SITE SELECTION AND BASELINE SURVEYS
OF THE AQUATIC DISPOSAL SITE

FIELD VERIFICATION PROGRAM (FVP)

DECEMBER 1982

US Army Corps of Engineers
New England Division

SCIENCE APPLICATIONS, INC.

SITE SELECTION AND BASELINE SURVEYS OF THE BLACK ROCK DISPOSAL SITE FOR THE FIELD VERIFICATION PROGRAM

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1.0 INTRODUCTION

During FY 82, the U.S. Army Corps of Engineers (COE) and the Environmental Protection Agency (EPA) established a joint five year research project called the Field Verification Program (FVP) designed to verify the results of existing and future laboratory testing protocols through in-situ field measurements. A second objective of the program is a comparison of the environmental effects resulting from open water disposal with those generated by wetland or upland disposal operations. The FVP is being directed by the Waterways Experiment Station (WES) in Vicksburg, Mississippi and implemented through cooperative efforts of the Narragansett Environmental Research Laboratory (NERL) of EPA and the New England Division (NED) of the Corps. At sea field measurements required for this program are coordinated by the NED through the on-going Disposal Area Monitoring System (DAMOS) which is managed by Science Applications, Inc. (SAI) under contract to the Corps.

In order to evaluate the laboratory/field prediction capability and to compare upland, wetland and open water disposal operations, an actual dredging operation was required which not only provided space for all three disposal options, but also consisted of sediments rich in possible contaminants which could cause adverse environmental impacts. The proposed dredging of Black Rock Harbor in Bridgeport, Connecticut, met all of these requirements and consequently was selected for study under the FVP.

The selection of Black Rock Harbor (Fig. 1.0-1) as the

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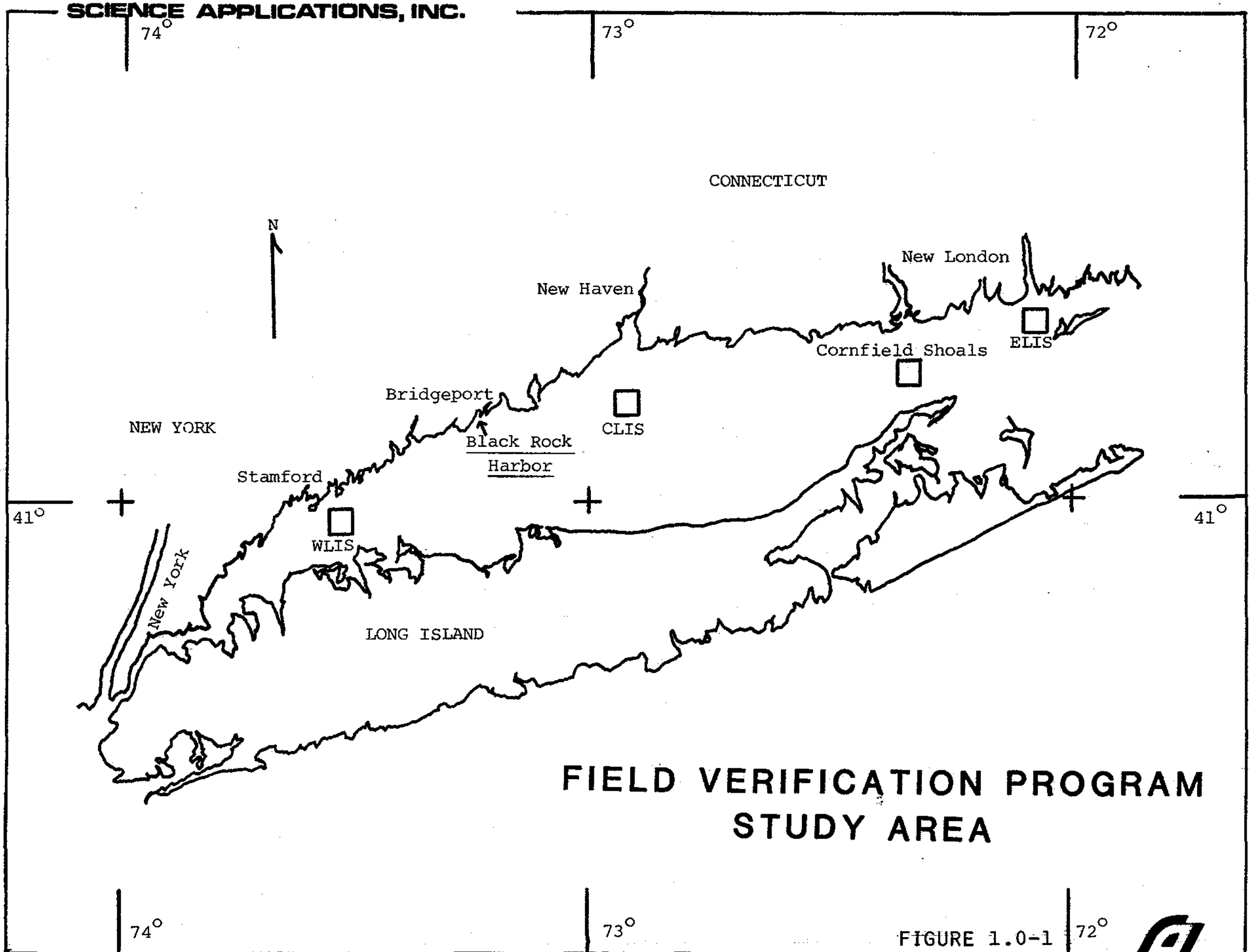

FIELD VERIFICATION PROGRAM STUDY AREA

FIGURE 1.0-1

dredging location dictated designation of an open water disposal site in Long Island Sound. The purpose of this report is to document the criteria that were used for selection of that site and to present baseline data obtained since March, 1982, to characterize the existing conditions in the disposal area.

2.0 DISPOSAL SITE SELECTION

Since the dredging of the Thames River in New London, CT was conducted in 1977, the New England Division, in conjunction with other federal and state agencies, has maintained a consistent dredged material disposal management policy for Long Island Sound. Consequently, disposal of Black Rock sediment had to be consistent with that management strategy. The basic principles applied to disposal in Long Island Sound are:

- Sediments must be deemed suitable for disposal in the Sound according to State and Federal criteria.
- Those sediments which do not pass the criteria for open water disposal may be dumped if effective mitigation techniques are employed, such as burial, capping, upland disposal, etc.
- Four disposal areas are designated in the sound for receiving dredged material. These are (Fig. 1.0-1):
    - Eastern Long Island Sound (New London)
    - Cornfield Shoals (Connecticut River)
    - Central Long Island Sound (New Haven)
    - Western Long Island Sound (Stamford)
- Whenever possible, sediments will be placed at containment sites under controlled disposal operations. (Cornfield Shoals is considered a dispersal site.)

Since the sediment from Black Rock would normally only be disposed in Long Island Sound with some sort of protecting procedure such as capping, it is important that the selected disposal site is a containment site to reduce the potential for additional impacts beyond the immediate dumpsite. Based on these considerations, the only potential sites for disposal are the Central or Western Long Island Sound Sites, since both are known to be containment sites and are within reasonable distance of the dredging operation (15-20 NM).

In terms of the FVP research objectives, the Central Long Island Sound (CLIS) site has several advantages over the Western Long Island Sound (WLIS) site. First, it has been extensively studied since 1974, when material from New Haven Harbor was deposited in the center of the area. Since that time, additional studies under the DAMOS program associated with the Stamford/New Haven, Norwalk, and Mill/Quinnipiac River disposal operations have resulted in continuous monitoring of the site since 1979. Compared with this effort, the WLIS site, although examined in generic and regional terms under DMRP in 1974, has had little attention until recent site designation studies as part of the DAMOS program in 1981-82.

An important aspect of the FVP program must be definition of impacts caused by the disposal of Black Rock sediment from those caused by background contaminant levels or other disposal operations. Here again the CLIS site is superior to the WLIS site since the water and sediments of the central Sound are less contaminated than the western sound where the influence of the East River and intense industrialization combine with more restricted circulation to increase the contaminant loading.

Furthermore, the area around the present WLIS Site has been used for disposal of dredged material since 1902, and a large volume of sediment (10 million yd^3 since 1954) was dumped in this region before controlled disposal operations were initiated. Consequently, sediments at this site today could be a mixture of both natural and dredged material and would not be expected to provide a consistent, low level background for comparison with post-Black Rock disposal conditions.

Based on these considerations, the Central Long Island Sound Disposal Site was selected as the most suitable location for open water disposal of Black Rock sediment. However, a specific disposal point within the site had to be selected based on the following criteria:

- reduction of the potential for adverse environmental impact
- minimal interaction or interference caused by material from past or future disposal projects with this program
- minimize background variability in topography, sediment chemistry, grain size and benthic community

In order to meet these criteria, the disposal point had to be located as far as possible from previous and on-going disposal operations yet at sufficient distance from the margins of the site to insure minimal spreading of dredged material beyond the designated boundaries. The locations of previous disposal points within the CLIS site are shown in Figure 2.0-1 with associated sample locations and hydrographic survey coverage for study under the DAMOS program. A brief description of the characteristics of each mound in chronological order of deposition are as follows:

- 1974 New Haven Mound - 1.2 million m^3 of silt and clay, covered with a sand layer from outer New Haven Harbor. Minimal change since initiation of study under DAMOS program

- Stamford/New Haven South - 38,000 m^3 of Stamford material, capped by 72,000 m^3 of silt from New Haven. Some loss of capping material during Hurricane David in 1979. No significant change during subsequent study.

- Stamford/New Haven North - 26,000 m^3 of Stamford material capped with approximately 33,000 m^3 of sand from breakwater area of New Haven Harbor. No significant change since deposition in June 1979.

- Norwalk - 70,000 m^3 of material from inner harbor capped by 280,000 m^3 of outer harbor silt. Minor readjustment after disposal, but essentially stable.

- Mill and Quinnipiac River (MQR) - 70,000 m^3 of low density, high water content mixture of paper mill waste and silty clay from Mill River, capped by 190,000 m^3 of silty clay from the Quinnipiac River during spring of 1982. Mill River sediment spread over larger area than normally expected with point disposal, therefore capping not as effective as previous operations. Stability of sediment apppears adequate, but not fully proven due to short period of monitoring.

- "SP" Buoy - Permit disposal operations on a continuous basis. No distinct mound has been formed, however, sediments are generally coarser than the natural bottom.

Since most of the more recent disposal operations have taken place in the western half of the CLIS site, specifically at the "SP" Buoy and the MQR site, the best area for disposal of Black Rock material is on the eastern side. This location does have some problems, however, because the predominant tidal flow is known to be essentially east-west through the disposal site (DAMOS 1978).

Therefore, since most of the recent disposal has taken place in the southwest corner of the area, the northeast quadrant was selected as the most favorable for disposal of Black Rock sediment. In addition to being remote from recent operations, the closest mound to the disposal point would be the STNH-N site, which with its sand cap, is the most stable and least likely to cause any contamination of samples taken at the Black Rock site.

Selection of the actual disposal point in the northeast corner was made by balancing the criteria for maximum distance from other mounds with the requirement to keep all dumping operations within the specified CLIS disposal site. Since the proposed disposal volume of 80,000 yds^3 is of similar magnitude to previous STNH operations, those mounds were used as a basis to estimate potential spread of the Black Rock material. On all STNH mounds, stations 400 meters from the disposal point had no indication of dredged material. Therefore, to be conservative, an initial proposed disposal point 400 meters from the north and east boundaries of the CLIS site was proposed at $41^\circ 09.3'$N, $72^\circ 51.9'$W (Fig. 2.0-1).

After selection of this point, a joint effort between NED, NERL and SAI was initiated to conduct in-situ measurements to assess its suitability for disposal and to develop baseline data for comparison with post-disposal information. The following sections detail the results of these measurements and their effect on final designation of a disposal point.

3.0 INITIAL SURVEYS

During March, 1982, a short investigation of the proposed disposal area was conducted as an addition to a DAMOS monitoring cruise to the CLIS site. The purpose of this study was to provide a measure of the suitability of the area for disposal, before more before more extensive baseline studies were initiated. One day was spent in the vicinity of the disposal point conducting depth measurements supplemented by sediment samples at the locations shown in Figure 3.0-1.

Two depth profiles were made across the site, one on an east-west course (Fig. 3.0-2) and the other on a north-south course (Fig. 3.0-3). Both of these transects indicated a relatively smooth bottom at a depth of approximately 60 feet on the fathometer trace which represented a true depth of 20 meters after application of correction factors for tide, ship draft and sound velocity. Microtopography was less than .3 meter, however, there was a slight slope to the south of approximately one meter over the extent of the profile. This smooth topography was expected based on previous surveys conducted within the CLIS site and should provide a good baseline for future surveys to delineate topographic changes caused by disposal.

The sediment samples obtained during this cruise were also quite similar to those obtained on natural bottom during previous studies. The sediment in this area consists predominantly of a fine silty clay which is oxidized to a depth of 5-10 cm. A surface "fluff" layer is generally found consisting of fine oxidized silt and organic detritus. This natural bottom sediment was found at all stations except 500m South and 500m West. At the 500m South station a coarse, arkosic sand was sampled typical of sediment found at other disposal points in the CLIS site which has been attributed to early disposal operations from the New Haven harbor area. At the 500m West station the

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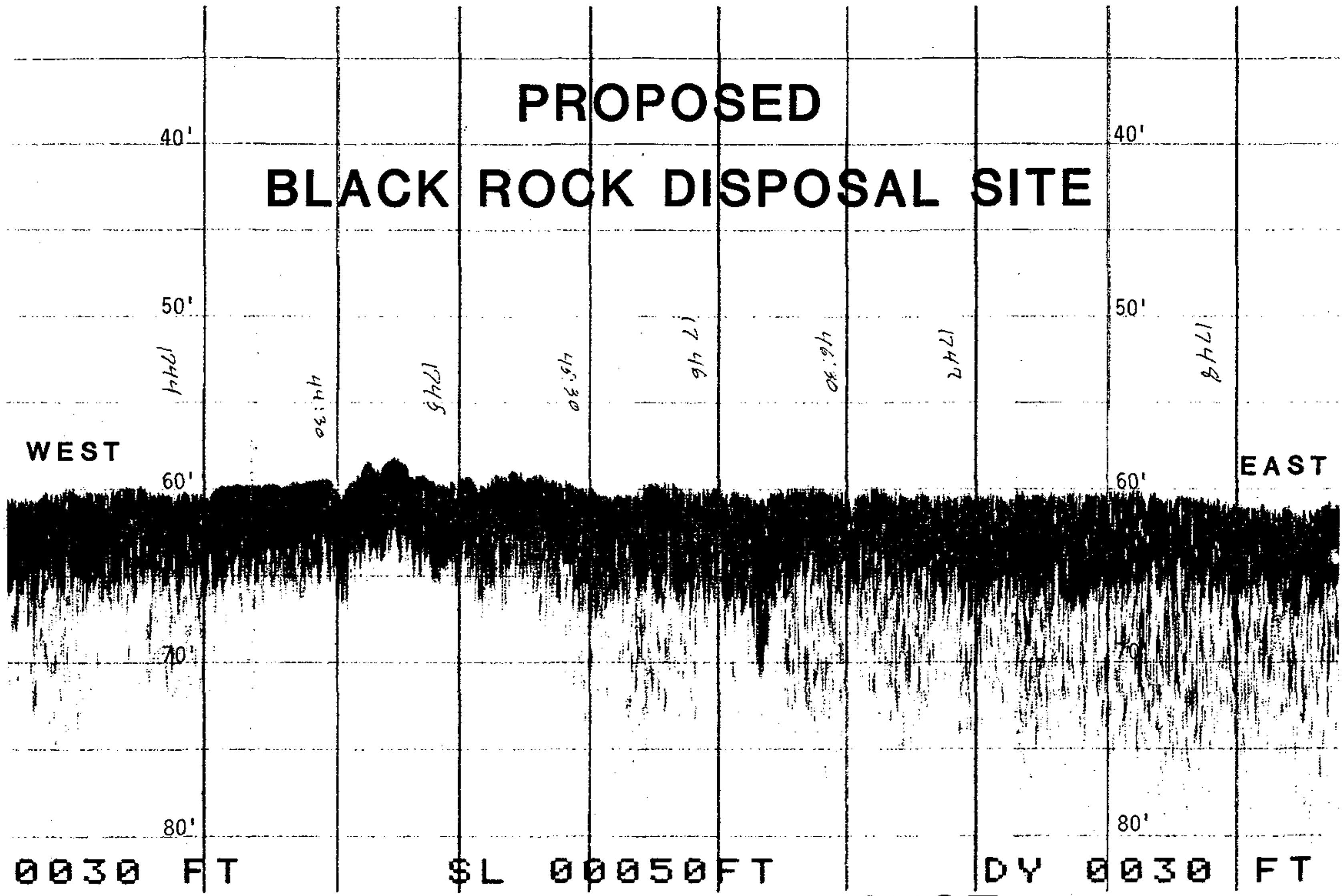

EAST-WEST TRANSECT

FIGURE 3.0-2

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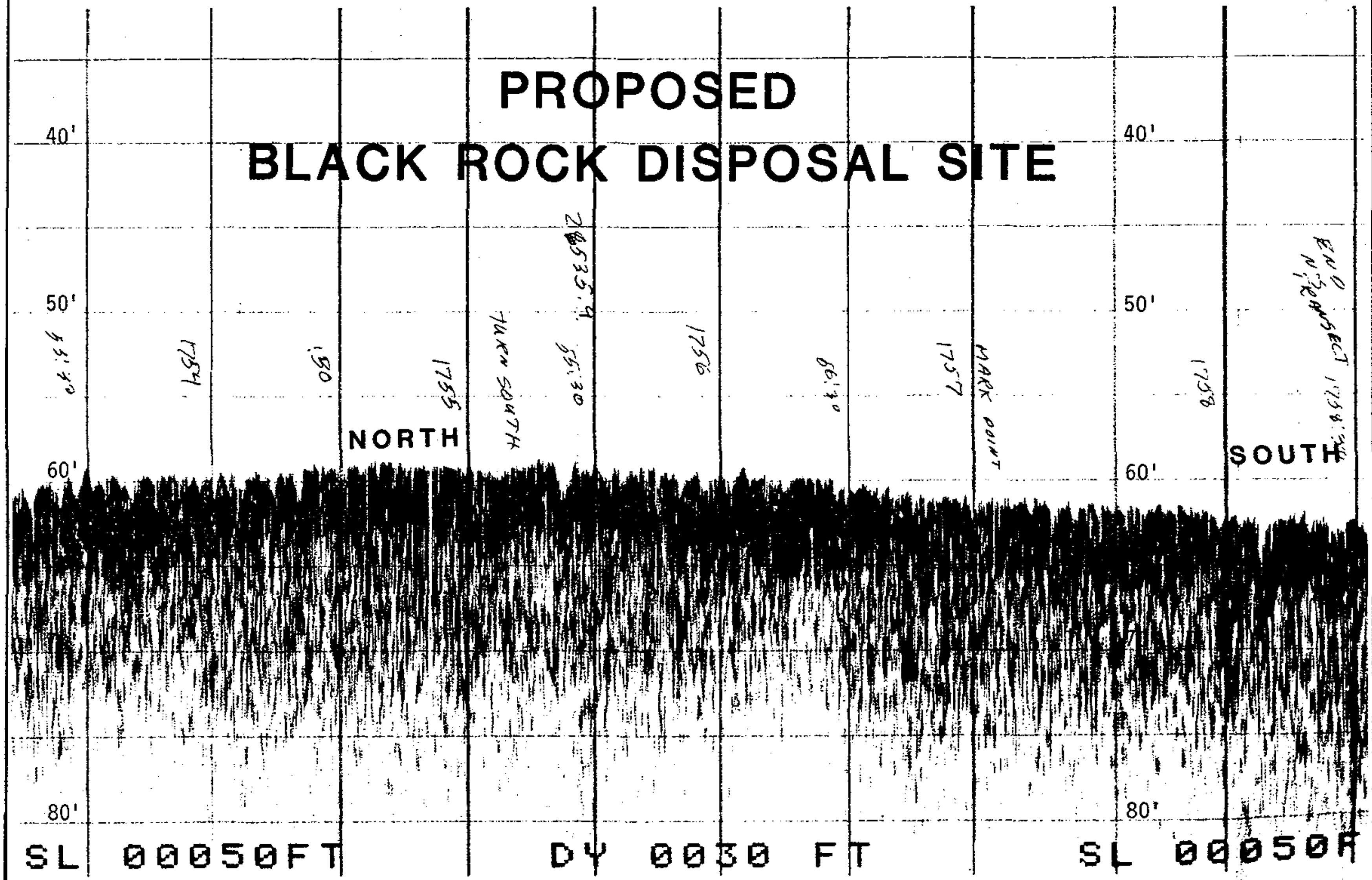

NORTH-SOUTH TRANSECT

FIGURE 3.0-3

surface sediment contained slightly more shell hash material, also indicative of the presence of disposed dredge material, probably from the margins of the STHN-N mound.

Chemical analyses of these samples (Table 3.0-1) indicated that in all cases the background levels of heavy metals are consistent with previous levels and should be quite low in comparison to the Black Rock sediment to be dumped. It is interesting to note that the sample from 500m South, while indicative of dredged material, had even lower values for most metals because of its coarse sandy nature. Because of the low, stable background concentrations, mapping of the dredged material distribution through chemical parameters following disposal should be possible.

Based on the results of this study and in particular the indications of previous disposal at the 500m South and West stations, a decision was made to move the designated disposal point farther to the north and east, but still remain within the CLIS disposal area. The final position selected for disposal of Black Rock dredged material was thus designated as 41°9.39'N, 72°51.75'W (Fig. 2.0-1) and all subsequent measurements were made relative to this point.

4.0 BASELINE SURVEYS

After specification of the disposal point, a comprehensive series of measurements were obtained during the spring and summer of 1982 to characterize the baseline conditions at the site and to verify that the presence of other disposal operations in the same general area would not significantly affect

TABLE 3.0-1

BLACK ROCK DISPOSAL AREA (FVP)
MARCH, 1982
DISPOSAL AREA MONITORING SYSTEM (DAMOS)
SEDIMENT SAMPLE CHEMISTRY DATA

STATION	HG	PB	ZN	AS	CD	CR	CU	V	FE
CTR-1	0.20	53	--	1.7	3.0	59	60	<DL	--
CTR-2	0.45	65	--	1.3	<DL*	60	57	<DL	--
CTR-3	0.22	66	--	2.7	<DL	60	56	<DL	--
500E-1	0.31	62	--	<DL	<DL	59	140	<DL	--
500N-1	0.26	59	--	2.2	<DL	64	62	<DL	--
500W-1	0.43	64	--	0.8	<DL	55	129	<DL	--
500S-1	0.12	20	--	0.7	<DL	22	27	<DL	--
250S-1	0.35	57	--	1.7	<DL	59	60	<DL	--

*DETECTION LEVELS -	Vanadium	100 ppm
	Cadmium	2 ppm
	Arsenic	.5 ppm

VALUES IN PARTS PER MILLION (PPM) UNLESS OTHERWISE NOTED the results of the Field Verification Program.

4.1 Bathymetry

A detailed bathymetric survey was made using the SAI navigation and data acquisition system interfaced to a Del Norte Model 540 Trisponder and an EDO 216C depth digitizer. This survey was conducted over an area 800 X 800 meters square centered at the designated disposal point (Fig. 4.1-1) to form a baseline for future measurement of dredged material volume and to identify any significant topographic features in the study area. The survey grid consisted of 33 east-west transects, 800 meters long and spaced 25 meters apart. This grid should easily cover the mound developed during disposal and will serve as the basis for replicate surveys and sampling control in the future.

Vertical profiles of depth for each of the survey transects are presented in Figure 4.1-2 (a-i) and the depth contour chart resulting from the survey is presented in Figure 4.1-3. From these data the expected lack of topography is readily apparent. Although there are no significant topographic features on the profiles, a gentle slope to the south is evident as the depth increases from 19.5 to 20.5 meters over the survey area.

Based on these results, future measurement of dredged material volume should be very accurate since a smooth, flat bottom provides an excellent baseline for comparison of replicate surveys.

