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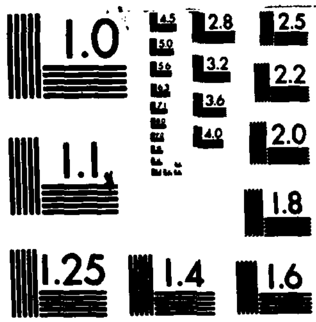
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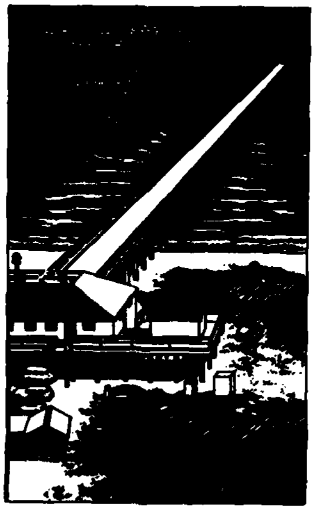

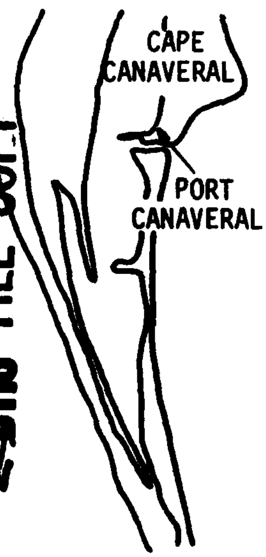

MISCELLANEOUS PAPER CERC-84-3

INTERPRETATIVE ANALYSIS OF SURFICIAL SEDIMENTS AS AN AID IN TRANSPORT STUDIES OF DREDGED MATERIALS CAPE CANAVERAL, FLORIDA

by

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Final Report

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Analyses of surface and core sediment samples; dredging records; bathymetric surveys; wind, wave, and current data; and pertinent literature were undertaken to determine the amount and direction of sediment transport from a dredge disposal site. The site is located 4.5 miles east of Cocoa Beach, Florida, in 40-55 ft of water, on the inner continental shelf. Dredge disposal material is composed of clay, silt, and fine sand removed from the (Continued)

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20. ABSTRACT (Continued).

entrance channel to Port Canaveral Harbor located approximately 7 miles to the north.

Volumetric calculations were made using 1983 bathymetric data. Comparison between the bathymetric data and the known amount of sediment placed on the site during disposal operations (1974-1983) indicates a loss of material from the site. However, consolidation of disposal material, unknown predisposal bathymetry, and "short-dumping" could account for much of the loss.

Sediment analysis and subsequent plotting of sedimentologic parameters (mean grain size, standard deviation, and skewness) revealed no trends in sediment distribution at the disposal site. Insufficient sample intensity and the general similarity in the size and composition of the dredge disposal material and the indigenous shelf sediments may explain the lack of identifiable trends in sediment distribution.

Sediment transport studies conducted in the Cape Canaveral region by previous investigators indicate that net movement is alongshore, or approximately north-south. The variability of local winds and currents in the vicinity of Cape Canaveral makes such generalizations only moderately reliable relative to this specific disposal site. Sand waves on the shelf surface, detected on side-scan sonar profiles, indicate recent current activity at the disposal site capable of transporting sediment.

Results of this study suggest that detailed site-specific data are necessary in order to make conclusive statements about sediment transport off the disposal site.

PREFACE

The study described herein was authorized by the U. S. Army Engineer District, Jacksonville (SAJ), under the general direction of Dr. Jonathan Moulding, Environmental Branch. Special thanks go to B. Lancaster, D. Rosen, and P. Schmidt, all of SAJ, for their efforts in obtaining much of the data and unpublished material used in the investigation.

