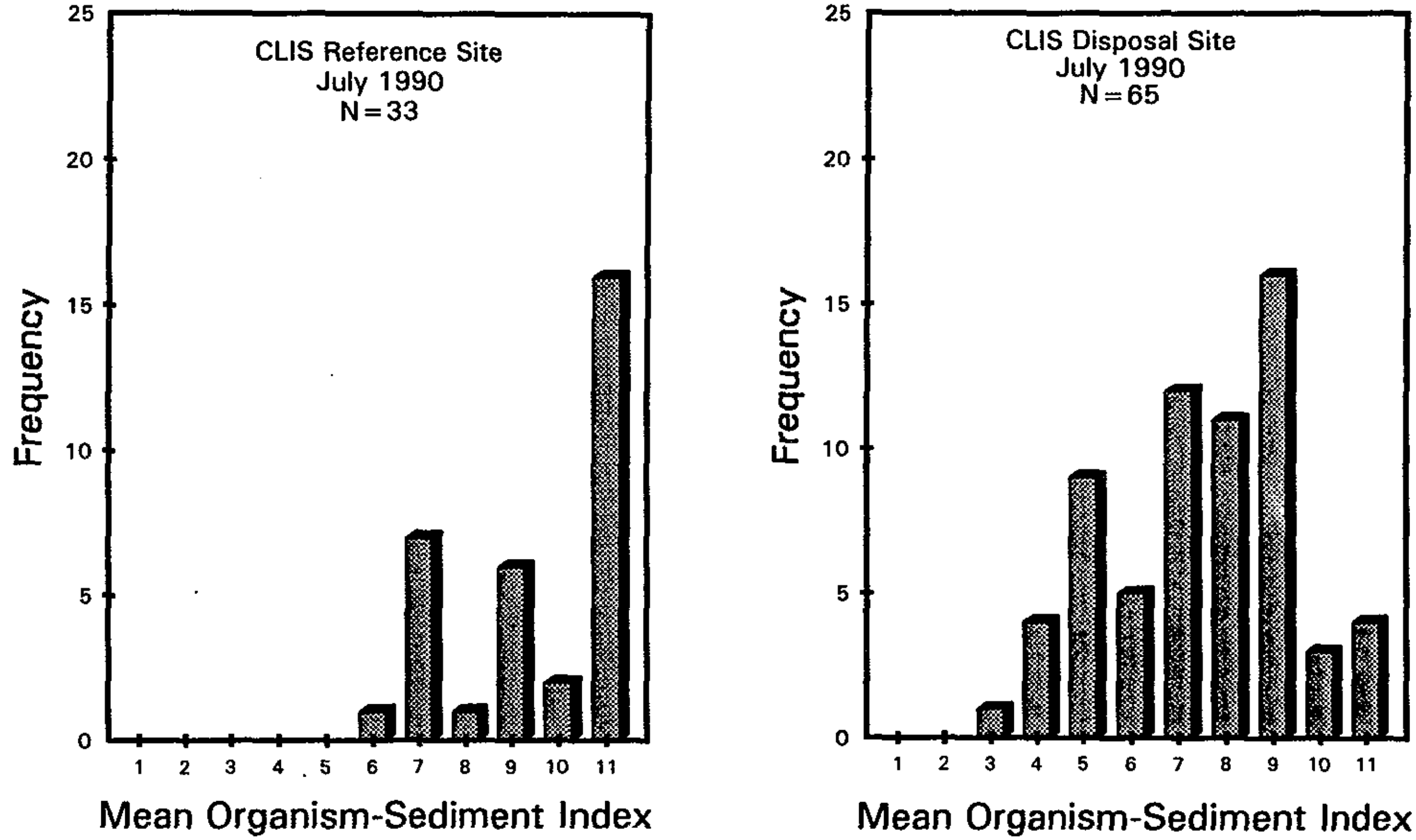


Figure 3-18. Frequency distribution of Organism-Sediment Indices for all replicates at both the reference and disposal site stations at CLIS, July 1990