4.2 Side Scan Survey

Although bathymetric surveys can identify significant

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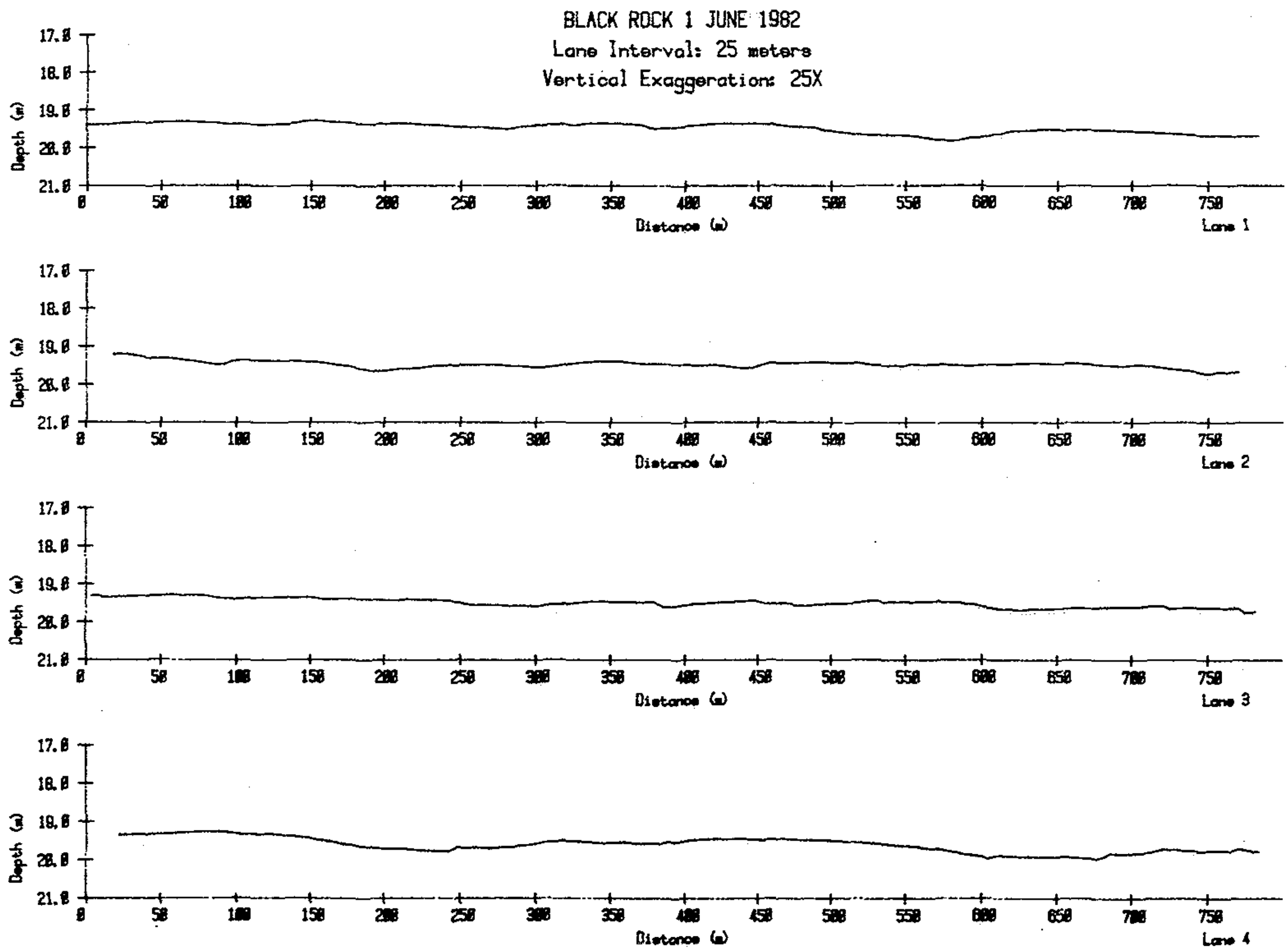

FIGURE 4.1-2a

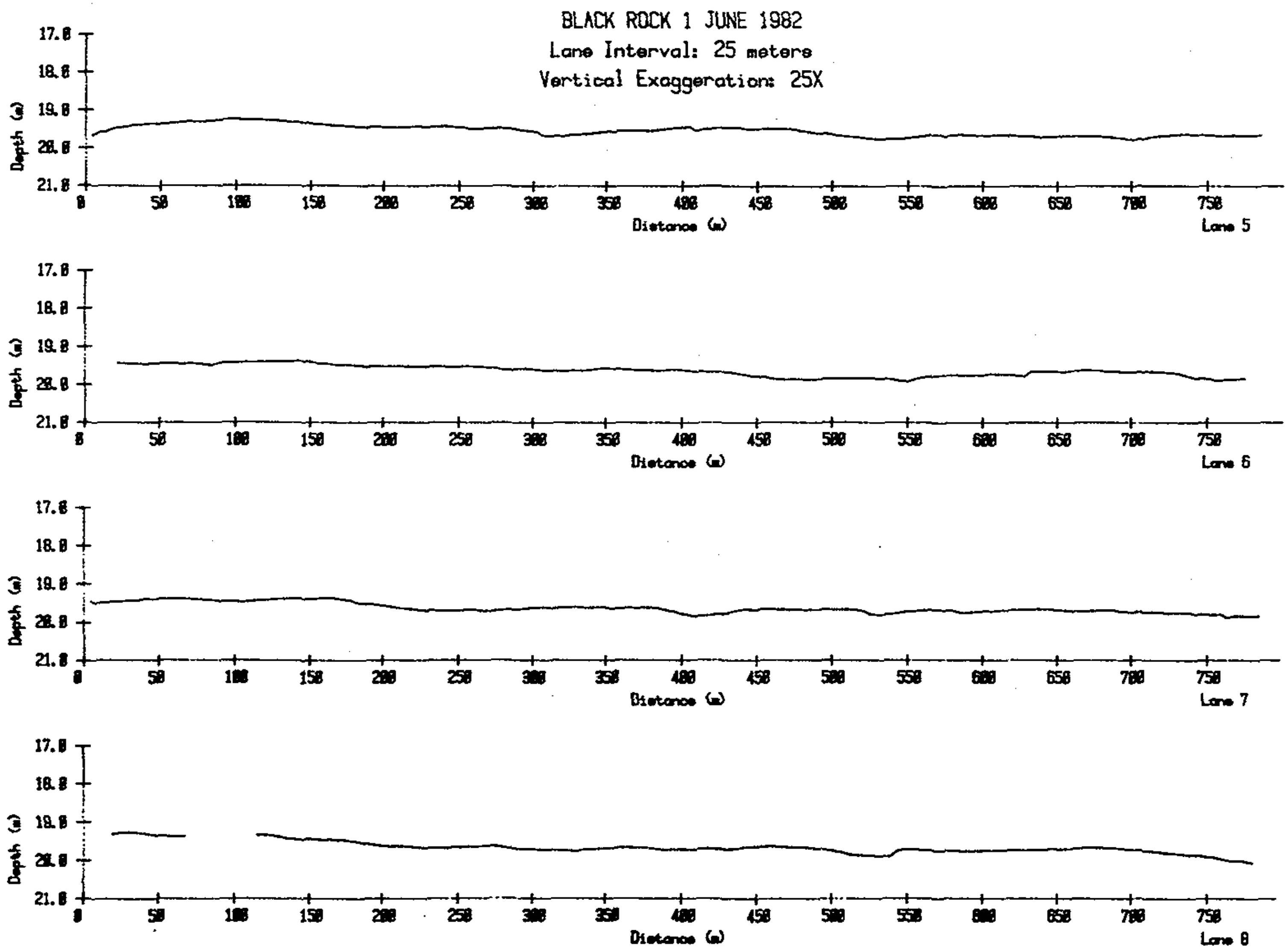
BLACK ROCK 1 JUNE 1982
Lane Interval: 25 meters
Vertical Exaggeration: 25X
Depth (m)
17.0
18.0
19.0
20.0
21.0
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Distance (m)
Lane 5
Lane 6
Lane 7
Lane 8

FIGURE 4.1-2b

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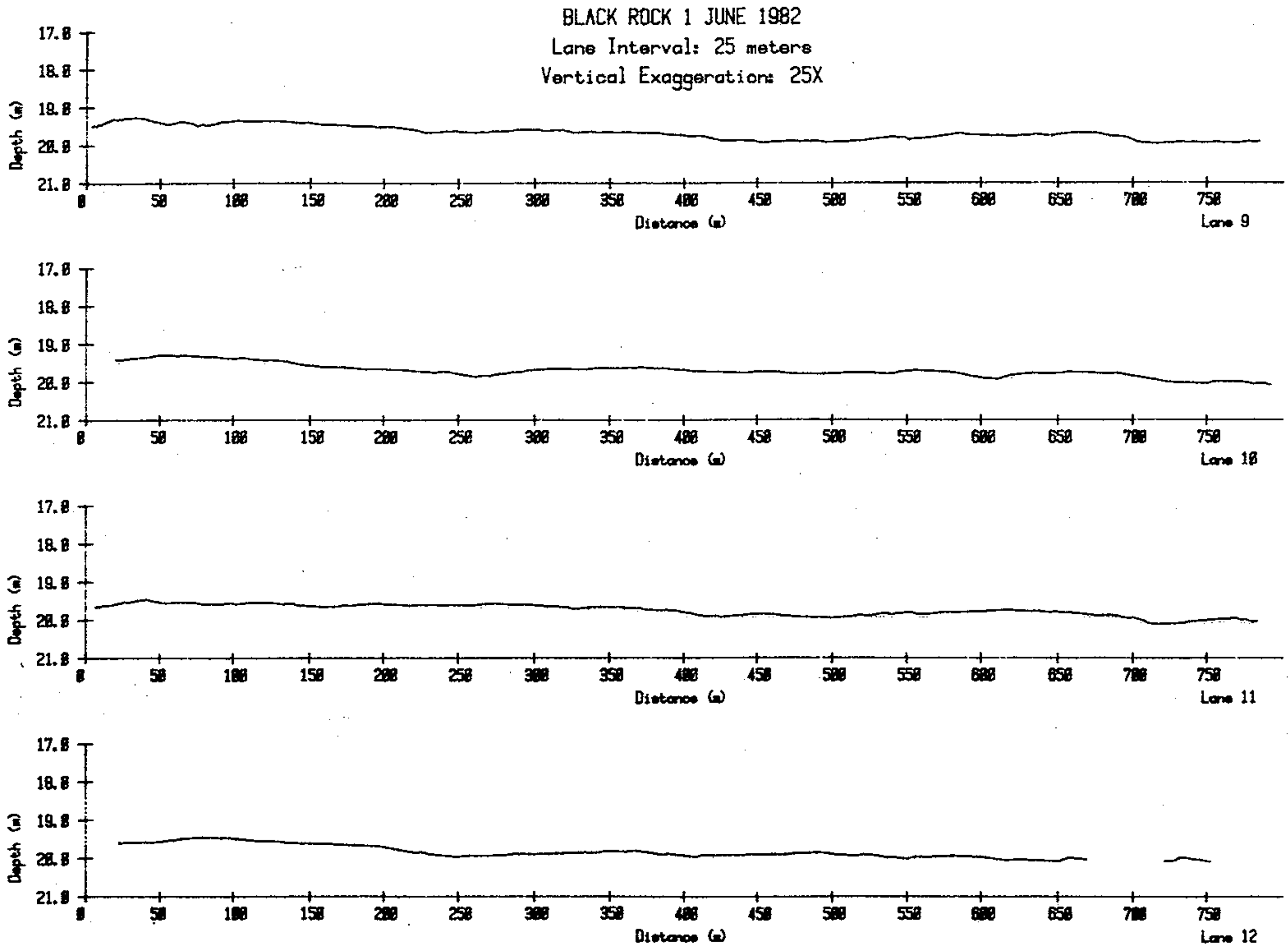

FIGURE 4.1-2c

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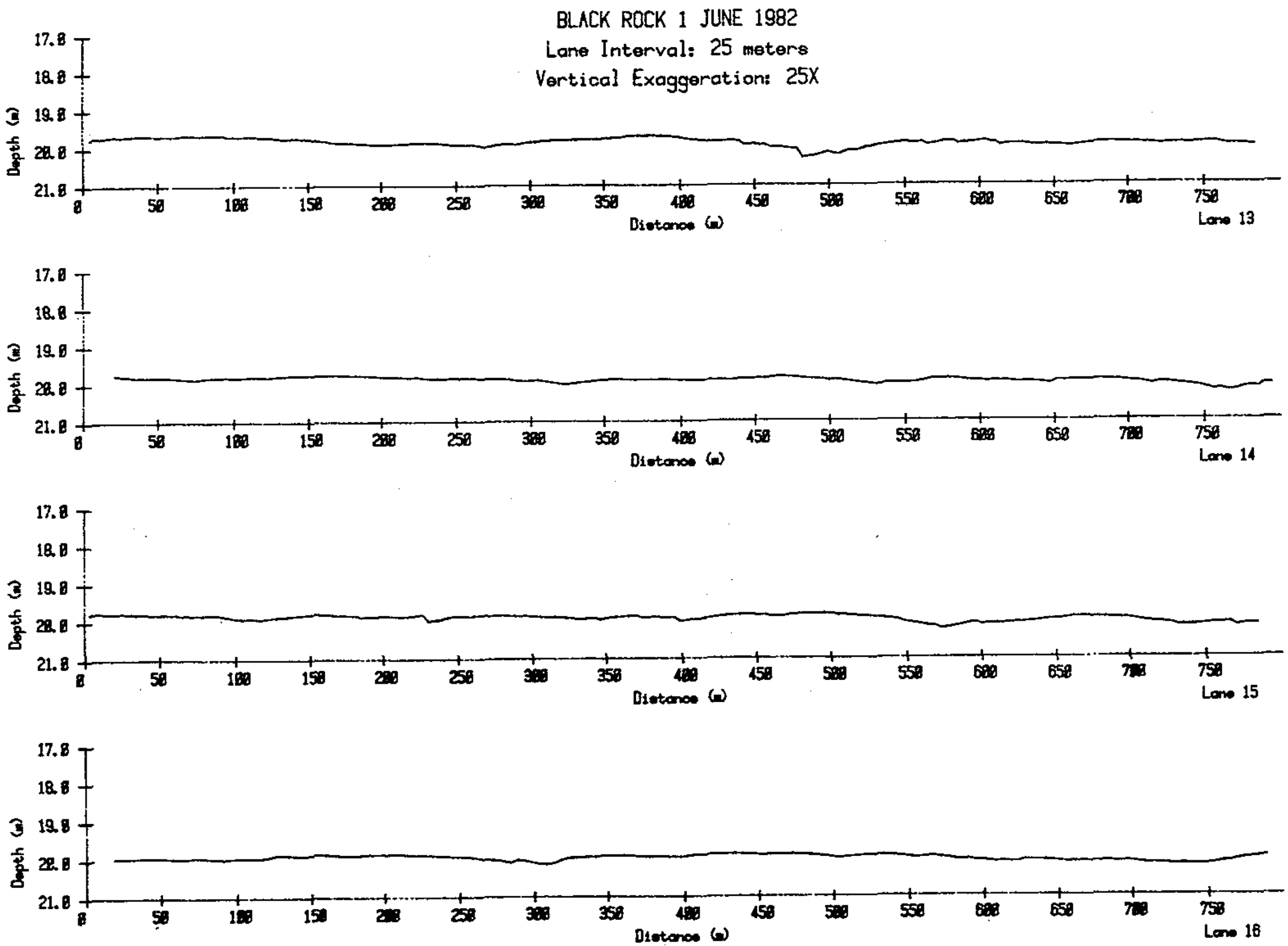

FIGURE 4.1-2d

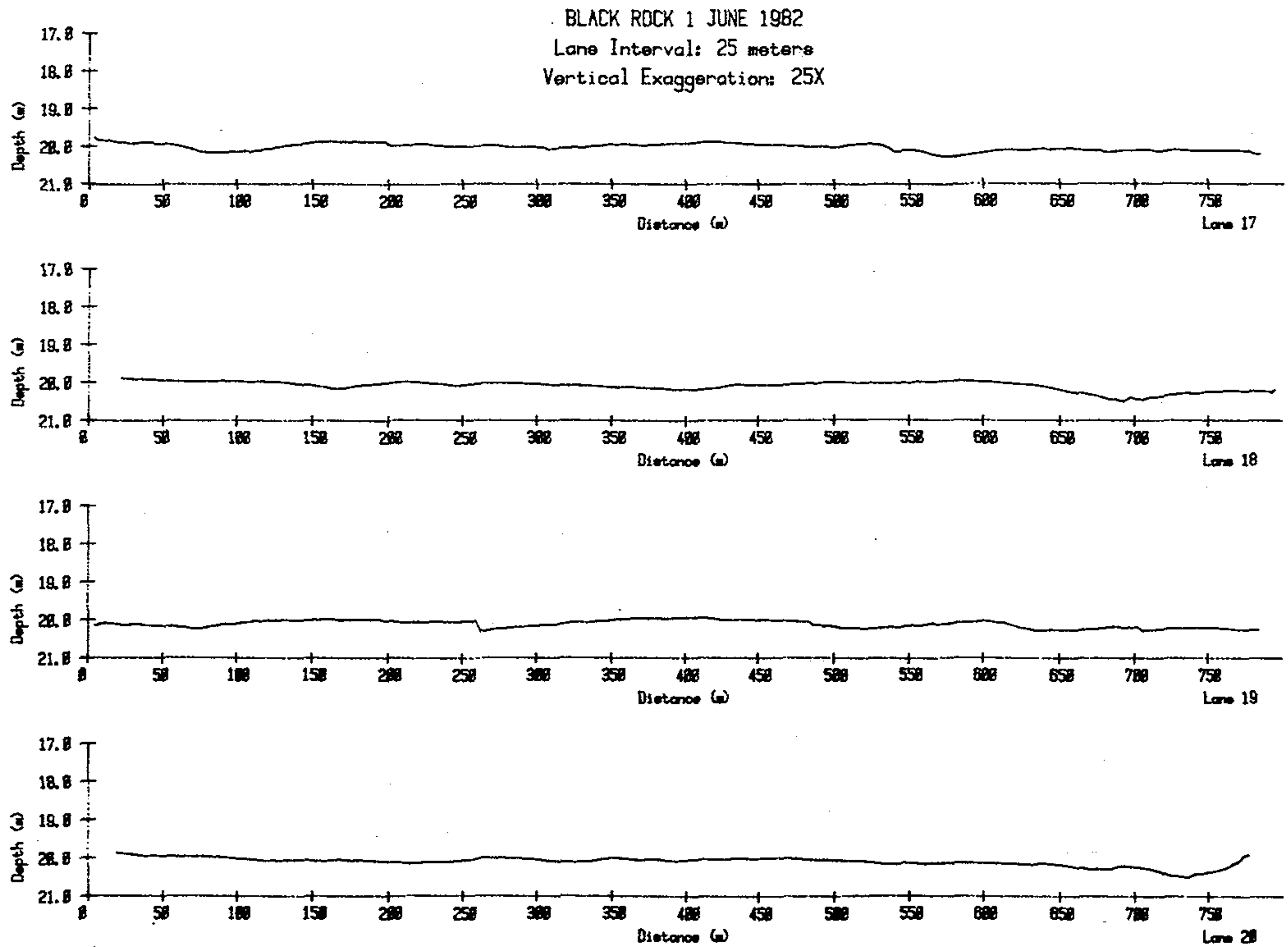
BLACK ROCK 1 JUNE 1982
Lane Interval: 25 meters
Vertical Exaggeration: 25X
Depth (m)
17.0
18.0
19.0
20.0
21.0
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750
Distance (m)
Lane 17
Lane 18
Lane 19
Lane 20

FIGURE 4.1-2e

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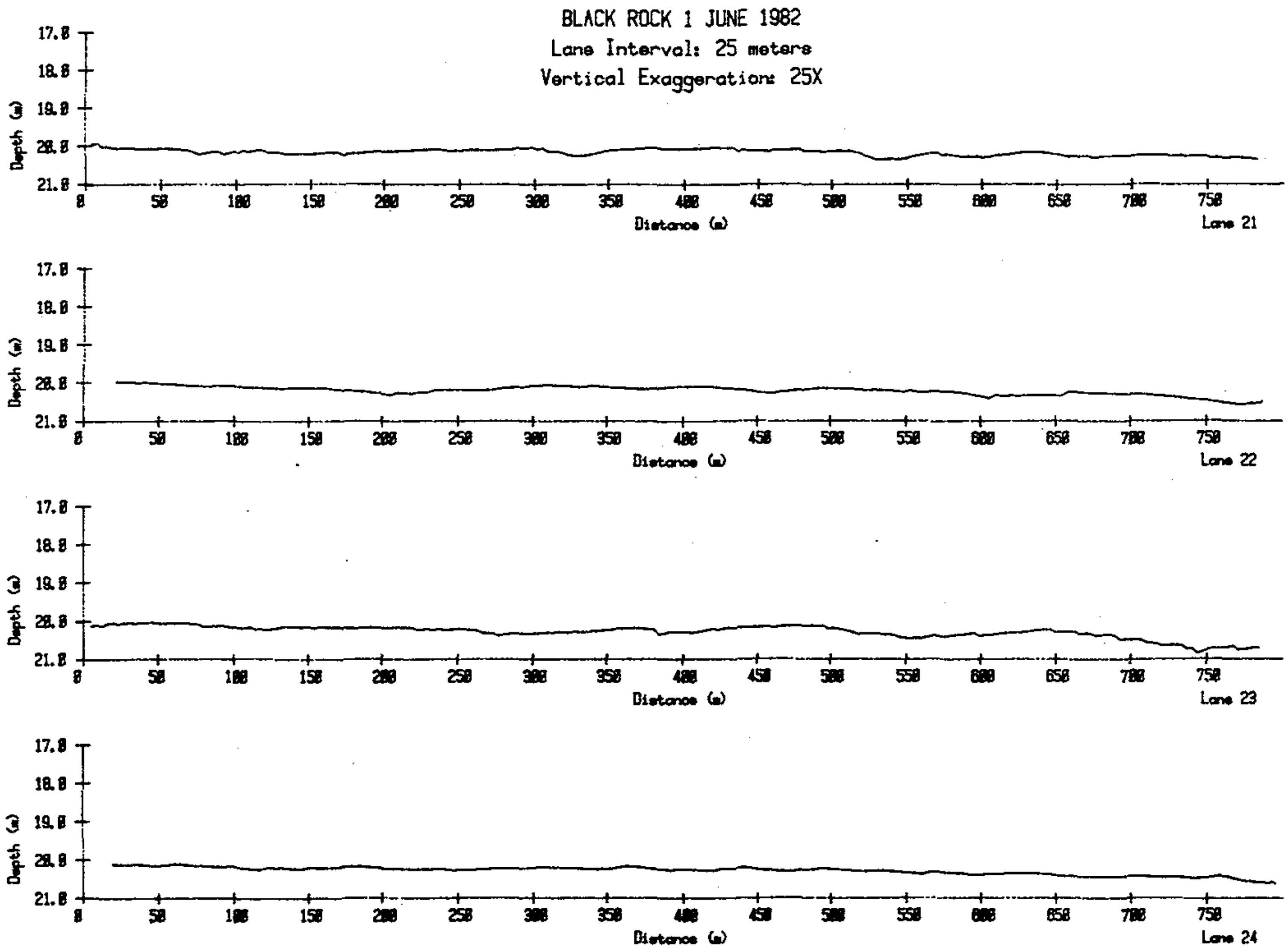

FIGURE 4.1-2f

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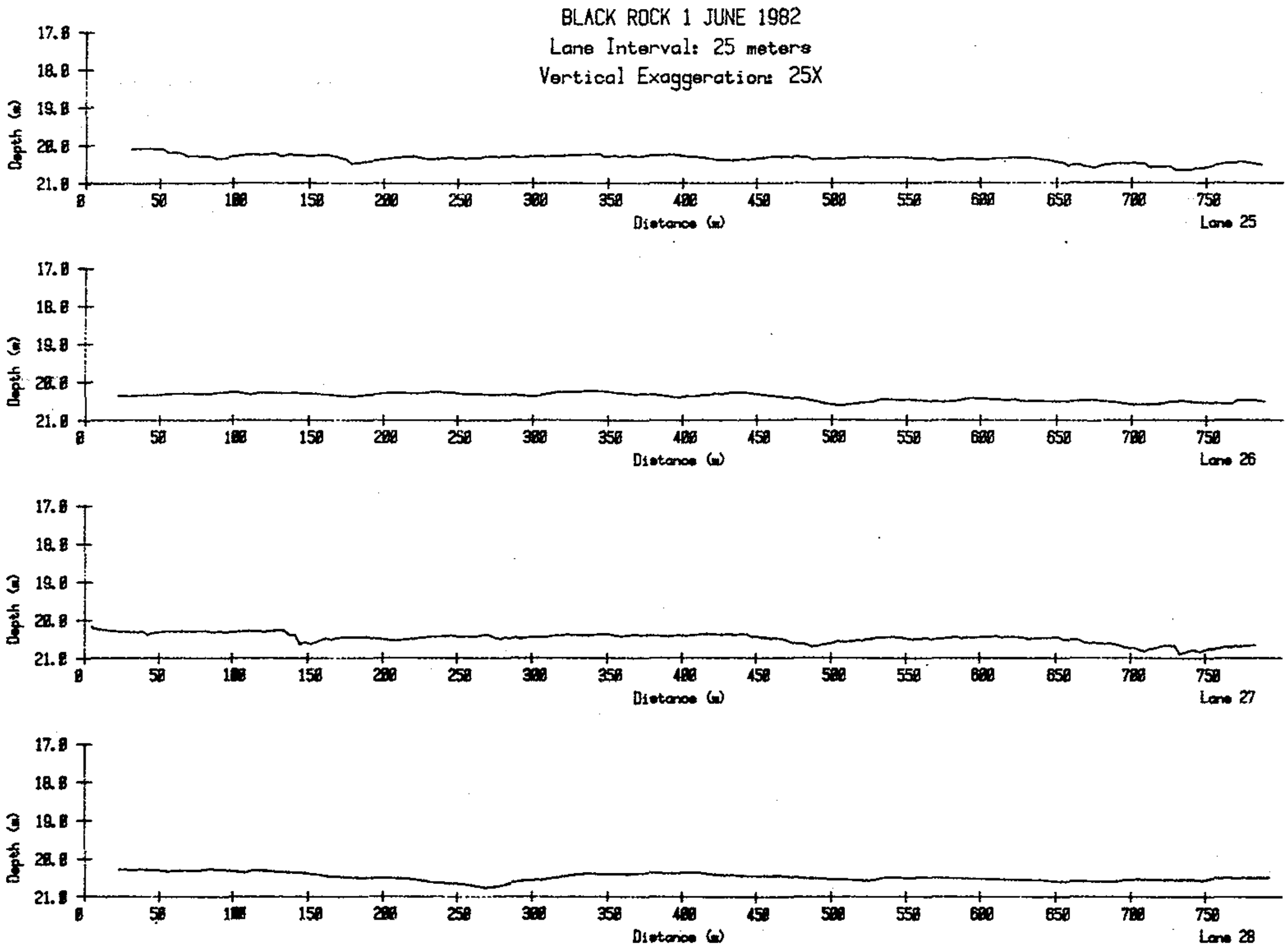