All elements of the study were conducted at the U. S. Army Engineer Waterways Experiment Station (WES) by personnel in the Coastal Engineering Research Center (CERC) under the direction of Dr. R. W. Whalin, Chief, CERC, Dr. J. R. Houston, Chief, Research Division, and H. L. Butler, Chief, Coastal Processes Branch. Second LT J. P. Rodriguez, CE, assisted in volumetric and grain-size calculations and collection of historical data. The report was written by Marie A. Ferland and Dr. Lee L. Weishar.

Commander and Director of WES during the course of the investigation and the preparation and publication of this report was COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

CONVERSION FACTORS, INCH-POUND TO METRIC (SI) UNITS OF MEASUREMENT

Inch-pound units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
miles (U. S. statute)	1.609347	kilometers
feet	0.3048	meters
cubic yards	0.7645549	cubic meters
knots (international)	0.5144444	meters per second

INTERPRETATIVE ANALYSIS OF SURFICIAL SEDIMENTS AS AN AID IN TRANSPORT STUDIES OF DREDGED MATERIALS CAPE CANAVERAL, FLORIDA

PART I: INTRODUCTION

1. This study was undertaken by the Coastal Engineering Research Center (CERC) for the U. S. Army Engineer District, Jacksonville (SAJ), to determine the direction and amount of sediment transport from a dredge disposal site. The site, located 7 miles* south of Cape Canaveral and 4.5 miles east of Cocoa Beach, Florida (Site B, Figure 1), has been in use since 1974. During the past 9 years, approximately 7.75 million cu yd of material have been deposited on the site. Surface sediment samples were collected by the Environmental Protection Agency under the direction of SAJ from the disposal site and adjacent area and analyzed for grain size and composition. In addition, historical information was obtained on current measurements, wind and wave spectra, dredging records for the site, and regional geology. An analysis of the available data and a discussion of the results are presented to indicate potential transport patterns.

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* A table for converting the inch-pound units of measure found in this report to metric (SI) units is found on page 3.

