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Baseline Study, March 1990

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From 27 to 29 March 1990, field operations were conducted at the Buzzards Bay Disposal Site to provide information on the effects of past disposal operations and establish baseline conditions for future monitoring. Field operations included a precision bathymetric survey, REMOTS® sediment profile photography, and sediment sampling for benthic, chemical, and physical analyses.

The information obtained from the bathymetric survey and REMOTS® photos permitted the detection of two disposal mounds within the surveyed area. The primary mound was central to the disposal site, 1.2 m high and 60 m wide. The other, south and west of the center mound, was 1.6 m high and approximately 90 m wide.

The major modal grain size over the surveyed area ranged from medium sand (2-1 phi) to silt-clay (≥4 phi). All stations containing a major mode of medium (2-1 phi) and fine (3-2 phi) sand fractions were rippled. The distribution of the major modal grain size, as deduced from REMOTS® photographs, indicated a net bedload sediment transport of fine-grained material to the southeast along an 11.6 m isobath. Currents are most likely the dominant force contributing to the transport. The disposal site center consisted of rippled bedforms and fine sands which limited penetration by the REMOTS® camera.

The species composition found in this study was similar to that of benthic communities in Cape Cod Bay and Boston Harbor/Massachusetts Bay. Sediment chemistry and grain size analysis results indicated expected levels of percent fines, metals, PAHs, PCBs, and pesticides. Currently, the surveyed area is healthy biologically and relatively uncontaminated.

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EXECUTIVE SUMMARY

This report presents a synopsis of relevant background information on baseline conditions at the Buzzards Bay Disposal Site (BBDS) as of March 1990. Disposal records indicate that since 1979, 92,000 m^3 of dredged material consisting of relatively uncontaminated sands and silty-sands have been disposed at the site. Monitoring activities at the site have not been conducted by the DAMOS program over the past several years, because the site has been used infrequently. The largest collection of site-specific data was gathered by Germano et al., (1989) in 1981, and regional data have been summarized in an earlier report (SAIC, 1989a).

From 27 to 29 March 1990, field operations were conducted at BBDS to provide information on the effects of past disposal operations. Field operations included a precision bathymetric survey, REMOTS® sediment profile photography, and sediment sampling for benthic, chemical, and physical analyses. The overall objective of the cruise was to characterize existing bathymetric, sediment grain size, sediment chemistry, and benthic conditions at and around the disposal site. Three reference areas were selected to provide comparisons between ambient and on-site conditions and were located 3107 m northwest, 3940 m west, and 2600 m southwest of the disposal site center.

The information obtained from the bathymetric survey and REMOTS® photos permitted the detection of two disposal mounds within the surveyed area. The primary mound was central to the disposal site, 1.2 m high and 60 m wide. The other, south and west of the center mound, was 1.6 m high and approximately 90 m wide.

The major modal grain size over the surveyed area ranged from medium sand (2-1 phi) to silt-clay (≥4 phi). All stations containing a major mode of medium (2-1 phi) and fine (3-2 phi) sand fractions were rippled. The distribution of the major modal grain size, as deduced from REMOTS® photographs, indicated a net bedload sediment transport of fine-grained material to the southeast along an 11.6 m isobath. Currents are most likely the dominant force contributing to the transport. The disposal site center consisted of rippled bedforms and fine sands which limited penetration by the REMOTS® camera.

The species composition found in this study was similar to that of benthic communities in Cape Cod Bay and Boston Harbor/Massachusetts Bay. Species richness was somewhat higher at the reference stations; however, both on-site and off-site stations were well within the range observed in soft-bottom, shallow water environments. Significant differences existed between reference stations and on-site stations in REMOTS® parameters for RPD depth, successional stages, and OSI values.

Sediment chemistry and grain size analysis results indicated expected levels of percent fines, metals, PAHs, PCBs, and pesticides. Currently, the surveyed area is healthy biologically and relatively uncontaminated. Continued monitoring of the site, through the DAMOS program, is suggested due to the proposed increase in utilization of the site. It is recommended that future physical oceanography studies of sediment transport be carried out to determine if off-site transport may be a problem.

BUZZARDS BAY DISPOSAL SITE
BASELINE STUDY
MARCH 1990

1.0 INTRODUCTION

The Buzzards Bay Disposal Site (BBDS) is located in the northern half of the bay, 1.4 nautical miles from Chappaquiot Point, West Falmouth, MA. The site is a 500 yard diameter circle centered at 41° 36.000'N and 70° 41.000'W, lying within a slight depression between the 9m (30 ft) and 12m (40 ft) isobaths. Disposal records indicate that, since 1979, 92,000 cubic meters of dredged material have been deposited at the site. From February 1979 to January 1984, an average of 17,200 m^3 of material was deposited annually from small harbor and river channels throughout the Buzzards Bay region. The last substantial use of the site was in the fall of 1985, when the Massachusetts Maritime Academy disposed of 55,000 m^3 of material. Several projects recently have received permits to use the site, and 600 m^3 were disposed from a small project in the fall of 1989. Sediments disposed at BBDS have been relatively uncontaminated sands and sands containing some silt and clay (Table 1-1).

Monitoring activities at the site have not been conducted by the DAMOS program over the past several years, because the site has been used infrequently. The largest collection of site-specific data was gathered in 1981 by Germano et al. (1989), and regional data have been summarized in an earlier report (SAIC, 1989a).

A side-scan sonar and REMOTS® sediment-profile survey of the region was conducted in 1981 to characterize the historic disposal site with an area of 2.8 km^2. Five major textural regions were revealed: 1.) a deposit of coarse-grained material, 2.) a small wave field possibly consisting of large sand waves overlying silt-clay sediments, 3.) a cratered bottom, 4.) a rubble bottom, and 5.) two areas of flat bottom on the east and west sides of the disposal mound (Figure 1-1). The eastern and western flat bottoms have been interpreted to represent natural ambient bottom unaffected by disposal operations. In 1981, the disposal mound apex rose to within seven meters of the sea surface and apparently was the center of prior disposal operations. The disposal site surveyed in March 1990 was smaller (0.8 km^2) in area than the 1981 site and encompassed the wave field and portions of the rubble

field. The reference stations selected for the 1990 survey fall outside the area studied in 1981.

Tidal currents within the disposal site average 20 cm/sec or 0.4 knots (SAIC, 1989a). Complete tidal mixing of Bay water with ocean water is estimated to occur approximately every 10 days. Water temperatures in the Bay range from a summer maximum of 22°C to 0°C in winter. Salinity levels are essentially the same as those of Block Island and Vineyard Sounds, ranging from 29.5 to 32.5 ppt, due to a minimal amount of freshwater inflow (primarily groundwater seepage) (SAIC, 1989a).

From 27 to 29 March 1990, field operations were conducted at BBDS to provide information on the effects of past disposal operations. Field operations included a precision bathymetric survey, REMOTS® sediment profile photography, and sediment sampling for benthic, chemical, and physical analyses. The overall objective of the cruise was to characterize existing bathymetric, sediment grain size, sediment chemistry, and benthic conditions at and around the disposal site. Based on results of the 1981 survey, the disposal site was predicted to contain a low relief disposal mound, and the bottom sediment in and around the site was expected to be heterogeneous. The benthic community at the site was believed to consist of small pioneering polychaetes (Stage I) and larger burrowing deposit feeders (Stage III) as would be typical of a shallow fishery-rich embayment. Stage III was expected to predominate at most stations due to infrequent use of the disposal site. Stage III taxa represent high-order successional stages typically found in low disturbance regimes.

2.0 METHODS

2.1 Navigation and Bathymetry

The precise navigation required for all field operations was provided by the SAIC Integrated Navigation and Data Acquisition System (INDAS). A complete description of this system is provided in DAMOS contribution #48 (SAIC, 1985). Shore stations used in the 1990 field operations were established at the Falmouth fire tower (41° 35.876'N and 70° 37.093'W) and Wings Neck Lighthouse (41° 40.809'N and 70° 39.699'W).

Depth was determined to a resolution of 3.0 cm (0.1 feet) using an Odom DF3200 Echotrac® Survey Recorder with a narrow-beam 208 kHz transducer. The speed of sound was determined from the water temperature and salinity data measured by an Applied Microsystems CTD probe.

The bathymetric survey conducted on 27 March encompassed an 800 x 800 m grid centered around BBDS at coordinates 41°36.000'N and 70°41.000'W. Thirty-three lanes were run south to north at 25

m spacing. The objective of the survey was to map the existing bottom topography at and around the disposal site. The configuration provided adequate coverage to assess the distribution of dredged material deposited at the site. Raw depth values were corrected to Mean Low Water during analysis of the bathymetric data by adjusting for the ship draft, tidal changes during the survey, and the speed of sound.

2.2 REMOTS® Sediment-Profile Photography

REMOTS® photography was used to detect the distribution of thin (0-20 cm) dredged material layers, map benthic disturbance gradients, and monitor the status of infaunal recolonization on and adjacent to the mound. A detailed description of REMOTS® photo acquisition, analysis, and interpretative rationale is given in DAMOS Contribution #60 (SAIC, 1989b).

A REMOTS® survey was performed on 27, 28, and 29 March 1990. REMOTS® photos were taken, in triplicate, at each of 37 stations surrounding the disposal site center (Figure 2-1). In addition, 9 REMOTS® stations were occupied at each of the three reference areas to allow comparisons between ambient and on-mound conditions. The 9 stations at each reference area were arranged in a cross-shaped pattern and spaced 100 m apart. Reference areas were centered at 41° 36.30'N, 70° 43.20'W (reference area 1), 41° 35.35'N, 70° 43.70'W (reference area 2), and 41° 34.60'N, 70° 41.15'W (reference area 3). Distances from the disposal site center for the three areas were 3107 m NW, 3940 m W, and 2600 m SW. Depths for the three reference areas were 11 m for reference area 1, 12 m for reference area 2, and 14 m for reference area 3.

2.3 Benthic Sampling

Macrofaunal benthic community samples were taken on 28 and 29 March to ground-truth the REMOTS® photos and provide an indication of potential species for any future body burden analyses. A 0.1 m^2 Smith-McIntyre grab sampler was used to take samples at six stations in the disposal site (1, 13, 20, 22, 23, and 24; Figure 2-1) and at the center and 200 m W of each reference area (Figure 2-1). The samples were sieved on a 0.5 mm mesh screen, preserved in 10% formalin on board, transferred to 70% ethanol after 48 hours, and forwarded to the Cove Corporation laboratory for species identification and enumeration.

2.4 Sediment Sampling and Analysis

Sediment samples were collected at each of the benthic community stations to provide a baseline and to verify the nature of material deposited at the disposal site. Samples were obtained using a 0.1 m^2 Smith-McIntyre grab sampler. Four polycarbonate plastic core liners (6.5 cm ID) were pushed into each sediment grab sample and extracted; the top 10 cm of sediment from three of these

cores were combined and placed into bags for subsequent chemical analysis. The fourth sample was saved for physical analysis. The samples were kept cold (at approximately 4°C) and submitted to the NED laboratory. The parameters measured included sediment grain size, trace metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn), total organic carbon (TOC), polychlorinated biphenyls (PCBs), pesticides and polycyclic aromatic hydrocarbons (PAHs). Analytical methods were those of the U.S. Environmental Protection Agency (EPA, 1987).

3.0 RESULTS

3.1 Bathymetry

Depths in the area surveyed at Buzzards Bay Disposal Site ranged from 8.2-14.4 m (Figure 3-1). An 11.6 m contour separated the survey area into a northwest quadrant with depths ranging from 8.2 - 11.6 m and a southeast quadrant with depths up to 14.4 m.

In general, the disposal site consisted of small topographic elevations. The REMOTS® survey, taken in conjunction with the bathymetric survey, assisted in determining the nature of these elevations, i.e., whether they were natural or man-made. Three mounds were included in both the bathymetric and REMOTS® surveys: 1.) a center mound, 1.2 m high and approximately 60 m wide, 2.) a mound to the southwest, 1.6 m in height and about 90 m in diameter, and 3.) a mound, west and north of center, 1.2 m in height and 100 m in diameter. All three mounds exhibited a steeper slope to the southeast.

3.2 REMOTS® Sediment-Profile Photography

3.2.1 Major modal grain size and boundary roughness

The major modal grain size over the surveyed area ranged from medium sand (2-1 phi) to silt-clay (≥4 phi) (Figure 3-2). The coarsest sediments, consisting of patches of fine to medium sands intermixed with some silt-clay, were located at reference area 1 and at the REMOTS® stations located in the northwest quadrant of the surveyed area (Figure 3-3). The finest sediments were located in the southeast quadrant of the disposal site, reference area 2, and reference area 3 (Figure 3-4). This transition occurred along the 11.6 m isobath.

All stations containing a major mode of medium (2-1 phi) and fine sand (3-2 phi) fractions were rippled (Figure 3-5). Several stations showed the superposition of sand over mud, suggesting that the net sediment transport in this region was from the northwest (sand source) to the southeast (mud area). This was particularly apparent in reference area 2 (Figure 3-6). While this statement generally holds true for the mapped area, individual stations showed evidence of stratigraphy related to disposal events

rather than lateral transport. For example, Station 19 had a surface layer of mud over sand apparently related to the presence of dredged material (Figure 3-7). Sand over mud at stations 17 and 32 may also be related to disposal events (Figure 3-8; see section 3.4 below). The disposal site center (station 1) consisted of rippled bedforms and fine sands which limited penetration by the REMOTS® camera (Figure 3-5).

The small-scale boundary roughness frequency distribution for the disposal site showed a major mode at 1.0-1.4 cm (class 3) with values as high as 2.6-3.0 cm (class 7; Figure 3-9). The mean was 1.10 ± 0.56 cm (n=100). The origin of this roughness was related largely to the presence of rippled bedforms in the sandy facies and biogenic (bioturbational) features in the mud facies. On dredged material, small-scale boundary roughness can also be related to the presence of gravel deposited at the site.

The boundary roughness frequency distribution for the reference stations indicated a major mode at 0.6-1.0 cm (class 2), and a mean of 0.80 ±0.43 cm (n=27; Figure 3-10). Boundary roughness values at the disposal site were significantly greater than the reference areas ($p<0.05$, Mann-Whitney test). Reference areas were located in areas with a lower kinetic energy regime (i.e., fewer bedforms) and lacked dredged material.

3.2.2 Distribution of Dredged Material

The "footprint" of past disposal at the Buzzards Bay site was determined primarily from REMOTS® photos; the presence of dredged material was indicated by chaotic sedimentary fabrics and anomalous grain size distributions at the site (Figure 3-11). The bathymetric survey showed a 60 m wide mound at the center of the site with a height of 1.2 m. The distribution of dredged material, as deduced from REMOTS® photographs, extended well beyond this mound. Dredged material extended at least 100 meters west and 200 meters east of the mound apex. Most of the area occupied by disposed material was located south of the mound apex (to at least 200 meters south). Station 28, located 200 meters south and west of the mound, was apparently located on a second 1.6 meter-high mound of dredged material.

3.2.3 Mean Apparent RPD Depth Distributions

Steep spatial gradients existed between the disposal site, where most RPD values fell between 2 and 4 cm, and the three reference areas, where most values were greater than 4 cm (Figure 3-12). The mean apparent RPD depths for the reference areas were significantly greater than those for the disposal site ($p<0.05$, Mann-Whitney, Figure 3-13). The mean value for reference stations was 5.7 ± 2.14 cm while the mean apparent RPD depth distribution for the disposal site was 3.43 ± 1.25 cm.

Discrimination of mean apparent RPD depths was particularly difficult in this March survey. Most photos showed that the near-surface region of the sediment profile had a lower optical reflectance than at depth (Figure 3-14). Our experience has shown that late winter to early spring sediment profiles have this transient feature related to the recent sedimentation of labile (reactive) planktonic detritus. The spring plankton bloom takes place in this period with sedimentation of eaten or senescent cells. The decay of this material on the bottom lowers the optical reflectance of the near-surface layers of sediment. To avoid this difficulty in the future, surveys should be scheduled for the summer period.

3.2.4 Infaunal Successional Stages

The spatial distribution of infaunal successional seres at the reference stations, as inferred from REMOTS® photos, showed a high frequency of well-developed Stage III seres (Figure 3-15). Toward the center of the disposal site sampling grid, station replicate photographs showed patchy mixtures within a station; some pictures contained evidence of Stage III infauna while others showed only Stage I seres. This type of patchiness is typical of relatively thin-flank deposits where past disposal has resulted in small spatial differences in mortality of Stage III residents. Within-station patchiness also may be related to small-scale differences in recruitment success of Stage III taxa. The cause of this patchiness is due either to minimal impacts at localized regions or to sufficient time for infaunal recovery coupled with a lack of recent disturbance.

Stations located at the center of the disposal site and north and west of the center apparently are dominated by Stage I seres. Notable exceptions are Station 21, located on relict dredged material, and Station 8, located on the ambient bottom.

3.2.5 Organism-Sediment Indices

Past mapping experience has shown that OSI values less than +6 indicate bottom disturbance by either chemical or physical means. Only those stations with mean OSI values $\leq$ +6 were contoured and include stations 14, 18, 19, 20, 25, 26, 11, and 34 (Figure 3-16). With the exception of Station 11, all of these stations were located on dredged material. The first six stations were located around the center of the disposal site. The three reference areas all had uniformly high OSI values, typical of undisturbed bottoms.

The OSI frequency distribution for the disposal site shows a distinctly bimodal distribution with a mode at +5 and another at +11 (Figure 3-17). Some disposal site stations were located on dredged material (+5 values) while others were located on the ambient bottom (+11 values). The reference areas (combined)

have uniformly high OSI values of +11 and were significantly greater than disposal site stations ($p<0.05$, Mann-Whitney).

3.3 Benthic Sampling

A total of 148 taxa were found in the benthic samples taken at stations 1, 13, 20, 22, 23, and 24 from the disposal site and from the reference stations R1, R2, and R3. The largest number of taxa (67, 45 % of the total fauna) were polychaetes, followed by molluscs (35 taxa, 24 %) and crustaceans (29 taxa, 20 %). Other major taxonomic groups, such as cnidarians, nemerteans, echinoderms, and tunicates, contributed only small percentages to the total fauna.