FIGURE 4.1-2g

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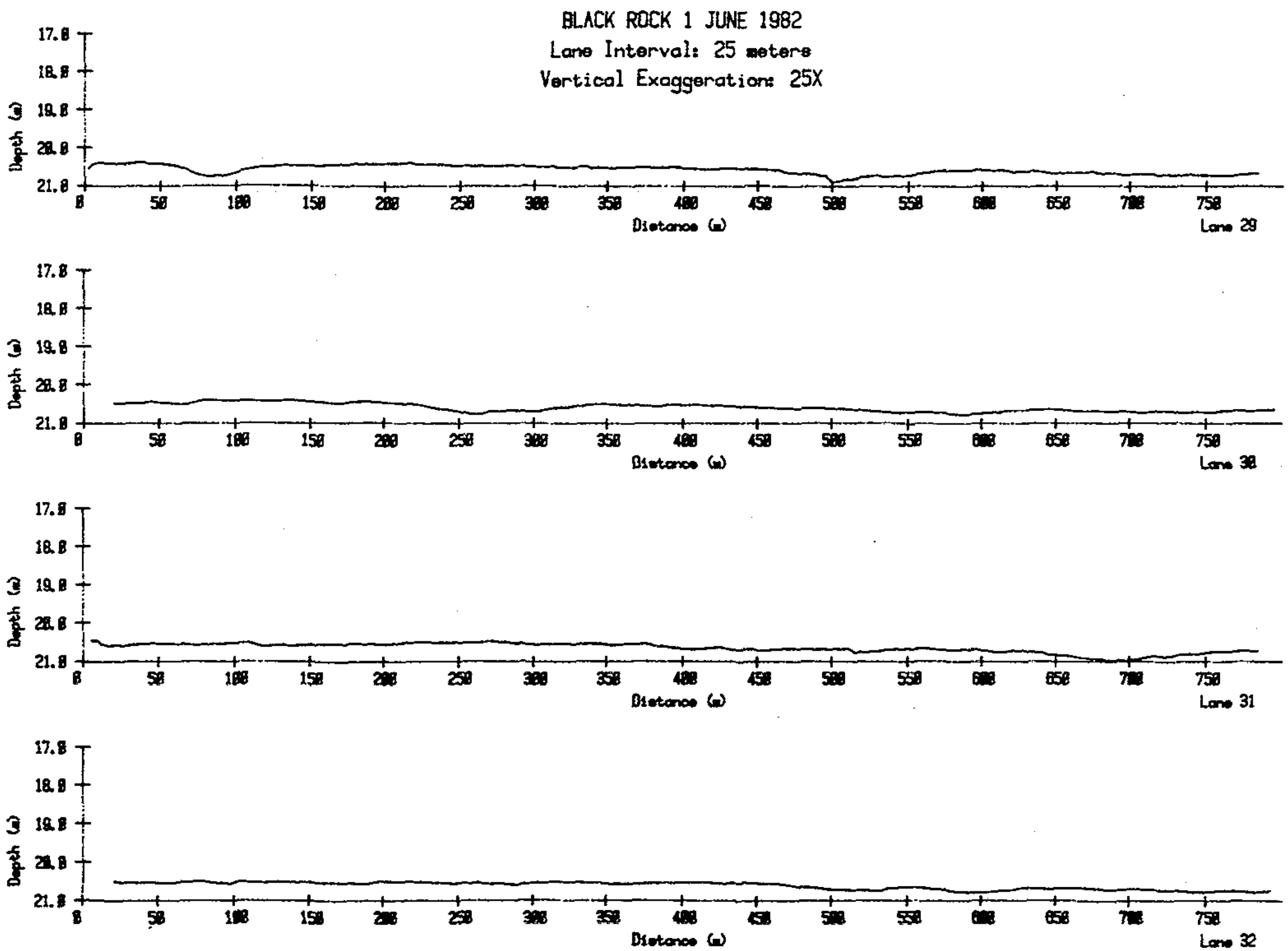

FIGURE 4.1-2h

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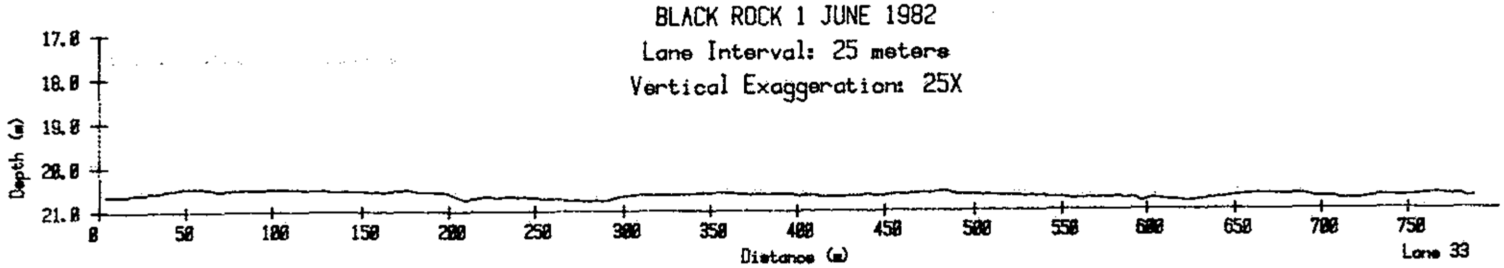


FIGURE 4.1-2i

topographic features, more extensive data are required because changes in bottom conditions can occur which do not have a topographic expression. Consequently, a side scan sonar survey was conducted over a larger area in order to map any apparent differences in bottom type and to locate any indications of previous disposal in the site. The area surveyed by side scan was centered at the designated disposal point and consisted of 11 lanes, 2000m long, spaced 200m apart (Fig. 4.2-1). A Klein 100 KHz sonar was towed behind the vessel at a nominal height above bottom of 7.5 meters using a 100m sweep to each side. Using this set-up an optimal coverage of nearly 100% without overlap, but with high resolution, could be obtained in a reasonable time period.

The survey revealed a major change in bottom conditions from the western margin of the site toward the east. On the western edge the bottom was much more variable with frequent patches of strong reflecting sediment and obvious detritus. Toward the east the reflectance of the surface sediment decreased, there were fewer detritus outcrops, and the bottom was dominated by a series of troughs oriented in an east-west direction parallel to the tidal current flow.

Figures 4.2-2 through 4.2-6 are examples of typical bottom conditions in the western regions of the survey area at the locations shown in Figure 4.2-1. Figure 4.2-2, from the northwest section, displays the random distribution of targets spread over the bottom indicative of a continual spillage and debris from disposal operations taking place over a long period of time. Such conditions appear common in the vicinity of disposal

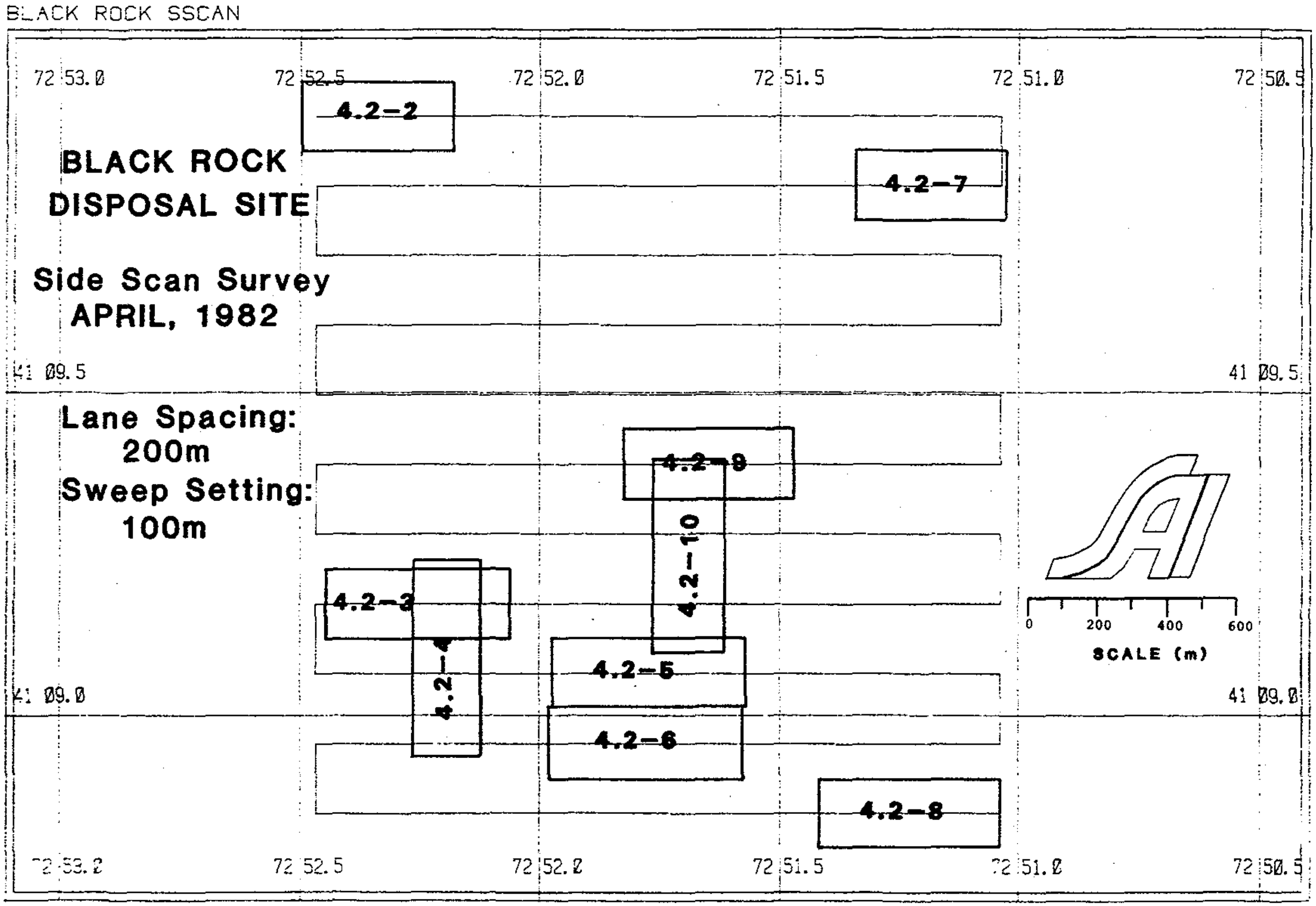

BLACK ROCK SSCAN
72 53.0
72 52.5
72 52.0
72 51.5
72 51.0
72 50.5
4.2-2
BLACK ROCK
DISPOSAL SITE
4.2-7
Side Scan Survey
APRIL, 1982
41 09.5
41 09.5
Lane Spacing:
200m
Sweep Setting:
100m
4.2-9
4.2-10
4.2-3
4.2-4
4.2-5
4.2-6
4.2-8
0
200
400
600
SCALE (m)
41 09.0
41 09.0
72 53.0
72 52.5
72 52.0
72 51.5
72 51.0
72 50.5

FIGURE 4.2-1

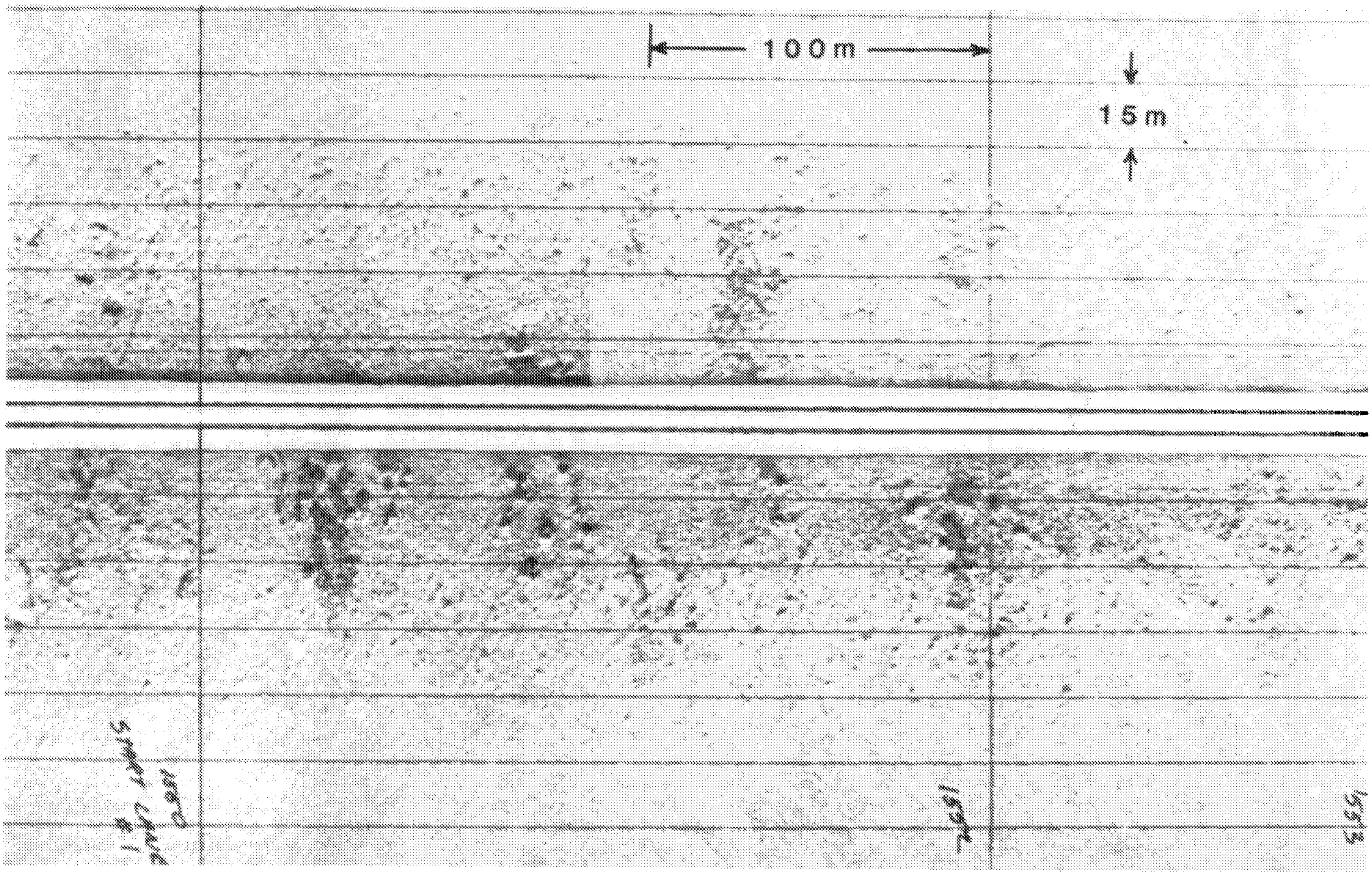


FIGURE 4.2-2

points where a standard approach lane is designated as was the case with the Stamford/New Haven project.

Figures 4.2-3 and 4.2-4 show two views of the bottom conditions apparently resulting from an older dumping operation. The circular impact zones and increased reflectivity associated with the deposit have been identified in other areas, particularly in Buzzards Bay. A similar deposit is observed in Figures 4.2-5 and 4.2-6 in the area sampled at 500m South on the preliminary sampling cruise to the proposed site. The fact that the coarse arkosic sand sample corresponds to a localized high reflectance area further emphasizes the isolated nature of the deposit in a background of low reflectance silty clay bottom.

Figures 4.2-7 through 4.2-10 are examples of side scan traces over the soft mud bottom in the vicinity of the disposal point and farther to the east in the disposal area. Figures 4.2-7 and 4.2-8 are located in the northeast and southeast corners of the survey area and are characterized by the relatively strong reflections from a series of troughs or furrows in an east-west direction. These troughs oriented parallel to the dominant tidal flow direction were not observed on previous surveys of the CLIS site but have been identified in other tidal regions where deposition of fine grained sediments was occurring. Similar bedforms have been observed in cohesive sediments of estuaries on the South Coast of England (Flood, 1981), other shallow water areas (McKinney, et al, 1974), and in the deep sea (Flood & Hollister, 1980). These furrows are often associated with areas of sediment accumulation with the depth of the furrow directly related to the sedimentation rate. Many furrows have been found