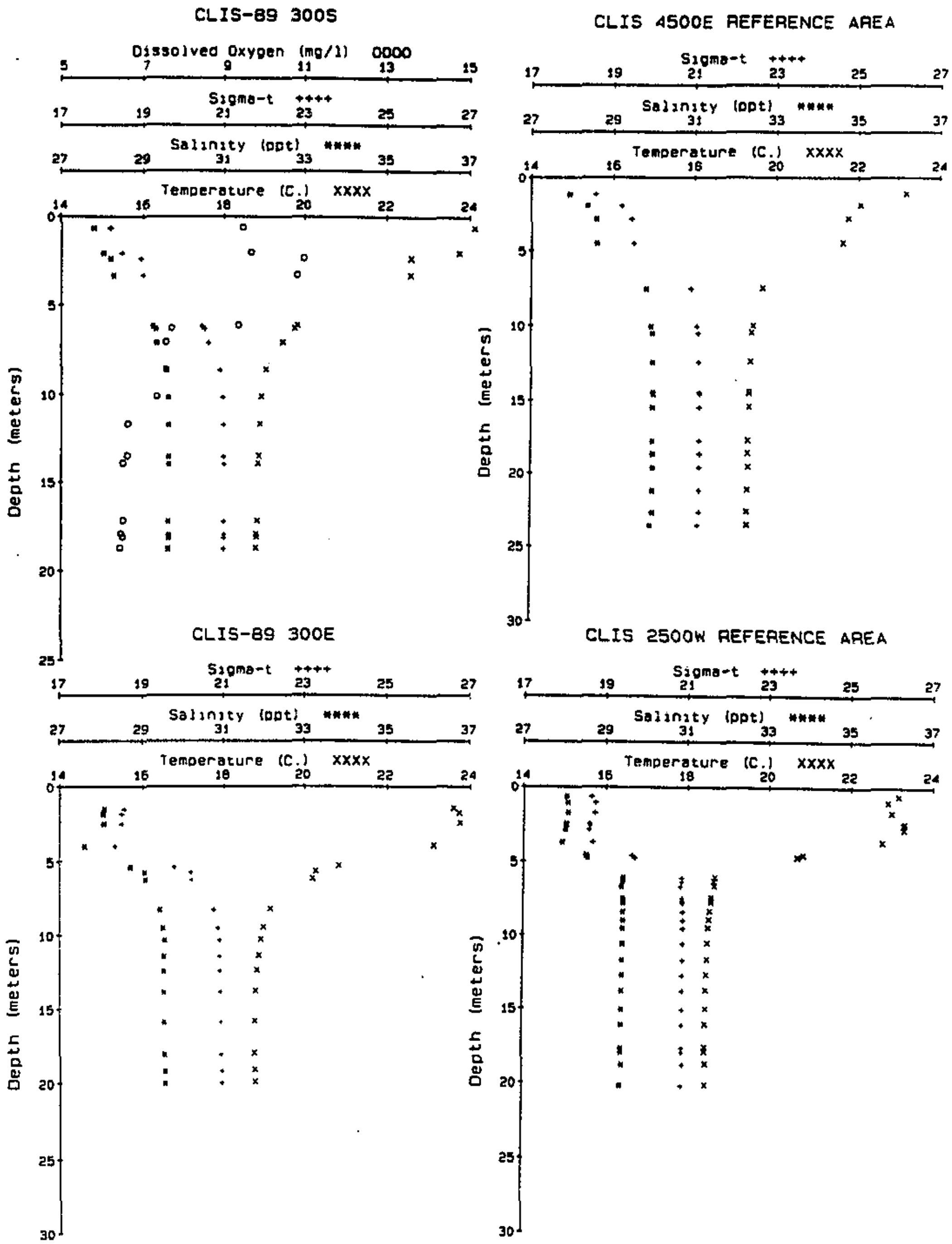


Figure 3-19. CTD plots obtained at CLIS in July 1990.