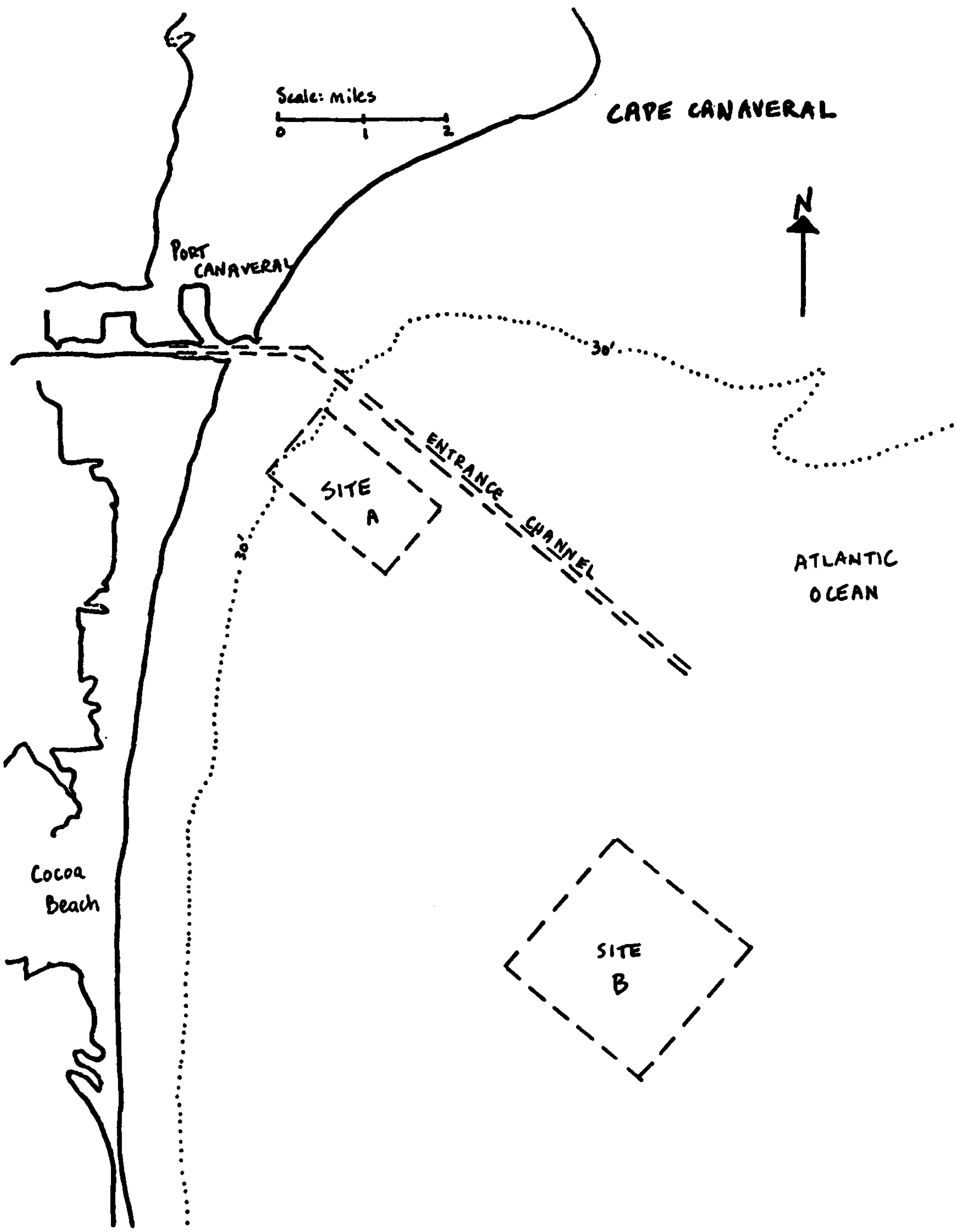

Figure 1. Location map of the Cape Canaveral region, including the dredge disposal sites and the entrance channel

PART II: LITERATURE REVIEW

2. In order to determine sediment transport direction b, analysis of sediment samples, an investigation of the indigenous sediments was conducted in the vicinity of the disposal site and in the dredged channel (Figure 1). Sedimentological data, including vibracore logs, grain-size analyses, and cross sections, are available for the Canaveral region from research conducted by CERC. Meisburger and Duane (1971) and Field and Duane (1974) provide baseline data on the sediments and geomorphology of the inner continental shelf. A similar data set is available for the region adjacent to Indialantic-Melbourne Beach, resulting from the search for a source of sediment for beach nourishment (U. S. Army Corps of Engineers (USACE) 1978; Brooks 1976; Mims 1975).

3. Unpublished SAJ core data and grain size analyses also were utilized to provide information about the material dredged from Port Canaveral channel, since no samples of material actually placed in the hoppers were available.

4. A review of literature concerning recent current and sediment transport studies in the vicinity of the disposal site was conducted. Early work, begun in 1962 during a joint project by the Chesapeake Bay Institute and the Woods Hole Oceanographic Institution, resulted in two reports. Bumpus (1964) discusses nontidal drift results obtained from current meters placed at selected depth contours, near the water surface and at the bottom, for several locations adjacent to Cape Canaveral. Carter and Okubo (1965) employed fluorescent dyes to monitor the dispersion processes active on the Canaveral inner shelf. More recently, investigators (Kerr 1980; Smith 1982) have completed circulation studies on the continental shelf off Ft. Pierce, Florida, approximately 60 miles south of Cape Canaveral. The 1982 studies were based on current meter data and will be used as a comparison with the results of the 1962 experiments.

5. Data for average wind and wave conditions in the study area were obtained from several sources. Wind speed and direction diagrams, calculated for Cocoa Beach for the 10-year period (1945-1947 and 1950-1958), were located on project plansheets (SAJ 1979). A frequency and directional swell diagram also was included on the plansheets. Wave period and wave height rose diagrams were obtained from shipboard observations (Summary of Synoptic Meteorological Observations) and calculated by Walton (1973).