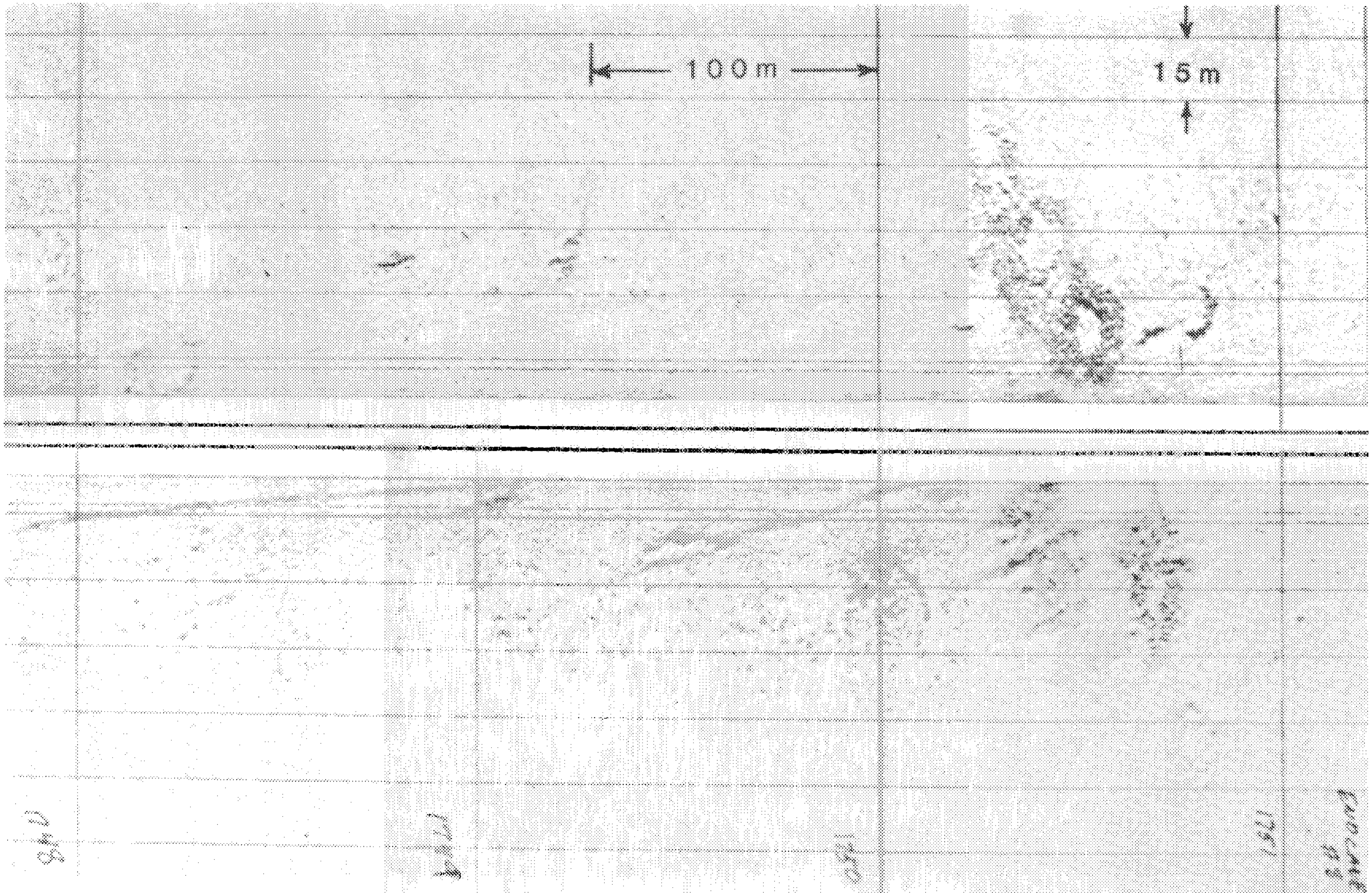


FIGURE 4.2-3

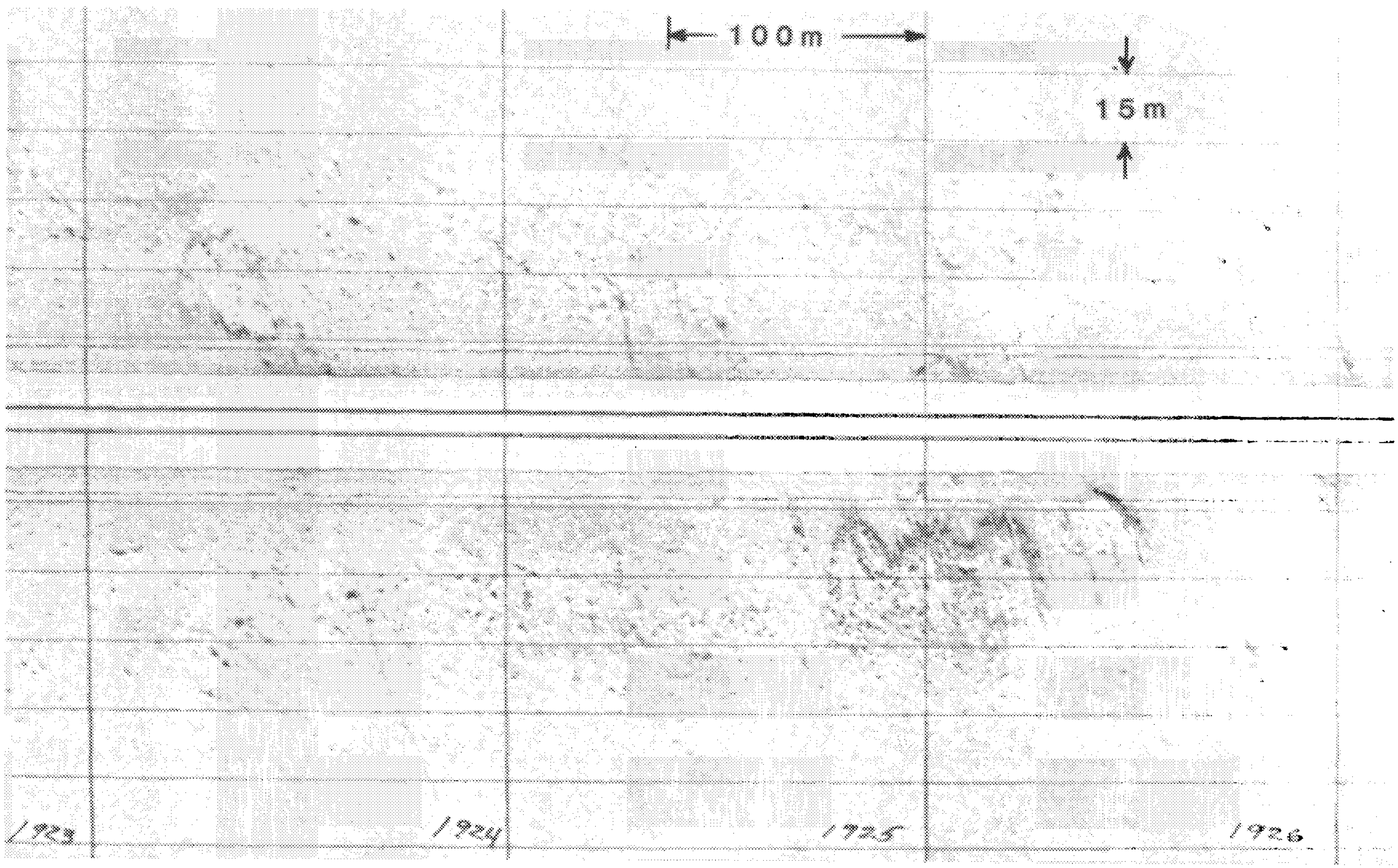


FIGURE 4.2-4

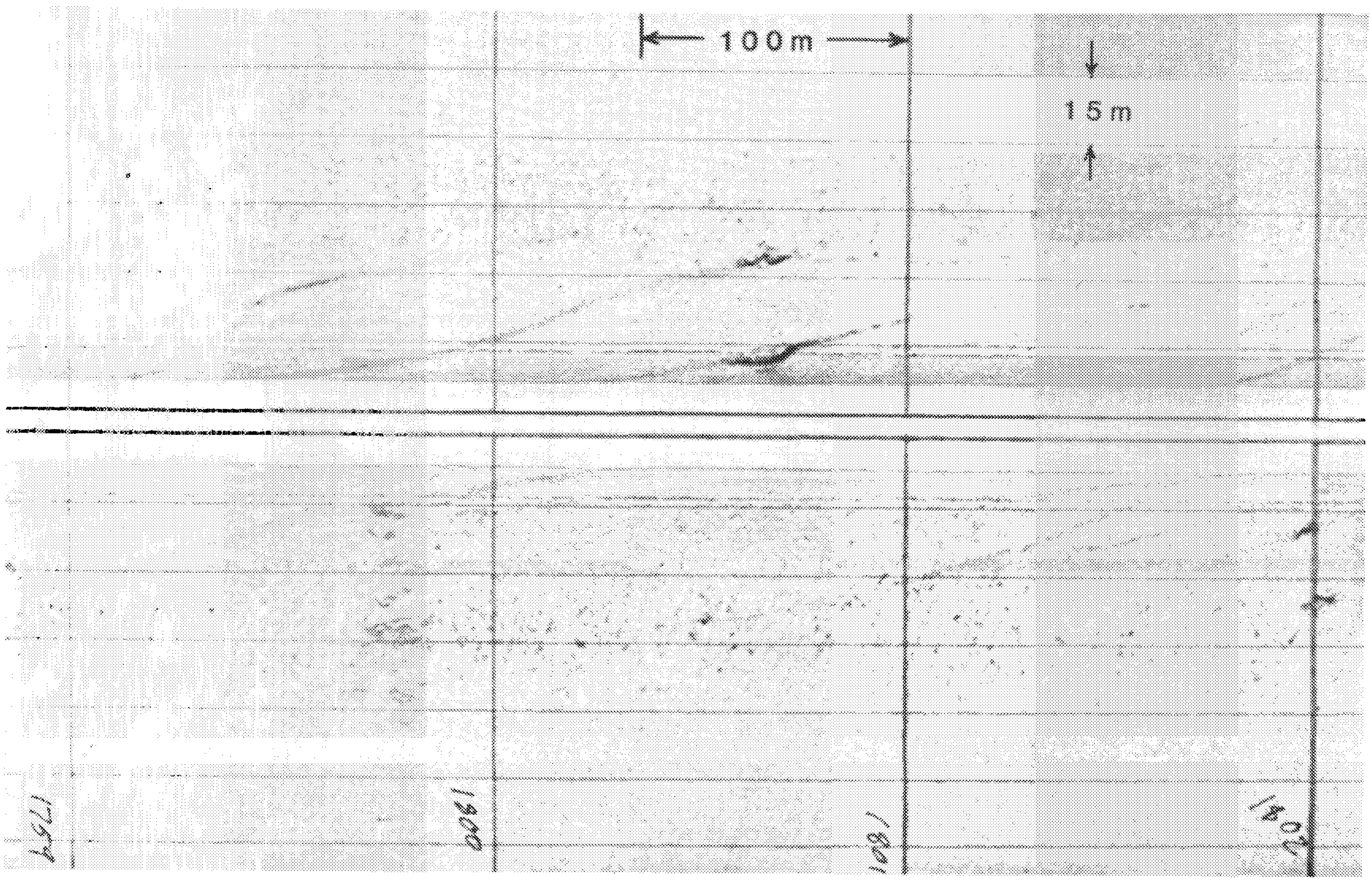


FIGURE 4.2-5

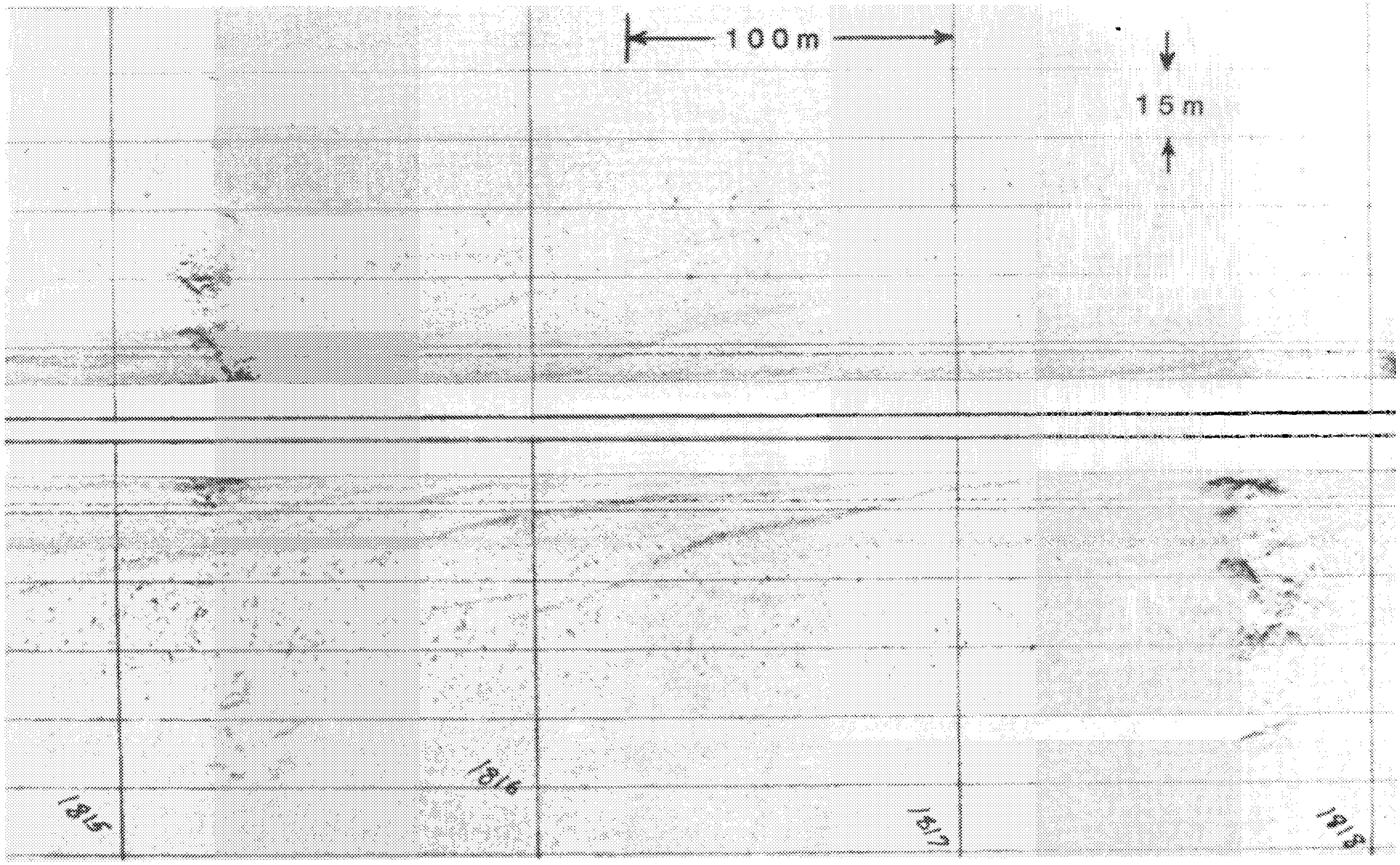


FIGURE 4.2-6

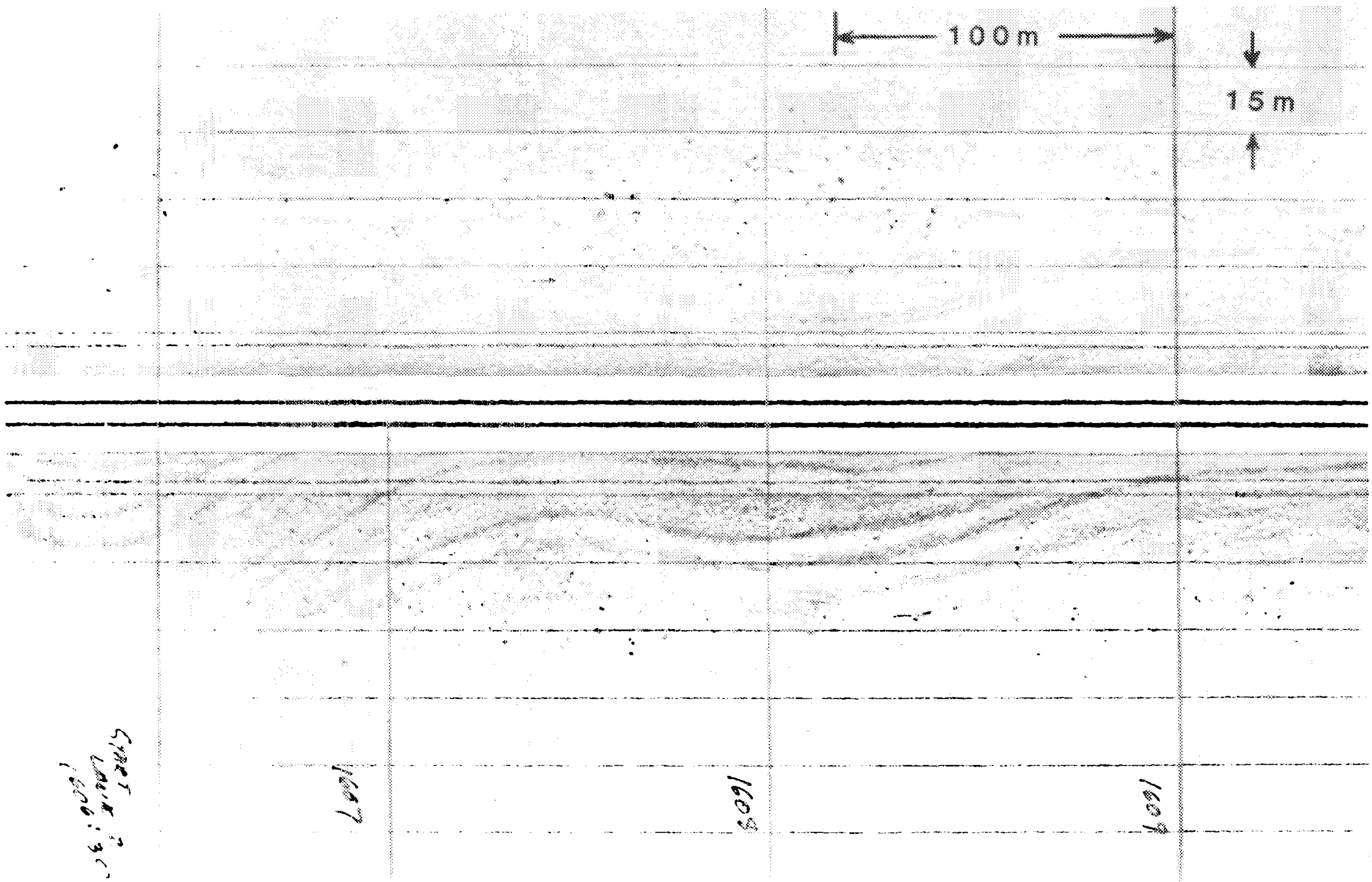


FIGURE 4.2-7

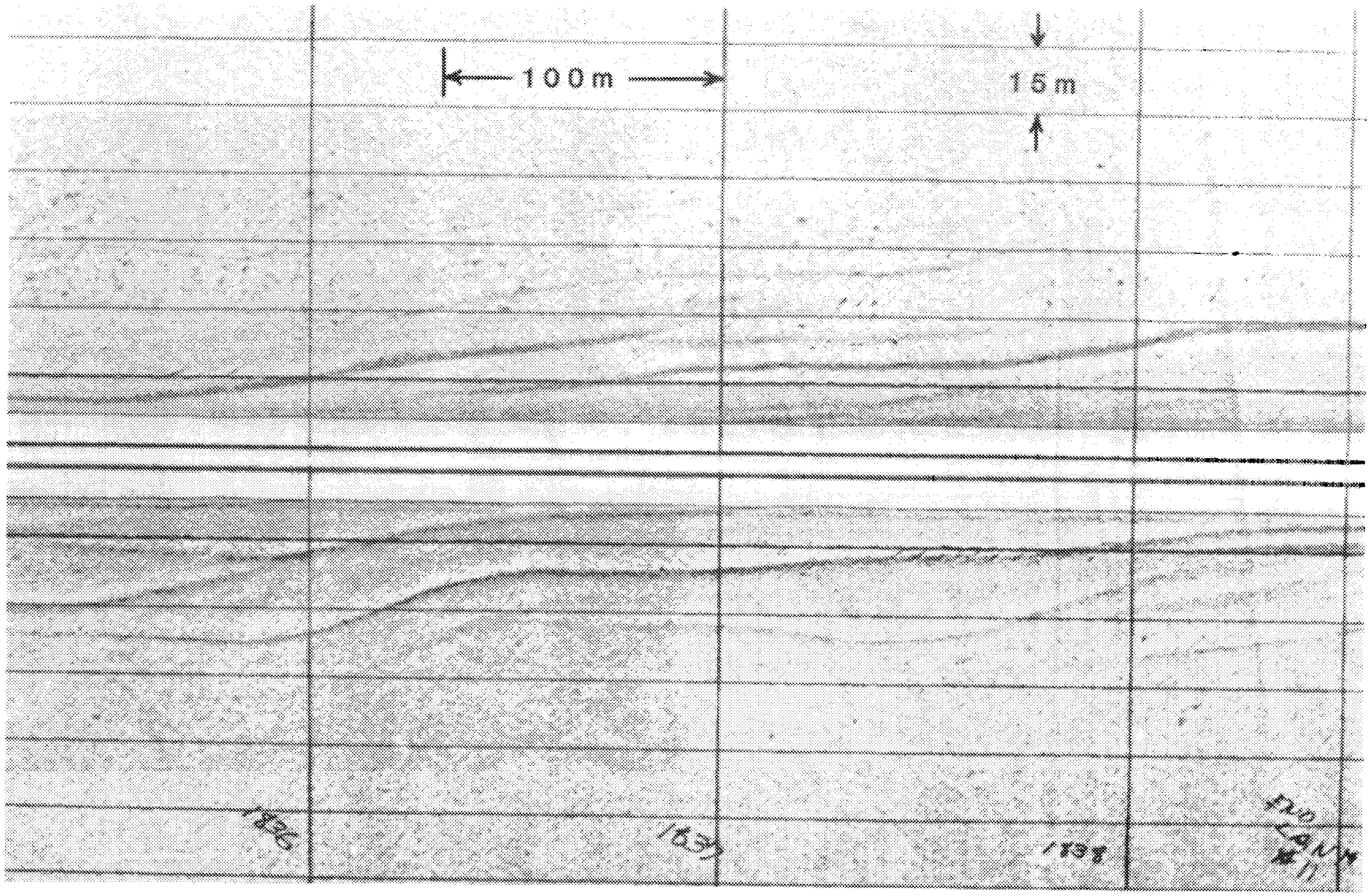


FIGURE 4.2-8

with coarse sediment or shell hash in the depression as seen in Figure 4.2-5.

Formation of the furrow features is thought to be the result of two factors: helical secondary flow patterns and localized abrasion or scour around coarser particles. The helical flow patterns have been shown to develop in well-mixed bottom boundary layers associated with short-term, non steady tidal flows similar to those that occur in Long Island Sound.

The permanence of these furrows is thought to be variable depending on the size of the feature, with larger furrows exhibiting more permanence. Although they were not observed in surveys prior to April 1982, a later side scan survey in August, 1982, showed the same furrows present with the same orientation. Divers were able to discern these furrows during three dives in May, 1982 and did notice increased detritus at the base of the furrows. Although a second attempt to observe the furrows was made during the August survey, no data were obtained because of poor visibility. Future cruises will include more detailed examination of these features to assess their significance in terms of local sediment transport.

Figures 4.2-9 and 4.2-10 are taken from the vicinity of the designated disposal point and are indicative of the consistant, soft mud bottom present in the area. The mud furrows can be seen clearly in the east-west sweep, but are also evident in the north-south sweep as depressions in the bottom trace associated with lineations of slightly greater reflectivity. Based on these records, the bottom in the vicinity of the disposal site appears uniform and typical of natural sediment in the

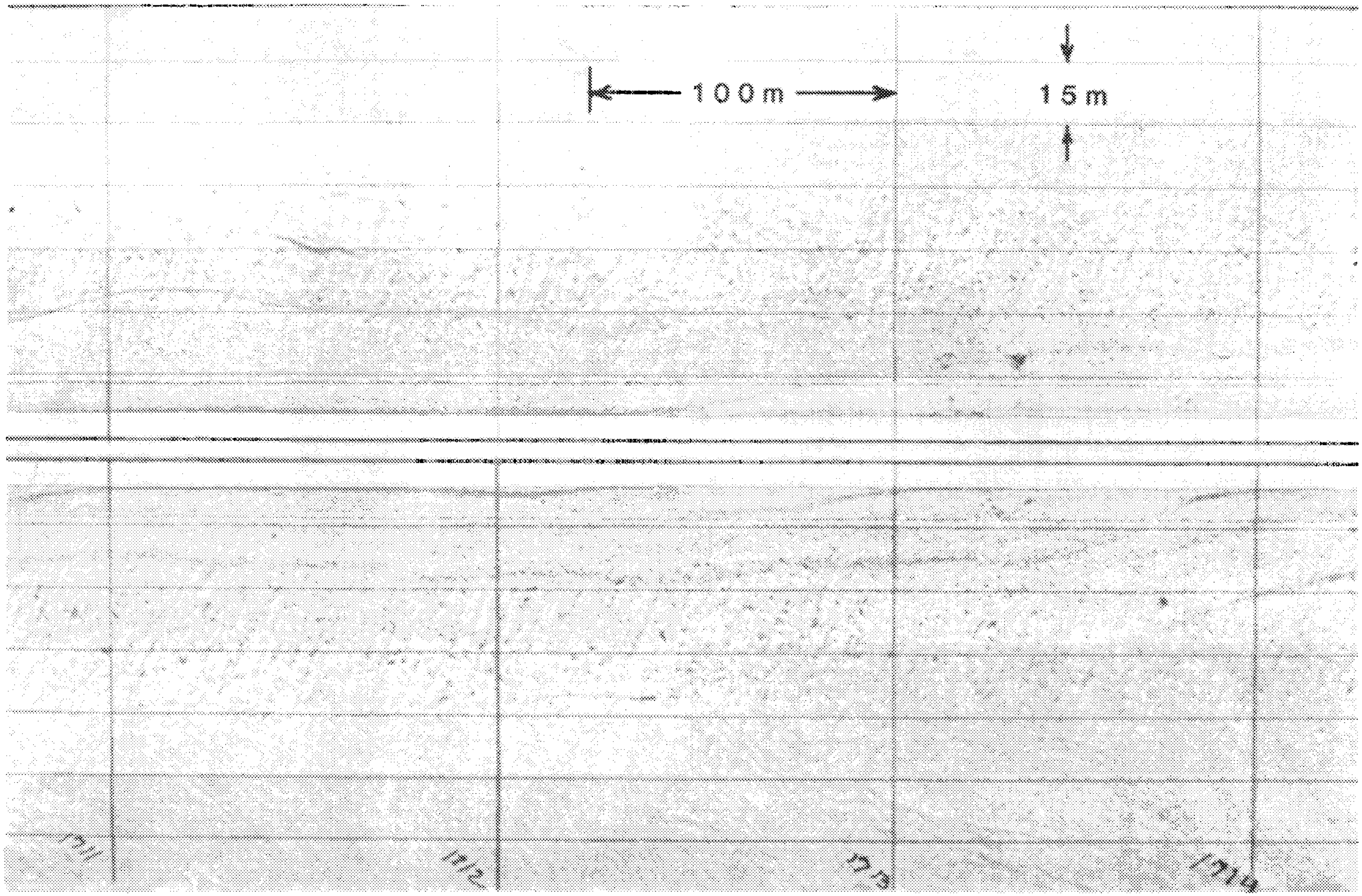


FIGURE 4.2-9

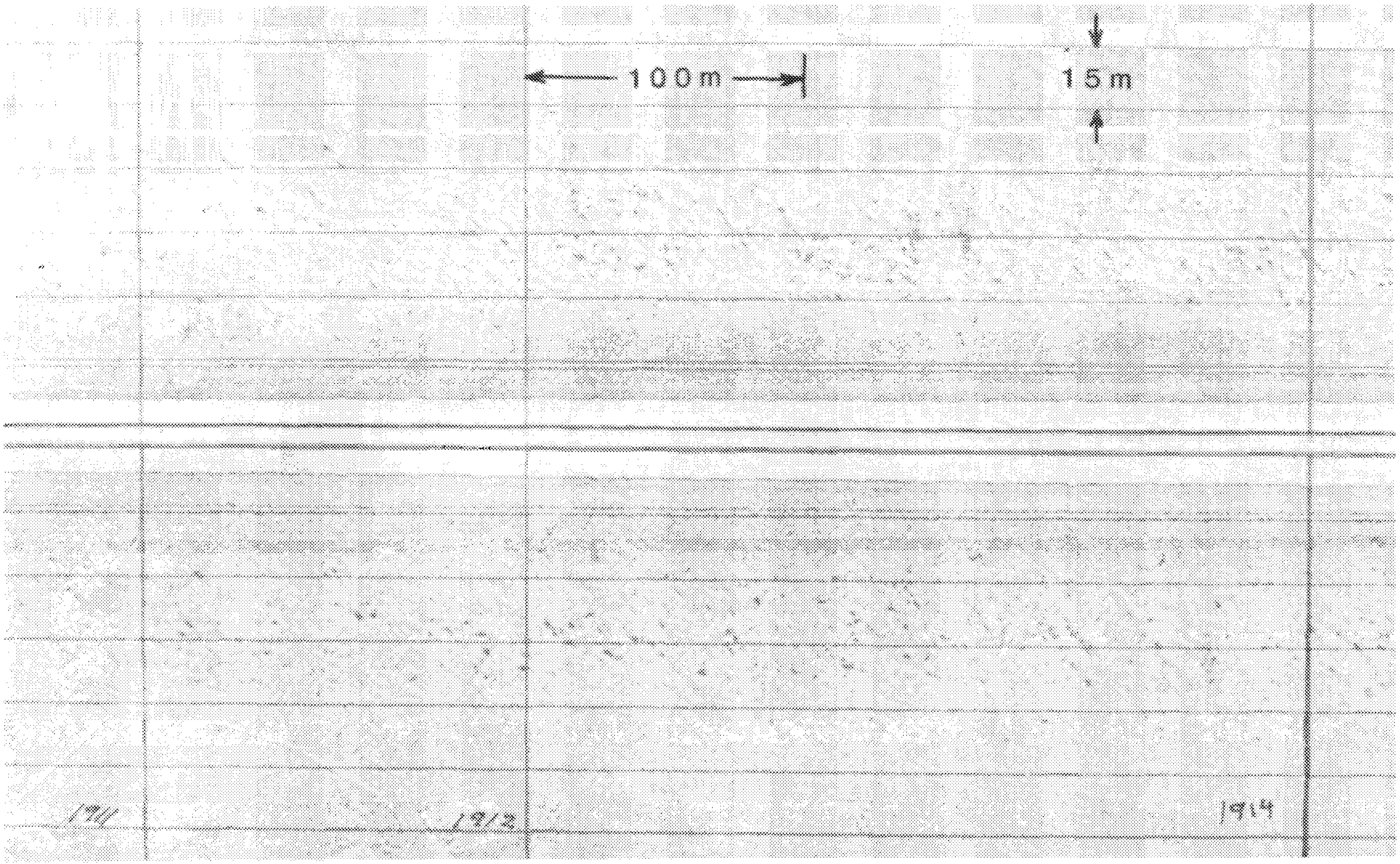


FIGURE 4.2-10

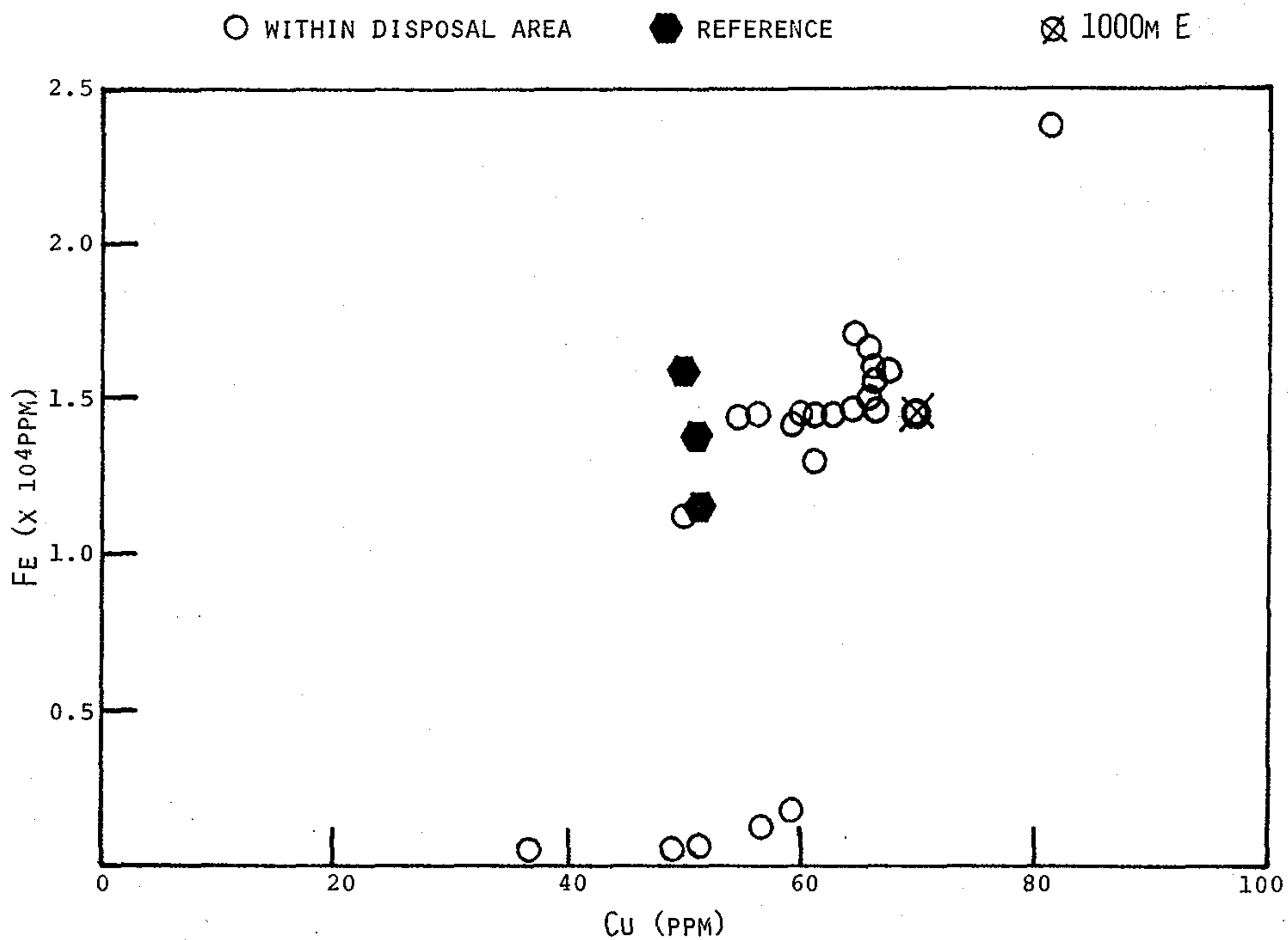
Central Long Island Sound region. These records also indicate that by moving the disposal point farther to the north and east, interference from earlier disposal operations was eliminated from the potenial area of deposition for Black Rock material.

4.3 Sediment Chemistry

During the April-May 1982 baseline survey of the Black Rock Disposal Site, sediment samples were obtained at the stations shown in Figure 4.1-1 in order to provide background data on the heavy metal content of sediments in the area to be covered by disposed dredge material. Three replicate samples were taken at each station, stored under ice aboard ship and submitted to the chemistry lab of the New England Division for analysis. The results of this analysis are presented in Table 4.3-1 and compared with previous heavy metal chemistry data from natural bottom sediment in the Central Long Island Sound Disposal site in Table 4.3-2. The mean grain size distribution for all sediments was very consistant with a mean of .013mm and a range of only .011-.016mm. This grain size is indicative of a fine silt with substantial amounts of clay sized sediment capable of adsorbtion of heavy metal ions.

Comparison of these data with previous samples indicates a general consistancy with earlier data except for mercury which is an order of magnitude less. Compared with samples obtained during the preliminary cruise to the site, mercury values remain low, however, chromium, lead and arsenic values are substantially higher.