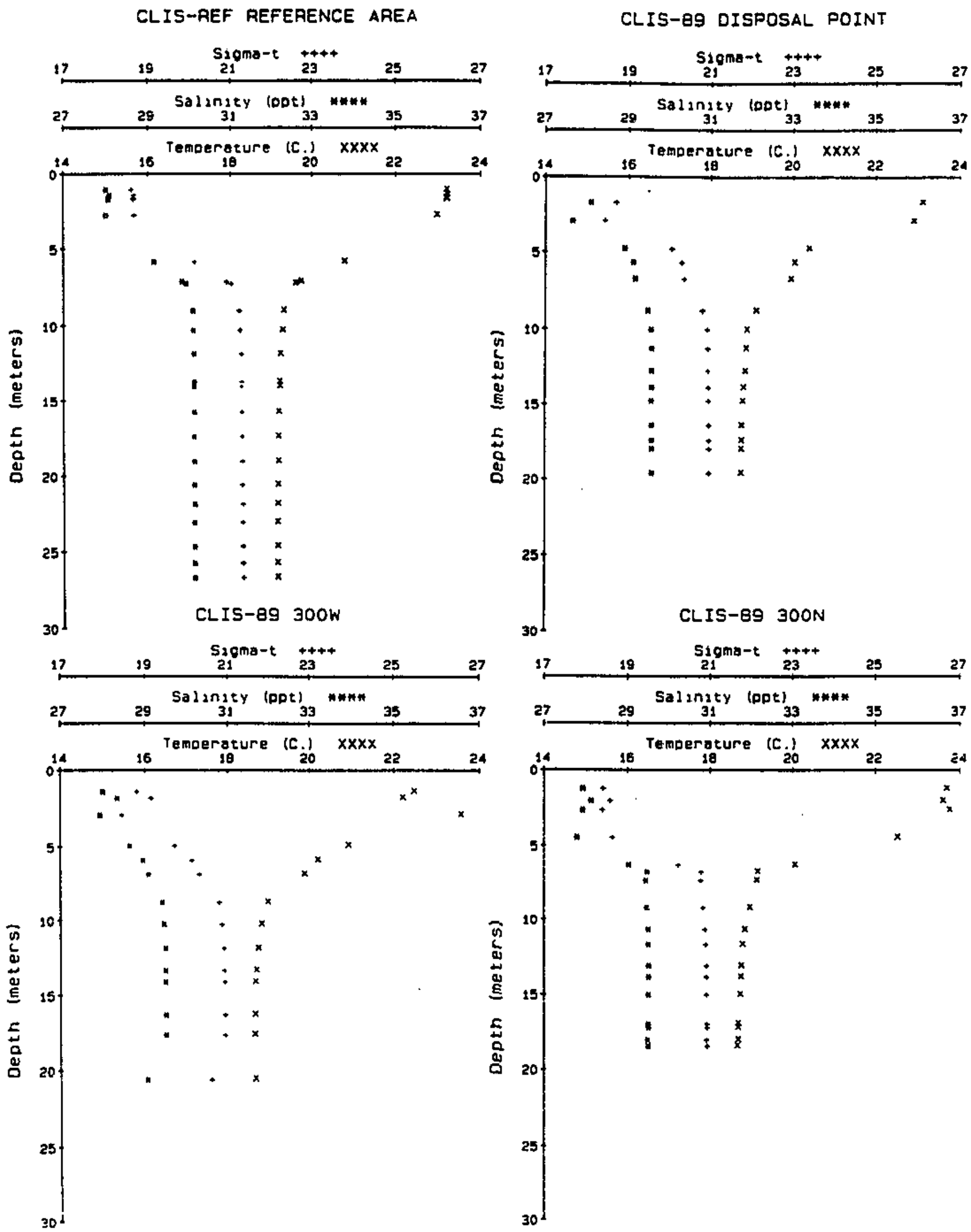


Figure 3-20. CTD plots obtained at CLIS in July 1990.

Table 3-1

Dissolved Oxygen Concentrations at Selected Disposal Site
and Reference Stations at CLIS, July 1990
Concentrations are in $mg \cdot l^{-1}$

Station	At Bottom
CLIS-REF	6.34
4500E	6.24
2500W	3.40
CLIS-89	
300 m south	4.23
300 m center	4.02
300 m north	4.02
300 m west	4.33
300 m east	4.02

4.0 DISCUSSION

The objective of the combined REMOTS® and precision bathymetric surveys was to delineate the areal extent and the height of dredged material deposits resulting from the release of dredged material at CLIS since the 1988 survey. The bathymetric survey showed accumulations of dredged material in the vicinity of the disposal buoys used during the 1988/89 and 1989/90 disposal seasons (CLIS-88, CLIS-89, and CS-90-1). The disposal buoy in 1988/1989 was located approximately 100 m southwest of the CLIS-87 disposal mound. As dredged material was deposited at the CLIS-88 location, it formed a mound with a radius of 150 to 200 m that merged with the CLIS-87 mound. When disposal was completed, a distinct peak of 4.4 m had formed at the CLIS-88 buoy location. The CLIS-87 disposal mound retained its 4.6 m peak. The disposal mound formed in 1989/1990 at CLIS-89, northeast of CLIS-87 and CLIS-88, had a height of 3.0 m and a radius of 200 m.