The total number of species was between 40 and 65 per station at the disposal site and between 45 and 71 per station at the reference areas. Densities were between 4,800 and 9,800 individuals per m^2 on the disposal mound, with the lowest density found at station 1 and the highest density found at station 22. Densities at the reference stations ranged from 5,100 to 9,400 individuals per m^2. The top 10 species by station were defined by only 25 of the 148 taxa constituting the total fauna (Table 3-1). The polychaete Mediomastus ambiseta ranked first at all disposal site stations and the reference station R1; at reference stations R2 and R3, it ranked second and third, respectively. Another polychaete, Ninoe nigripes, was also found at all stations, ranking between 2 and 9. Other taxa present at all disposal mound stations, but not all reference stations, were Oligochaeta and the nemertean Tubulanus pellucidus.

Stations 1, 20, 22, 24, and R1 clearly were dominated by Mediomastus ambiseta; the species contributed between 30 and 44 percent of the total number of individuals. Other top ranked organisms were Oligochaeta (stations 1, 20, 24, and R1), the polychaete Aricidea catherinae (stations 24 and R1), Ascidiacea (stations 1 and 20), the nemertean Tubulanus pellucidus (station 22), and the mollusc Cylichnella bidentata (station 22). Stations 23 and 13 were characterized by the polychaetes Mediomastus ambiseta, Aricidea catherinae, Ninoe nigripes (station 23), and Spiophanes bombyx (station 13) in the highest ranks, with Mediomastus contributing only about 20 percent of the total number of individuals. The reference stations R2 and R3 differed somewhat from the other stations sampled for this program. At station R2, relatively high numbers of Ascidiacea were found, together with the polychaetes Cirrophorus furcatus, Mediomastus ambiseta, and Ninoe nigripes, each contributing 11 to 16 percent of the total number of individuals. Station R3 was characterized by two molluscs (Cylichnella bidentata and Nucula proxima) in high ranking positions (1 and 3 out of the top 10) and only one polychaete (Mediomastus) which ranked 2 out of the top 10.

The similarity of the stations in terms of their benthic infauna can be estimated roughly by assessing the number of dominant species shared between each possible couplet of stations. Out of the 10 top dominants, about 7 taxa (6-9) were shared between all disposal mound couplets, whereas only 2 to 5 species were shared between reference station couplets. Comparison between the mound and reference stations shows that 7 to 8 species were shared between stations R1 and each mound station (except station 22 with only 4 species shared); 6 species were shared between stations R2 and each mound station, but only 4 species were shared between stations R3 and each mound station (except for station 22 with 6 species shared).

The total number of taxa and individuals per benthic sampling station at BBDS is provided in Appendix A, and a comprehensive list of macrobenthic invertebrates collected from BBDS is provided in Appendix B. Two species are suggested for future body burden analysis, Ninoe nigripes and Nephtys incisa. Both of these species are sufficient in number and size to allow for collection, concentration, and subsequent clean preservation (freezing). Mediomastus ambiseta and the remaining species in the dominance lists are small and do not lend themselves readily to collection procedures.

3.4 Sediment Analysis

3.4.1 Grain Size Analysis

Physical and chemical parameters were developed in 1980 by the New England River Basin Commission (NERBC) to assist in interpreting the nature of dredged material. NERBC classifications were used for interpretation of percent fines (percent silt and clay) and in the following section on sediment chemistry for interpretation of metals, pesticides, and PCB results.

The distribution of sediment grain size (Table 3-2 and Figure 3-18) corresponds with that mapped from REMOTS® photos (see Figure 3-2). Major modal grain size over the surveyed area ranged from medium sand (2-1 phi) to silt-clay (≥4 phi). The percent silt and clay for the disposal site stations and reference areas 1 and 2 fell into the NERBC Class 1 (< 60%) category. Reference area 3 contained a Class II (60-90%) level of silt and clay.

Fine sands (4-2 phi) dominated over medium sands (2-1 phi) for all stations tested, except at the center of reference area 1, where the percent of fine and medium sands was equal at 44%. Results for reference station 1-200W and reference station 3-200W also demonstrated a fairly even distribution between medium and fine sands. Percentages of medium sands were, however, much lower for reference area 3. Station 1 center and station 20 contained the highest percentages of sands, 94% and 97%, respectively.

3.4.2 Sediment Chemistry

The sediment collected at BBDS contained low NERBC concentrations of As, Cd, Cr, Cu, Pb, Hg, Ni, and Zn (Table 3-3). Metal concentrations tended to be higher in stations containing greater percentages of clay and total organic carbon (Table 3-4), namely reference area 3, center and 200W, followed by stations 23, 22, 24 and 13. Stations 1, the disposal site center, and 20 had the lowest concentrations of metals.

The pesticides tested belong to the group of organochlorines and fall within the general classification of chlorinated hydrocarbons (Table 3-5). Pesticide levels at BBDS were very close to or below method blank values for all compounds tested. Concentrations of all pesticides were slightly higher at reference area 3 and station 13. Levels of DDT and dieldrin were well below the high (NERBC) concentrations of >0.2 ppm and 0.1 ppm, respectively. Concentrations of PCBs were below 0.5 ppm and met the NERBC low limit of <0.5 ppm.

The majority of high molecular weight PAHs were low in comparison to concentrations measured for highly contaminated estuarine sediments such as those at New Bedford Harbor (Table 3-6; Pruell et al., 1990). No method blank results were reported for this analysis, and NERBC criteria do not exist for PAHs. Detection limits were higher for the lower molecular weight compounds napthalene, acenaphthylene, and acenaphthene. Low concentrations of the following higher molecular weight PAHs were detected at reference area 3: phenanthrene, flouranthene, benzo(b)-flouranthene, and benzo(a)pyrene. Pyrene was found in low levels at stations 24, 13, and 20.

4.0 DISCUSSION

4.1 Bathymetry

Based on results from the bathymetric survey and REMOTS® photographs, two mounds were determined to originate from disposal activity: the center mound, 1.2 m high and approximately 60 m wide, and a 1.6 m high mound about 90 m in diameter to the southwest.

4.2 REMOTS® Sediment-Profile Photography

The distribution of the major modal grain size over the surveyed area, as deduced from REMOTS® photographs, indicated a net bedload sediment transport of fine-grained material to the southeast. Stations containing a major mode of medium (2-1 phi) and fine sand (3-2 phi) fractions were rippled, and the superposition of sand over mud at stations not located on dredged material suggests that the net bedload transport of fine-grained material was from the north and west (source area) toward the

south. The overall grain size distribution generally corresponds to that mapped at this site in a combined side-scan and REMOTS® survey in 1981 (Germano et al., 1989). Further physical oceanographic studies of sediment transport within the BBDS are recommended to determine if off-site transport of disposed material may be a problem.

The topographic apex of the central mound was a small (60 m wide) feature with flank deposits located south of the mound. Dredged material deposits extended to 200 m east and 100 m west of the mound apex.

The thin nature of the mean apparent RPD depths on the mound apex and at stations 2, 3, and 16 probably were related to natural disturbance in this area (sediment transport as manifested by rippled sands). Deep bioturbators (Stage III taxa) were not observed in areas north and west of the grid center. Depth of the RPD is controlled largely by the depth of bioturbation, and the absence of Stage III seres in these areas supports this inference.

The distribution of Stage I seres around the disposal site center and to the northwest apparently was related to the disturbance of the bottom by dredged material and/or bedload transport of sand. The balance of stations showed within-station patchiness, with some replicates showing the presence of Stage III seres and others only Stage I seres. The photographs from all 3 reference areas contained evidence of Stage III infauna. These results are similar to those found in the 1981 survey; the "Rubble Field" was populated by Stage I organisms, and the "Wave Field", to the south and east of the disposal site center, was populated by Stage I, I-II, and III infauna (Figure 1-1; Germano et al., 1989).

The overall distribution of Organism-Sediment Indices shows that all reference areas represented undisturbed benthic habitats with mature successional assemblages. Areas where OSI values were <+6 were concentrated on the mound apex with the exception of stations 11 and 34. OSI values were not calculated for stations in the 1981 survey, so a comparison cannot be made for this parameter.

This REMOTS® data set showed significant statistical differences in the distributions of mean apparent RPD depths, successional stages, and OSI values between the disposal site and the three reference areas. This data set should allow for detection of change in future surveys for both reference and disposal site stations.

4.3 Benthic Communities

The species composition found in this study was similar to that of benthic communities in Cape Cod Bay (Battelle, 1987) and Boston Harbor/ Massachusetts Bay (Blake et al., 1987, 1989).

However, there were some differences with respect to the dominant species. With a few exceptions, the stations studied here were characterized by high relative abundances of the polychaete Mediomastus ambiseta, followed by the less abundant polychaete Aricidea catherinae, oligochaetes, ascidians, and occasionally the polychaete Spiophanes bombyx. High abundances of Mediomastus are also found in Cape Cod Bay but are unusual for Massachusetts Bay where spionids and Aricidea predominate, although Mediomastus is generally present. Mediomastus is an opportunist, and its occurrence on the disposal mound may suggest that the community is stressed by disturbance or organic enrichment; however, due to the relatively unpolluted condition of the disposal site this is unlikely. It is possible that a Mediomastus-dominated community is a natural phenomenon in Buzzards Bay as it is in Cape Cod Bay. Results of the REMOTS® survey indicated a Stage I community at the disposal site. The reference station R1 had a very similar infaunal community even though the station was clearly away from the disposal site. The benthic community at reference area 1 consisted of Stage I, Stage III, and Stage I on Stage III taxa (Figure 3-15).

Species richness was slightly higher at the reference stations than at the disposal site stations, but both groups of stations were well within the range usually observed in soft-bottom shallow-water environments (see Blake et al., 1987 for Massachusetts Bay data). Total densities were similar at the disposal mound and reference stations; in comparison to other adjacent areas, such as Massachusetts Bay, the densities found in Buzzards Bay were relatively low. This may be in part a seasonal effect, because the samples were taken in March when juveniles were either not yet present or were still too small to be retained on 0.5 mm mesh screen. Detailed information on the relative abundances of juveniles in 0.5 mm and 0.3 mm fractions of the same sample can be found in Blake et al., (1987).

The assessment of the number of dominant species shared among stations revealed that the disposal site stations were very similar. Only station 22 differed somewhat, due to the presence of molluscs and nemerteans, rather than polychaetes and oligochaetes, among the highest ranked species. Reference stations differed more from each other than the disposal site stations. This was especially true of reference area 3, where the top ranks were occupied by molluscs rather than polychaetes (except for Mediomastus). Reference area 1 was most similar to the disposal site stations, followed by reference areas 2 and 3. A relatively high similarity existed between reference area 3 and station 22. The very different character of reference area 3 is also documented in the great difference in the mean apparent RPD depth in this location as compared to the other reference areas (Figure 3-12). Results of the benthic grab analyses correlate well with results obtained from REMOTS® for infaunal successional stages, OSI, and RPD depths.

4.4 Sediment Chemistry and Grain Size

Results of the sediment grain size analysis demonstrate a major mode of fine sand (4-2 phi) throughout most of the area. Reference area 3 contained a Class II (NERBC) level of fines (>4 phi). The distribution of material corresponded with results obtained in the REMOTS® survey and supported the interpretation of an apparent transport of fine-grained materials to the southeast.

Sediment chemistry results indicated low levels of metals, pesticides, PCBs, and PAHs. Distribution of these materials was highest on stations containing greater amounts of clay and organic matter (% TOC) and lowest on those containing more than 90% sands (stations 1 and 20). The affinity for these pollutants to the colloidal material in sediment is well documented (Pequegnat et al., 1990).

The levels of PAHs found were low in comparison with levels detected near the Fox Point area of Narragansett Bay (Pruell et al., 1985). Near the Fox Point area, levels of total PAHs were found in the 2-3 ppm range while, in contrast, New Bedford Harbor contained high-molecular PAH concentrations that were at least 2-3 times higher than those at Fox Point (Pruell et al., 1990). Narragansett Bay is considered to be a relatively unpolluted urban estuary while New Bedford Harbor is a highly contaminated estuary (Pruell et al., 1985, 1990).

5.0 CONCLUSIONS

The information obtained from the bathymetric survey and REMOTS® photos permitted the detection of two disposal mounds within the surveyed area. The primary mound was central to the disposal site, 1.2 m high and 60 m wide. The other, south and west of the center mound, was 1.6 m high and approximately 90 m wide. Currents are most likely the dominant force contributing to a bedload transport of fine-grained material from the northwest to the southeast.

The sediment grain size analysis was in agreement with results obtained in the REMOTS® survey, and both sets of results corresponded with the major mode distribution found in the 1981 survey. Sediment chemistry results indicated low levels of pollutants.

Although species richness was somewhat higher at the reference stations, both on-site and off-site stations were well within the range observed in soft-bottom, shallow-water environments. Significant differences existed between reference stations and on-site stations in REMOTS® parameters for RPD depth, successional stages, and OSI values. Currently, the surveyed area is healthy biologically and relatively uncontaminated. Based on

the type of materials previously disposed (relatively uncontaminated sands and sands with some silt and clay), the low use of the site, and the rapid rate of recovery displayed by benthic organisms in general, these conditions are expected. Further monitoring of the site, through the DAMOS program, is suggested if increase in utilization of the site occurs. It is recommended that future physical oceanographic studies of off-site sediment transport be conducted if sediments requiring high levels of containment are proposed for disposal.

6.0 REFERENCES

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Table 1-1. Grain size analysis of dredged material disposed of at BBDS from 5/85 - 4/90.

Source/ Sample #	Date Sampled	% Coarse Material 1- -1Ø	% Medium Sand 2-1Ø	% Fine Sand 4-2Ø	% Medium & Fine Sands 4-1Ø	% Silt	% Clay	%Fines (Silt & Clay) >4Ø	Sample Depth
Mass. Maritime Academy									
B-S4-1	5/20/85	3	15	65	80			17	0-2'
B-S4-2A	5/20/85	2	19	63	82			16	3'-6'
B-S4-3	5/20/85	11	26	55	81			8	6'-8'
B-S1-1	5/21/85	42	33	24	57			1	0-2'
B-S1-5	5/21/85	24	23	31	54			21	12'-15'
B-S2-1	5/22/85	22	20	34	54			24	0-3'
B-S2-3	5/22/85	34	25	27	52			14	6-8'
B-S2-4	5/22/85	19	32	36	68			14	8-11'
B-S3-2	5/22/85	4	24	68	92			4	3'-6'
B-S3-6	5/22/85	21	40	35	75			4	13'-16'
B-S5-1	5/23/85	17	33	48	81			2	0-3'
B-S5-8	5/23/85	34	32	32	64			2	18'-21'
S6	6/17/85	5	40	54	94			<1	±0-1'
S7	6/17/85	3	32	65	97			<1	±0-1'
Allen's Harbor Yacht Club	6/9/87 - 7/22/88	12			84	3	1	4	--
		6			86	5	3	8	--
		2			92	4	2	6	--
		3			94	2	1	3	--
Woods Hole, M. Vineyard, Nantucket Steam-Ship Authority	7/21/87 - 4/6/90				69				--
					98				--
					98.				--

Table 3-1
Top 10 Dominant Species for the Benthic Sampling Locations at BBDS, March 1990.

STATION 1 - Total Individuals, 486

TAXA	REP 1	MEAN
Mediomastus ambiseta	208	208.0
Oligochaeta	63	63.0
Ascidiacea sp. (indeterminate)	43	43.0
Ninoe nigripes	26	26.0
Tubulanus pellucidus	23	23.0
Cylichnella bidentata	18	18.0
Aricidea (Acmira) catherinae	17	17.0
Cirrophorus furcatus	16	16.0
Turbonilla sp. (indeterminate)	16	16.0
Natica pusilla	10	10.0

STATION 13 - Total Individuals, 597

TAXA	REP 1	MEAN
Mediomastus ambiseta	130	130.0
Aricidea (Acmira) catherinae	76	76.0
Spiophanes bombyx	45	45.0
Cirrophorus furcatus	37	37.0
Tubulanus pellucidus	30	30.0
Oligochaeta	25	25.0
Ninoe nigripes	24	24.0
Ampelisca sp. (indeterminate)	24	24.0
Glycera sp. (indeterminate)	21	21.0
Ascidiacea sp. (indeterminate)	19	19.0

STATION 20 - Total Individuals, 694

TAXA	REP 1	MEAN
Mediomastus ambiseta	205	205.0
Oligochaeta	54	54.0
Ascidiacea sp. (indeterminate)	54	54.0
Cirrophorus furcatus	36	36.0
Ninoe nigripes	35	35.0
Cylichnella bidentata	27	27.0
Tubulanus pellucidus	26	26.0
Aricidea (Acmira) catherinae	23	23.0
Spiophanes bombyx	16	16.0
Cnemidocarpa mollis	16	16.0

Table 3-1, continued
Top 10 Dominant Species for the Benthic Sampling Locations at BBDS, March 1990

STATION 22 - Total Individuals, 985

TAXA	REP 1	MEAN
Mediomastus ambiseta	430	430.0
Cylichnella bidentata	95	95.0
Tubulanus pellucidus	67	67.0
Scolelepis (P.) bousfieldi	51	51.0
Oligochaeta	38	38.0
Ascidiacea sp. (indeterminate)	37	37.0
Ninoe nigripes	31	31.0
Cirrophorus furcatus	26	26.0
Prionospio (M.) perkinsi	24	24.0
Acteocina canaliculata	19	19.0

STATION 23 - Total Individuals, 541

TAXA	REP 1	MEAN
Mediomastus ambiseta	101	101.0
Ninoe nigripes	51	51.0
Aricidea (Acmira) catherinae	43	43.0
Ampelisca sp. (indeterminate)	31	31.0
Tubulanus pellucidus	30	30.0
Cirrophorus furcatus	29	29.0
Oligochaeta	29	29.0
Cirratulidae sp. (indeterminate)	27	27.0
Cylichnella bidentata	25	25.0
Scolelepis (p.) bousfieldi	20	20.0