The concentration of each metal was compared with the



IRON/COPPER CONCENTRATIONS
BLACK ROCK DISPOSAL SITE
MAY, 1982

FIGURE 4.3-1

Table 4.3-1

BLACK ROCK DISPOSAL SITE
SEDIMENT CHEMISTRY DATA
MAY 1982

Location	% NED Volatile Solids	PPM^{X10-5} COD	C:N	PPM^{X10-4} Fe	PPM Hg	PPM Pb	PPM Zn	PPM As	PPM Cr	PPM Cu	Grain Size (mm)
400N-A	3.2	0.02	10.8	<0.03	0.04	<40	185	13	62	52	
-B	4.4	0.75	10.8	<0.03	0.01	<40	160	12	<20	35	.013
-C	4.3	0.73	10.4	<0.03	0.10	<40	205	16	40	49	
200N-A	3.9	0.37	11.3	1.61	0.15	69	195	12	92	65	
-B	4.0	0.92	11.4	1.47	0.16	73	166	8.6	84	59	.011
-C	3.8	0.38	11.6	1.43	0.14	59	151	22	88	61	
Center-B	4.3	0.64	10.4	1.25	0.03	<40	153	13	82	51	
-C	4.2	0.14	11.0	1.39	0.04	47	210	14	82	55	.016
400S-A	3.6	0.50	10.3	0.06	0.08	<40	188	11	42	57	
-B	4.2	0.38	10.3	1.60	0.06	66	176	11	56	64	.013
-C	4.2	0.49	10.5	1.48	0.11	74	189	13	54	55	
400W-A	4.0	0.55	14.0	1.47	<0.01	123	198	6.7	90	61	
-B	3.8	0.04	11.2	1.49	0.14	96	217	9.6	94	64	.013
-C	4.0	0.07	12.5	1.46	0.14	115	158	10	91	59	
200W-A	6.7	0.78	10.7	1.57	0.10	<40	191	15	94	65	
-B	3.8	0.48	10.6	1.47	0.13	101	251	16	89	66	.012
-C	4.1	0.25	10.2	1.58	0.12	109	168	15	96	65	
200E-A	3.8	0.52	10.6	1.32	0.13	74	173	5.2	83	63	
-B	4.0	0.53	12.0	0.08	0.06	50	181	10	40	59	.013
-C	4.4	0.61	9.9	2.37	0.02	84	212	17	73	84	
400E-A	4.2	0.02	11.6	1.56	0.07	102	226	13	92	67	
-B	4.4	1.37	10.0	1.54	0.03	102	209	9.6	97	66	.015
-C	4.2	0.06	10.0	1.47	0.12	119	215	11	87	62	

Table 4.3-1(cont)

BLACK ROCK DISPOSAL SITE
SEDIMENT CHEMISTRY DATA
MAY 1982

Location	% NED Volatile Solids	PPM X10-5 COD	C:N	PPM X10-4 Fe	PPM Hg	PPM Pb	PPM Zn	PPM As	PPM Cr	PPM Cu	Grain Size (mm)
1000E-A	3.8	0.25	11.1	1.49	0.10	70	366	16	93	70	
-B	3.3	0.86	10.5	1.48	0.06	116	153	8.6	96	65	.014
-C	3.8	0.64	11.1	1.50	0.16	108	163	11	99	65	
Reference-A	4.2	0.52	9.8	1.37	0.11	42	109	1.4	82	52	
-B	4.5	0.56	9.9	1.61	0.13	66	244	9.4	84	52	.014
-C	4.4	0.48	10.3	1.26	0.07	40	323	12	76	48	

Table 4.3-2

COMPARISON OF PREDISPOSAL CHEMICAL DATA FROM SITES WITHIN CENTRAL LONG ISLAND SOUND DISPOSAL AREA

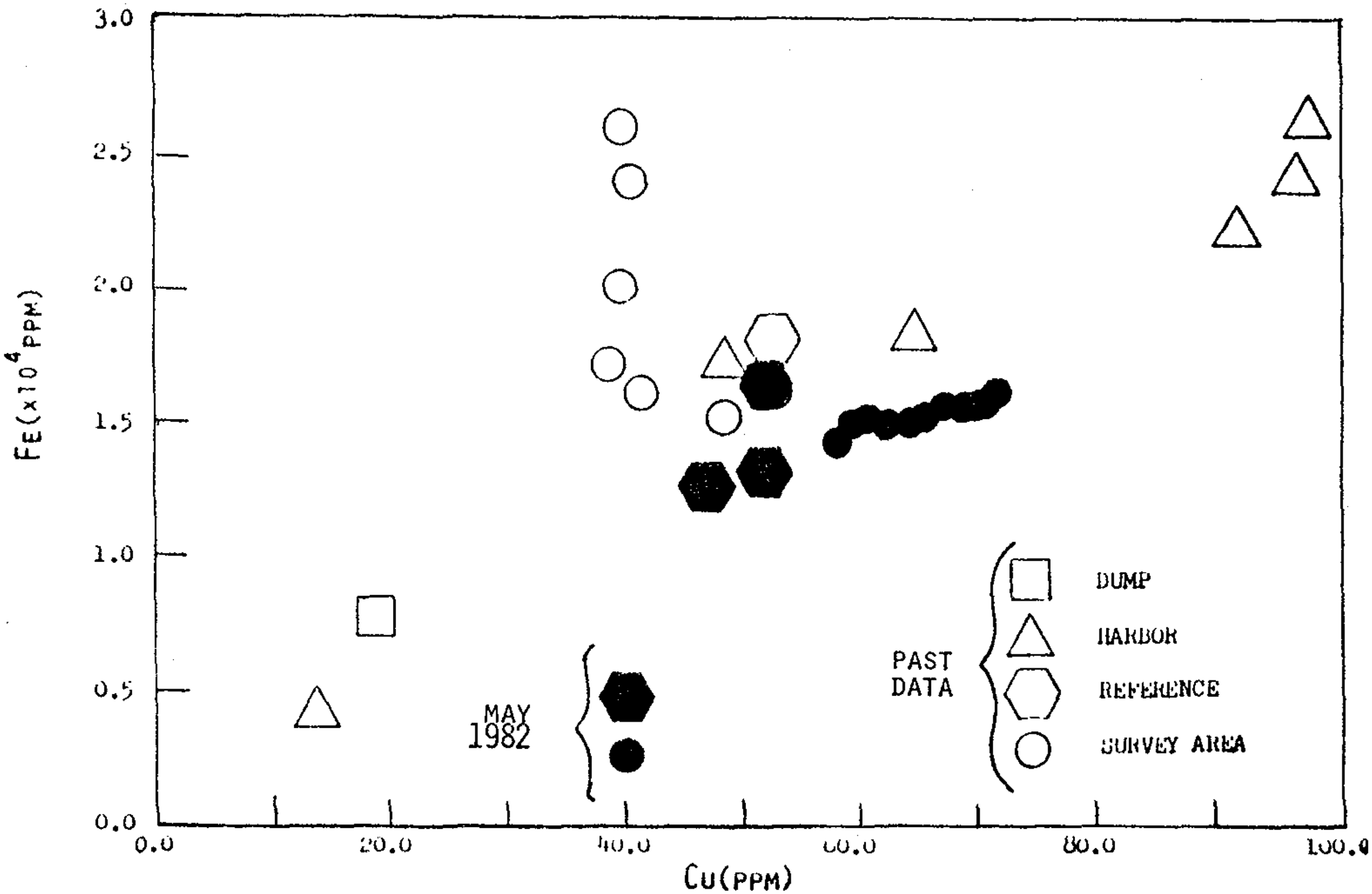
Substance	North Site (12)*		South Site (33)		Norwalk, Apr 1980 (27)		Norwalk, Aug 1980 (30)		Black Rock (23)	
	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.	Range	Ave.
Hg, ppm	0.37-1.5	0.83	0.04-1.1	0.53	<0.5-1.5	0.77	<0.1-1.8	0.46	<0.01-1.6	0.04
As, ppm	2.5-10	7.1	2.2-11.0	7.2	1-8	3.8	5.5-17	9.3	5.2-22	13.7
Pb, ppm	23-35	28	15-32	24	30-210	56	<10-118	70	<40-123	74
Cr, ppm	48-64	60	28-74	59	42-110	57	55-126	98	<20-98	75
Cu, ppm	51-73	64	26-84	68	49-173	75	78-192	114	35-84	60
Zn, ppm	114-203	146	63-267	132	112-999	204	128-280	202	153-251	190
COD, ppm X10-5	0.54-0.79	0.66	0.18-1.71	0.54	0.35-1.20	0.63	0.49-1.12	0.64	0.02-1.37	0.46

*Numbers in parentheses mean number of samples concentration of iron to assess the contribution of contaminants to the sediment. High iron/metal ratios indicate a relatively clean sediment, while low ratios provide evidence for addition of other heavy metals replacing iron as contaminants. A typical plot of iron versus other metals is presented for copper in Figure 4.3-1. In this case, as in most others, the values are clustered about Fe concentrations of 1.5×10^4 ppm and Cu concentrations of 60 ppm for an Fe/Cu ratio of 250. An obvious anomaly occurs with samples from the 400N station and other low Fe samples, which should be rerun to determine the validity of the measurements. These data compare very well with previous data obtained from the CLIS site when plotted on Figure 4.3-2 taken from the 1979 DAMOS Annual Report (Jones, 1979).

Although substantial variability between stations has been observed in these data, it is certain to be significantly less than the difference between natural sediment and Black Rock dredged material, consequently tracking of dredged material distribution in the vicinity of the disposal mound, through comparison of the Fe/metal ratio appears feasible.

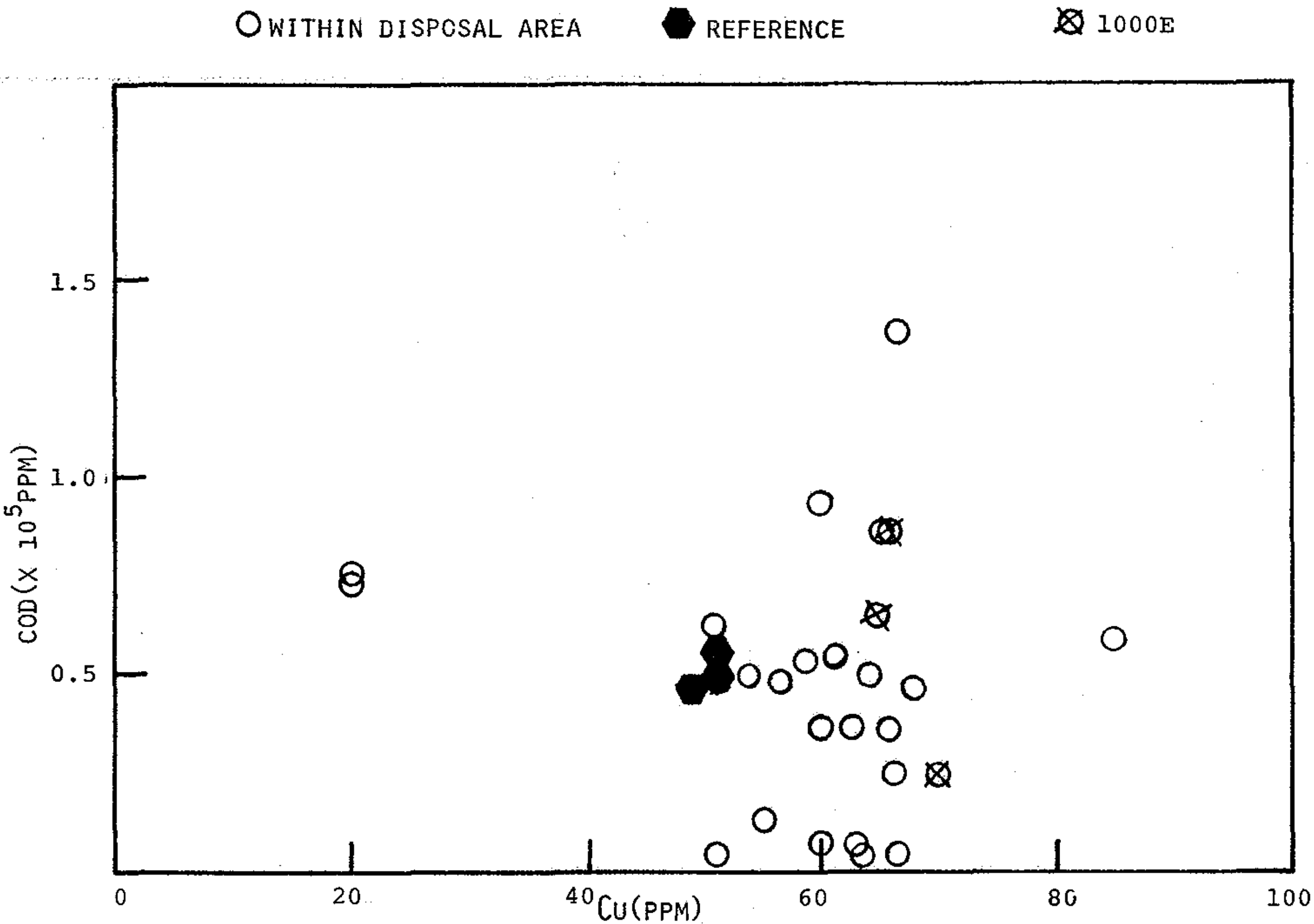
In addition to iron, the Chemical Oxygen Demand (COD) was also plotted as a function of heavy metal concentration. For this parameter the variability was much greater as shown by Figure 4.3-3 which also presents the relationship for copper. Although the higher variability in COD prohibits evaluation of differences between baseline stations, the increased COD of Black Rock sediment should be substantially higher and thus permit definition of disposed dredged material from natural sediment.

An evaluation of the Central Long Island Sound Reference



COMPARISON OF BASELINE
IRON/COPPER CONCENTRATIONS AT
BLACK ROCK DISPOSAL SITE
WITH PREVIOUS CENTRAL LONG
ISLAND SOUND DATA

FIGURE 4.3-2



BASELINE
COD/COPPER CONCENTRATIONS
BLACK ROCK DISPOSAL SITE
MAY 1982

FIGURE 4.3-3

station and the 1000m East station in terms of the natural sediment at the disposal site is presented in Table 4.3-3. In all cases the comparison is adequate although the 1000 m East station does have higher concentrations of most metals. Based on these data, both reference sites are representative of conditions existing at the disposal site.

4.4 REMOTS^{tm} Survey

During August, 1982, a REMOTS^{tm} benthic survey of the proposed Black Rock disposal area was conducted from the R/V UCONN. Fifty-one stations were located on an orthogonal grid, a control or reference station was located 1000m East of the center of the grid, and a second reference station was located south of the grid at the DAMOS CLIS Reference station. Station locations and number of photographs analyzed at each station are listed in Table 4.4-1.

The purpose of the REMOTS^{tm} survey was two-fold. First, the REMOTS^{tm} data were intended to define gradients in the benthic habitat through measurement of boundary roughness, estimated major sediment mode, and definition of the patch sizes of infaunal successional stages. Maps of these gradients will be used in future surveys to define the temporal and spatial changes in the benthic habitat following disposal of Black Rock Harbor sediment in the center of the sampled area. Second, the REMOTS^{tm} maps should provide an economical ground-truth sampling program for pre- and post-dump monitoring of benthic conditions.

4.4.1 Methods

Table 4.3-3

BULK SEDIMENT CHEMISTRY
COMPARISON OF FVP REFERENCE STATIONS TO STATIONS
WITHIN THE BLACK ROCK DISPOSAL SITE

	PPM X10-4 Fe	PPM HG	PPM Pb	PPM Zn	PPM As	PPM Cr	PPM Cu
1000E	1.49	.11	98	227	11.9	96	66
	(1.48-1.50)	(.06-.16)	(70-116)	(153-366)	(8.6-16)	(93-99)	(65-70)
Reference	1.41	.10	49	255	7.6	81	51
	(1.26-1.61)	(.07-.13)	(40-66)	(198-323)	(1.4-12)	(76-84)	(48-52)
Black Rock Disposal Site	1.54*	.09	74	190	12.3	75	60
	(1.26-1.61)	(.10-.16)	(40-123)	(151-251)	(5.2-22)	(20-97)	(51-84)

*Omits abnormally high and low values

TABLE 4.4-1

REMOTS SAMPLING STATIONS

Black Rock Disposal Site

STATION	# PHOTOS	STATION	# PHOTOS
BR-CTR	3	100W	3
100N	3	150W	3
150N	3	200W	3
200N	3	250W	3
250N	3	300W	3
300N	3	400W	3
400N	3	500W	3
100E	3	100S	3
150E	3	150S	3
200E	3	200S	3
250E	3	250S	3
300E	3	300S	3
400E	3	400S	3
500E	3	CLIS-REF	3
1000E	3		
200N-100E	3	200S-100E	3
200N-300E	3	200S-300E	3
200N-500E	3	200S-500E	3
400N-100E	1	400S-100E	1
400N-300E	1	400S-300E	1
400N-500E	1	400S-500E	1
200N-100W	3	200S-100W	3
200N-300W	3	200S-300W	3
200N-500W	3	200S-500W	3
400N-100W	1	400S-100W	1
400N-300W	1	400S-300W	1
400N-500W	1	400S-500W	1

The REMOTS^{tm} sediment-profile camera was deployed from the survey vessel at fifty-three stations. Replicate images were taken at each station. Of these, three replicates were analyzed for forty-one stations and one replicate for the remaining twelve stations. Stations were located using the SAI Navigation and Data Acquisition System, with positions recorded for each camera lowering.

Measurements of boundary roughness, camera prism penetration depth, and the area of the positive redox in the sediment as seen in profile were taken from the black and white negatives. These measurements were accomplished with the Measuronics LMS^{tm} Image Analysis System. Negatives were used instead of positive prints in order to avoid changes in image density that can accompany printing of a positive image. The image analysis system is capable of detecting 256 grey scale values while density slicing an image. Data on grain-size estimates, evidence of surface erosion, and faunal information were determined from 8 X 10 inch positive prints. At this magnification, the resulting print is 1.5 times real scale.

The major modal grain-size and subordinate modes were estimated from the photographs by overlaying a grain-size comparator at the same scale as the photographs. This comparator was prepared by photographing a series of Udden-Wentworth size classes through the profile camera (equal to, or less than, coarse silt up to granule and larger sizes). Seven grain-size classes are available on this comparator. The lower limit of optical resolution of the photographic system is about 62 microns, allowing recognition of grain sizes equal to, or greater than, coarse silt. The accuracy of this method has been documented by comparing REMOTS^{tm} estimates with grain-size statistics determined from laboratory sieve analysis.

The boundary roughness values represent the maximum topographic relief measured over the width of the optical window of the profile camera. This width is 12.75cm.

If there is oxygen in the overlying water column, the near surface sediment will usually have a high reflectance value relative to anoxic sediment underlying it. This is because the oxidized surface sediment contains ferric hydroxide (an olive color when associated with organic particles), while the hydrogen sulphide sediments below this oxygenated layer are grey to black. Although the high reflectance value of the surface layer is discussed in this report as the "oxidized layer", it is recognized that sulphate reduction can take place in microanaerobic environments (interiors of fecal pellets or diatom frustules) within this ferric hydroxide zone. The boundary between the light colored ferric hydroxide surface sediment and underlying grey to black sediment is called the redox potential discontinuity and is abbreviated as the RPD.

The area of the positive (aerobic) RPD was determined with the Measuronics LMS^{tm} System by density slicing its unique reflectance value. This oxidized area was then digitized and measured at scale. These cm^2 values were then divided by 12.75 (the prism window width) to obtain a mean depth for the RPD.

The RPD depth is a sensitive indicator of infaunal succession, within station patchiness, and bioturbation activity. In the absence of bioturbating organisms, the RPD depth can be less than 0.5 cm thick in organic-rich muds. Pioneering stages produce RPD depths generally less than 3 cm deep, while mature infaunal successional stages generate RPD depths greater than 3 cm.

A detailed discussion on evaluation of the stage of succession from REMOTS^{tm} images is given in Rhoads and Germano (1982) and Rhoads and Boyer (1982). These two papers deal with primary succession, i.e., faunal colonization of a new or recently disturbed sedimentary surface, however, this survey was conducted over a natural, undisturbed bottom and conditions of secondary colonization had to be considered. Secondary colonization occurs when pioneering polychaete species appear on bottoms that are already populated by mature successional stages. This transient condition has been observed at other locations and was common throughout this survey. Pioneering species make appearances at the surface of mature systems in late summer and fall months. In our data coding we describe these associations as III-I, i.e., a Stage III mature assemblage invaded by a Stage I polychaete assemblage.

A multi-parameter habitat index has been constructed to characterize habitat quality according to criteria presented in Table 4.4.1-1. 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 within the sediment (see Rhoads and Germano, 1982 for REMOTS^{tm} criteria for those conditions). The habitat index for such a condition is minus 10. At the other end of the scale, an aerobic

Table 4.4.1-1

The habitat index is determined by summing the following subset indices:

Planimetered RPD Area	Index Value
0-10 cm^2	1
10.1 - 20.0	2
20.1 - 30.0	3
30.1 - 40.0	4
40.1 - 50.0	5
>50.1	6

Chemical Parameters	Index Value
Methane present	-2
No/low dissolved O_2	-4

Successional Stage (primary succession)	Index Value
Azoic	-4
Stage 1	1
Stage 1-2	2
Stage 2	3
Stage 2-3	4
Stage 3	5

Successional Stage (secondary succession)	Index Value
Stage 1 on a Stage 3	5.00[I]
Stage 2 on a Stage 3	5.00[II]

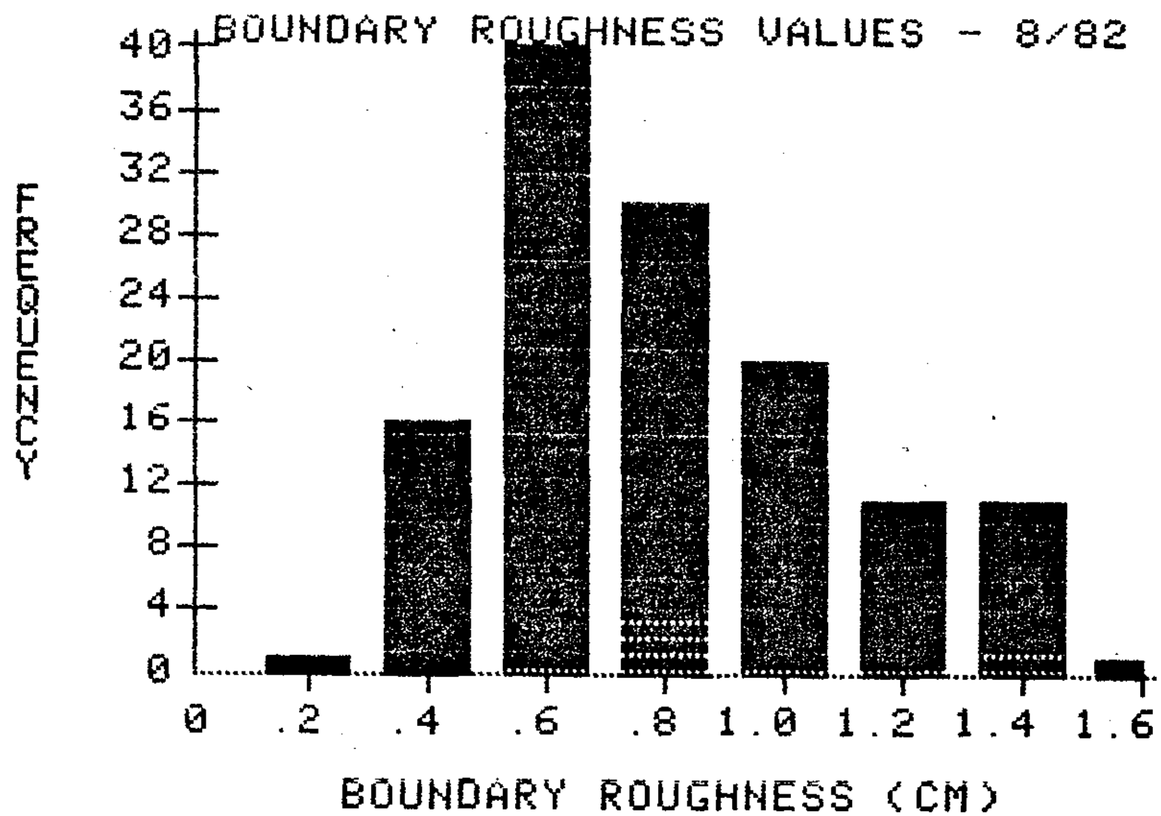
HABITAT INDEX = Total of all subset indices bottom with a deeply depressed RPD, evidence of a mature macrofaunal assemblage, and no apparent methane gas bubbles at depth has a habitat index of plus 11.

4.4.2 Results

All stations from the Black Rock Disposal Sites had a major textural mode equal to, or less than, coarse silt (62 microns). All of the surveyed area, including the reference stations 1000E and CLIS-REF were classified as silt-clay with subordinate textural modes falling within fine sand or coarser depending on the quantity of shell present.

Boundary roughness values were normally distributed about a right-skewed major mode of 0.42 to 0.62 cm (Fig. 4.4.2-1). Most, if not all of this boundary roughness, was biogenic microtopography produced by fecal mounds, feeding pits, burrowing and predator excavation of the surface. Only nine station replicates showed evidence of local erosion (Fig. 4.4.2-2), and these values are shown as a stippled pattern on the histogram of Figure 4.4.2-1. Surface erosion was postulated for those stations exhibiting surface shell lags, a truncated redox, mud clasts, or "exhumed" shells and tubes at the sediment surface.

The frequency distribution of redox depths was normally distributed (Fig. 4.4.2-3). The major mode was 3.5 - 4.0 cm, however, this depth class can be expected to change with season, related to the effects of changing water temperatures on metabolic activities of both microbial decomposition processes and infaunal bioturbation rates (Q_{10} effects). Holding temperature constant, the redox depths should change if the faunal composition changes.