The capping operation at the CS-90-1 mound involved releasing material from the Harbor Village project at the CS-90-1 buoy and capping it with material from the Branford River project. The postdisposal, precapping survey in January 1990 found a 1 m high mound approximately 50 m east of the disposal buoy (Figure 4-1). Based on the distribution of the Harbor Village sediments, as identified from REMOTS® photographs and bathymetry, eight LORAN-C locations, A through H, were chosen as release points for cap material. When the pre- and postcapping bathymetric surveys at CS-90-1 were compared, points F and H were covered with a minimum of 60 cm of cap material. Between points C and D, the location of the thickest dredged material base deposit, the cap thickness was also at least 60 cm. The remaining cap material release points appeared to have less than 20 cm of accumulation (Figure 4-2). The final height of the mound formed by all disposal activity at the CS-90-1 buoy was a minimum of 80 cm (Figure 3-3). The decrease in the height of the mound since it was capped can be attributed to consolidation of the base and mound sediments, which also contributed to underestimating cap thickness.

With each survey, 1986, 1988, and 1990, there were depth changes of $\geq$0.20 m on the flanks of the disposal mounds (Figures 3-5 and 3-6). Small, 0.20 to 0.40 m decreases in water depth from 1988 to 1990 corresponded to dredged material located by the REMOTS® survey south of the CLIS-88 disposal mound. Similar depth decreases between 1986 and 1990 may also be due to the presence of dredged material forming the flanks of the disposal mound. The depth difference chart based on a comparison of 1988 and 1990 bathymetric surveys had negative contours, i.e., an increase in depth of 0.20 m to greater than 0.60 m. Observed depth changes greater than 0.60 m were on the edges of the CLIS-87 mound. However, the rapidly sloping topography in these areas could result in inaccurate estimates of differences in depth due to the actual locations of the depth transducer during the 1988 and 1990 surveys. Less dramatic changes in topography between 1988 and 1990 over more gradually sloping bottom could be due to erosion, consolidation, and/or errors in navigation.