STATION 24 - Total Individuals, 604

TAXA	REP 1	MEAN
Mediomastus ambiseta	235	235.0
Oligochaeta	73	73.0
Aricidea (Acmira) catherinae	50	50.0
Ninoe nigripes	46	46.0
Ascidiacea sp. (indeterminate)	41	41.0
Cirrophorus furcatus	32	32.0
Tubulanus pellucidus	26	26.0
Nephtys incisa	9	9.0
Spiophanes bombyx	8	8.0
Ampelisca sp. (indeterminate)	8	8.0

Table 3-1, continued
Top 10 Dominant Species for the Benthic Sampling Locations at BBDS, March 1990

STATION R1 - Mean Total Individuals, 662.5

TAXA	REP 1	REP 2	MEAN
Mediomastus ambiseta	298	93	195.5
Aricidea (Acmira) catherinae	24	105	64.5
Oligochaeta	56	52	54.0
Byblis serrata	2	98	50.0
Cirratulidae sp. (indeter.)	74	16	45.0
Tubulanus pellucidus	32	12	22.0
Cirrophorus furcatus	21	23	22.0
Ninoe nigripes	33	10	21.5
Ampelisca sp. (indeterminate)	27	12	19.5
Spiophanes bombyx	5	25	15.0

STATION R2 - Mean Total Individuals, 788.5

TAXA	REP 1	REP 2	MEAN
Ascidiacea sp. (indeterminate)	96	154	125.0
Cirrophorus furcatus	75	128	101.5
Mediomastus ambiseta	101	84	92.5
Ninoe nigripes	74	97	85.5
Cnemidocarpa mollis	32	39	35.5
Cirratulidae sp. (indeterminate)	33	32	32.5
Tharyx dorsobranchialis	22	32	27.0
Oligochaeta	35	14	24.5
Leptocheirus pinguis	17	32	24.5
Aricidea (Acmira) catherinae	36	6	21.0

STATION R3 - Mean Total Individuals, 727.0

TAXA	REP 1	REP 2	MEAN
Cylichnella bidentata	135	196	165.5
Mediomastus ambiseta	60	150	105.0
Nucula proxima	62	57	59.5
Tubulanus pellucidus	50	54	52.0
Scolelepis (P.) bousfieldi	30	70	50.0
Nephtys incisa	40	53	46.5
Turbonilla interrupta	8	61	34.5
Pitar morrhuanus	11	52	31.5
Ninoe nigripes	23	28	25.5
Prionospio (M.) perkinsi	1	21	11.0

Table 3-2
Results of Sediment Grain Size Analysis for Buzzards Bay Disposal Site, March, 1990

Station ID	Sample Description	% Coarse Material 1- -1 Ø	% Medium Sands 2 -1 Ø	% Fine Sands 4 -2 Ø	% Silt Clay >4 Ø
Reference 1 Center	Gray, poorly graded sand with clay	4	44	44	8
Reference 1 200W	Medium to dark gray, clayey sand	2	40	46	12
Reference 2 Center	Gray, poorly graded sand with clay	<1	23	56	11
Reference 2 200W	Medium to dark gray, clayey sand	<1	15	72	13
Reference 3 Center	Medium to dark gray sandy, lean clay	<1	10	23	67
Reference 3 200W	Medium to dark gray sandy, lean clay	2	13	15	70
Station 1 Center	Gray, poorly graded sand with clay	<1	32	62	6
Station 13	Light to medium gray,silty sand	<1	9	72	19
Station 20	Light to medium poorly graded sand	<1	22	75	3
Station 22	Medium to dark gray, clayey sand	8	22	48	22
Station 23	Medium to dark gray, clayey sand	<1	20	53	27
Station 24	Medium to dark gray, clayey sand	<1	10	71	19

Table 3-3: Results of metals (ppm), TOC (%), and PCBs (ppb) in sediments collected at BBDS, March 1990 (Concentrations based on dry weight.)

Parameter	NERBC Low Limits	Method Blank	Ref. 1 Ctr.	Ref. 1 200 W	Ref. 2 Ctr.	Ref. 2 200 W	Ref. 3 Ctr.	Ref. 3 200 W	Station 24	Station 1 Ctr.	Station 13	Station 20	Station 22	Station 23
Arsenic	<10	<2.0	1.9	2.1	2.4	2.2	6.3	7.3	2.1	1.1	2.3	1.1	2.8	3.8
Cadmium	<3	<0.74	0.71	<0.66	<0.70	<0.93	<0.93	<1.1	<0.71	0.76	<0.76	<0.68	<0.74	<0.83
Chromium	<100	<1.5	8.2	9	9.8	7.4	26	38	12	5.3	11	3	14	21
Copper	<200	<3.7	2.5	2.6	3.3	2.7	10	14	5.1	2.2	4	1.9	5.8	8.6
Lead	<100	<0.60	5.6	6.1	7.4	6	20	28	11	3.8	8	2.9	12	17
Mercury	<0.5	<0.037	<0.045	<0.046	<0.046	<0.051	<0.066	<0.079	<0.053	<0.048	<0.054	<0.046	<0.053	<0.060
Nickel	<50	<5.9	3.7	3.5	4.4	5.8	12	16	6.3	3.2	5.1	4.2	8.1	9.7
Zinc	<200	<3.0	15	15	14	11	50	66	25	7	15	1.5	31	39
TOC (%)	--	<0.01	0.15	0.2	0.18	0.18	0.57	0.59	0.27	0.09	0.24	0.1	0.38	0.45
Total PCBs	<500	<40 <80*	<78	<91	<97	<75	<106	<119	-- <77*	<75	<103	<82	<87	<119

* Station 24 was re-analyzed for PCBs.

Table 3-4: Percentages of Clay and Total Organic Carbon (TOC) for Buzzards Bay Disposal Site March, 1990

Station ID	% Clay	% TOC
Reference 1 Center	6.4	0.15
Reference 1 200W	9.3	0.20
Reference 2 Center	9.1	0.18
Reference 2 200W	8.8	0.18
Reference 3 Center	46.5	0.57
Reference 3 200W	50.4	0.59
Station 1 Center	6.2	0.09
Station 13	8.1	0.24
Station 20	2.3	0.10
Station 22	15.5	0.38
Station 23	18.3	0.45
Station 24	11.1	0.27

- Results of clay percentages are from hydrometer analysis data.

Table 3-5: Results of pesticides (ppb) in sediment collected at BBDS, March 1990
(Concentrations based on dry weight.)

Parameter	Method Blank	Ref. 1 Ctr.	Ref. 1 200 W	Ref. 2 Ctr.	Ref. 2 200 W	Ref. 3 Ctr.	Ref. 3 200 W	Station 24	Station 1 Ctr.	Station 13	Station 20	Station 22	Station 23
Alpha-BHC	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Gamma-BHC (Lindane)	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Beta-BHC	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Heptachlor	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Delta-BHC	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Aldrin	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Heptachlor epoxide	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
Endosulfan I	<8.0	<7.8	<9.1	<9.7	<7.5	<10.6	<11.9	<9.9	<7.5	<10.3	<8.2	<8.7	<8.10
4,4'-DDE	<16.0	<15.6	<18.3	<19.4	<15.0	<21.2	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
Dieldrin	<16.0	<15.6	<18.3	<19.4	<15.0	<21.2	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
Endrin	<16.0	<15.6	<18.3	<19.4	<15.0	<21.2	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
4,4'-DDD	<16.0	<15.6	<18.3	<19.4	<15.0	<21.2	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
Endosulfan II	<16.0	<15.6	<18.3	<19.4	<15.0	<21.2	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
4,4'-DDT	<16.0	16.0	18.9	20.6	16.1	23.3	28.3	<19.8	<15.0	20.6	16.3	18.4	<16.21
Endrin aldehyde	<16.0	<15.6	<18.3	<19.4	<15.0	<21.2	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
Endosulfan sulfate	<16.0	<15.6	<18.3	<19.4	<15.0	21.4	<23.8	<19.8	<15.0	<20.6	<16.3	<17.3	<16.21
Methoxychlor	<80.0	<78.1	<1.3	<97.0	<75.1	<105.9	<119.1	<99.2	<75.1	<103.2	<81.5	<86.6	<81.04

Table 3-6: Results of PAHs (mg/kg) in sediment collected at BBDS, March 1990 (Concentrations based on dry weight.)

Parameter	Ref. 1 Ctr.	Ref. 1 200 W	Ref. 2 Ctr.	Ref. 2 200 W	Ref. 3 Ctr.	Ref. 3 200 W	Station 24	Station 1 Ctr.	Station 13	Station 20	Station 22	Station 23
Napthalene	<0.40	<0.40	<0.34	<0.37	<0.64	<0.63	<0.43	<0.39	<0.50	<0.40	<0.45	<0.51
Acenaphthylene	<0.80	<0.80	<0.69	<0.73	<1.27	<1.26	<0.87	<0.79	<1.00	<0.79	<0.90	<1.01
Acenaphthene	<0.40	<0.40	<0.34	<0.37	<0.64	<0.63	<0.43	<0.39	<0.50	<0.40	<0.45	<0.51
Flourene	<0.08	<0.08	<0.07	<0.07	<0.13	<0.13	<0.09	<0.08	<0.10	<0.08	<0.09	<0.10
Phenanthrene	<0.04	<0.04	<0.03	<0.04	<0.06	0.20	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Anthracene	<0.04	<0.04	<0.03	<0.04	<0.06	<0.06	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Fluoranthene	<0.08	<0.08	<0.07	<0.07	<0.13	0.40	<0.09	<0.08	<0.10	<0.08	<0.09	<0.10
Pyrene	<0.04	<0.04	<0.03	<0.04	<0.06	<0.06	0.10	<0.04	0.20	0.20	<0.05	<0.05
Benzo(a)anthracene	<0.04	<0.04	<0.03	<0.04	<0.06	<0.06	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Chrysene	<0.04	<0.04	<0.03	<0.04	<0.06	<0.06	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Benzo(k)-fluoranthene	<0.04	<0.04	<0.03	<0.04	<0.06	<0.06	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Benzo(b)-fluoranthene	<0.08	<0.08	<0.07	<0.07	0.30	0.30	<0.09	<0.08	<0.10	<0.08	<0.09	<0.10
Benzo(a)pyrene	<0.04	<0.04	<0.03	<0.04	0.20	0.20	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Indeno(1,2,3-cd)-pyrene	<0.04	<0.04	<0.03	<0.04	<0.06	<0.06	<0.04	<0.04	<0.05	<0.04	<0.05	<0.05
Dibenzo(a,h)-anthracene	<0.08	<0.08	<0.07	<0.07	<0.13	<0.13	<0.09	<0.08	<0.10	<0.08	<0.09	<0.10
Benzo(g,h,i)-perylene	<0.08	<0.08	<0.07	<0.07	<0.13	<0.13	<0.09	<0.08	<0.10	<0.08	<0.09	<0.10

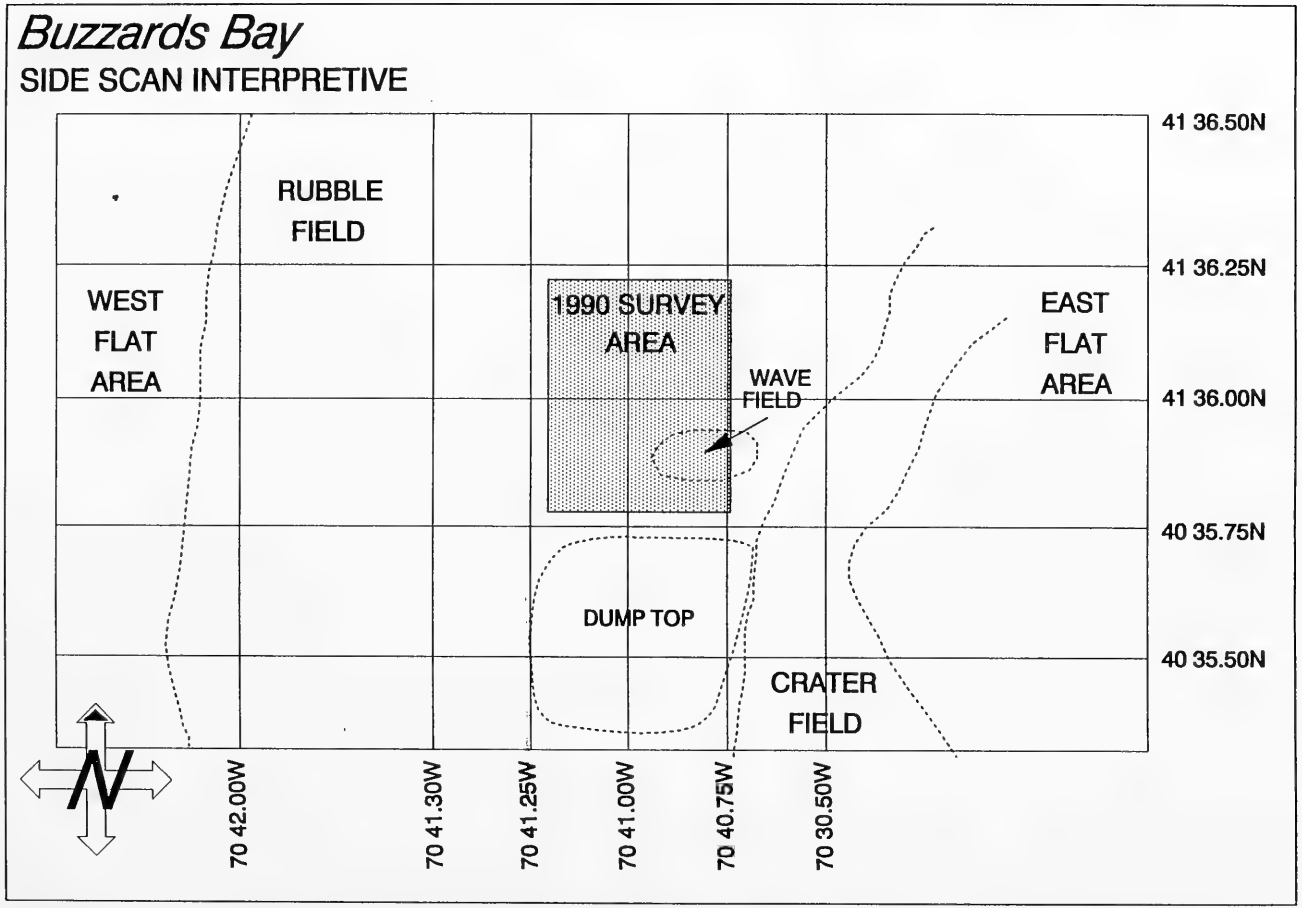


Figure 1-1. Results of side-scan interpretation of the BBDS in 1981 (from Germano et al., 1989). The surveyed area was 2.8 km² in 1981 compared with 0.8 km² in the March 1990 survey.

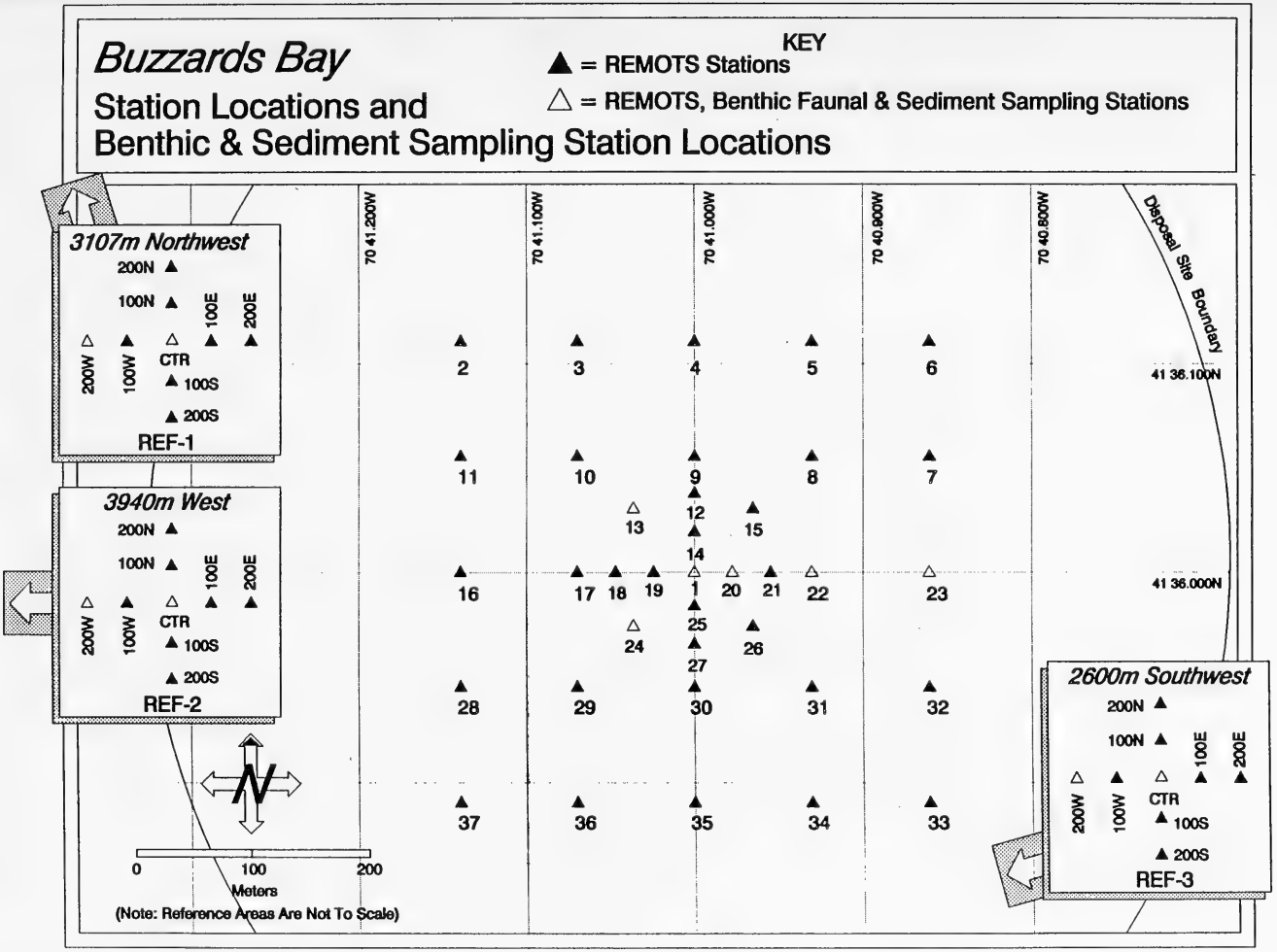


Figure 2-1. REMOTS® station locations and sampling locations for benthic and sediment analyses at the BBDS, March 1990.