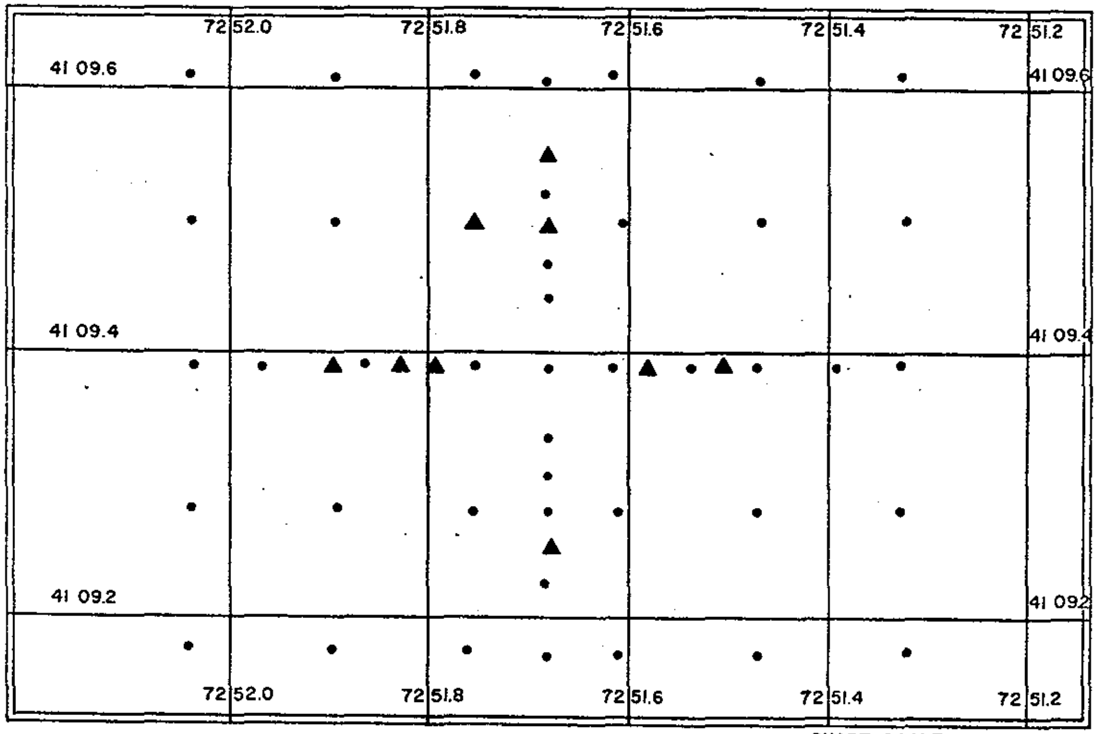


Histogram of boundary roughness, predisposal conditions, August, 1982 (n=135)

The length scale of the measurements is limited to 12.75 cm (width of the REMOTS[tm] window). The values represent the maximum vertical relief of the sediment surface. The stippled portion of the histogram represents the number of replicates in each boundary roughness class that show physical evidence of surficial erosion (scour relief, shell lag deposits, mud clasts, and exhumed shells and tubes).

FIGURE 4.4.2-1

BLACK ROCK REMOTS STATION LOCATIONS



REMOTS STATIONS SHOWING RECENT EROSION = ▲

REMOTS[tm] STATIONS WITH PHYSICAL EVIDENCE OF SURFICIAL EROSION

FIGURE 4.4.2-2

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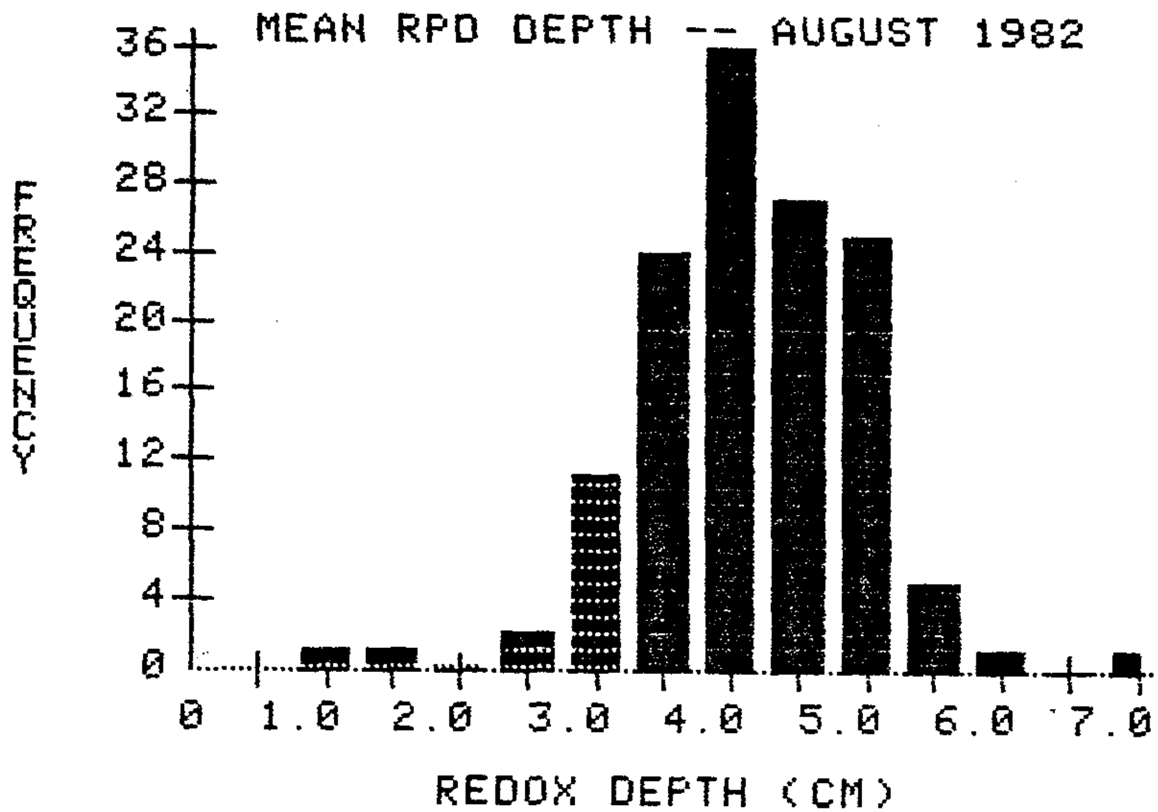
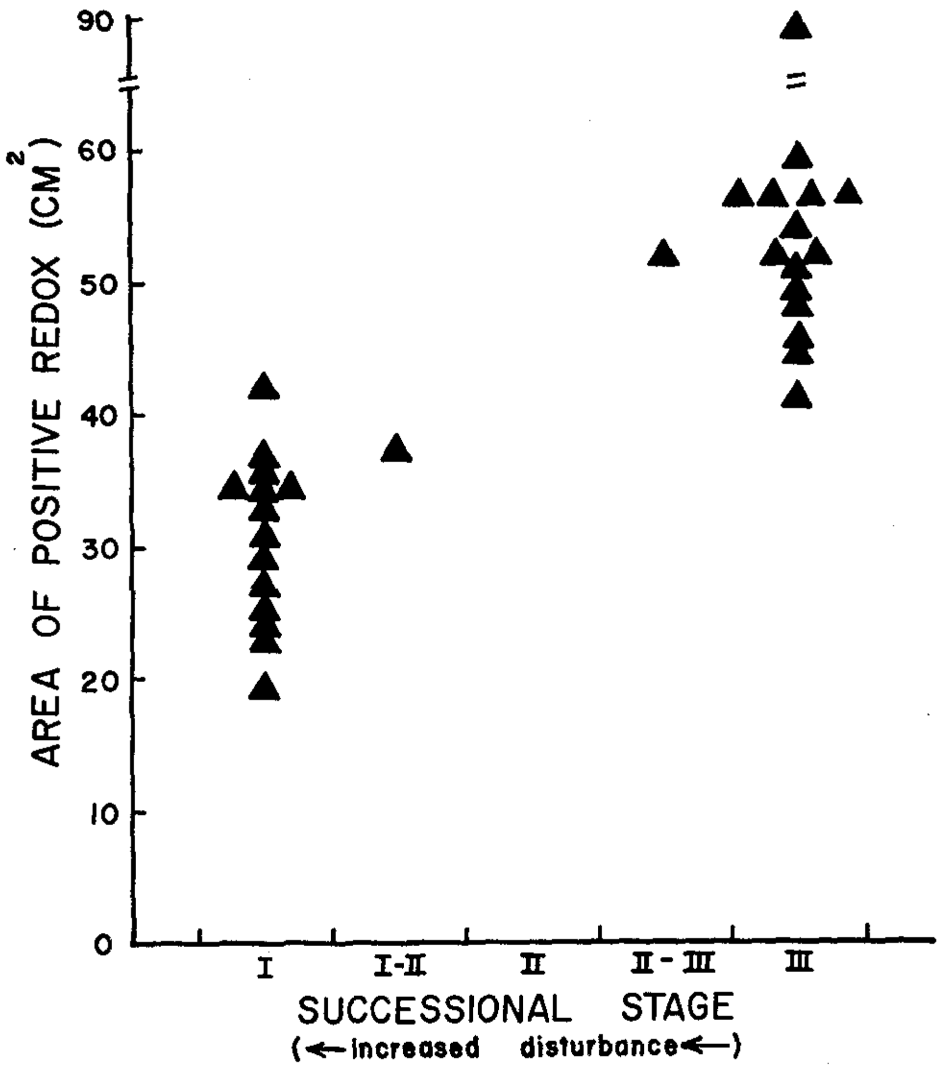


Histogram of predisposal RPD conditions in the surveyed area and reference stations, August 1982. Total sample size = 135. Stations with values < 3.14 cm (n = 14) shown in stippled pattern are interpreted to represent retrograde successional seres or replicates where surficial sediment erosion has made the redox boundary appear to be nearer the sediment surface than non-eroded replicates.

FIGURE 4.4.2-3

This latter point is important in the context of defining change in the benthic habitat related to dumping activity. Pioneering species are less efficient than mature successional stage species in pumping oxygenated water into the bottom. This means that the RPD depth should be much shallower during the initial stages of colonization of the disposal mound. For example, Figure 4.4.2-4 illustrates the difference in mean RPD depth on the Buzzards Bay disposal site related to disturbance history. In November, 1980, areas occupied by Stage I or I-II had redox depths less than 3.14 cm (40 cm^2 / 12.75 cm window width) while Stage III or mature bottoms had values greater than 3.14 cm.

Figure 4.4.2-5 shows the contoured values of the RPD depth at the proposed Black Rock site. Values range from a low of 2.79 to 5.25 cm. The reference stations 1000E and CLIS-REF have values of 3.57 and 3.92 respectively, which fall within the median interval for the surveyed area. Most of the area has a uniformly deep redox as might be expected for a faunally mature bottom, consequently an extremely small contour interval of 5mm was required to detect gradients over the area. Figure 4.4.2-6 displays the number of replicates at stations where redox depth values were less than 3.14 cm. No stations were encountered where all three replicates fell below this value. These replicates represent poorly developed (relative to the majority of stations) bioturbation regimes representing a retrograde condition in an otherwise mature state. Figure 4.4.2-7A is a digitized profile of the positive RPD area at a station replicate where pore-water irrigation is not well developed or the surface has recently experienced erosion. Figure 4.4.2-7B shows a well developed RPD



REDOX DEPTH AS A FUNCTION OF SUCCESSIONAL STAGE

Early successional stages (I and I-II) appear to have positive redox areas <40 cm^2 (equivalent to a mean RPD depth of 3.14 cm). Mature stages (III) tend to have redox areas >40 cm^2. Data are from the Buzzards Bay Disposal Area. From Menzie et al., 1982.

FIGURE 4.4.2-4

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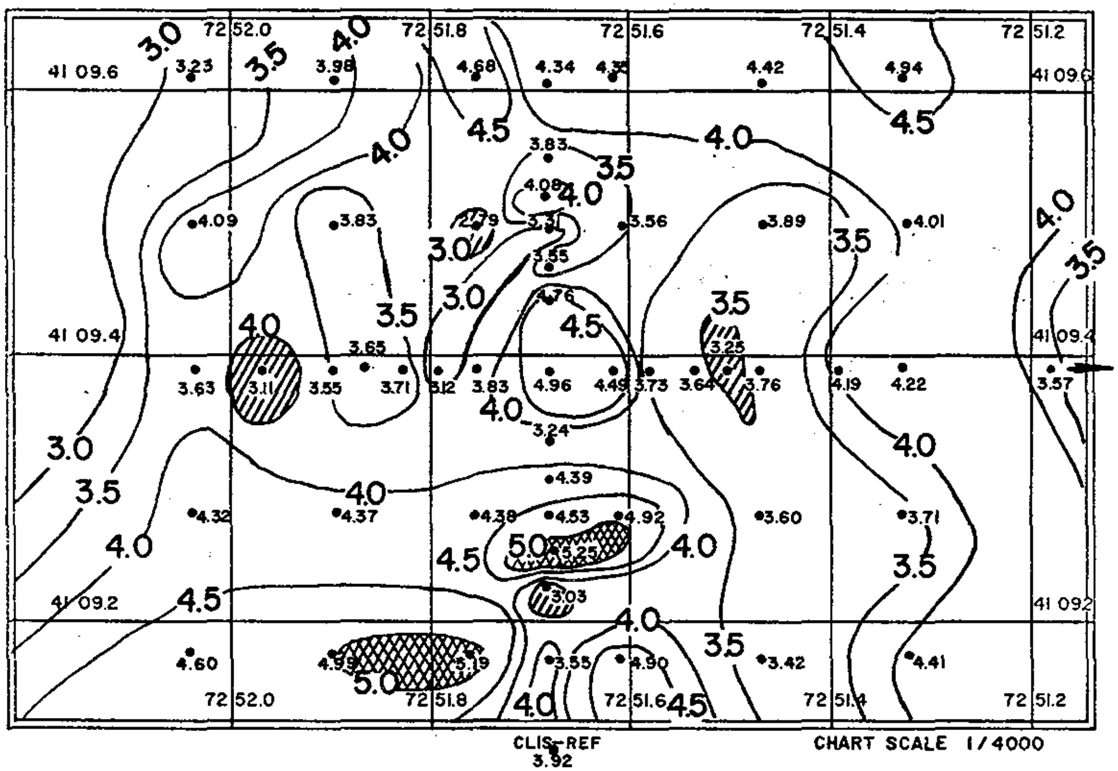
BLACK ROCK REMOTS STATION LOCATIONS

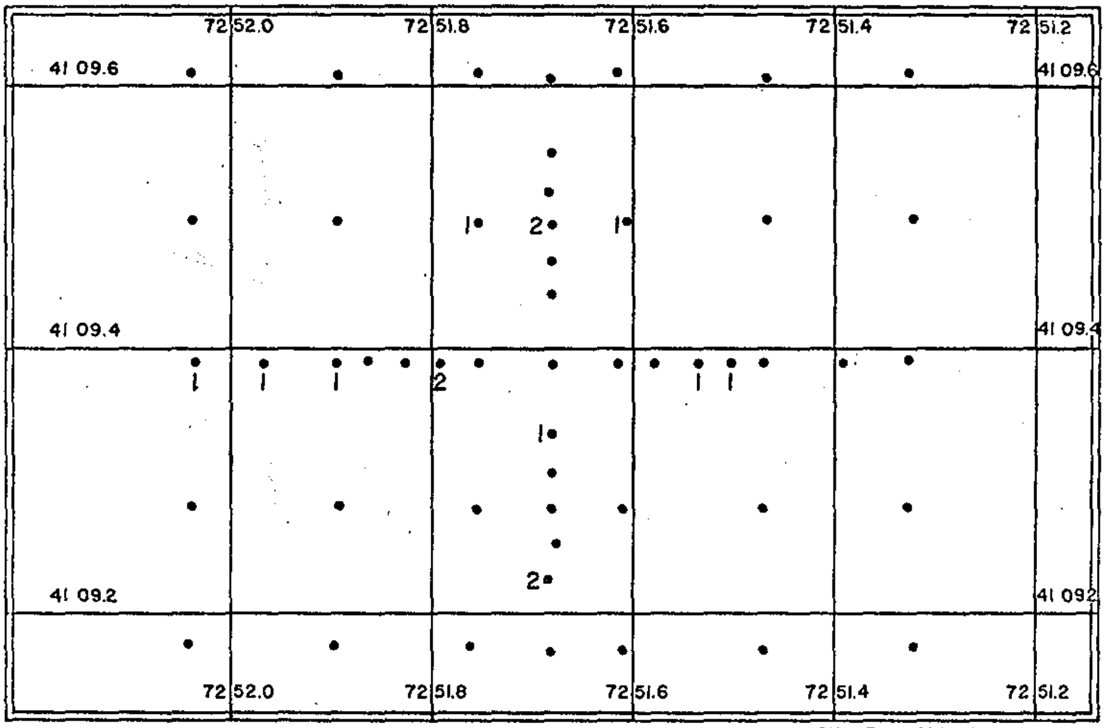


$\overline{X}$ RPD DEPTH (CM) ——— CI = 5 MM

Contoured redox depths in the surveyed area. The contour interval is .5 mm. Station values are mean of three replicates except for 400 N and S tracks where only one image was analyzed per station

FIGURE 4.4.2-5

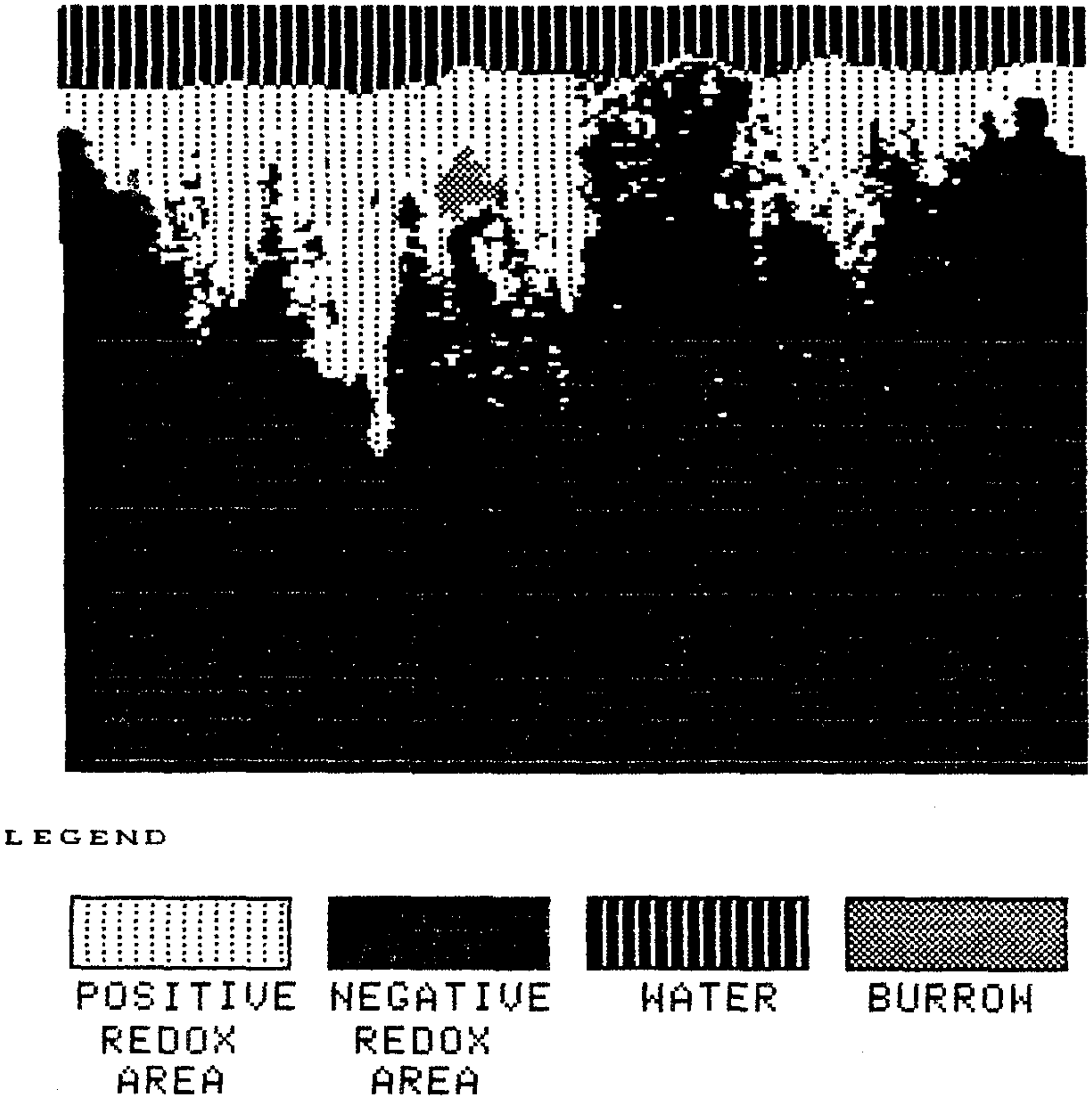
BLACK ROCK REMOTS STATION LOCATIONS



NUMBER OF STATION REPLICATES WITH RPD DEPTHS ≤ 3.14 CM (40 CM^2)

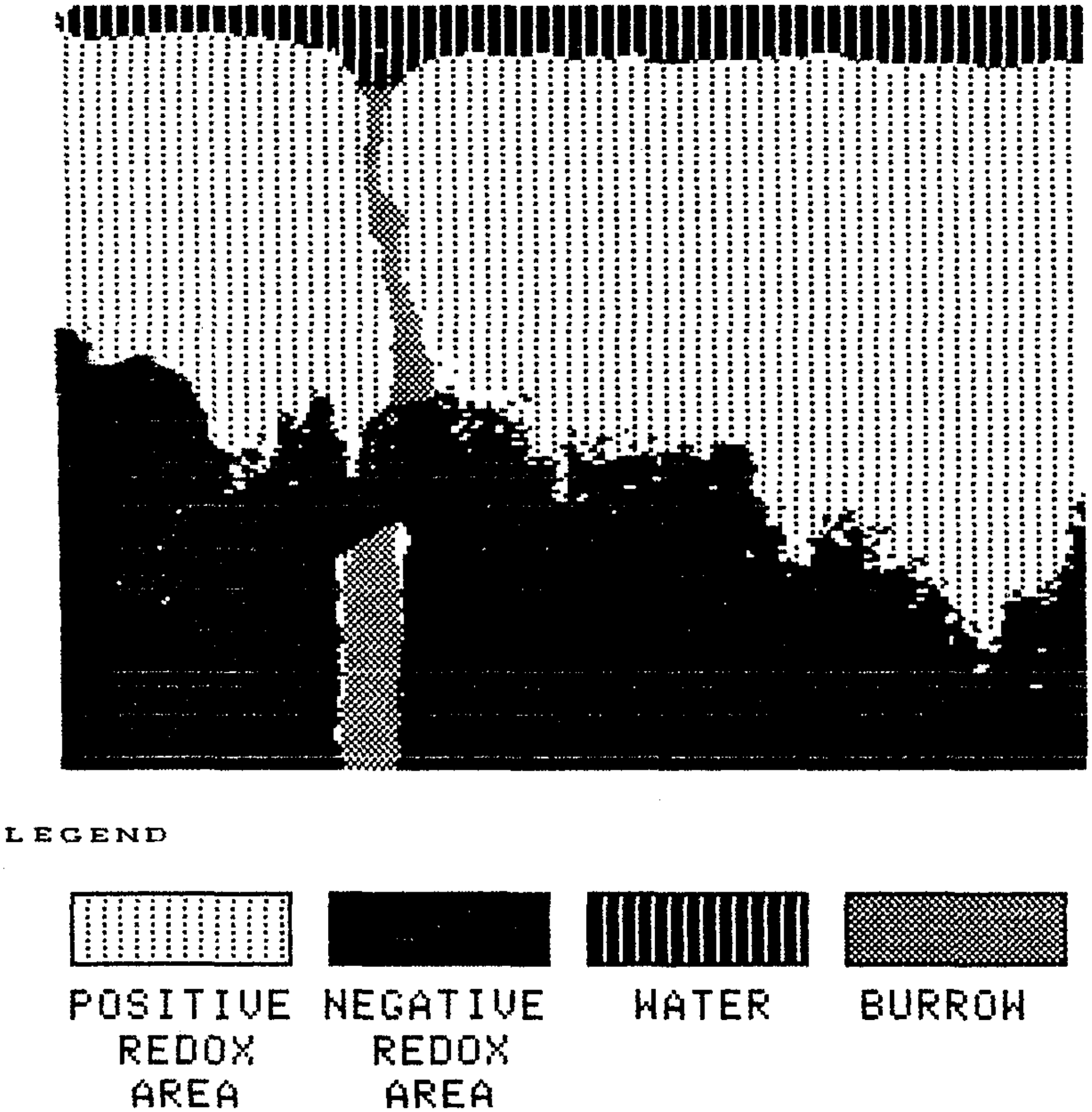
Number of station replicates with RPD depths < 3.14 cm. These replicates represent either retrograde successional seres or are surficially eroded

FIGURE 4.4.2-6



Density sliced and digitized sediment profile image from the Measuronics LMS™ Image Analysis System. Horizontal distance = 12.75 cm. Station 200n/100W, illustrating a shallow redox. The positive redox area is 17.23 cm^2, equivalent to a mean depth of 1.35 cm. This was one of the lowest values found during the August survey.

FIGURE 4.4.2-7a



Density sliced and digitized sediment profile image from the Measuronics LMS^{tm} Image Analysis System. Horizontal distance = 12.75cm. Station 400N-300E illustrates a deep redox. The positive redox area is 56.32 cm^2, equivalent to a mead depth of 4.42 cm, this is typical of a well-developed Stage III sere.

FIGURE 4.4.2-7b

area typical of the normal mature stage.