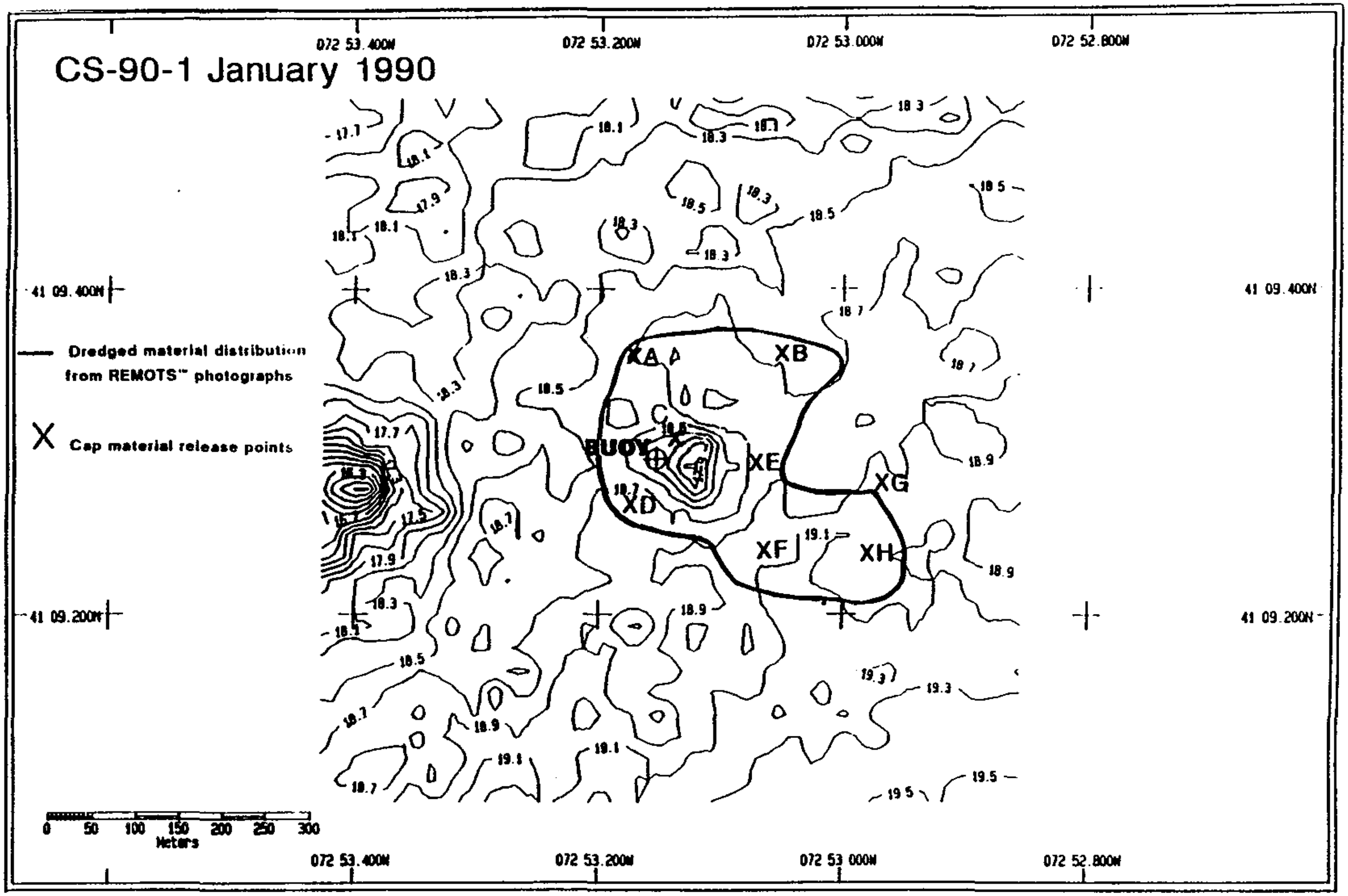


Figure 4-1. Contoured bathymetric chart (depth in meters) of the CS-90-1 disposal mound, January 1990