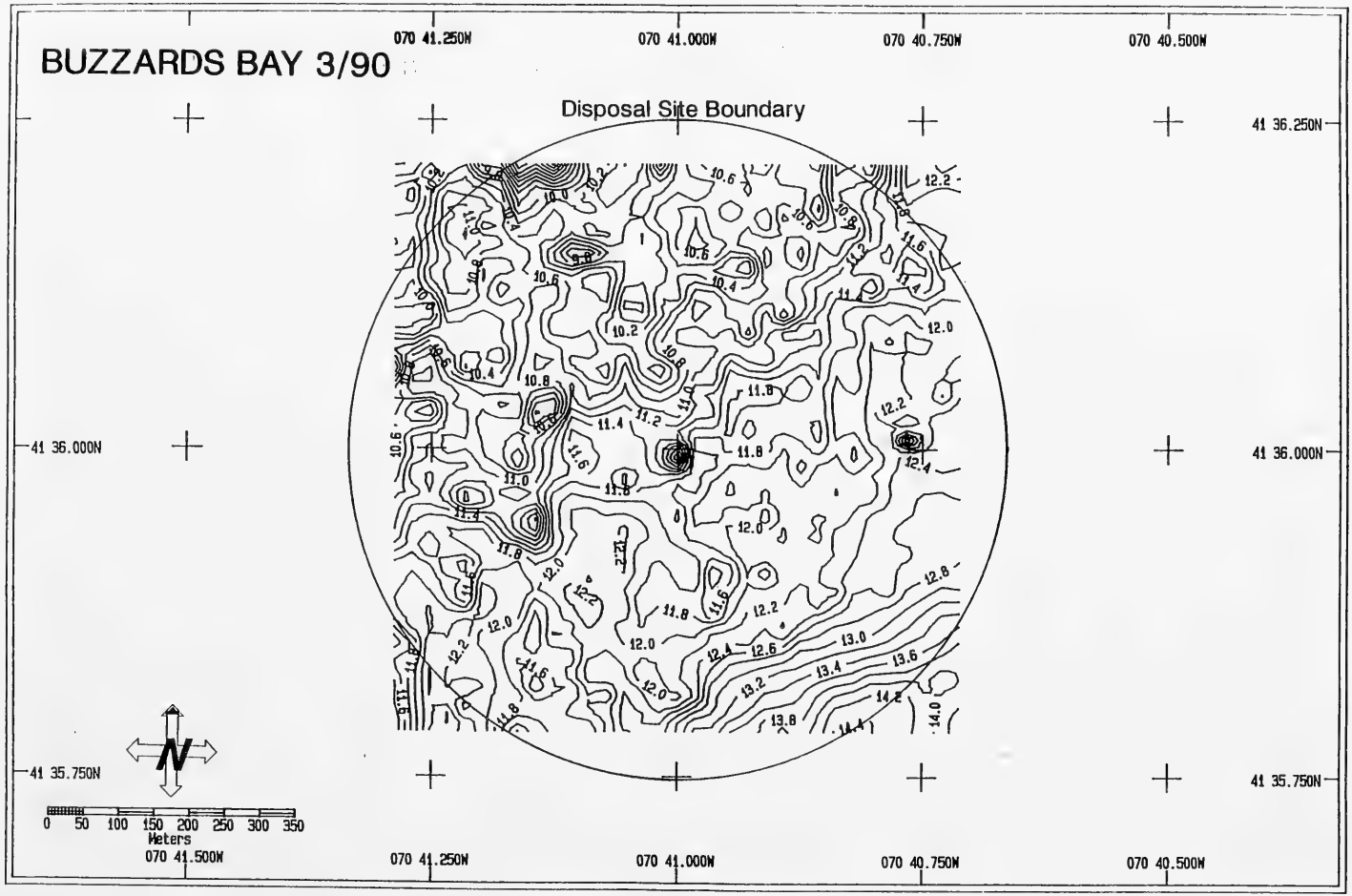


Figure 3-1. Contoured bathymetric chart of BBDS, March 1990.

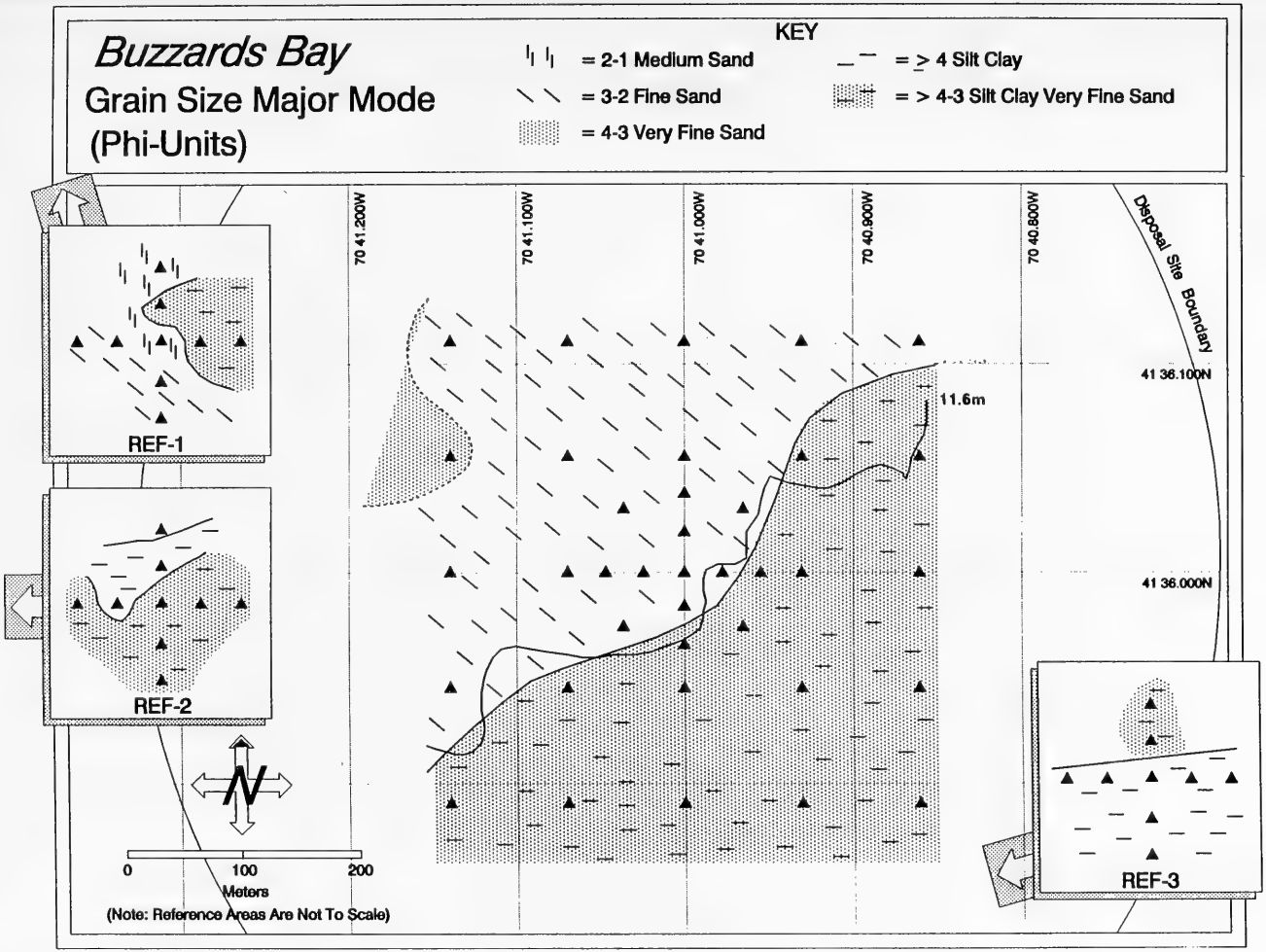


Figure 3-2. Distribution of grain size major mode for BBDS, March 1990.

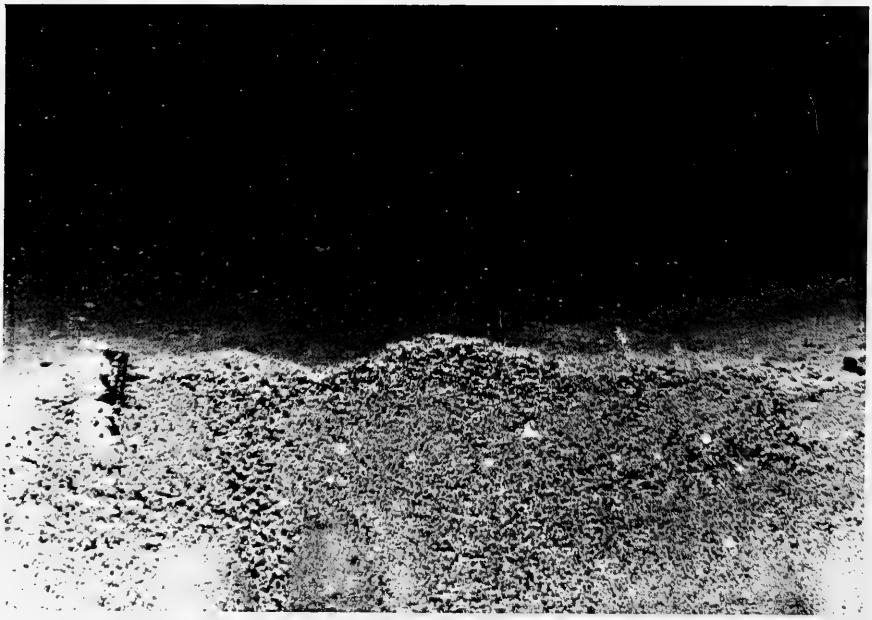


Figure 3-3. A REMOTS® photograph from BBDS reference area 1.

Figure 3-4. A REMOTS® photograph from BBDS reference area 3 showing an ambient bottom of fine-grained material and a Stage III assemblage.

Figure 3-5. A REMOTS® photograph of rippled sandy bottom at the BBDS center. Successional stage is indeterminate.

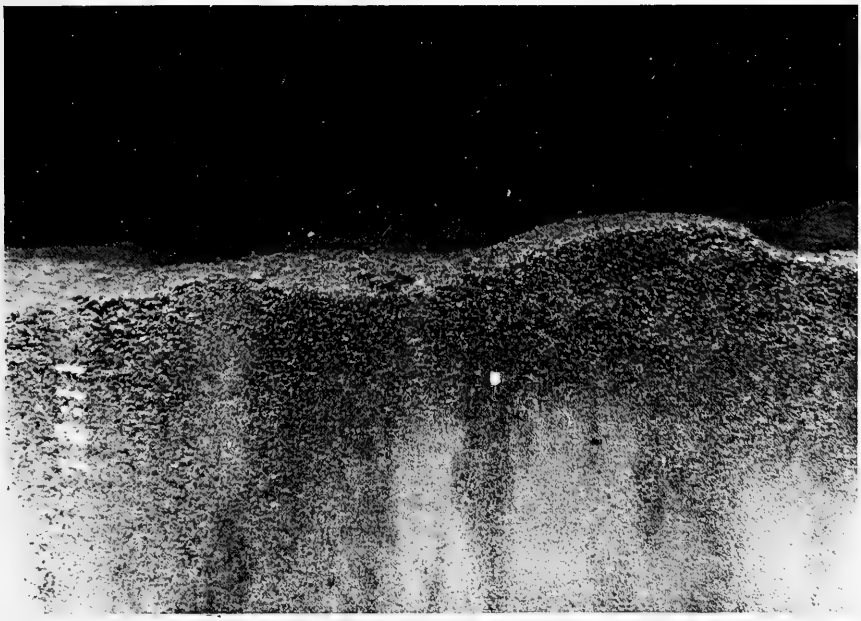


Figure 3-6. A REMOTS® photograph from BBDS reference area 2 showing the superposition of sand over mud.

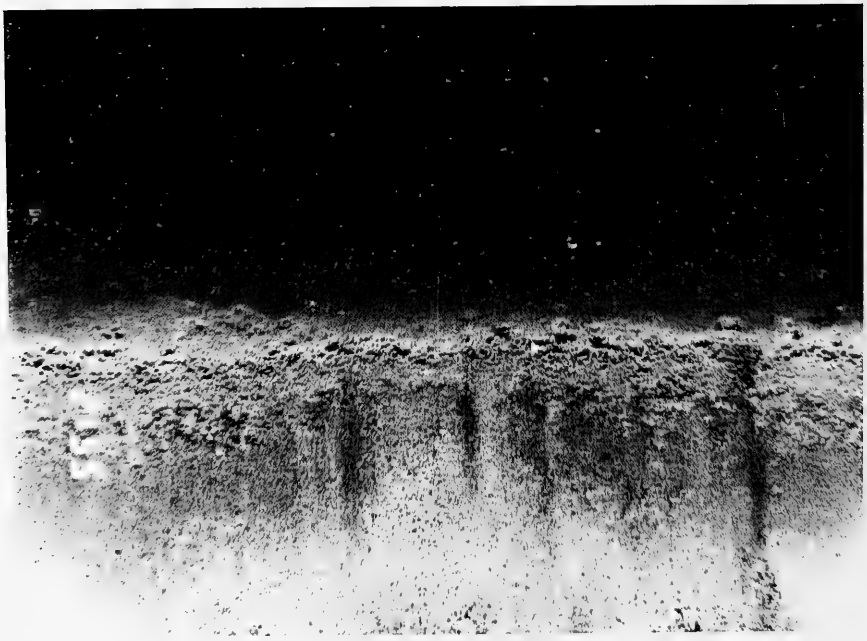


Figure 3-7. A REMOTS® photograph from BBDS station 19 which had a surface layer of mud over sand related to the presence of dredged material.

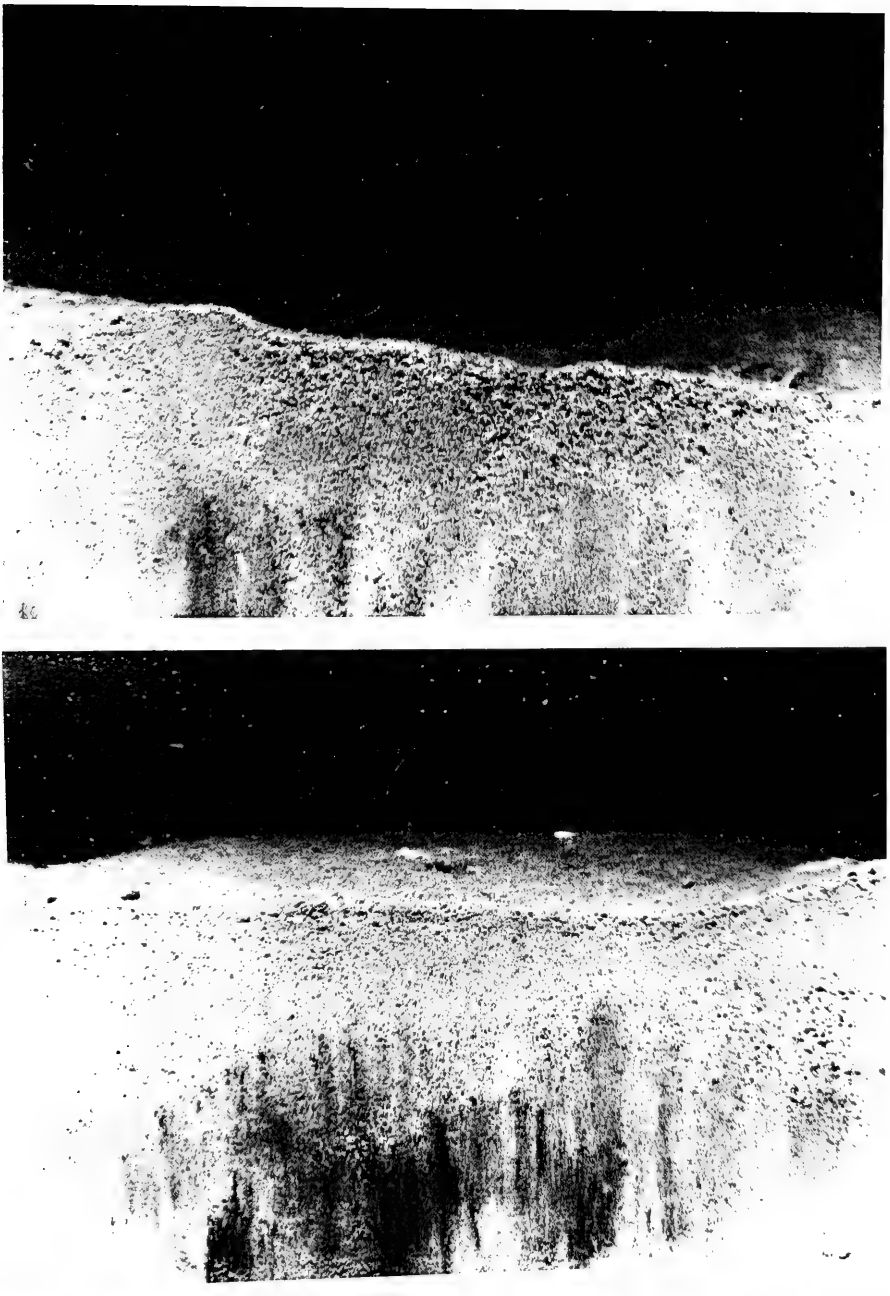


Figure 3-8. A REMOTS® photograph from BBDS stations 17 and 32 showing the deposition of sand over mud possibly related to disposal events.