6. The Glossary of Inlets Report (Hunt 1980) for Port Canaveral Entrance provided useful information about the region and served as a general reference. Specific statements regarding dredging, and sediment transport from disposal sites, were obtained from several publications (Bokuniewicz 1982; Schwartz and Musialowski 1977; USACE 1954), and personal communications.*

* Information was provided by Edward Hands, CERC, and David Williams, Hydraulics Laboratory (HL), both of the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and by Andy Hobbs, SAJ.

PART III: DATA ANALYSES

Indigenous and Dredged Sediments

7. The disposal area is located in 40-55 ft of water on the inner continental shelf, which is 32 miles wide and dips seaward with a 1:440 slope at the Cape. The regional geology can be generalized as unconsolidated marine clays and sands resulting from numerous depositional and erosional events due to fluctuations in sea level (Field and Duane 1974). Generally, the sediments in the vicinity of the Cape are highly variable in size, texture, composition, and lateral continuity. The shelf surface also is irregular, with isolated ridges, shoals, and depressions (Field and Duane 1974).

8. The Canaveral shelf was previously cored as part of the Inner Continental Shelf Sediment and Structure Study (ICONS) carried out by CERC (Meisburger and Duane 1971; Field and Duane 1974). Samples from cores within the area contain a mixture of modern clays, detrital carbonate and quartz silt, very fine quartz sands, and varying amounts and sizes of shell fragments (Field and Duane 1974). A diagram from the ICONS report (Figure 2) shows modern clays, silts, and fine sands in the area adjacent to Cocoa Beach. Often this unit is underlain by a stiff clay unit containing shell fragments. The fine sediments (silts and clays) are deposited in the region under the relatively low energy conditions created in the lee of the Cape and in its associated shoals (Meisburger and Duane 1971).

9. Similar sediments were mapped in the Melbourne Beach area during the evaluation of borrow material for beach nourishment (Mims 1975). Within 1 mile of the shore, the surface sediment was very fine silty sand. Moving seaward, the sediment was slightly sticky, cohesive mud (silt and clay) with some very fine sand and shell fragments. The final report for the beach nourishment project (Brooks 1976) cites a 9-ft thick overburden of mud at distances of 1 mile offshore. This overburden is representative of the material that has been dredged to deepen and lengthen the navigation channel and subsequently was deposited at Site B (Figure 2).

10. Cores from Port Canaveral channel were examined in conjunction with the original core logs and grain-size analysis (unpublished SAJ data) to determine the nature of dredged material actually deposited at Site B. The