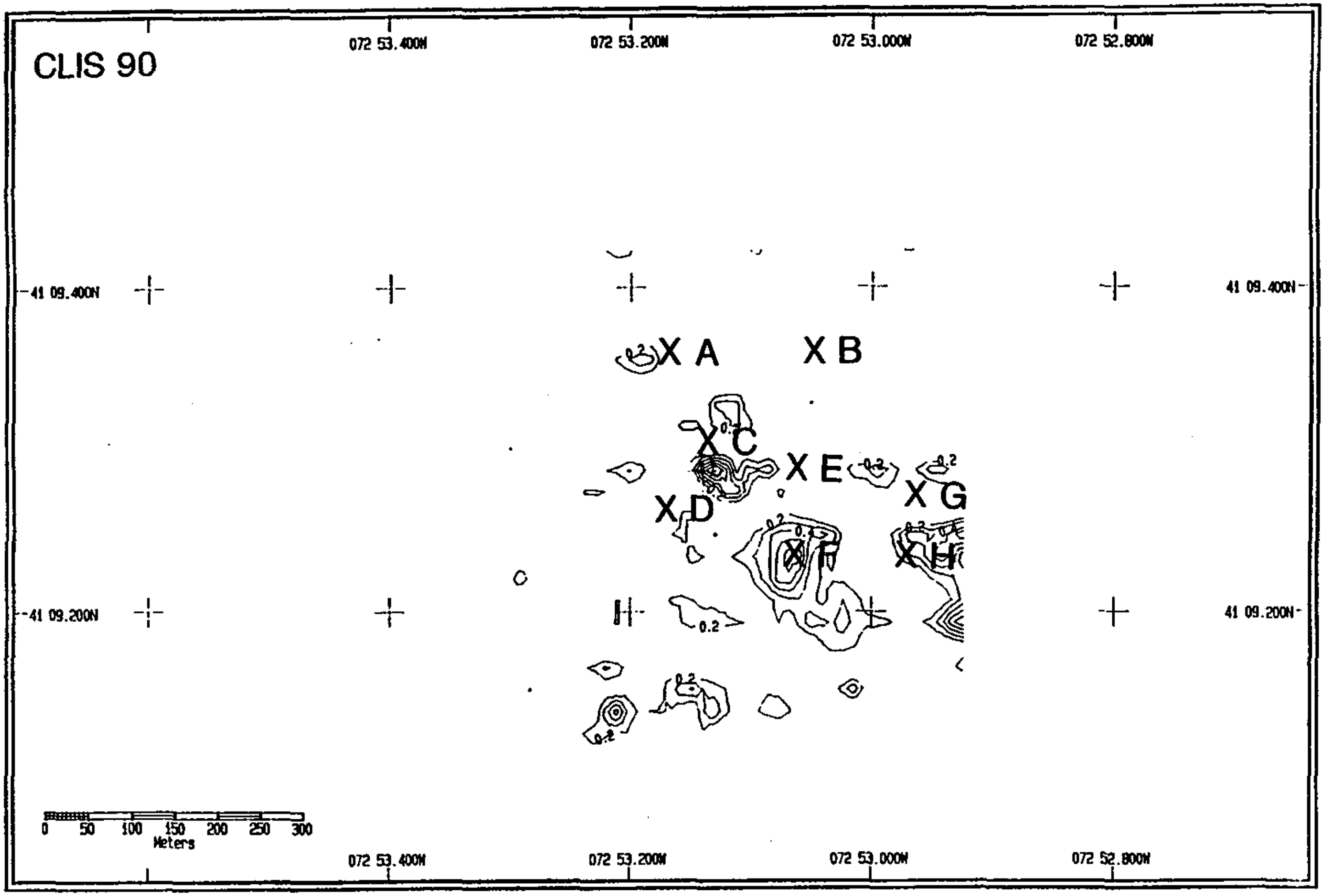


Figure 4-2. Contoured depth difference chart (meters) from January 1990 to July 1990 surrounding the CS-90-1 disposal mound.

During the 1990 survey, dredged material was detected at several REMOTS® stations up to 300 m from the buoy locations (Figure 3-9). This seems to indicate that some sediments were released more than 200 m from the buoy. Cross-checking release locations recorded in the barge logs for the 1988/89 and 1989/90 disposal seasons confirm this (Figure 4-3). However, most release points did fall within 200 m of the buoy location.

The disposal of Harbor Village dredged material at the CS-90-1 buoy between October 1989 and January 1990 was followed by a capping operation using Branford River/Harbor sediments that were to be released at eight designated LORAN-C coordinates. The objective was that the material would be released around these eight points and spread relatively evenly over the seafloor. Comparing the pre- and postcap bathymetry showed the greatest accumulations of cap material at three discrete locations within the radius of the dredged material deposit. The thinner cap at the remaining LORAN-C locations (Figure 4-2) seemed to indicate that the material was not released evenly at all intended locations. Comparing bathymetric values to obtain cap thickness has two inherent limitations which may partially explain the apparent cap thinness. The bathymetric survey has a resolution of between 20 and 25 cm, and sediment thicknesses less than the resolution will not be detected in a bathymetric survey. The bathymetry also only measures the depth to the seafloor. As material (the ambient bottom and the dredged material under the weight of the cap) is compressed, the cap will appear thinner than it actually is.

The significantly shallower RPD depths at disposal site stations versus the reference stations probably were due to the recent disturbance (disposal events) and the presence of dredged material with its increased sediment oxygen demand compared to the ambient sediment at the reference areas. Localized areas of oxidized sediment layers greater than 3 cm were near CS-90-1, CLIS-87, and in the northwest corner of the survey area. The increased RPD depths in these areas were due to greater bioturbational activity by the local infaunal assemblages. With the exception of the area around CS-90-1, most of the greater RPD depths correspond to areas with fewer dredged material release points (Figure 4-3).

Prevalence of Stage I organisms is characteristic of newly recolonized mounds, whereas dominance by Stage III organisms typifies an undisturbed climax community. The predicted recolonization at CLIS was Stage I on the CLIS-89 and CS-90-1 mounds, progressing to Stage III on CLIS-87 and CLIS-88. Only Stage I organisms were found at the six stations around the CLIS-89 mound and at two stations adjacent to CS-90-1. Stage III or I/III was identified at CLIS-87 and CLIS–88, and at most of the REMOTS® stations away from the active disposal mounds and at the reference areas (Figure 3-14). The exceptions were isolated occurrences of Stage I assemblages at reference stations 2500W and CLIS-REF and at station D1 in CLIS. None of these locations had any obvious benthic disturbance.