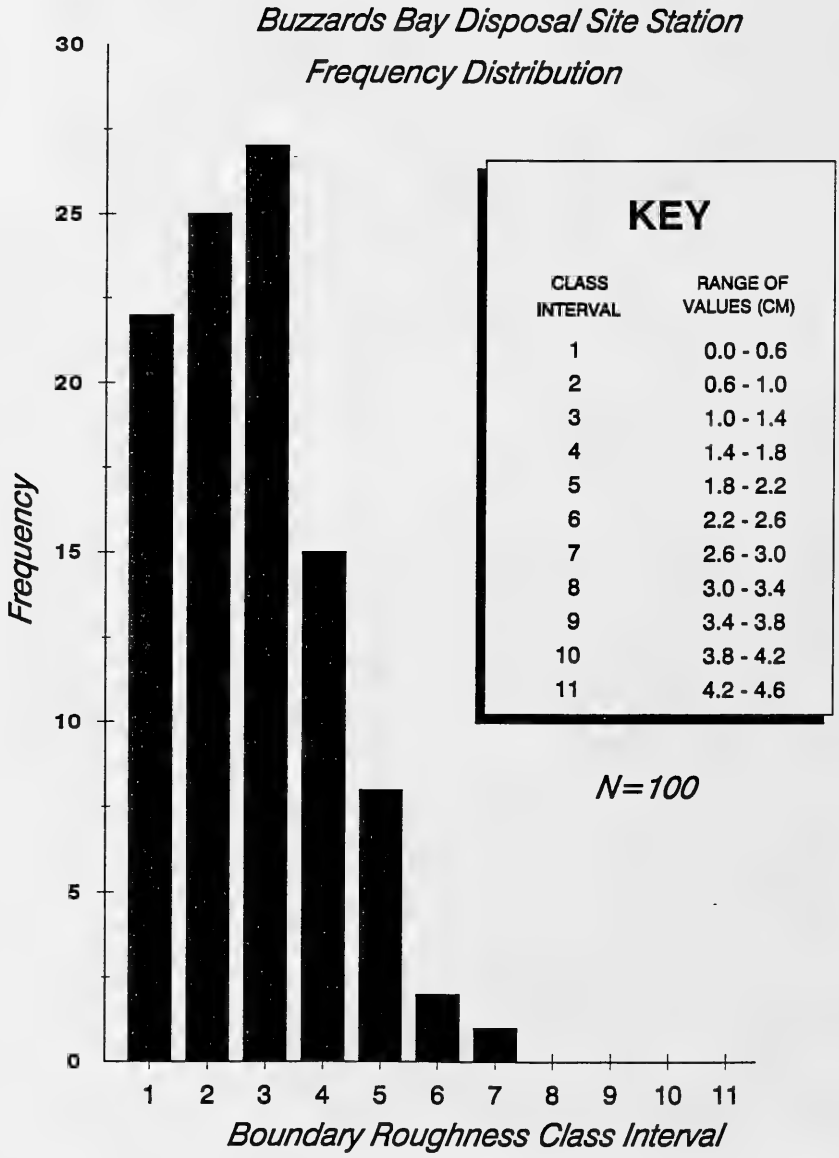


Figure 3-9. Frequency distribution of small-scale surface boundary roughness for disposal stations at BBDS, March 1990.

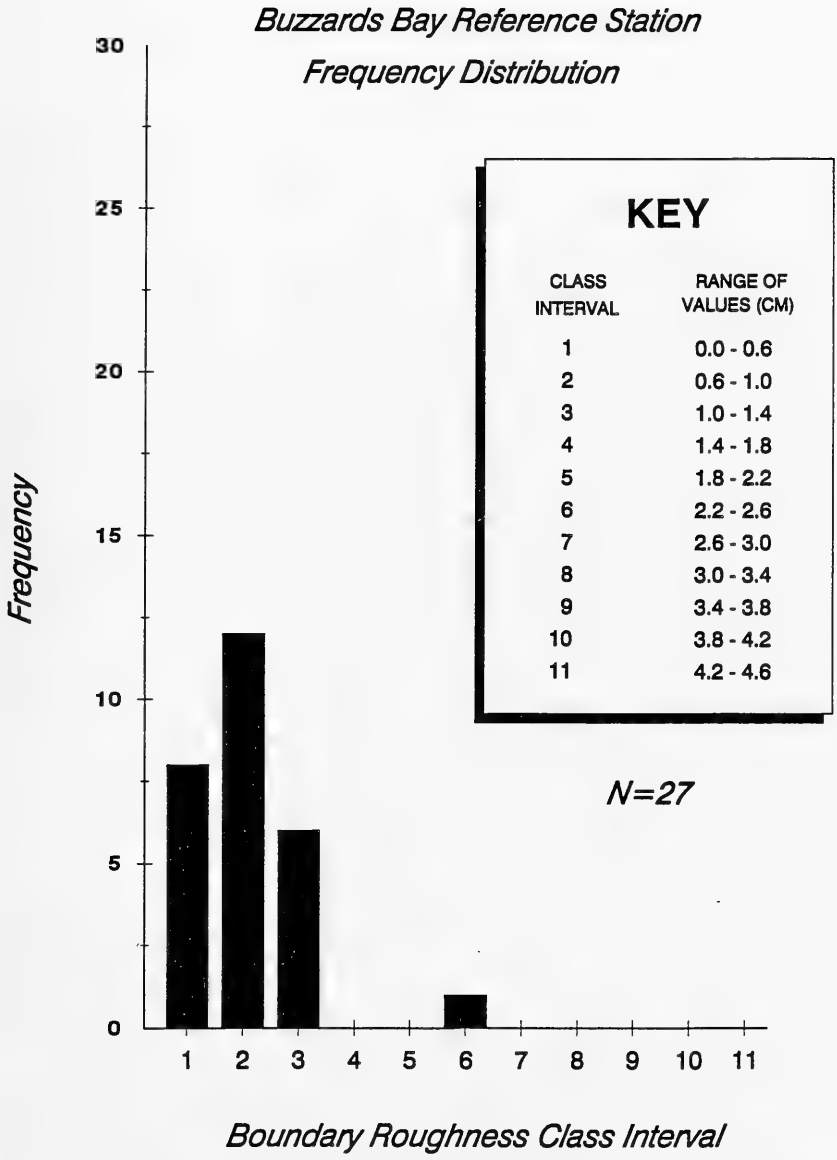


Figure 3-10. Frequency distribution of small-scale surface boundary roughness for reference stations at BBDS, March 1990.

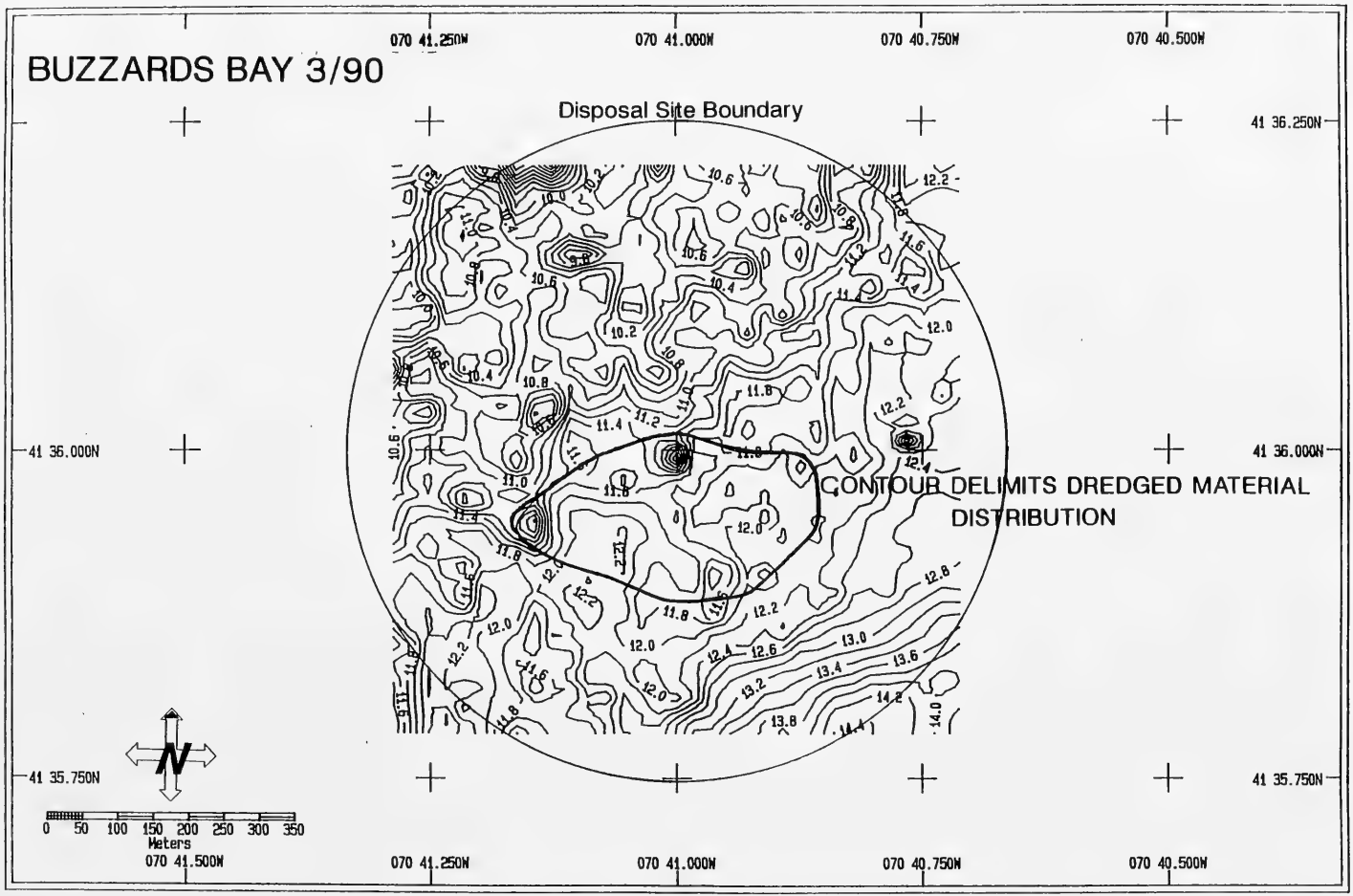


Figure 3-11. Distribution of dredged material at BBDS, March 1990.

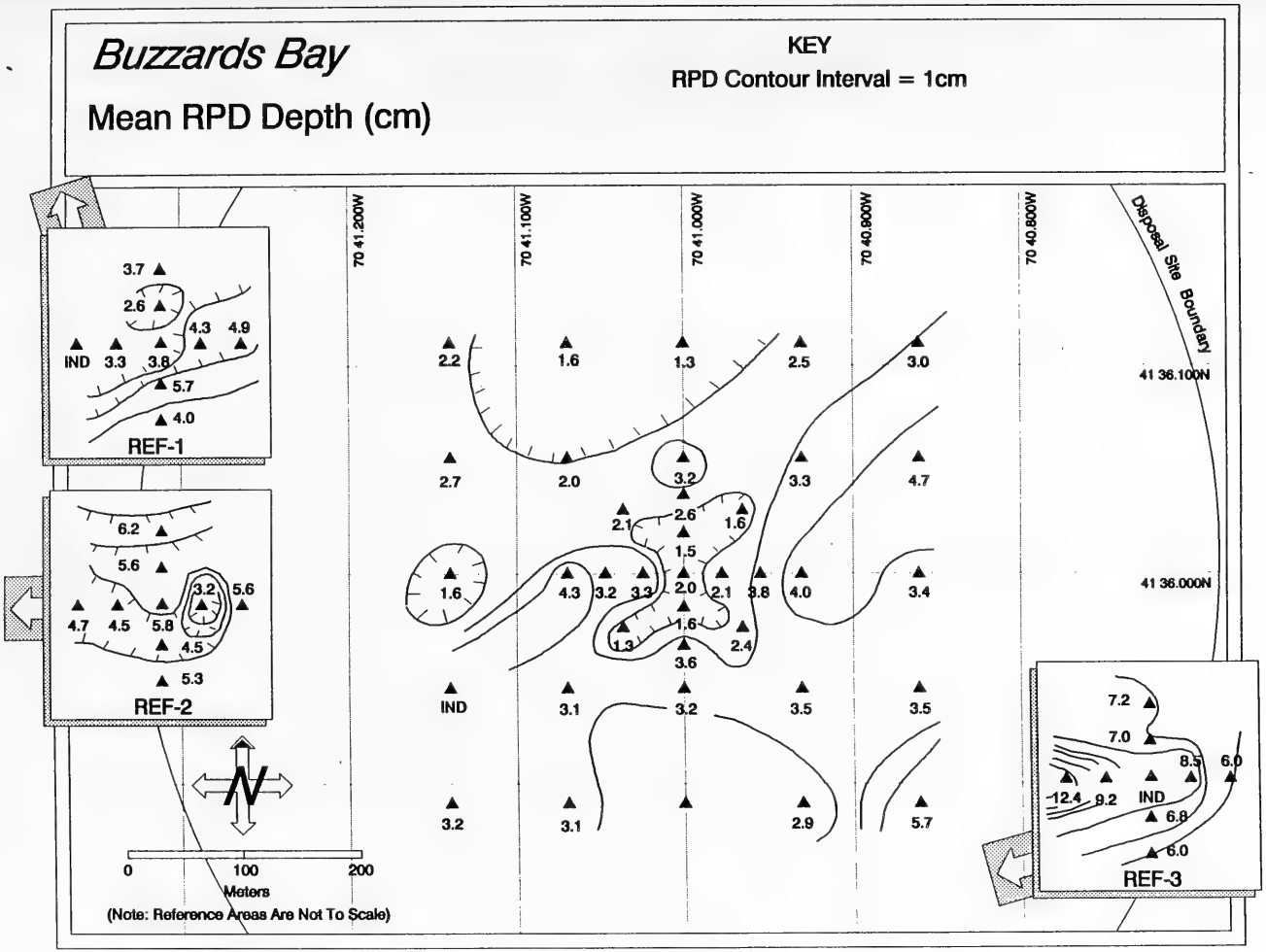
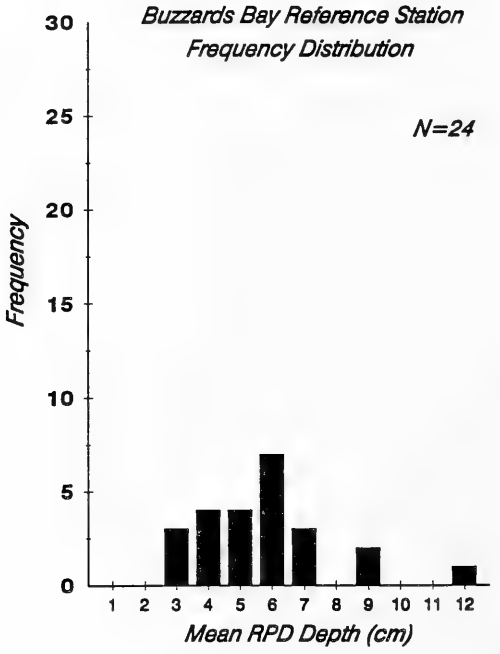


Figure 3-12. Mean apparent RPD depths for BBDS, March 1990.



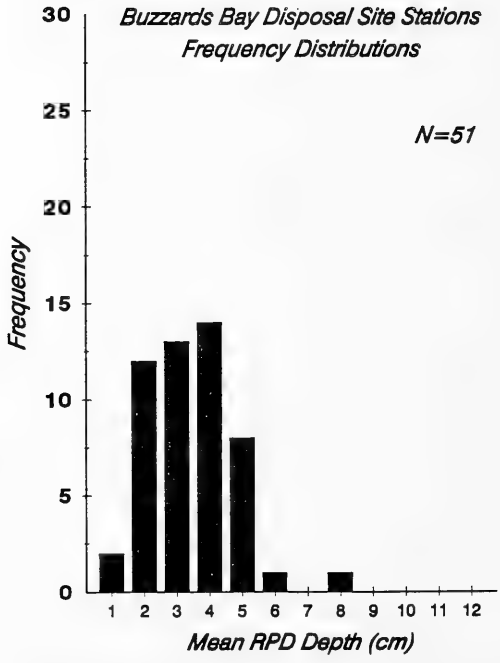


Figure 3-13. Frequency distributions for mean apparent RPD depths for on-site and off-site locations at BBDS, March 1990.

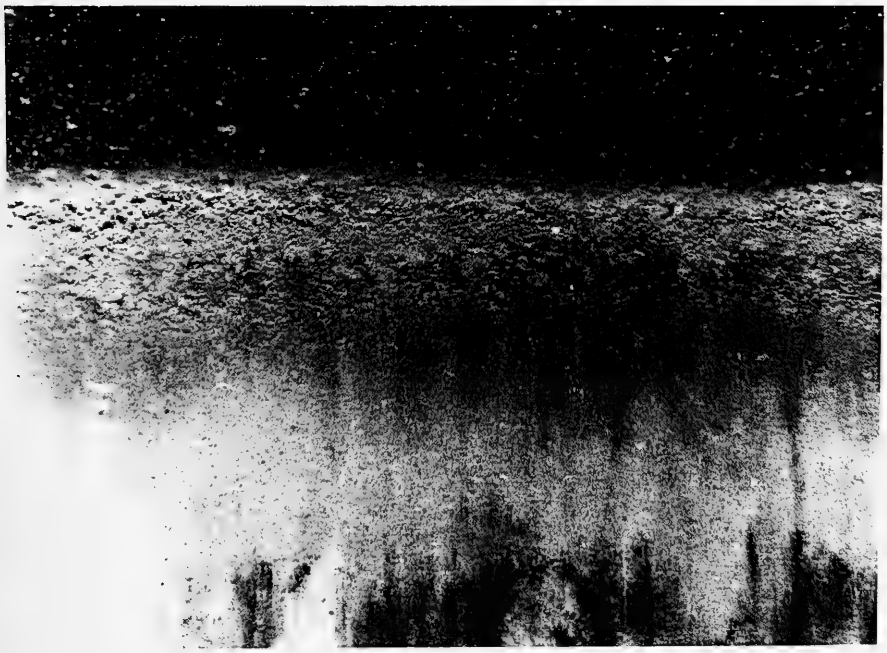


Figure 3-14. A REMOTS® photograph showing lower optical reflectance at depth due to the spring plankton bloom.