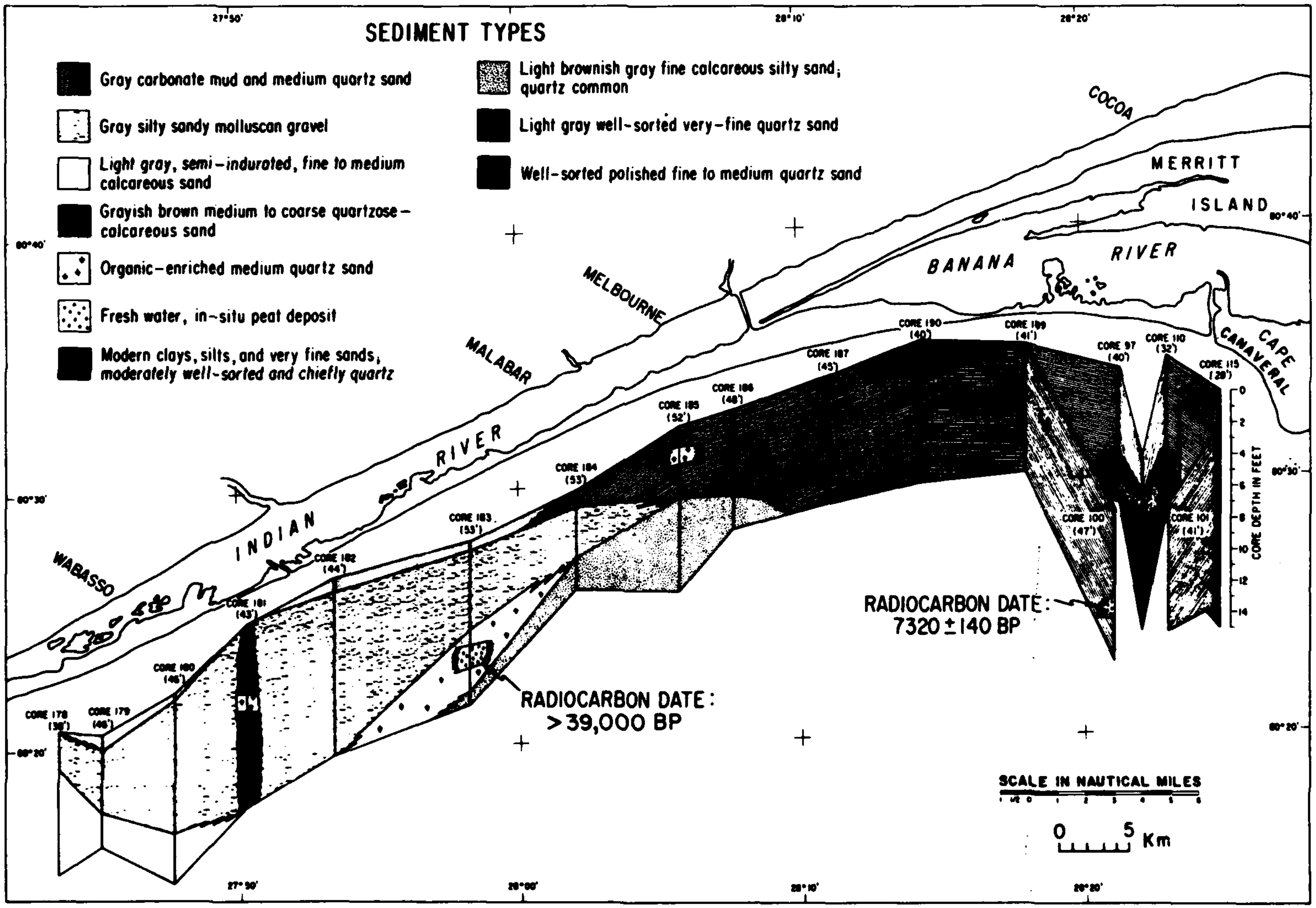

Figure 2. Fence diagram illustrating spatial distribution of lithologies south of Cape Canaveral from Field and Duane 1974

average depth of the cores was 20 ft, taken in 20-35 ft of water (mlw) in the inner reach of the entrance channel. Generally, the sediments were stiff clays and silts, with horizons of very fine silty sand, shell fragments, and organics. Grain-size analysis of core samples showed most sediments to be finer than fine sand (0.250-0.0125 mm in diameter), with large quantities of silt (0.063-0.039 mm) present. There were locations within the channel where clay (0.019-0.006 mm) was continuously encountered for 5-10 ft in the cores. These agree with data presented in Figure 2.

Dredging History and Volumetric Calculations

11. The dredge disposal area is a 2- by 2-mile-square area located 2 miles south of the seaward extreme of the Port Canaveral entrance channel (Site B, Figure 1) which was first used in 1974. At that time a project was begun to lengthen and deepen (from -37 to -44 feet mlw) the channel for the U. S. Navy Trident Base. Before 1974, dredged material was placed either in the disposal area located directly adjacent to the inner reach of the channel (Site A, Figure 1), or it was stockpiled on land for future use. Initiation of the Trident project warranted a new disposal site, since Site A had been used for many years and the projected amount of dredged material to be removed from the channel would exceed the capacity of the site. Site B was chosen for its increased depth of water, increased distance from shore, and proximity to the outer reach of the lengthened channel where much of the new and maintenance dredging would take place.

12. Dredging dates, amounts of material dredged, and nature of the work at Site B for the years 1974-1983 are summarized in the tabulation below.