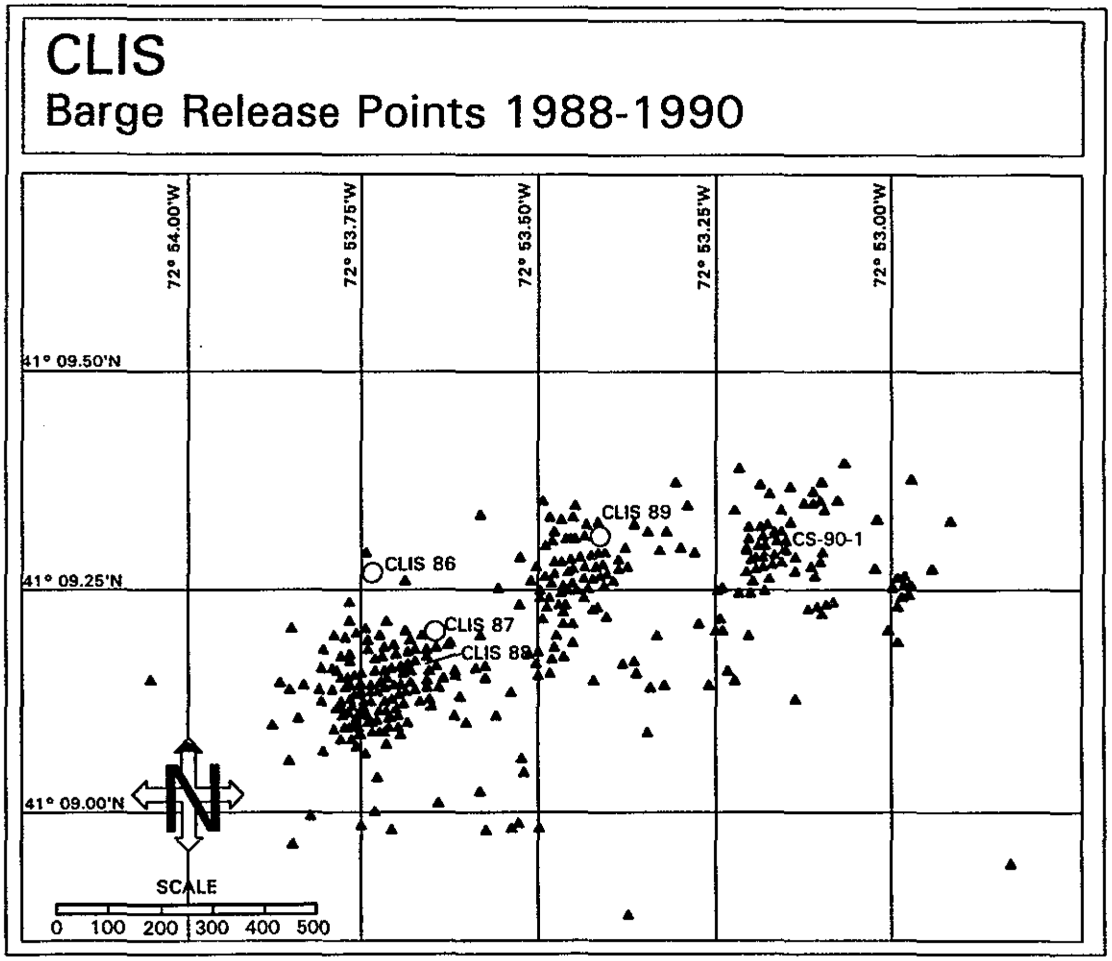


Figure 4-3. Reported LORAN-C positions for barge release points at CLIS during the 1988/89 and 1989/90 disposal seasons

The eastern half of the 1988 REMOTS® survey (centered at CLIS-86) overlapped the western half of the 1990 REMOTS® survey area. In 1988, Stage I taxa were identified at the CLIS-86 (Center) station, and 400 m to the east. The remaining 1988 stations exhibited Stage III taxa. By 1990, the REMOTS® station at the CLIS-86 mound was recolonized by Stage III taxa. During the 1989/1990 disposal season, dredged material was again released at the station 400 m east of CLIS-86, resulting in the continuation of Stage I taxa at this station.