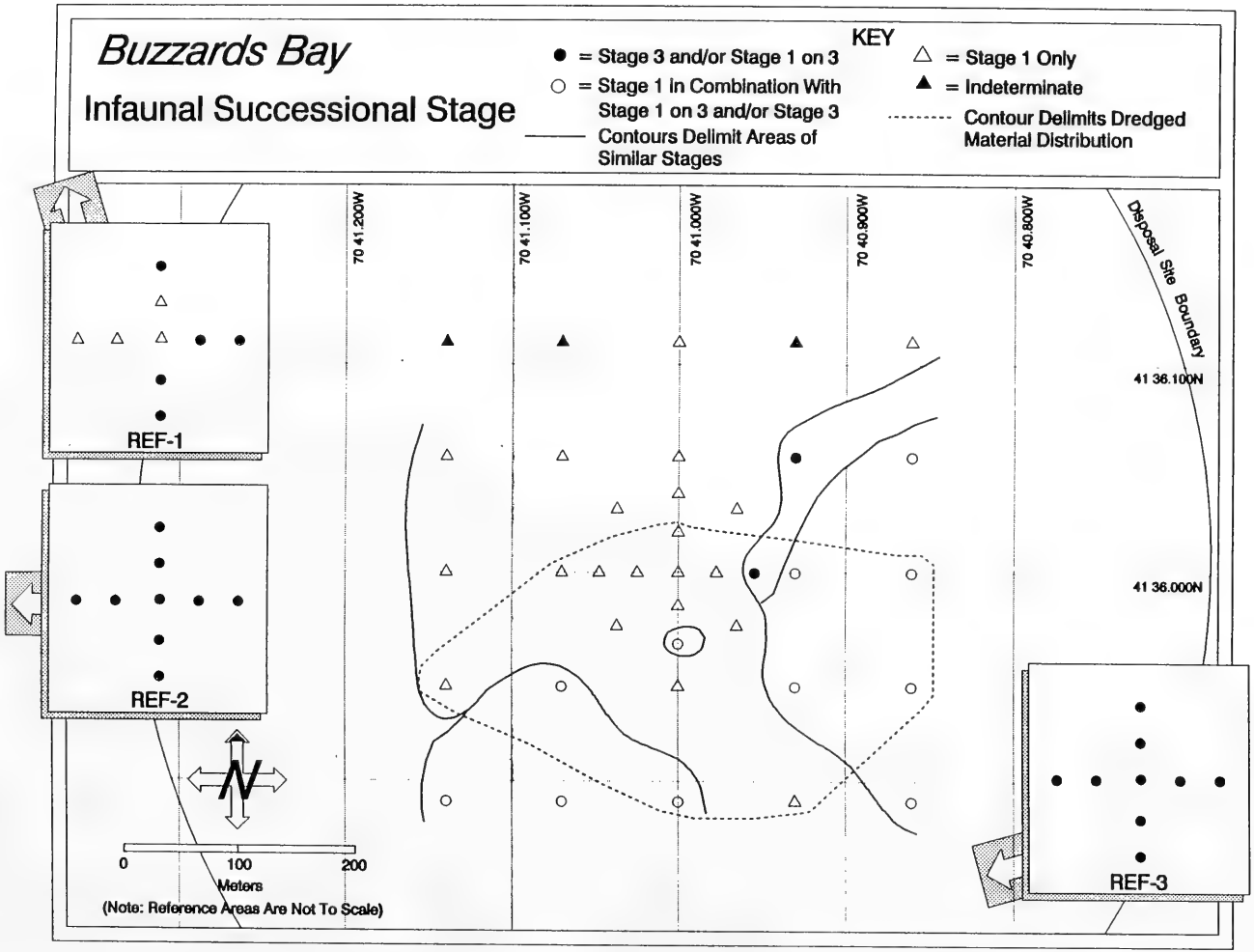


Figure 3-15. The spatial distribution of infaunal successional seres for BBDS, March 1990.

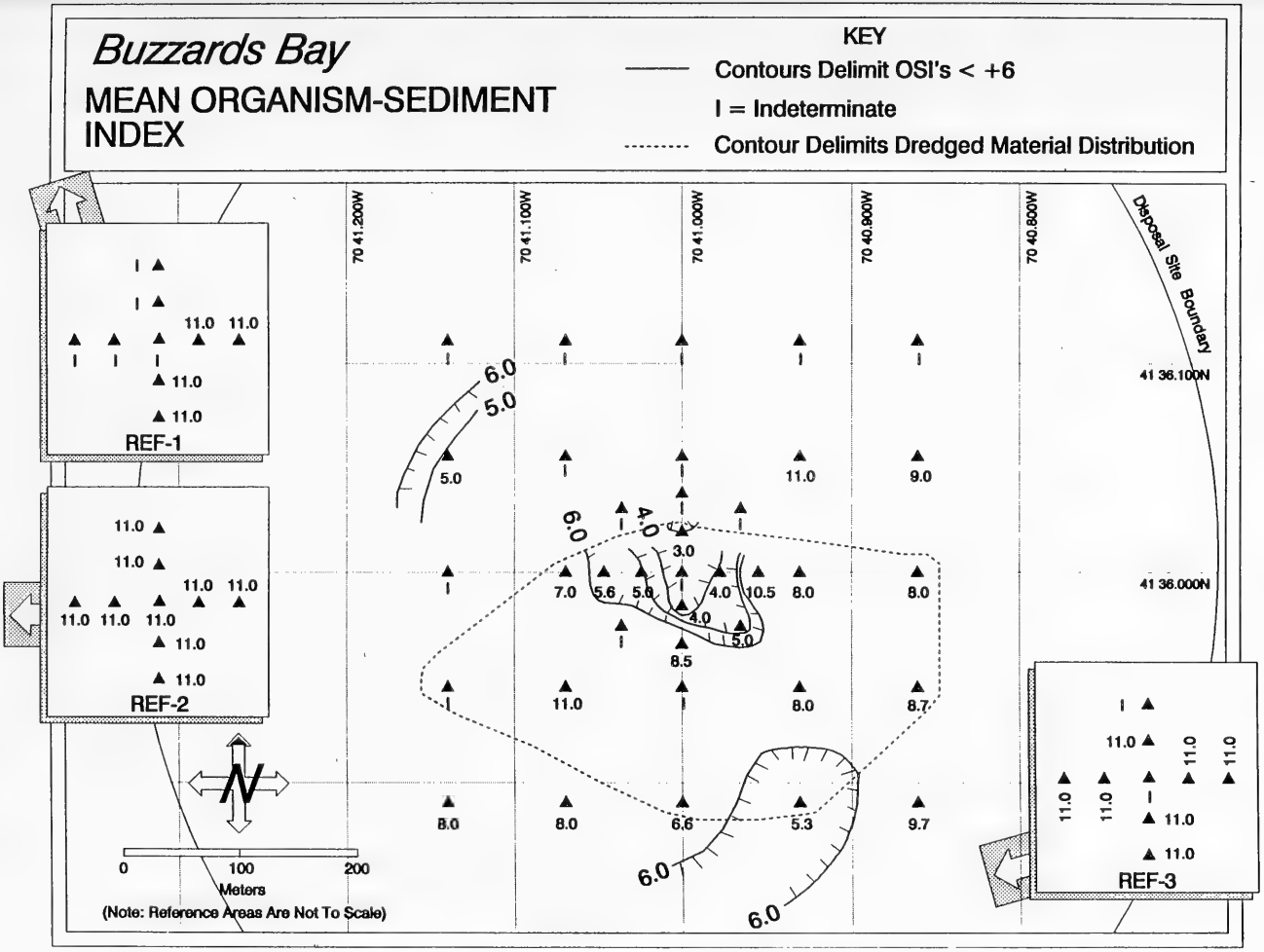
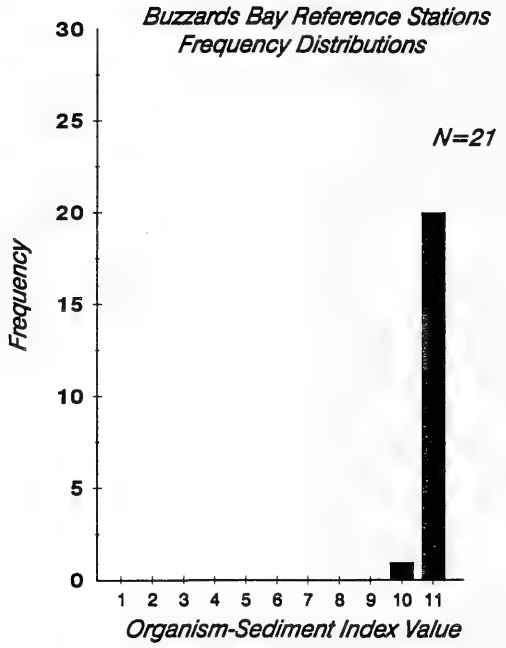


Figure 3-16. The Organism Sediment Index values for BBDS, March 1990.



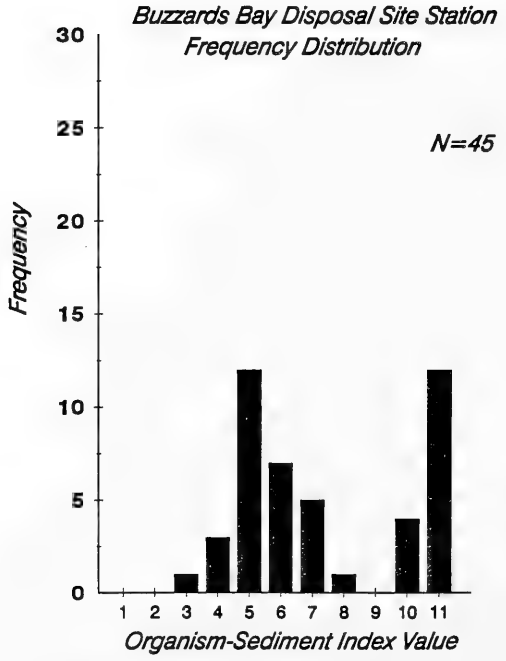


Figure 3-17. Frequency distribution of OSI values for on-site and off-site locations at BBDS, March 1990.

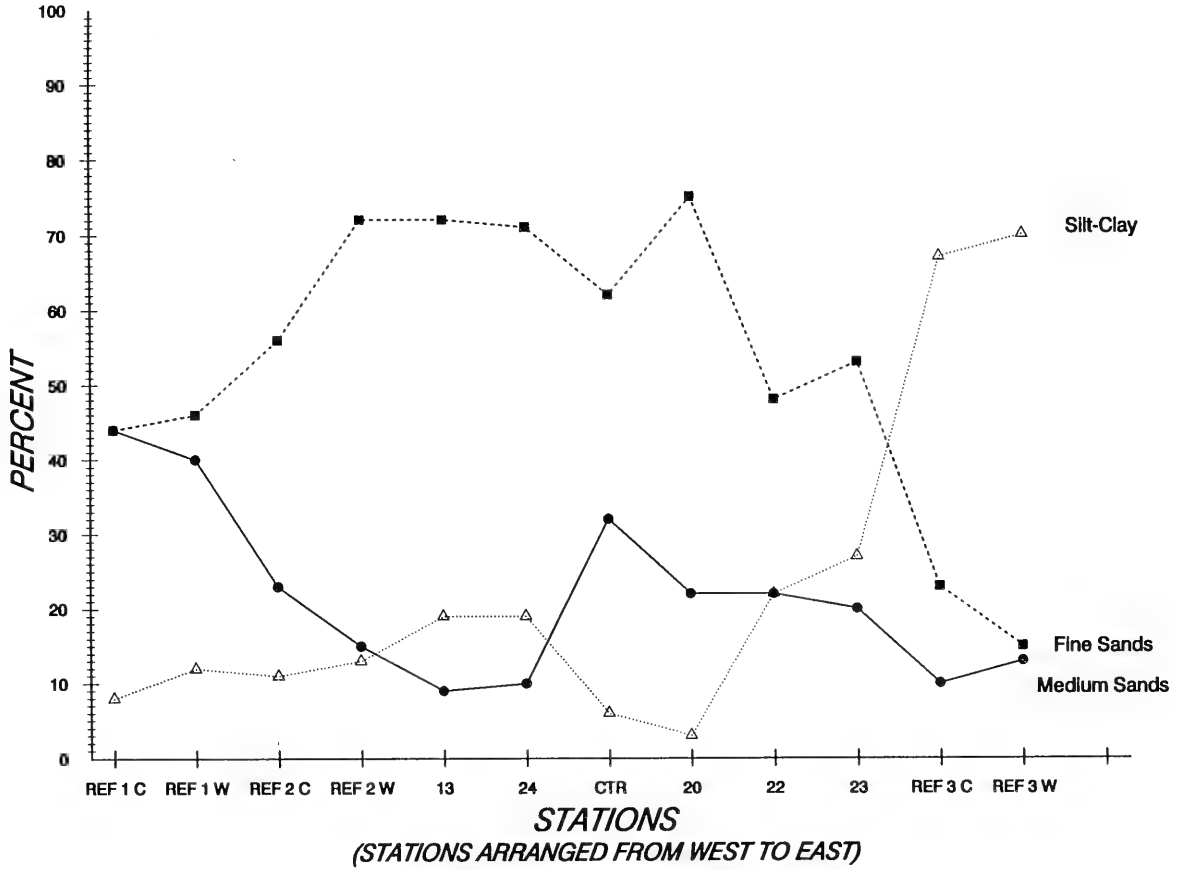


Figure 3-18. Sediment grain size analyses for BBDS, March 1990.

APPENDIX A

STUDY SITE
BUZZARDS BAY

APPENDIX A
STUDY SITE = BUZZARDS BAY
STATION = 1
COLLECTION DATE = MARCH 1990

TAXA - Total Individuals, 486	REP 1	% OF TOTAL
Mediomastus ambiseta	208	42.80
Oligochaeta	63	12.96
Ascidiacea sp. (indeterminate)	43	8.85
Ninoe nigripes	26	5.35
Tubulanus pellucidus	23	4.73
Cylichnella bidentata	18	3.70
Aricidea (Acmira) catherinae	17	3.50
Cirrophorus furcatus	16	3.29
Turbonilla sp. (indeterminate)	16	3.29
Natica pusilla	10	2.06
NINETY PERCENT BREAKPOINT		
Scolelepis (P.) bousfieldi	6	1.23
Nassarius trivittatus	4	0.82
Cirratulidae sp. (indeterminate)	3	0.62
Notomastus spp. (indeterminate)	3	0.62
Brania wellfleetensis	2	0.41
Turbonilla interrupta	2	0.41
Yoldia limatula	2	0.41
Sipuncula	2	0.41
Asychis elongata	1	0.21
Owenia fusiformis	1	0.21
Ampharetidae (Melinninae) sp.	1	0.21
Hydroides dianthus	1	0.21
Nereis grayi	1	0.21
Glycera americana	1	0.21
Nephtys incisa	1	0.21
Lumbrineridae sp. (indeterminate)	1	0.21
Tharyx acutus	1	0.21
Acteocina canaliculata	1	0.21
Nephtyidae sp. (indeterminate)	1	0.21
Dorvilleidae sp. A	1	0.21
Ensis directus	1	0.21
Tellina agilis	1	0.21
Pitar morrhuanus	1	0.21
Anoplodactylus lentus	1	0.21
Cirripedia	1	0.21
Ampelisca verrilli	1	0.21
Pagurus sp.	1	0.21
Anemone sp. A	1	0.21
Exogone dispar	1	0.21
Cnemidocarpa mollis	1	0.21
TOTAL NUMBER OF TAXA	40	
TOTAL NUMBER OF INDIVIDUALS	486	

STUDY SITE = BUZZARDS BAY
STATION = 13
COLLECTION DATE = MARCH 1990

TAXA - Total Individuals, 597	REP 1	% OF TOTAL
Mediomastus ambiseta	130	21.78
Aricidea (Acmira) catherinae	76	12.73
Spiophanes bombyx	45	7.54
Cirrophorus furcatus	37	6.20
Tubulanus pellucidus	30	5.03
Oligochaeta	25	4.19
Ninoe nigripes	24	4.02
Ampelisca sp. (indeterminate)	24	4.02
Glycera sp. (indeterminate)	21	3.52
Ascidiacea sp. (indeterminate)	19	3.18
Dorvilleidae sp. A	17	2.85
Nassarius trivittatus	12	2.01
Lumbrineridae sp. (indeterminate)	11	1.84
Ampharetidae (Ampharetinae) sp.	10	1.68
Brania wellfleetensis	10	1.68
Natica pusilla	9	1.51
Notomastus spp. (indeterminate)	9	1.51
Tellina agilis	7	1.17
Ensis directus	6	1.01
Polynoidae sp. (indeterminate)	5	0.84
Turbonilla sp. (indeterminate)	5	0.84
Lumbrineris acicularum	5	0.84
Ampelisca vadorum	5	0.84
NINETY PERCENT BREAKPOINT		
Tharyx acutus	4	0.67
Oxyurostylis smithi	4	0.67
Ampharetidae (Melinninae) sp.	3	0.50
Sphaerosyllis taylori	3	0.50
Nereis grayi	3	0.50
Cirratulidae sp. (indeterminate)	3	0.50
Byblis serrata	3	0.50
Nephtyidae sp. (indeterminate)	3	0.50
Glycera americana	2	0.34
Exogone dispar	2	0.34
Astyris lunata	2	0.34
Cylichnella bidentata	2	0.34
Spiochaetopterus costarum	1	0.17

STUDY SITE = BUZZARDS BAY
STATION = 13
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	% OF TOTAL
Pista palmata	1	0.17
Drilonereis longa	1	0.17
Phyllodoce arenae	1	0.17
Turbonilla interrupta	1	0.17
Terebellidae sp. (indeterminate)	1	0.17
Leitoscoloplos sp. (indeter.)	1	0.17
Nephtys incisa	1	0.17
Pandora sp. (indeterminate)	1	0.17
Edwardsia sp.	1	0.17
Prionospio (P.) heterobranchia	1	0.17
Amphiporus bioculatus	1	0.17
Ampelisca verrilli	1	0.17
Maldanidae sp. (indeterminate)	1	0.17
Leptocheirus pinguis	1	0.17
Idunella barnardi	1	0.17
Phoxocephalus holbolli	1	0.17
Pagurus sp.	1	0.17
Scalibregma inflatum	1	0.17
Cnemidocarpa mollis	1	0.17
TOTAL NUMBER OF TAXA	56	
TOTAL NUMBER OF INDIVIDUALS	597	