The within-station variation of the RPD depth is an indirect measure of patchiness in bioturbation or surficial sediment erosion; localized erosion can make the RPD appear to be shallower than it would be in an uneroded state. Figure 4.4.2-8 shows the variation between maximum and minimum RPD depths at each station. There were 19 stations with differences over one centimeter, which show some physical evidence of surficial erosion, as explained above (Fig. 4.4.2-2).

The habitat index values were determined by evaluating the successional stage of the benthic population and associated physical chemical properties of the sediment. For primary successional stages, the habitat index ranges from 1 to 5, with five the highest value (Stage III) that we can recognize in Long Island Sound for primary successional stages. The majority of stations surveyed exhibited secondary colonization. Most values were 5.00^{I}, i.e., a mature Stage III with the appearance of a Stage I polychaete assemblage at the sediment surface. This condition is shown in Figure 4.4.2-9. Since all stations showed the presence of a positive redox, and no stations had methane gas bubbles at depth; no negative values were added to the habitat index derived from the successional stages. The results of this study indicated a narrow range of habitat indices (7.7 to 11.0) over the disposal area (Fig. 4.4.2-10) which represents high habitat quality as defined by this index (only 9 stations had values less than 10). As a matter of contrast, past REMOTS^{tm} surveys carried out in Long Island Sound harbors in August showed many areas with negative values for a habitat index.

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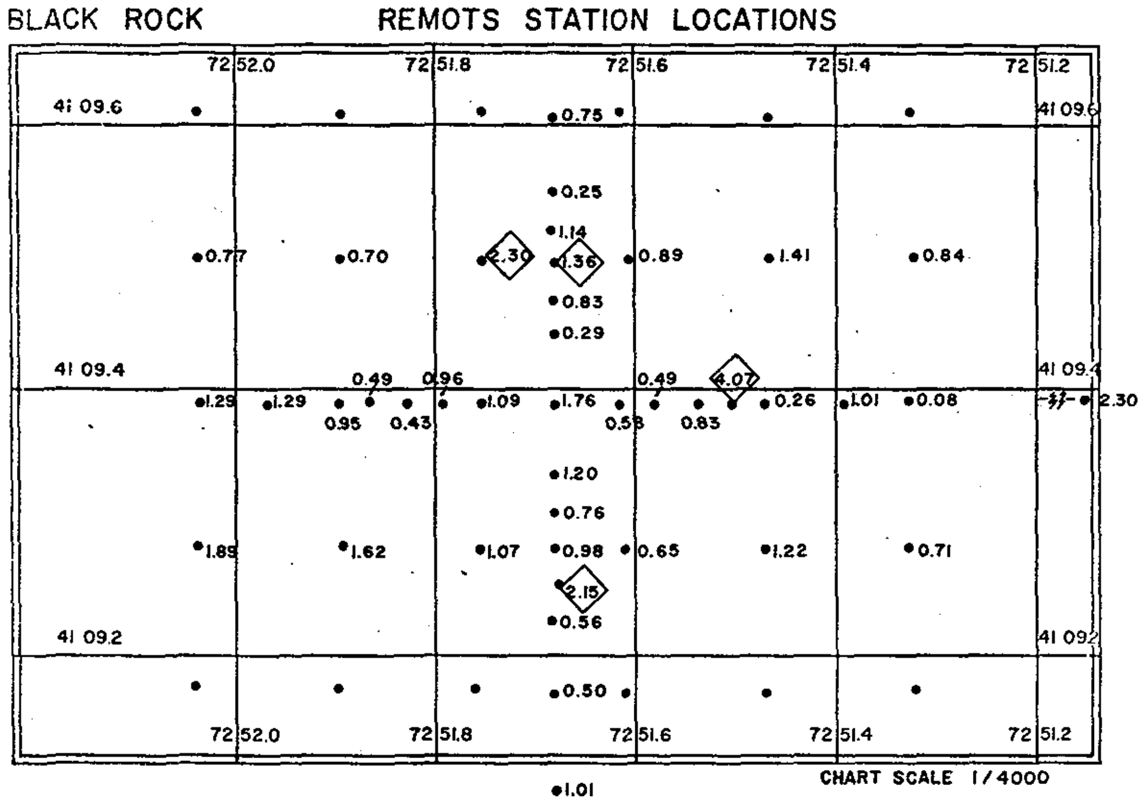
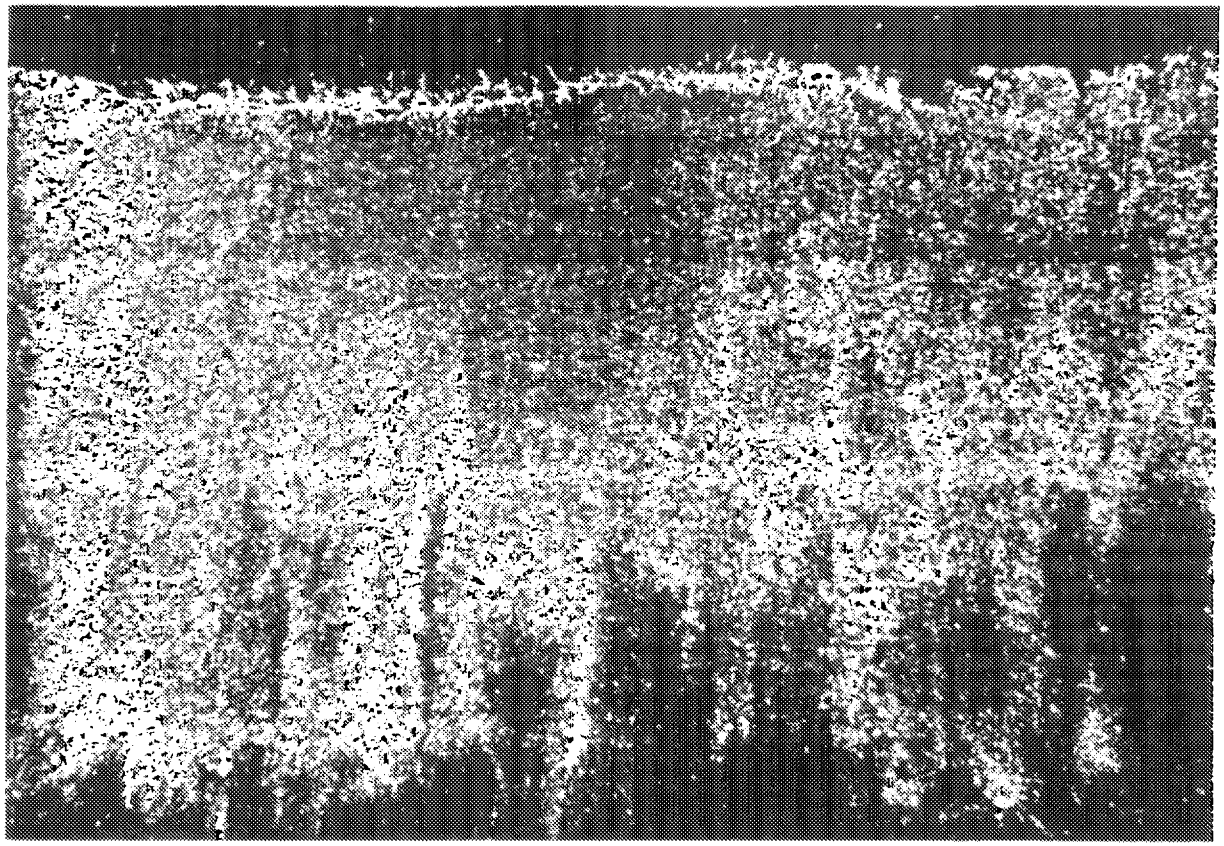


ΔRPD: DIFFERENCE BETWEEN MAXIMUM & MINIMUM RPD DEPTH VALUES– A MEASURE OF FAUNAL PATCHINESS (VALUES IN CM)

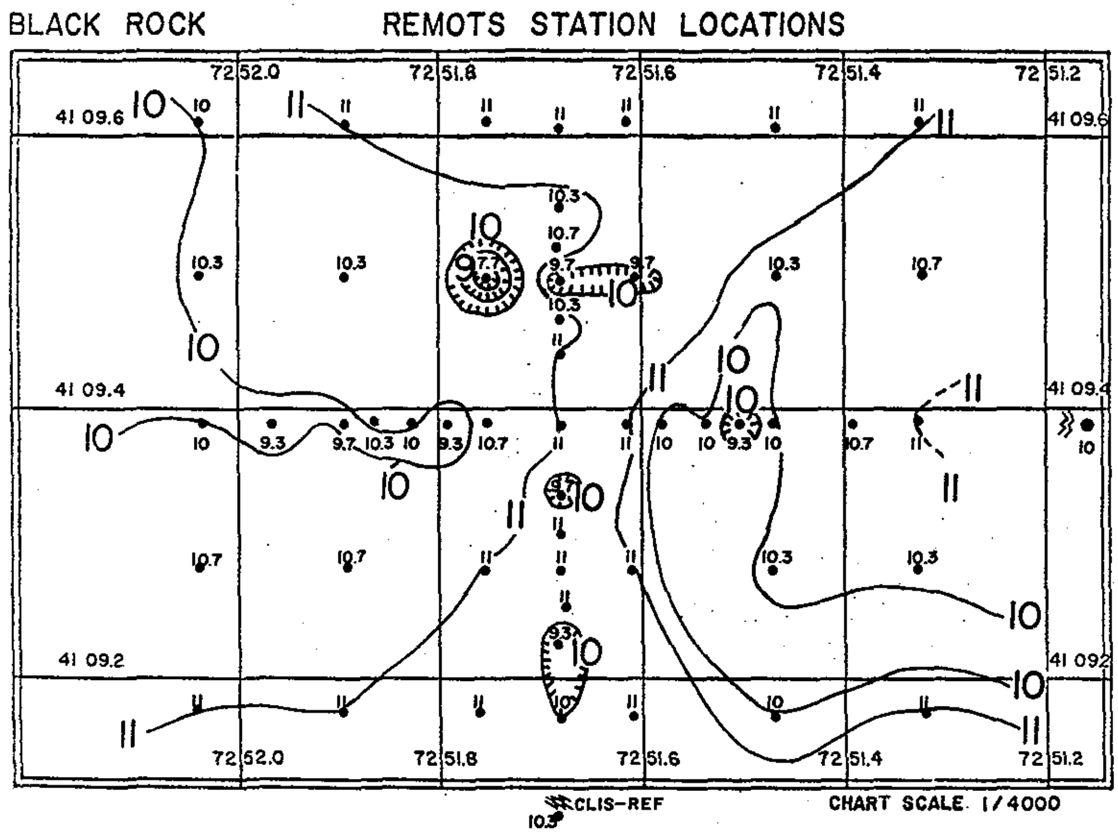
Within station difference between maximum and minimum RPD values (cm). Nineteen stations have values greater than one centimeter. This variability can be accounted for by either faunal patchiness in sediment irrigation or surficial erosion. Station values in boxes represent replicates which show independent evidence of surface erosion (n = 4).

FIGURE 4.4.2-8



Profile image showing a typical mixture of Stage III sere with a Stage I sere. Note the feeding pocket at depth, produced by Stage III head-down deposit feeders (arrow). Surface of the bottom is covered with a dense assemblage of tubicolous polychaetes (Stage I).

FIGURE 4.4.2-9



HABITAT INDICES – X̄ OF 3 EXCEPT FOR N-S 400 QUADS WHERE N=1

Contoured habitat indices. The total range of values that this index can take is -10 to +11. Most of the study area has values above +9. This is a seafloor area of high habitat quality.

FIGURE 4.4.2-10

4.4.3 Conclusions

Given the relative homogeneity of the area, the number of grab sampling locations required to detect variation in the system identified by the camera for conditions existing in August can be greatly reduced. A total of 14 grab stations would encompass the gradients observed from the REMOTS^{tm} images. These 14 locations are: BR CTR, 150E, 250E, 500E, 100W, 150W, 500W, 100S, 250S, 300S, 400S, 150N, 200N, and 400N (Figure 4.4.3-1). Such a sampling scheme would represent a significant savings in labor and ship time for the Field Verification Program. Because all of the gradients observed are of such small magnitude, these 14 stations could still be described as "oversampling"; a minimum of 5 stations (BR-CTR, 150W, 250E, 300S, 200N) would sample the major gradients observed. However, given the fact that the patchiness will shift seasonally and at random, 14 stations should be adequate to account for future pre-dump variation within the system.

As a result of this work, the following major conclusions relative to the proposed disposal site can be specified:

- Major modal grain-size over the entire surveyed area is uniformly the same (silt-clay).
- The modal redox depth is 3.5 to 4.0 cm. Only 14 replicates have values less than 3.14 cm, which is the value interpreted as a minimum redox for a well developed Stage III assemblage.
- The modal boundary roughness is 0.42 to 0.62 cm. Most of this microrelief is related to biogenic activity such as burrowing or foraging. Only 9 station replicates show physical evidence of erosion. This erosion may have been produced by currents or foraging by larger

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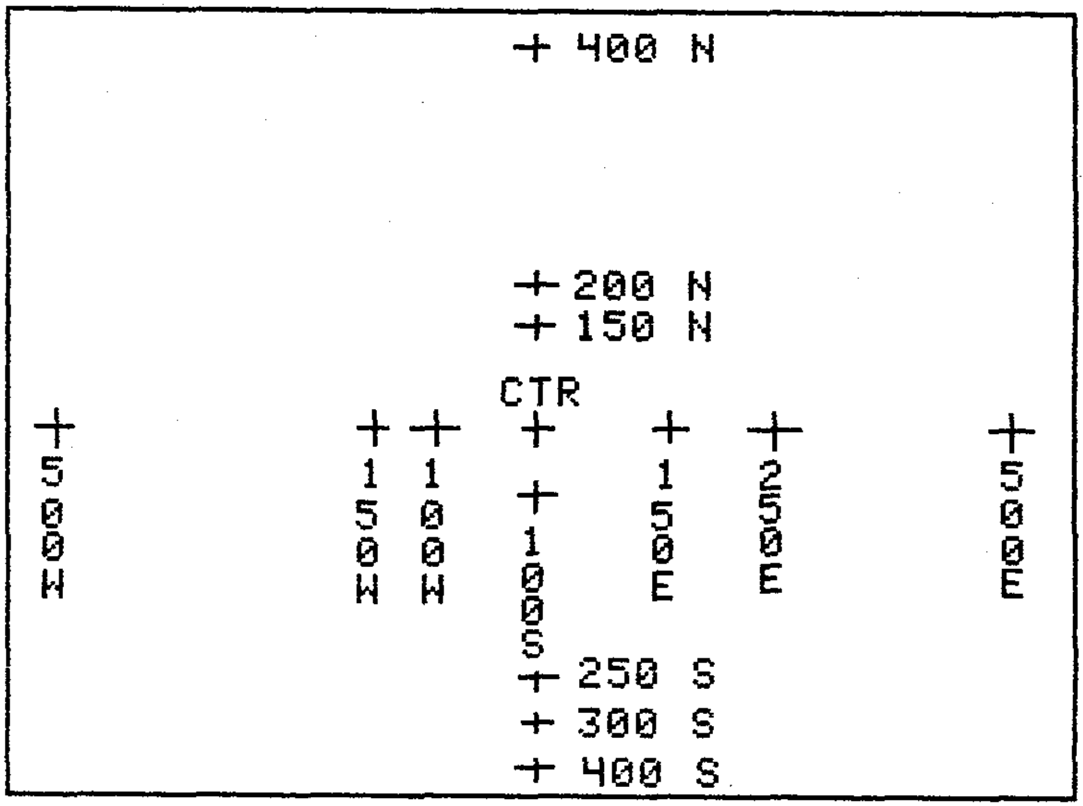


Recommended grab-sampling station locations based on REMOTS™ data for pre-dump conditions.

FIGURE 4.4.3-1

epifauna.

- Habitat indices are high quality, with most stations having values greater than +10.

- The reference stations 1000E and CLIS-REF are similar to most of the stations within the survey grid with respect to all measured parameters and are valid control stations for comparing post-dumping impacts.

- Based on the contour maps generated from the survey, the following stations would adequately sample the patchiness of the area for future pre-dump surveys: BR-CTR, 150E, 250E, 500E, 100W, 150W, 500W, 100S, 250S, 300S, 400S, 150N, 200N, and 400N.

- Variability in all parameters measured during this survey was small; consequently the data sets will serve as a more than adequate baseline for detecting changes in the measured parameters during the post-dump survey.

4.5 VISUAL OBSERVATIONS

On May 4, 1982, a series of three dives were made in the vicinity of the Black Rock Disposal Site to characterize the bottom conditions and assess the epibenthic and macrofauna present at the site. The first dive started at the center of the disposal point and proceeded in an easterly direction for 125 meters. The second dive took place at the 400m East station and the third was located at the 1000m East reference site.

The bottom observed on all of these dives was consistantly made up of soft mud sediment similar to other areas of the Central Long Island Sound Site. Divers were not able to distinguish the troughs observed on the sidescan but did notice concentrations of detritus in depression zones (Fig. 4.5-11) similar to that observed in other areas (Flood, 1982).

Corymorpha pendula were ubiquitous over the entire region as expected from earlier studies and should be a unique indicator of dredged material distribution after disposal in the

Spring of 1983. Other fauna present at the site included juvenile lobsters, the mantis shrimp, Squilla impusa, winter flounder, Pseudopluronectes americanus and the crab, Cancer irroratus. Further evidence of epibenthic and macrofaunal activity was also present in the form of fecal pellets, mucal tracks and burrow mounds.

Photographs taken during these dives are presented in Figures 4.5-1 through 4.5-16. Additional observations were attempted during the August cruise to the site, however, visibility was extremely limited throughout Long Island Sound and no additional information was obtained at that time.

4.6 Suspended Sediment Measurements

An important aspect of site designation for the Field Verification Program is an evaluation of the potential for contamination from other disposal operations which might affect the measurement of biological parameters. Since future disposal operations are planned for points in the southwest corner of the CLIS site, the ongoing dumping of Quinnipiac River sediment at the MQR site (Fig. 2.0-1) located in that region, provided an excellent opportunity to assess whether or not significant amounts of suspended material could be detected from that operation at the Black Rock site.

To accomplish this objective, the DAISY instrumentation array was deployed for a one month period during late spring 1982. This deployment began on April 23, 1892 with all instruments initialized at 1000 EST. The deployment was terminated and the

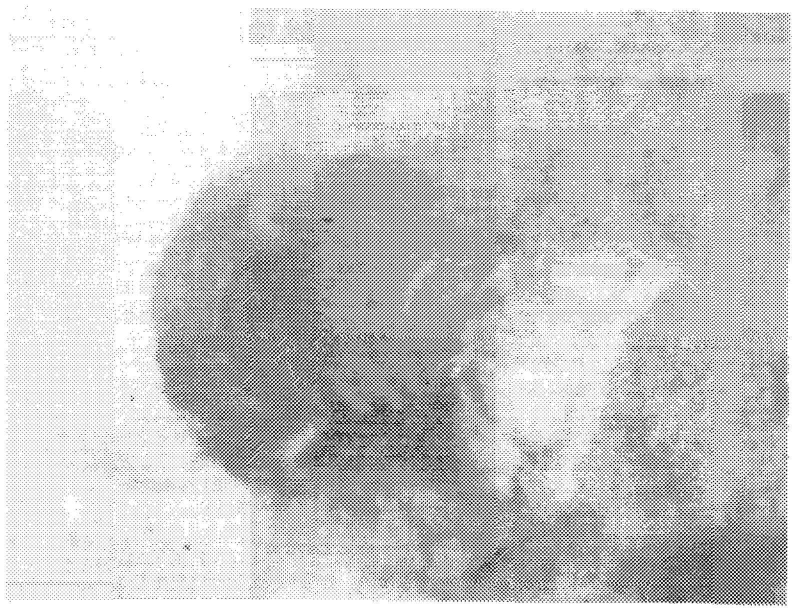


Figure 4.5-1

Juvenile lobster entering recently excavated burrow. Note shell fragments incorporated in sediment matrix of burrow wall.

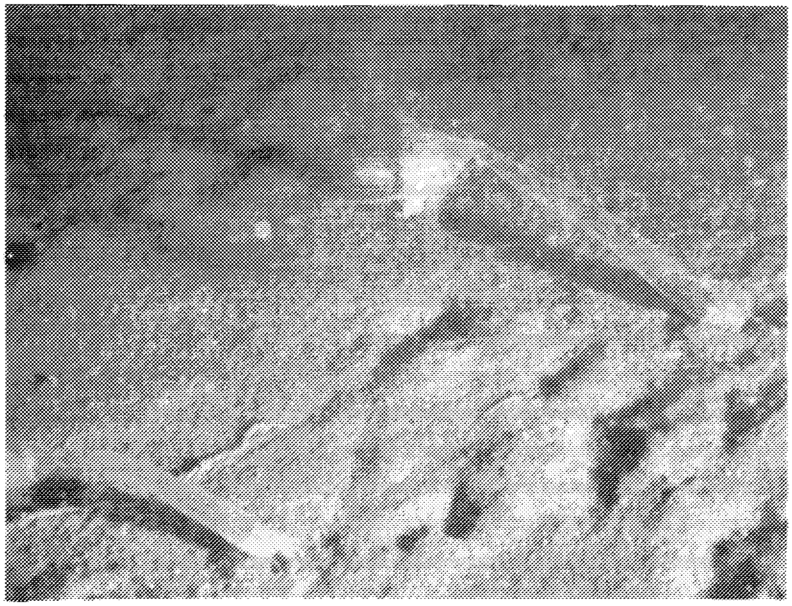


Figure 4.5-2

The stalked solitary hydroid, Corymorpha pendula, was the most obvious epibenthic dominant, with densities 10-30/.25 m^2. Note crab track "dimples" and fecal ribbons on sediment surface.

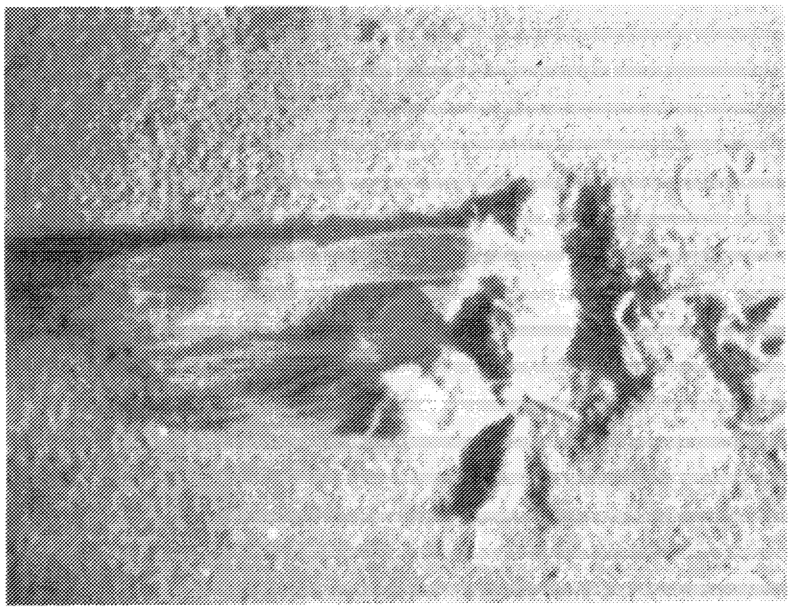


Figure 4.5-3

Corymorpha stalk polyp shows process of autolysis (lower specimen). After 1 June the adult sessile stage disappears from the central LIS site. Note sediment displacement by holdfast organ.

Figure 4.5-4

Boundary layer tidal current forces are evident on the C. pendula stalk (current from left to right). Build-up of fecal ribbon at stalk base and controlled hydranth tentacle posture are typical. Some selected larger specimens measured 8-10 cm height.

Figure 4.5-5

The mantis shrimp, Squilla empusa, was observed after divers forced the animal from a 1m deep vertical mud burrow.

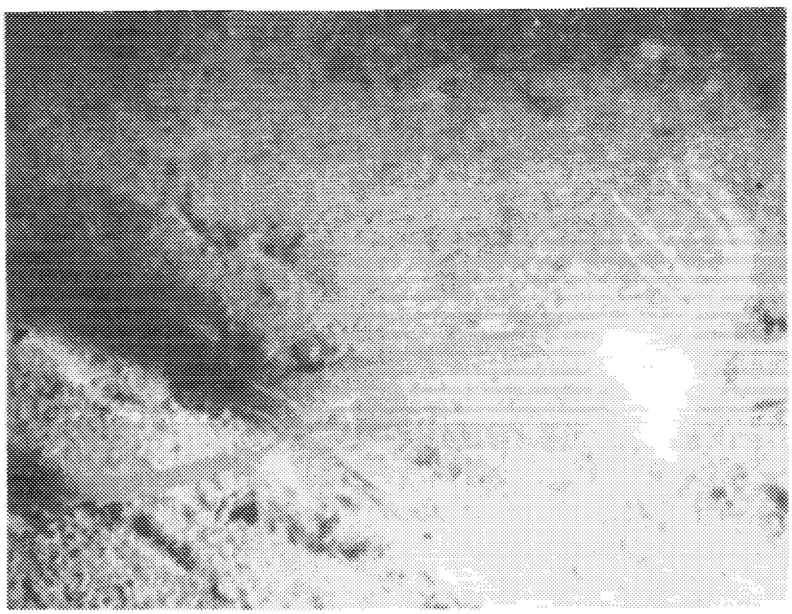


Figure 4.5-6

C. pendula pair illustrating sediment-organism-current relationships at this site. Note grannular surface texture.

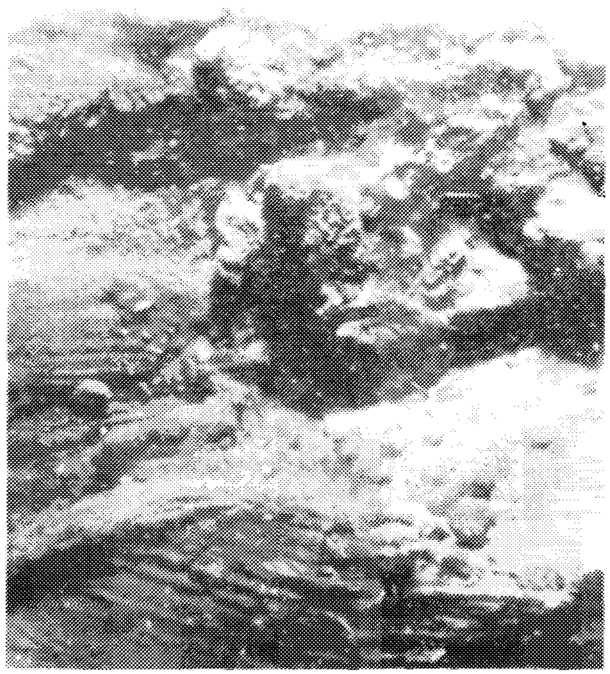


Figure 4.5-7

A vertical sediment profile demonstrates: cohesive upper 30 cm of benthis sediment; 2-3 cm brown oxygenated surface layer; semi-suspension 1-5 mm light brown nephaloid layer prone to tidal flux.