The objective of the CTD/DO sampling was to assess near-bottom dissolved oxygen concentrations in relation to benthic habitat conditions at and near the site. The dissolved oxygen concentrations in the bottom waters, 3.4 to 6.3 $mg \cdot l^{-1}$, were all within the aerobic DO range (Table 4-1). In addition, the 1990 REMOTS® analysis suggested that a relatively healthy and stable benthic habitat persisted within the three reference areas and that infaunal recolonization of the recently deposited dredged material was proceeding at on-site stations. In conjunction with near-bottom DO concentrations, the 1990 REMOTS® analysis indicated that no recent or significant stress relating to near-bottom hypoxic conditions has occurred at CLIS.

Table 4-1

Ecologically Important Dissolved Oxygen Ranges as Determined
from Permanently Stratified Low-Oxygen Marine Basins
(from Rhoads and Morse 1971)

Dissolved Oxygen Range ($mg \cdot l^{-1}$)	Facies
>3.0	Aerobic
3.0 to 0.41	Hypoxic*
0.4 to 0.14	Dysaerobic
<0.14	Anaerobic

*The hypoxic facies has been added to the Rhoads and Morse (1971) basin model by Dr. Barbara Welsh, University of Connecticut, to include responses of high metabolic rate demersal or benthic megafauna.

5.0 CONCLUSIONS

The July 1990 monitoring cruise at the Central Long Island Sound Disposal Site was conducted to delineate the areal extent of the dredged material from the previous disposal season and to monitor the recolonization status of the resident infaunal community. Distinct dredged material mounds were formed at all buoy locations (CLIS-88, CLIS-89, and CS-90-1), and dredged material was detected in all REMOTS® photographs around these disposal locations. The REMOTS® photographs confirmed the recolonization predictions with Stage III on inactive mound CLIS-88 and mostly Stage I on CLIS-89 and CS-90-1.

As measured by bathymetry, the cap at CS-90-1 was thickest (20-100 cm) over the main portion of the contaminated sediment mound. While much of the flank deposit had 20 cm or more of cap, other flank areas appeared to have less than 20 cm of cap. The apparent cap thickness of less than 20 cm over these thin flank deposits occurs due to several factors including compaction of the underlying deposits. To assure complete coverage of the thinner cap areas, additional material should be directed to this mound during future disposal operations.

It appears that the use of multiple barge disposal points on capping projects of this size or smaller should be reconsidered in favor of one central cap disposal point. Alternatively, releasing material underway may have resulted in a more even distribution of cap. Such operational modifications should be investigated in future capping projects.

6.0 REFERENCES

Parsons, T. R.; Maita, Y.; Lalli, C. M. 1984. A manual of chemical and biological methods for seawater analysis. New York: Pergamon Press. p. 173.

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

Rhoads, D. C.; Morse, J. 1971. Ecological and evolutionary significance of oxygen-deficient marine basins. Lethaia. 4:413-428.

SAIC. 1989. Monitoring surveys at the New London Disposal Site, August 1985–July 1986. DAMOS Contribution No. 60 (SAIC Report No. SAIC-86/7540&C60). US Army Corps of Engineers, New England Division, Waltham, MA.

SAIC. 1990a. Monitoring cruise at the Central Long Island Sound Disposal Site, July 1988. DAMOS Contribution No. 72 (SAIC Report No. SAIC-88/7548&C75). US Army Corps of Engineers, New England Division, Waltham, MA.

SAIC. 1990b. Monitoring cruise at the New London Disposal Site, July 1987. DAMOS Contribution No. 66 (SAIC Report No. SAIC-88/7511&C66). US Army Corps of Engineers, New England Division, Waltham, MA.

SAIC. 1990c. Monitoring cruise at the Central Long Island Sound Disposal Site, July 1986. DAMOS Contribution No. 63 (SAIC Report No. SAIC-87/7514&C63). US Army Corps of Engineers, New England Division, Waltham, MA.

Strickland, J. D. H.; Parsons, T. R. 1972. A practical handbook of seawater analysis. Fish. Res. Board Can. Bull. 167.

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