STUDY SITE = BUZZARDS BAY
STATION = 20
COLLECTION DATE = MARCH 1990

TAXA - Total Individuals, 694	REP 1	% OF TOTAL
Mediomastus ambiseta	205	29.54
Oligochaeta	54	7.78
Ascidiacea sp. (indeterminate)	54	7.78
Cirrophorus furcatus	36	5.19
Ninoe nigripes	35	5.04
Cylichnella bidentata	27	3.89
Tubulanus pellucidus	26	3.75
Aricidea (Acmira) catherinae	23	3.31
Spiophanes bombyx	16	2.31
Cnemidocarpa mollis	16	2.31
Astyris lunata	14	2.02
Ampelisca sp. (indeterminate)	13	1.87
Lumbrineridae sp. (indeterminate)	12	1.73
Brania wellfleetensis	12	1.73
Notomastus spp. (indeterminate)	12	1.73
Natica pusilla	9	1.30
Cirratulidae sp. (indeterminate)	7	1.01
Tellina agilis	7	1.01
Nephtys incisa	6	0.86
Turbonilla sp. (indeterminate)	6	0.86
Glycinde solitaria	6	0.86
Glycera sp. (indeterminate)	6	0.86
Nicolea zostericola	5	0.72
Cerastoderma pinnulatum	5	0.72
Polynoidae sp. (indeterminate)	5	0.72
Maldanidae sp. (indeterminate)	4	0.58
Sphaerosyllis taylori	4	0.58
NINETY PERCENT BREAKPOINT		
Nassarius trivittatus	4	0.58
Acteocina canaliculata	4	0.58
Dorvilleidae sp. A	4	0.58
Cirripedia	4	0.58
Tharyx dorsobranchialis	3	0.43
Ampelisca verrilli	3	0.43
Paracaprella tenuis	3	0.43

STUDY SITE = BUZZARDS BAY
STATION = 20
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP	% OF TOTAL
Tharyx acutus	3	0.43
Scalibregma inflatum	2	0.29
Phyllodoce arenae	2	0.29
Prionospio (M.) perkinsi	2	0.29
Turbonilla interrupta	2	0.29
Yoldia limatula	2	0.29
Laevicardium mortoni	2	0.29
Melinna maculata	2	0.29
Ensis directus	2	0.29
Pitar morrhuanus	2	0.29
Lyonsia hyalina	2	0.29
Nereis grayi	2	0.29
cf. Columbellidae sp. (indeter.)	1	0.14
Typosyllis sp. 1	1	0.14
Acteon punctostriatus	1	0.14
Odontosyllis fulgurans	1	0.14
Nemertinea sp. B	1	0.14
Pandora sp. (indeterminate)	1	0.14
Exogone dispar	1	0.14
Owenia fusiformis	1	0.14
Scolelepis (P.) bousfieldi	1	0.14
Ampharetidae (Melinninae) sp.	1	0.14
Byblis serrata	1	0.14
Unciola sp. (indeterminate)	1	0.14
Unciola irrorata	1	0.14
Spiochaetopterus costarum	1	0.14
Pagurus sp.	1	0.14
Pinnixa sp. (indeterminate)	1	0.14
Sipuncula	1	0.14
Polycirrus sp. (indeterminate)	1	0.14
Lumbrineris acicularum	1	0.14
TOTAL NUMBER OF TAXA	65	
TOTAL NUMBER OF INDIVIDUALS	694	

STUDY SITE = BUZZARDS BAY
STATION = 22
COLLECTION DATE = MARCH 1990

TAXA - Total Individuals, 985	REP 1	% OF TOTAL
Mediomastus ambiseta	430	43.65
Cylichnella bidentata	95	9.64
Tubulanus pellucidus	67	6.80
Scolelepis (P.) bousfieldi	51	5.18
Oligochaeta	38	3.86
Ascidiacea sp. (indeterminate)	37	3.76
Ninoe nigripes	31	3.15
Cirrophorus furcatus	26	2.64
Prionospio (M.) perkinsi	24	2.44
Acteocina canaliculata	19	1.93
Aricidea (Acmira) catherinae	13	1.32
Cirratulidae sp. (indeterminate)	12	1.22
Nephtys incisa	11	1.12
Hutchinsoniella macracantha	10	1.02
Sphaerosyllis taylori	9	0.91
Macoma tenta	9	0.91
Turbonilla sp. (indeterminate)	8	0.81
NINETY PERCENT BREAKPOINT		
Lumbrineridae sp. (indeterminate)	6	0.61
Spiophanes bombyx	5	0.51
Nephtyidae sp. (indeterminate)	5	0.51
Pitar morrhuanus	5	0.51
Lyonsia hyalina	5	0.51
Eunicidae sp. (indeterminate)	4	0.41
Ampelisca sp. (indeterminate)	4	0.41
Tharyx acutus	3	0.30
Natica pusilla	3	0.30
Astyris lunata	3	0.30
Nassarius trivittatus	3	0.30
Yoldia limatula	3	0.30
Tellina agilis	3	0.30
Pandora sp. (indeterminate)	3	0.30
Sipuncula	3	0.30
Owenia fusiformis	2	0.20
Ampharetidae (Melinninae) sp.	2	0.20

STUDY SITE = BUZZARDS BAY
STATION = 22
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	% OF TOTAL
Glycera americana	2	0.20
Nucula proxima	2	0.20
Notomastus spp. (indeterminate)	2	0.20
Maldanidae sp. (indeterminate)	2	0.20
Polynoidae sp. (indeterminate)	2	0.20
Typosyllis sp. 1	2	0.20
Dorvilleidae sp. A	1	0.10
Acteon punctostriatus	1	0.10
Nereis grayi	1	0.10
Ceriantheopsis americanus	1	0.10
Microphthalmus sp. (indeter)	1	0.10
Crepidula sp. (indeterminate)	1	0.10
Exogone dispar	1	0.10
Anemone sp. A	1	0.10
Spio sp. (indeterminate)	1	0.10
Pectinaria sp. (indeterminate)	1	0.10
Lumbrineris acicularum	1	0.10
Tharyx dorsobranchialis	1	0.10
Cirripedia	1	0.10
Edotea tribola	1	0.10
Spiochaetopterus costarum	1	0.10
Ampelisca vadorum	1	0.10
Unciola irrorata	1	0.10
Pagurus sp.	1	0.10
Polyonyx gibbesi	1	0.10
Asychis elongata	1	0.10
Pherusa affinis	1	0.10
TOTAL NUMBER OF TAXA	61	
TOTAL NUMBER OF INDIVIDUALS	985	

STUDY SITE = BUZZARDS BAY
STATION = 23
COLLECTION DATE = MARCH 1990

TAXA - Total Individuals, 541	REP 1	% OF TOTAL
Mediomastus ambiseta	101	18.67
Ninoe nigripes	51	9.43
Aricidea (Acmira) catherinae	43	7.95
Ampelisca sp. (indeterminate)	31	5.73
Tubulanus pellucidus	30	5.55
Cirrophorus furcatus	29	5.36
Oligochaeta	29	5.36
Cirratulidae sp. (indeterminate)	27	4.99
Cylichnella bidentata	25	4.62
Scolelepis (p.) bousfieldi	20	3.70
Tharyx acutus	20	3.70
Ascidiacea sp. (indeterminate)	18	3.33
Ericthonius brasiliensis	16	2.96
Lumbrineridae sp. (indeterminate)	12	2.22
Tharyx dorsobranchialis	7	1.29
Turbonilla sp. (indeterminate)	7	1.29
Nephtys incisa	6	1.11
Natica pusilla	4	0.74
Nucula delphinodonta	4	0.74
Tellina agilis	4	0.74
Exogone dispar	3	0.55
NINETY PERCENT BREAKPOINT		
Acteocina canaliculata	3	0.55
Pitar morrhuanus	3	0.55
Asychis elongata	2	0.37
Polycirrus sp. (indeterminate)	2	0.37
Nassarius trivittatus	2	0.37
Sphaerosyllis taylori	2	0.37
Macoma tenta	2	0.37
Brania clavata	2	0.37
Pandora sp. (indeterminate)	2	0.37
Glycera sp. (indeterminate)	2	0.37
Gammarus annulatus	2	0.37
Ampharetidae (Melinninae) sp.	1	0.18
Ampharetidae (Ampharetinae) sp.	1	0.18
Phyllodoce arenae	1	0.18

STUDY SITE = BUZZARDS BAY
STATION = 23
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	% OF TOTAL
Typosyllis sp. 1	1	0.18
Vitrinellidae sp. A	1	0.18
Arabella iricolor	1	0.18
Nereis grayi	1	0.18
Lumbrineris acicularum	1	0.18
Acteon punctostriatus	1	0.18
Spiophanes bombyx	1	0.18
Glycera americana	1	0.18
Nucula proxima	1	0.18
Notocirrus spiniferus	1	0.18
Cerastoderma pinnulatum	1	0.18
Notomastus spp. (indeterminate)	1	0.18
Polynoidae sp. (indeterminate)	1	0.18
Stylochus ellipticus	1	0.18
Maldanidae sp. (indeterminate)	1	0.18
Lyonsia hyalina	1	0.18
Amphiporus bioculatus	1	0.18
Ampelisca vadorum	1	0.18
Leptocheirus pinguis	1	0.18
Spiochaetopterus costarum	1	0.18
Pectinaria sp. (indeterminate)	1	0.18
Paracaprella tenuis	1	0.18
Upogebia affinis	1	0.18
Sipuncula	1	0.18
Nemertinea sp. C	1	0.18
Cnemidocarpa mollis	1	0.18
Bostrichobranchus pilularis	1	0.18
TOTAL NUMBER OF TAXA	62	
TOTAL NUMBER OF INDIVIDUALS	541	

STUDY SITE = BUZZARDS BAY
STATION = 24
COLLECTION DATE = MARCH 1990

TAXA - Total Individuals, 604	REP 1	% OF TOTAL
Mediomastus ambiseta	235	38.91
Oligochaeta	73	12.09
Aricidea (Acmira) catherinae	50	8.28
Ninoe nigripes	46	7.62
Ascidiacea sp. (indeterminate)	41	6.79
Cirrophorus furcatus	32	5.30
Tubulanus pellucidus	26	4.30
Nephtys incisa	9	1.49
Spiophanes bombyx	8	1.32
Ampelisca sp. (indeterminate)	8	1.32
Cirratulidae sp. (indeterminate)	7	1.16
Scoletepis (P.) bousfieldi	6	0.99
Sphaerosyllis taylori	6	0.99
NINETY PERCENT BREAKPOINT		
Carazziella hobsonae	5	0.83
Tharyx dorsobranchialis	5	0.83
Lumbrineridae sp. (indeterminate)	4	0.66
Prionospio (M.) perkinsi	3	0.50
Glycera sp. (indeterminate)	3	0.50
Notomastus spp. (indeterminate)	3	0.50
Maldanidae sp. (indeterminate)	3	0.50
Asychis elongata	3	0.50
Tharyx acutus	2	0.33
Typosyllis sp. 1	2	0.33
Glycinde solitaria	1	0.17
Spiochaetopterus costarum	1	0.17
Glycera americana	1	0.17
Brania wellfleetensis	1	0.17
Polynoidae sp. (indeterminate)	1	0.17
Pherusa sp. (indeterminate)	1	0.17
Scalibregma inflatum	1	0.17
Notomastus luridus	1	0.17
Amphiporus bioculatus	1	0.17
Anemone sp. A	1	0.17
Levinsenia gracilis	1	0.17
Parougia caeca	1	0.17
Owenia fusiformis	1	0.17
Melinna maculata	1	0.17

STUDY SITE = BUZZARDS BAY
STATION = 24
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	% OF TOTAL
Ampharetidae (Melinninae) sp.	1	0.17
Exogone dispar	1	0.17
Turbonilla interrupta	1	0.17
Cylichnella bidentata	1	0.17
Nucula proxima	1	0.17
Nereis grayi	1	0.17
Sipuncula	1	0.17
Ophiuroidea	1	0.17
Phyllodoce arenae	1	0.17
Cnemidocarpa mollis	1	0.17
TOTAL NUMBER OF TAXA	47	
TOTAL NUMBER OF INDIVIDUALS	604	

STUDY SITE = BUZZARDS BAY
STATION = R1
COLLECTION DATE = MARCH 1990

TAXA - Mean Total Individuals 662.5	REP 1	REP 2	MEAN	% OF TOTAL
Mediomastus ambiseta	298	93	195.5	29.51
Aricidea (Acmira) catherinae	24	105	64.5	9.74
Oligochaeta	56	52	54.0	8.15
Byblis serrata	2	98	50.0	7.55
Cirratulidae sp. (indeter.)	74	16	45.0	6.79
Tubulanus pellucidus	32	12	22.0	3.32
Cirrophorus furcatus	21	23	22.0	3.32
Ninoe nigripes	33	10	21.5	3.25
Ampelisca sp. (indeterminate)	27	12	19.5	2.94
Spiophanes bombyx	5	25	15.0	2.26
Glycera sp. (indeterminate)	13	15	14.0	2.11
Ampelisca verrilli	8	19	13.5	2.04
Tharyx acutus	23	1	12.0	1.81
Tharyx dorsobranchialis	19	0	9.5	1.43
Ascidiacea sp. (indeterminate)	4	8	6.0	0.91
Leptocheirus pinguis	9	2	5.5	0.83
Notomastus spp. (indeterminate)	8	2	5.0	0.75
Ampharetidae (Ampharetinae) sp.	2	7	4.5	0.68
Natica pusilla	1	8	4.5	0.68
Pitar morrhuanus	7	2	4.5	0.68
Pinnixa sp. (indeterminate)	9	0	4.5	0.68
Nephtyidae sp. (indeterminate)	0	8	4.0	0.60
NINETY PERCENT BREAKPOINT				
Vitrinellidae sp. A	1	5	3.0	0.45
Cylichnella bidentata	4	2	3.0	0.45
Glycera americana	3	2	2.5	0.38
Ampelisca vadorum	1	4	2.5	0.38
Polynoidae sp. (indeterminate)	4	1	2.5	0.38
Lumbrineridae sp. (indeter.)	3	1	2.0	0.30
Turbonilla sp. (indeterminate)	1	3	2.0	0.30
Cerastoderma pinnulatum	0	4	2.0	0.30
Tellina agilis	0	4	2.0	0.30
Lumbrineris acicularum	0	4	2.0	0.30
Scolelepis (P.) bousfieldi	3	1	2.0	0.30
Nephtys picta	0	4	2.0	0.30
Unciola irrorata	2	2	2.0	0.30
Owenia fusiformis	0	3	1.5	0.23
Amphiporus bioculatus	0	3	1.5	0.23

STUDY SITE = BUZZARDS BAY
STATION = R1
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	REP 2	MEAN	% OF TOTAL
Phyllodoce arenae	0	3	1.5	0.23
Dorvilleidae sp. A	0	3	1.5	0.23
Unciola sp. (indeterminate)	1	2	1.5	0.23
Maldanidae sp. (indeterminate)	3	0	1.5	0.23
Idunella barnardi	2	1	1.5	0.23
Upogebia affinis	1	2	1.5	0.23
Spiochaetopterus costarum	1	1	1.0	0.15
Nassarius trivittatus	1	1	1.0	0.15
Turbonilla interrupta	0	2	1.0	0.15
Nucula proxima	0	2	1.0	0.15
Caulleriella cf. killariensis	0	2	1.0	0.15
Nereis grayi	0	2	1.0	0.15
Ampharetidae (Melinninae) sp.	1	1	1.0	0.15
Lyonsia hyalina	1	1	1.0	0.15
Polycirrus sp. (indeterminate)	2	0	1.0	0.15
Polygordius sp.	0	2	1.0	0.15
Pagurus sp.	2	0	1.0	0.15
Cnemidocarpa mollis	1	1	1.0	0.15
Anadara transversa	1	0	0.5	0.08
Pythinella cuneata	1	0	0.5	0.08
Crepidula plana	0	1	0.5	0.08
Ensis directus	0	1	0.5	0.08
Macoma tenta	0	1	0.5	0.08
Ampharete sp. (indeterminate)	0	1	0.5	0.08
Tagelus divisus	0	1	0.5	0.08
Leitoscoloplos sp. (indeter.)	0	1	0.5	0.08
Pandora sp. (indeterminate)	0	1	0.5	0.08
Acteon punctostriatus	0	1	0.5	0.08
Ptilanthura tenuis	1	0	0.5	0.08
Edotea tribola	1	0	0.5	0.08
Typosyllis sp. 1	0	1	0.5	0.08
Sphaerosyllis taylori	0	1	0.5	0.08
Brania wellfleetensis	1	0	0.5	0.08
Brania clavata	1	0	0.5	0.08
Anemone sp. A	0	1	0.5	0.08
Cabira incerta	1	0	0.5	0.08
Microphthalmus sp. (indeter.)	0	1	0.5	0.08
Astyris lunata	1	0	0.5	0.08
Asychis elongata	1	0	0.5	0.08

STUDY SITE = BUZZARDS BAY
STATION = R1
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	REP 2	MEAN	% OF TOTAL
Nuculanidae sp. (indeterminate)	1	0	0.5	0.08
Syllidae (epitoke)	0	1	0.5	0.08
Nephtys incisa	1	0	0.5	0.08
Yoldia limatula	1	0	0.5	0.08
TOTAL NUMBER OF TAXA	53	63		
TOTAL NUMBER OF INDIVIDUALS	725	600		

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	80
MEAN NUMBER OF INDIVIDUALS	662.5