Figure 4.5-8

Corymorpha pendula, predominant organism effect on surface substrate conditions, and boundary layer current flow is significant.

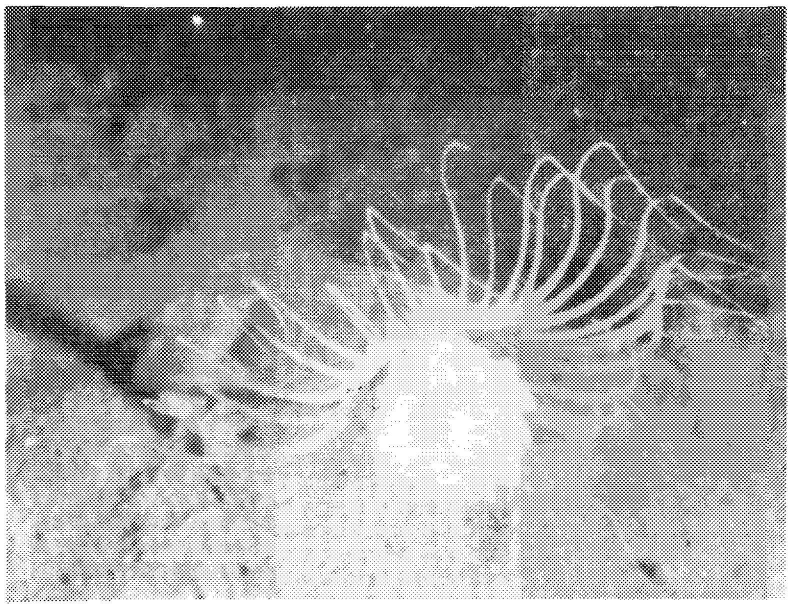


Figure 4.5-9

Corymorpha pendula, predominant organism effect on surface substrate conditions, and boundary layer current flow is significant.

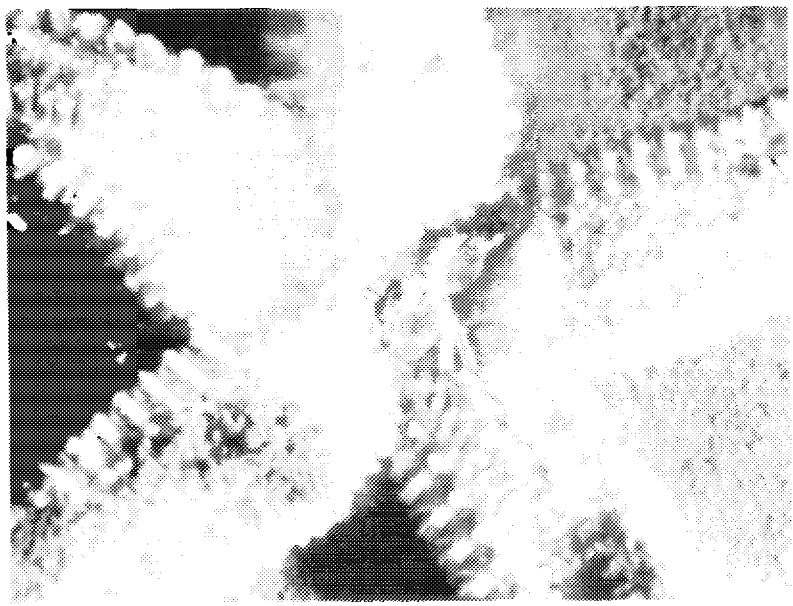


Figure 4.5-10

The starfish Asterias forbesii, shown actively grazing on Gemma and Mulina, small bivalve infauna.

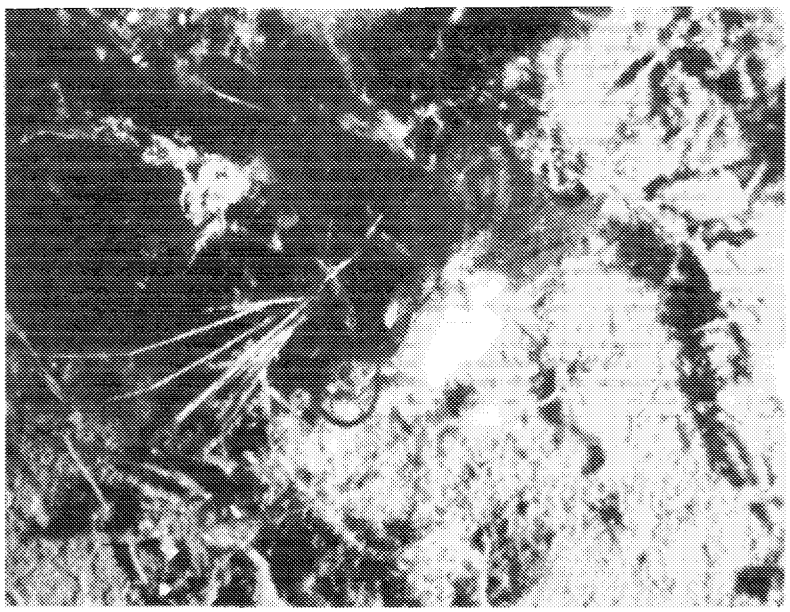


Figure 4.5-11

Occasional collection of aggregate detritus occurred along the transect path, notable in very slight sediment depression zones (large furrow pattern?). Here Ulva and Chrondrus are recognizable algae.

Figure 4.5-12

Photo taken from vertical altitude, shows Nassarrius mucal tracks, abundant C. pendula, and obvious nephaloid layer.

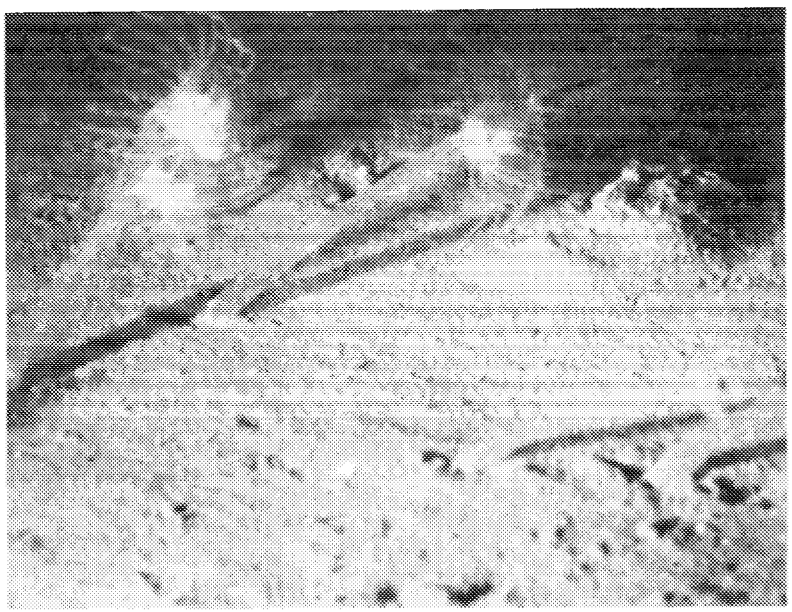


Figure 4.5-13

A macrophotograph of a Corymorpha stand with sediment current features and accumulation mounds of microtographic relief.

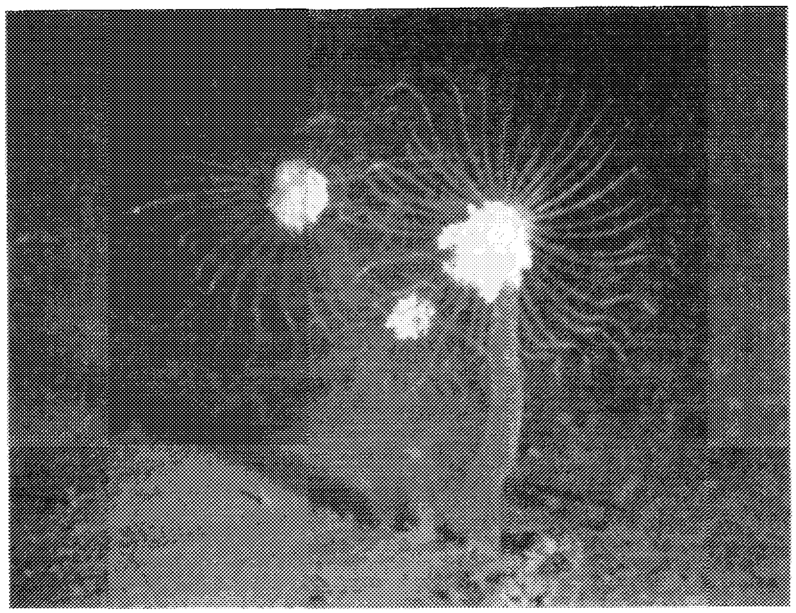


Figure 4.5-14

Corymorpha cluster with mysids Neomysis (sp.) around base.

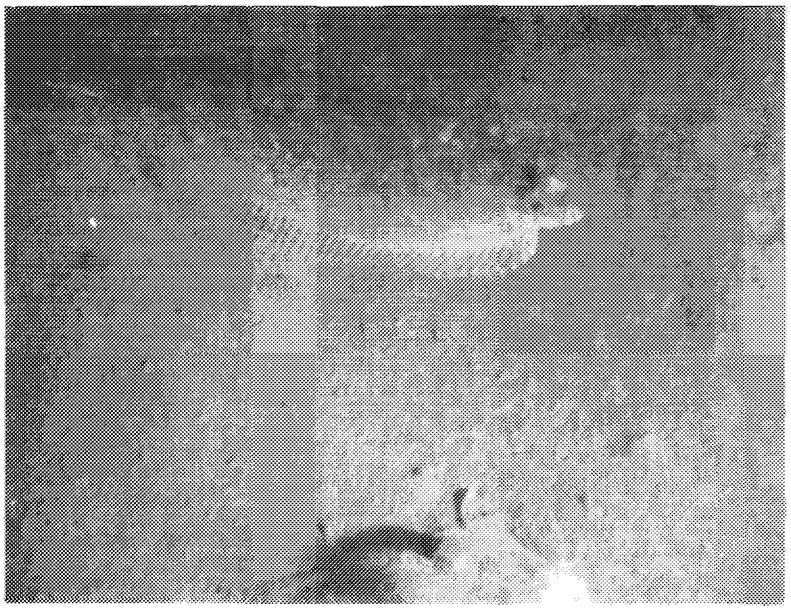


Figure 4.5-15

Juvenile winter flounder Pseudopleuronectes americanus, were recorded often in diver logs, foregound C. pendula gives indication of fish size 18-20 cm.

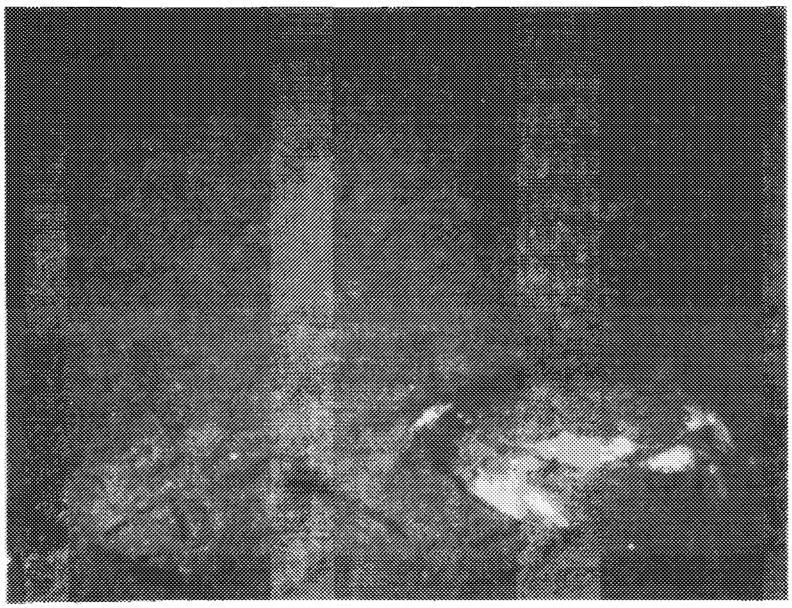


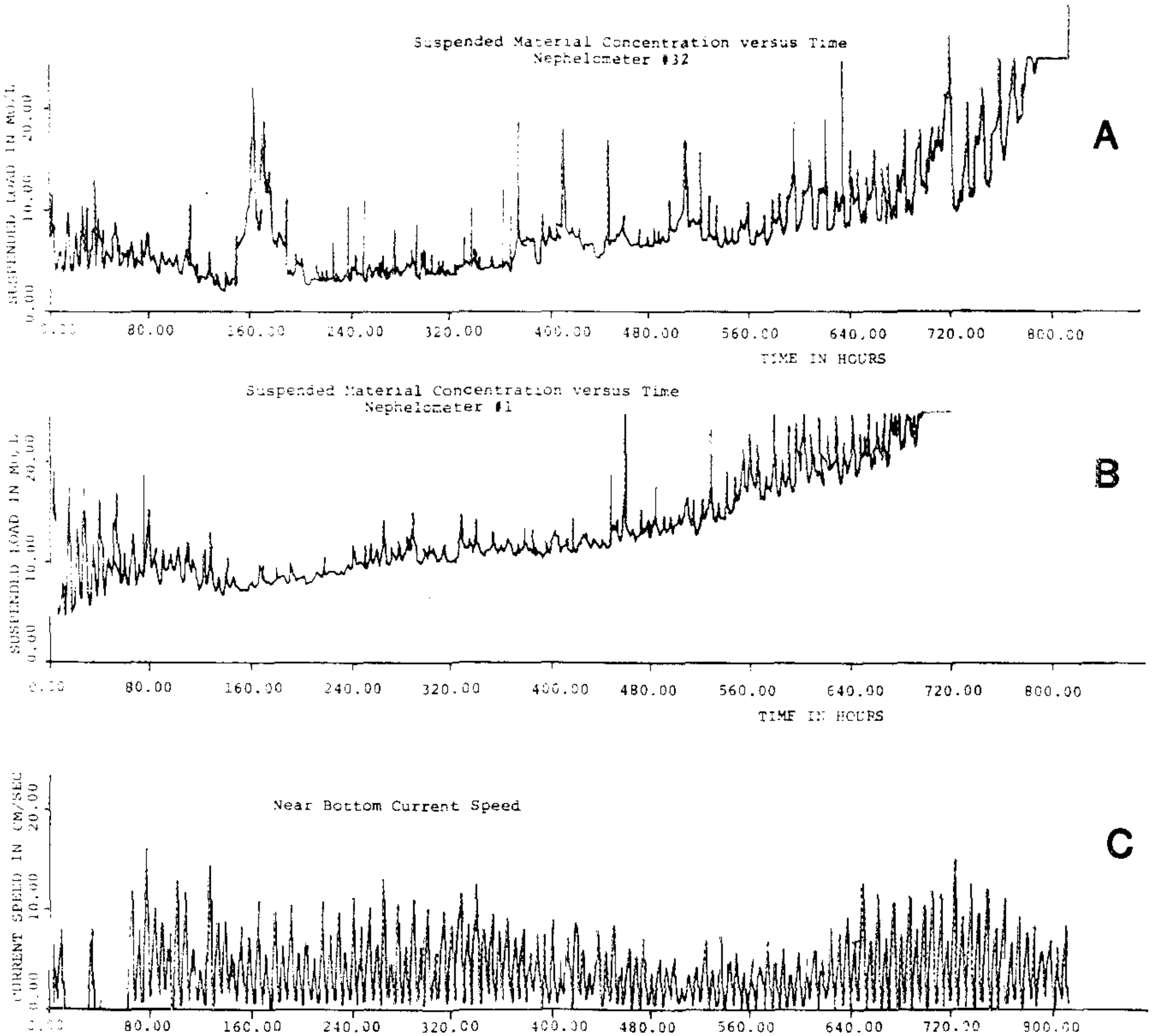
Figure 4.5-16

The most abundant decapod crustacean, Cancer irroratus characteristically burrows to carapace level, reworking large areas of sediment. Note patches of ubiquitous Corymorpha.

array recovered on May 27, 1982. The array, containing two optical transmissometer/nephelometers, a current meter, lapsed time camera, two temperature probes and a conductivity sensor, was located at the center of the proposed Black Rock disposal site in 20m of water. All instruments were sampled 4 times per hour throughout the deployment period. Post-deployment instrument checks and calibration indicated no evident malfunctions in the array. The initial plots of the data obtained during this deployment are shown in Figures 4.6-1 and 4.6-2.

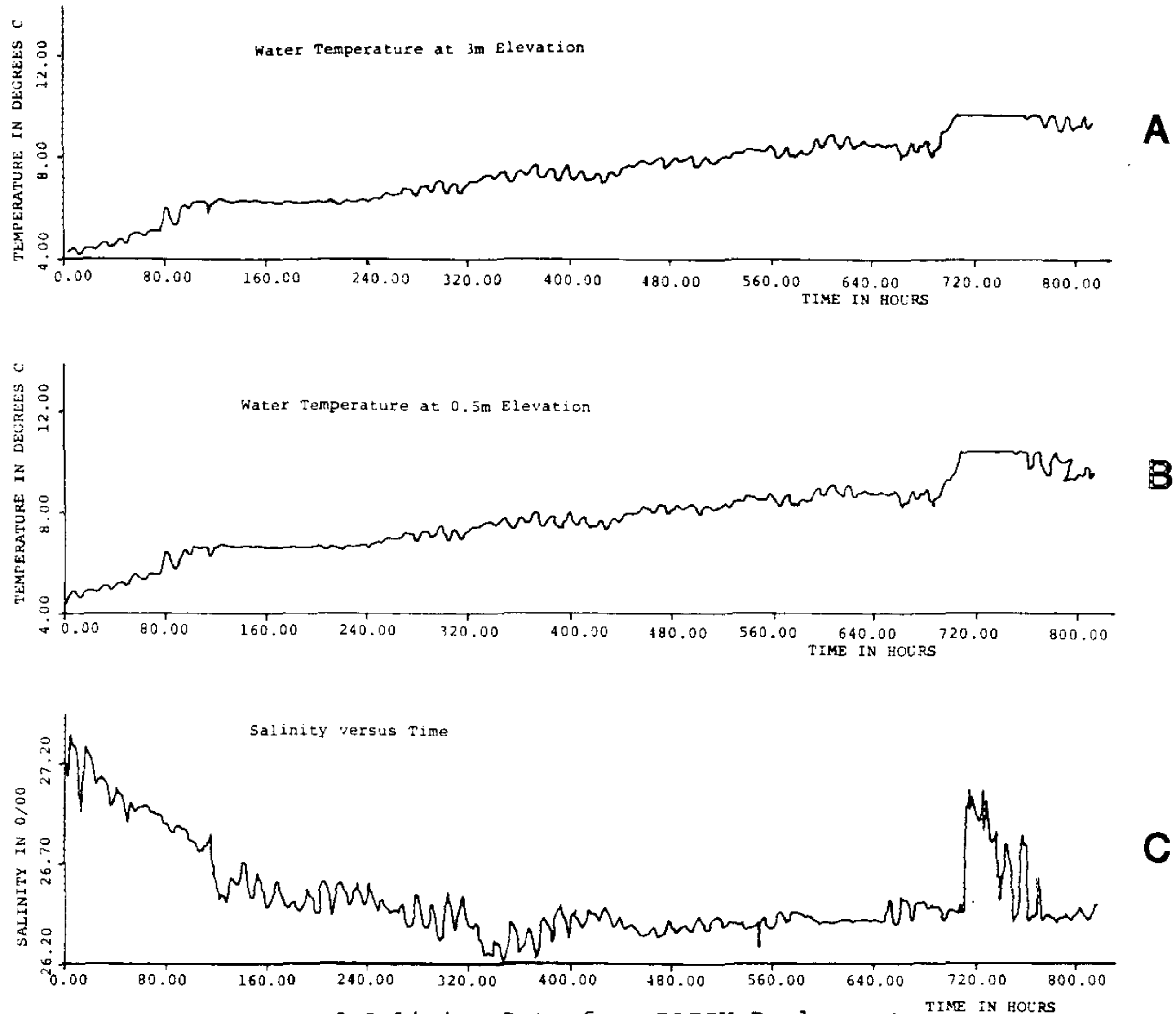
Review of the data indicates that suspended material concentrations at this site display a moderate to high degree of variability. Average near bottom concentrations ranged between 7 and 9/mg/l. A progressive increase in background concentration over the deployment period was observed, which was the result of significant accumulation of fine-grained materials on the windows of the optical sensors. Biological fouling was not observed to contribute to this accumulation. Over shorter time scales, suspended material concentrations displayed a periodic variability coincident with the local tidal cycle. During each tidal period concentration levels varied over a range of approximately $\pm 25\%$ about the mean. This range was approximately twice the range observed during deployments at the New London disposal site and described in previous DAMOS reports (Bohlen and Hamilton, 1980).

In addition to the tidal cycle variations, concentration levels also displayed several prominent aperiodic perturbations. The general lack of correlation between the observations provided by the two optical sensors (Fig. 4.6-1a and b) suggests that the majority of these perturbations were induced by the advection past



Suspended Load and Current Data from DAISY Deployment
23 April-27 May, 1982

FIGURE 4.6-1



Temperature and Salinity Data from DAISY Deployment
23 April-27 May, 1982

FIGURE 4.6-2

the array of biogenic detritus. Examination of the film data from the lapsed time camera revealed several periods of significant drifts past the array and suggested that the prominent perturbation occurring at approximately 155 hours in the record from Nephelometer 5 (Fig. 4.6-1a) was the result of an accumulation of seaweed on the sensor. Review of preliminary wind data obtained over the deployment period at the National Weather Service Station at Bridgeport, Conn. indicates that the period was essentially storm free, further supporting the importance of biogenic detritus to the generation of the observed pertubations.

The DAISY deployment at the Black Rock disposal site was intended to detail the extent to which the site was impacted by disposal operations being conducted along the western limits of the New Haven disposal area, particularly related to dumping of Quinnipiac River sediment at the MQR site. Initial review of the optical data (Figs. 4.6-1a and b) and comparison of these data to those obtained at the New London site during disposal operations (Bohlen and Hamilton, 1980) indicate that the MQR operations produced no significant variations in the suspended material concentrations at the Black Rock site. This conclusion was further emphasized when records of disposal time were compared with the presence of aperiodic spikes in the suspended sediment concentration. None of these spikes were correlated with a disposal event, nor were they of the magnitude observed during the New London dumping observations.

In addition to the optical data detailing suspended material concentrations, the array also provided a description of the local tidal current field over the deployment period (Fig.

4.6-1c). Near bottom current speed (1 meter above the bottom) averaged approximately 5cm/sec, with peak velocities approaching 20cm/sec. The tidal currents displayed a regular semi-monthly variation (spring-neap cycle). The small variations in suspended material concentrations associated with these relatively low energy tidal flows suggest that the sediment-water interface in the area is dominated by loosely aggregated, high water content sediments with low critical erosion velocities. Such a view is consistent with divers' reports of the existence of a "fluff layer" along the sediment-water interface during slack water and limited near bottom visibility during either the ebb or flood portions of the tidal cycle.

Water temperature and salinity (Fig. 4.6-2a, b and c) varied progressively during the deployment period. Water temperatures increased by approximately $5^{o}C$ over the month. These increases occurred in a series of "step-like" progressions where temperature increased smoothly to a plateau, then remained constant, or nearly constant, for a time, then increased smoothly again to another plateau. The cause of this variation appears to be associated primarily with the air temperature during the deployment period.

Salinity progressively decreased during the first 320 hours of the deployment period with average values falling from approximately $27^{o}/oo$ to $26^{o}/oo$. Following this decrease, values increased slightly to $26.5^{o}/oo$ and subsequently remained essentially constant. At approximately 700 hours, salinity values increased abruptly, displaying a high degree of temporal variability for a period of approximately 70 hrs before returning to pre-disturbance levels. The cause for this latter variation is unknown at this time, however it does not appear to be an instrumentation problem as there is a concurrent perturbation in water temperature (Figs. 4.6-2a and b) associated with the salinity change, suggesting an intrusion of high salinity water from the eastern sound. The lower frequency decrease in salinity should be primarily the result of streamflow variations. The factors governing both the long and short term variability in salinity at the study site will be subject of more detailed study during the second phase of this investigation to be initiated during September 1982.

5.0 SUMMARY AND CONCLUSIONS

All of the data obtained on the baseline surveys to the Black Rock Disposal Site support the selection of the designated point in terms of minimizing potential environmental impact, reducing interference from other projects and providing stable background conditions for measurement of changes resulting from disposal of dredged material.

The site is characterized by a flat, gently sloping topography with a soft mud bottom that is consistant over the entire Central Long Island Sound area. Sidescan records indicate the presence of mud furrows in the area, but do not show extensive contamination by earlier disposal operations. Sediment chemistry data, visual observations and the REMOTS^{tm} interface camera all support the conclusion that the bottom in the proposed area is healthy, typical of natural sediment in the region and consistant over relatively large areas.

The results of the suspended sediment measurements obtained during the disposal of Quinnipiac River sediment in the southwest corner of the Central Long Island Disposal Site showed no indication of contamination of the Black Rock area. Based on this information and the demonstrated stability of other disposal mounds in the area, the potential for interference with the Field Verification Program appears remote.

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