STUDY SITE = BUZZARDS BAY
STATION = R2
COLLECTION DATE = MARCH 1990

TAXA - Mean Total Individuals, 788.5	REP 1	REP 2	MEAN	% OF TOTAL
Ascidiacea sp. (indeterminate)	96	154	125.0	15.85
Cirrophorus furcatus	75	128	101.5	12.87
Mediomastus ambiseta	101	84	92.5	11.73
Ninoe nigripes	74	97	85.5	10.84
Cnemidocarpa mollis	32	39	35.5	4.50
Cirratulidae sp. (indeterminate)	33	32	32.5	4.12
Tharyx dorsobranchialis	22	32	27.0	3.42
Oligochaeta	35	14	24.5	3.11
Leptocheirus pinguis	17	32	24.5	3.11
Aricidea (Acmira) catherinae	36	6	21.0	2.66
Cylichnella bidentata	15	14	14.5	1.84
Tharyx acutus	17	11	14.0	1.78
Ampelisca sp. (indeterminate)	14	14	14.0	1.78
Tubulanus pellucidus	14	13	13.5	1.71
Pitar morrhuanus	12	13	12.5	1.59
Nephtys incisa	7	15	11.0	1.40
Brania wellfleetensis	17	3	10.0	1.27
Brania clavata	18	1	9.5	1.20
Scalibregma inflatum	2	11	6.5	0.82
Lumbrineridae sp. (indeterminate)	3	8	5.5	0.70
Scolelepis (P.) bousfieldi	3	7	5.0	0.63
Maldanidae sp. (indeterminate)	2	8	5.0	0.63
Polycirrus sp. (indeterminate)	1	8	4.5	0.57
Nucula delphinodonta	5	4	4.5	0.57
Pinnixa sp. (indeterminate)	4	5	4.5	0.57
Sphaerosyllis taylori	6	2	4.0	0.51
Natica pusilla	1	7	4.0	0.51
NINETY PERCENT BREAKPOINT				
Macoma tenta	3	5	4.0	0.51
Oxyurostylis smithi	4	4	4.0	0.51
Turbonilla sp. (indeterminate)	3	4	3.5	0.44
Nereis grayi	4	3	3.5	0.44
Cerastoderma pinnulatum	5	2	3.5	0.44
Lyonsia hyalina	4	3	3.5	0.44
Pandora sp. (indeterminate)	2	4	3.0	0.38
Ampharetidae (Ampharetinae) sp.	2	3	2.5	0.32
Nassarius trivittatus	1	4	2.5	0.32
Typosyllis sp. 1	3	2	2.5	0.32

STUDY SITE = BUZZARDS BAY
STATION = R2
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	REP 2	MEAN	% OF TOTAL
Polynoidae sp. (indeterminate)	0	5	2.5	0.32
Byblis serrata	2	3	2.5	0.32
Glycera sp. (indeterminate)	4	1	2.5	0.32
Nucula proxima	2	2	2.0	0.25
Ampelisca verrilli	3	1	2.0	0.25
prionospio (M.) perkinsi	1	2	1.5	0.19
Spiochaetopterus costarum	0	3	1.5	0.19
Odostomia cf. gibbosa	1	2	1.5	0.19
Spiophanes bombyx	1	2	1.5	0.19
Nuculanidae sp. (indeterminate)	0	3	1.5	0.19
Mulinia lateralis	1	2	1.5	0.19
Owenia fusiformis	1	2	1.5	0.19
Nephtyidae sp. (indeterminate)	2	1	1.5	0.19
Ampharetidae (Melinninae) sp.	1	2	1.5	0.19
Ceriantheopsis americanus	0	3	1.5	0.19
Amphiporus bioculatus	1	1	1.0	0.13
Carazziella hobsonae	0	2	1.0	0.13
Ensis directus	1	1	1.0	0.13
Cabira incerta	1	1	1.0	0.13
Asychis elongata	0	2	1.0	0.13
Pectinaria sp. (indeterminate)	1	1	1.0	0.13
Sipuncula	1	1	1.0	0.13
Notomastus spp. (indeterminate)	1	1	1.0	0.13
Tellinidae sp. (indeterminate)	0	1	0.5	0.06
Turtonia minuta	0	1	0.5	0.06
Parougia caeca	1	0	0.5	0.06
Turbonilla stricta	1	0	0.5	0.06
Cyclaspis varians	0	1	0.5	0.06
Ptilanthura tenuis	1	0	0.5	0.06
Lumbrineris acicularum	0	1	0.5	0.06
Ampelisca vadorum	0	1	0.5	0.06
Terebellidae sp. (indeterminate)	0	1	0.5	0.06
Polygordius sp.	0	1	0.5	0.06
Dorvilleidae sp. A	1	0	0.5	0.06
Unciola sp. (indeterminate)	1	0	0.5	0.06
Callianassa setimanus	0	1	0.5	0.06
Acteon punctostriatus	0	1	0.5	0.06
Polydora socialis	0	1	0.5	0.06
Saccoglossus kowalevskii	1	0	0.5	0.06
Pherusa sp. (indeterminate)	0	1	0.5	0.06

STUDY SITE = BUZZARDS BAY
STATION = R2
COLLECTION DATE = MARCH 1990
(continued)

TAXA	REP 1	REP 2	MEAN	% OF TOTAL
Phyllodoce arenae	1	0	0.5	0.06
Bostrichobranchus pilularis	1	0	0.5	0.06
TOTAL NUMBER OF TAXA	62	71		
TOTAL NUMBER OF INDIVIDUALS	726	851		

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	80
MEAN NUMBER OF INDIVIDUALS	788.5

STUDY SITE = BUZZARDS BAY
STATION = R3
COLLECTION DATE = MARCH 1990

TAXA - Mean Total Individuals, 727	REP 1	REP 2	MEAN	% OF TOTAL
Cylichnella bidentata	135	196	165.5	22.76
Mediomastus ambiseta	60	150	105.0	14.44
Nucula proxima	62	57	59.5	8.18
Tubulanus pellucidus	50	54	52.0	7.15
Scolelepis (P.) bousfieldi	30	70	50.0	6.88
Nephtys incisa	40	53	46.5	6.40
Turbonilla interrupta	8	61	34.5	4.75
Pitar morrhuanus	11	52	31.5	4.33
Ninoe nigripes	23	28	25.5	3.51
Prionospio (M.) perkinsi	1	21	11.0	1.51
Maldanidae sp. (indeterminate)	2	19	10.5	1.44
Oligochaeta	7	13	10.0	1.38
Asychis elongata	7	9	8.0	1.10
Cirrophorus furcatus	7	8	7.5	1.03
Levinsenia gracilis	1	11	6.0	0.83
Astyris lunata	8	3	5.5	0.76
Turbonilla sp. (indeterminate)	0	10	5.0	0.69
Macoma tenta	4	6	5.0	0.69
Ascidiacea sp. (indeterminate)	10	0	5.0	0.69
Nephtyidae sp. (indeterminate)	4	5	4.5	0.62
Nuculanidae sp. (indeterminate)	2	7	4.5	0.62
Yoldia limatula	4	5	4.5	0.62
NINETY PERCENT BREAKPOINT				
Hutchinsoniella macracantha	0	9	4.5	0.62
Luconacia incerta	4	5	4.5	0.62
Carazziella hobsonae	1	7	4.0	0.55
Ampelisca sp. (indeterminate)	0	8	4.0	0.55
Nereis grayi	3	4	3.5	0.48
Polynoidae sp. (indeterminate)	2	5	3.5	0.48
Acteon punctostriatus	1	5	3.0	0.41
Flabelligeridae sp. (indeter.)	0	5	2.5	0.34
Phoronis sp.	3	2	2.5	0.34
Glycera americana	2	2	2.0	0.28
Mulinia lateralis	1	3	2.0	0.28
Parougia caeca	0	4	2.0	0.28
Lyonsia hyalina	1	3	2.0	0.28
Brania clavata	0	4	2.0	0.28

STUDY SITE = BUZZARDS BAY
STATION = R3
COLLECTION DATE = MARCH 1990

TAXA	REP 1	REP 2	MEAN	% OF TOTAL
Ceriantheopsis americanus	0	4	2.0	0.28
Ericthonius brasiliensis	4	0	2.0	0.28
Natica pusilla	2	2	2.0	0.28
Saccoglossus kowalevskii	1	3	2.0	0.28
Acteocina canaliculata	1	2	1.5	0.21
Pinnixa sp. (indeterminate)	0	3	1.5	0.21
Cerastoderma pinnulatum	1	1	1.0	0.14
Tellina agilis	1	1	1.0	0.14
Autolytus cf. fasiatus	0	2	1.0	0.14
Sphaerosyllis taylori	0	2	1.0	0.14
Unciola sp. (indeterminate)	0	2	1.0	0.14
Parametopella cypris	2	0	1.0	0.14
Pinnixa sayana	0	2	1.0	0.14
Oxyurostylis smithi	0	1	0.5	0.07
Edotea tribola	0	1	0.5	0.07
Pectinaria sp. (indeterminate)	0	1	0.5	0.07
Aoridae sp. (indeterminate)	1	0	0.5	0.07
Batea catharinensis	1	0	0.5	0.07
Turridae sp. (indeterminate)	0	1	0.5	0.07
Typosyllis sp. 1	1	0	0.5	0.07
Unciola irrorata	0	1	0.5	0.07
Exogone dispar	0	1	0.5	0.07
Chaetopterus variopedatus	1	0	0.5	0.07
Pagurus sp.	1	0	0.5	0.07
Pinnotheridae sp. (indeterminate)	1	0	0.5	0.07
Lumbrineridae sp. (indeterminate)	0	1	0.5	0.07
Pinnixa chaetopterana	1	0	0.5	0.07
Odostomia cf. engonia	0	1	0.5	0.07
Sipuncula	0	1	0.5	0.07
Anemone sp. A	0	1	0.5	0.07
Nemertinea sp. A	0	1	0.5	0.07
Syllidae sp. (indeterminate)	1	0	0.5	0.07
Bostrichobranchus pilularis	0	1	0.5	0.07
TOTAL NUMBER OF TAXA	45	58		
TOTAL NUMBER OF INDIVIDUALS	514	940		

TOTAL STATION STATISTICS

TOTAL NUMBER OF TAXA	69
MEAN NUMBER OF INDIVIDUALS	727.0

APPENDIX B

COMPREHENSIVE LIST OF MACROBENTHIC INVERTEBRATES COLLECTED FROM BUZZARDS BAY STUDY SITE

APPENDIX B
COMPREHESIVE LIST OF MACROBENTHIC INVERTEBRATES
COLLECTED FROM BUZZARDS BAY STUDY SITE

Identifications Performed by Cove Corporation
May 1990

P. Cnidaria
- C. Anthozoa
  - F. Cerianthidae
    - Ceriantheopsis americanus
  - F. Edwardsiidae
    - Edwardsia sp.
  - Anemone sp. A

P. Nemertinea
- F. Amphiporidae
  - Amphiporus bioculatus
- F. Tubulanidae
  - Tubulanus pellucidus
- Nemertinea sp. A
- Nemertinea sp. B
- Nemertinea sp. C

P. Platyhelminthes
- C. Turbellaria
  - F. Stylochidae
    - Stylochus ellipticus

P. Annelida
- C. Oligochaeta
  - Oligochaeta
- C. Polychaeta
  - F. Ampharetidae
    - Ampharete sp. (indeterminate)
    - Melinna maculata
    - Ampharetidae (Ampharetinae) sp.
    - Ampharetidae (Melinninae) sp.
  - F. Arabellidae
    - Arabella mutans
    - Drilonereis longa
    - Notocirrus spiniferus

COMP. LIST OF MACROBENTHIC INVERTEBRATES
(CONTINUED)

F. Capitellidae
- Mediomastus ambiseta
- Notomastus luridus
- Notomastus spp. (indeterminate)

F. Chaetopteridae
- Chaetopterus variopedatus
- Spiochaetopterus costatum

F. Cirratulidae
- Caulleriella cf. killariensis
- Tharyx acutus
- Tharyx dorsobranchialis
- Cirratulidae sp. (indeterminate)

F. Dorvilleidae
- Dorvilleidae sp. A
- Parougia caeca

F. Eunicidae
- Eunicidae sp. (indeterminate)

F. Flabelligeridae
- Pherusa affinis
- Pherusa sp. (indeterminate)
- Flabelligeridae sp. (indeterminate)

F. Glyceridae
- Glycera americana
- Glycera sp. (indeterminate)

F. Goniadidae
- Glycinde solitaria

F. Hesionidae
- Microphthalmus sp. (indeterminate)

F. Lumbrineridae
- Lumbrineris acicularum
- Ninoe nigripes
- Lumbrineridae sp. (indeterminate)

F. Maldanidae
- Asychis elongata
- Maldanidae sp. (indeterminate)

F. Nephtyidae
- Nephtys incisa
- Nephtys picta
- Nephtyidae sp. (indeterminate)

COMP.LIST OF MACROBENTHIC INVERTEBRATES
(CONTINUED)

F. Nereididae
- Nereis grayi

F. Orbiniidae
- Leitoscoloplos sp. (indeterminate)

F. Oweniidae
- Owenia fusiformis

F. Paraonidae
- Aricidea (Acmira) catherinae
- Cirrophorus furcatus
- Levinsenia gracilis

F. Pectinariidae
- Pectinaria sp. (indeterminate)

F. Phyllodocidae
- Phyllodoce arenae

F. Pilargidae
- Cabira incerta

F. Polygordiidae
- Polygordius sp.

F. Polynoidae
- Polynoidae sp. (indeterminate)

F. Scalibregmatidae
- Scalibregma inflatum

F. Serpulidae
- Hydroides dianthus

F. Spionidae
- Carazziella hobsonae
- Polydora socialis
- Prionospio (Minuspio) perkinsi
- Prionospio (Prionospio) heterobranchia
- Scolelepis (Parascolelepis) bousfieldi
- Spio sp. (indeterminate)
- Spiophanes bombyx

F. Syllidae
- Autolytus cf. fasciatus
- Brania clavata
- Brania wellfleetensis
- Exogone dispar
- Odontosyllis fulgurans
- Sphaerosyllis taylori
- Typosyllis sp. 1 (NMFS)
- Syllidae sp. (indeterminate)
- Syllidae (epitoke)

COMP. LIST OF MACROBENTHIC INVERTEBRATES
(CONTINUED)

F. Terebellidae
- Nicolea zostericola
- Pista palmata
- Polycirrus sp. (indeterminate)
- Terebellidae sp. (indeterminate)

P. Mollusca
C. Bivalvia
F. Arcidae
- Anadara transversa

F. Carditidae
- Cerastoderma pinnulatum
- Laevicardium mortoni

F. Leptonidae
- Pythinella cuneata

F. Lyonsiidae
- Lyonsia hyalina

F. Mactridae
- Mulinia lateralis

F. Nuculanidae
- Nuculanidae sp. (indeterminate)
- Yoldia limatula

F. Nuculidae
- Nucula delphinodonta
- Nucula proxima

F. Pandoridae
- Pandora sp. (indeterminate)

F. Solecurtidae
- Tagelus divisus

F. Solenidae
- Ensis directus

F. Tellinidae
- Macoma tenta
- Tellina agilis
- Tellinidae sp. (indeterminate)

F. Turtonidae
- Turtonia minuta

F. Veneridae
- Pitar morrhuanus

COMP. LIST OF MACROBENTHIC INVERTEBRATES
(CONTINUED)

C. Gastropoda
F. Acteocinidae
Acteocina canaliculata
F. Acteonidae
Acteon punctostriatus
F. Crepidulidae
Crepidula sp. (indeterminate)
Crepidula plana
F. Columbellidae
cf. Columbellidae sp. (indeterminate)
Astyris lunata
F. Cylindrobullidae
Cylichnella bidentata
F. Nassariidae
Nassarius trivittatus
F. Naticidae
Natica pusilla
F. Pyramidellidae
Odostomia cf. engonia
Odostomia cf. gibbosa
Turbonilla interrupta
Turbonilla stricta
Turbonilla sp. (indeterminate)
F. Turridae
Turridae sp. (indeterminate)
F. Vitrinellidae
Vitrinellidae sp. A

P. Arthropoda
Sub P. Chelicerata
C. Pycnogonida
F. Phoxichilidiidae
Anoplodactylus lentus
Sub P. Crustacea
C. Cephalocarida
Hutchinsoniella macracantha
C. Cirripedia
Cirripedia
C. Malacostraca
O. Amphipoda

COMP. LIST OF MACROBENTHIC INVERTEBRATES
(CONTINUED)

F. Ampeliscidae
- Ampelisca vadorum
- Ampelisca verrilli
- Ampelisca sp. (indeterminate)
- Byblis serrata

F. Aoridae
- Aoridae sp. (indeterminate)
- Leptocheirus pinguis
- Unciola irrorata
- Unciola sp. (indeterminate)

F. Bateidae
- Batea catharinensis

F. Caprellidae
- Luconacia incerta
- Paracaprella tenuis

F. Gammaridae
- Gammarus annulatus

F. Ischyroceridae
- Ericthonius brasiliensis

F. Liljeborgiidae
- Idunella barnardi

F. Phoxocephalidae
- Phoxocephalus holbolli

F. Stenothoidae
- Parametopella cypris

O. Cumacea

F. Bodotriidae
- Cyclaspis varians

F. Diastylidae
- Oxyurostylis smithi

O. Isopoda

F. Anthuridae
- Ptilanthura tenuis

F. Idoteidae
- Edotea triloba

O. Decapoda

Infra O. Anomura

F. Callianassidae
- Callianassa setimanus (=C. atlantica)

COMP. LIST OF MACROBENTHIC INVERTEBRATES
(CONTINUED)

F. Paguridae
Pagurus sp.
F. Porcellanidae
Polyonyx gibbesi
F. Upogebiidae
Upogebia affinis
Infra O. Brachyura
F. Pinnotheridae
Pinnixa chaetopterana
Pinnixa sayana
Pinnixa sp. (indeterminate)
Pinnotheridae sp. (indeterminate)

P. Sipuncula
Sipuncula

P. Phoronida
F. Phoronidae
Phoronis architecta

P. Echinodermata
C. Ophiuroidea
Ophiuroidea sp.

P. Hemichordata
C. Enteropneusta
F. Harrimanidae
Saccoglossus kowalewskii

P. Chordata
Sub. P. Urochordata
C. Ascidiacea
F. Molgulidae
Bostrichobranchus pilularis
F. Styelidae
Cnemidocarpa mollis
Ascidiacea sp. (indeterminate)

BUZZARDS BAY DISPOSAL SITE
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(Continued)