	Material Dredged (cu yd)	
Date	New	Maintenance
1974	556,616	1,010,457
1975	2,762,100	312,771
1976	2,394,041	494,720
1977		40,593
1978		282,517
1980	No	1,402,547
1981	new	494,620
1983	work	609,898
Subtotal	5,712,757	4,648,123
Total	10,360,880	

(Henceforth, all references to the disposal site refer to Site B, unless otherwise noted.)

13. The total of 10,360,880 cu yd actually represents the bulk sediment-water content, or an increase in volume of the sediment as it is dredged by an amount equal to the water by which it is diluted (Bokuniewicz 1982). Given a bulking factor of approximately 1.3 (SAJ), the estimate for material actually placed on the site is 7,750,000 cu yd. However, this estimate is tentative at best due to the unreliability of the bulking factor.

14. Volumetric calculations in the dredge disposal area can help determine how much of the material deposited is still present. Volume can be estimated by comparing detailed pre- and post-disposal bathymetry of the site. Although attempts to locate pre-disposal bathymetry have not proven successful to date, rough calculations were made using 1983 data. The bathymetric data are given in 1-ft contours and extend 0.5 mile beyond the 2- by 2-mile disposal site on each of the four sides (Figure 3). Many topographic highs are evident and are thought to be individual dredge disposal mounds in some instances, or composites of multiple disposals. Difference in elevation between the base and top of the mound was used, in conjuction with length and width measurements, to estimate volume.

15. Results of the calculations showed a volume of about 1.5 million cu yd occurring as mounds within the site. Given the inaccuracy of the method, these estimates could vary by a factor of at least two. It should not be assumed that the remainder of the material has necessarily been transported from the area; many factors can explain sediment that is unaccounted for in the volumetric calculations. Several of these factors, such as pre-existing depressions on the shelf, consolidation of disposal material, and "short-dumping," are considered significant and are discussed below.

16. The existence of numerous depressions in the disposal area (Figure 3) may explain unaccounted for sediment. Without predisposal bathymetry, it is impossible to determine the magnitude of each depression and how many may have existed at the site and were subsequently filled by dredge material. Attempts to determine the origin of these depressions have not proven successful.*

* Personal communications, James Breckenridge, U.S. navy; John Anderson and Charles Lloyd, Patrick Air Force Base, Fla.; Jerry Seaman, Canaveral Marina Cape Canaveral, Fla.

Interesting to note is the anomalous linear depression along the northeast boundary of the disposal site (Figure 3). The origin of this depression is still unknown although several explanations have been explored. The possibility that the depression was a borrow site for beach nourishment was not verifiable by SAJ dredging records. Similarly, the depression might have been part of the entrance channel for Port Canaveral (Figure 1), but this was also discounted by SAJ records. Lastly, it is possible, though unlikely, that regional processes are responsible for excavation of the depression. However, the extreme linear form suggests a non-natural origin. The continued maintenance of the depression might suggest that either (a) there is sufficient current activity velocity to prevent sediment from being deposited, or (b) that there is no significant movement of sediments in the disposal area. Until the date and mechanism of origin of the depression are known, neither of which is within the scope of this study, it is impossible to determine the volume of sediment transport into or out of the anomalous depression.

17. Dredged material consisting of clays, silts, and fine-grained sand is subject to consolidation as the weight of the overlying material expels pore water and causes the deposit to decrease in volume. This consolidation could account for as much as a 10-20 percent reduction in volume* at the disposal site.

18. An additional explanation for differences between the volume of material deposited and the volume calculated to be at the site presently could be "short dumping."** This is a term used to describe disposal of dredged material before the vessel actually reaches the bounds of the disposal site. Whether inadvertent or intentional, short dumping results in an unknown amount of material being deposited outside of the site and thus not recorded on the bathymetric surveys.

Currents, Waves, and Littoral Transport

19. Ex[illegible]iments conducted in 1962-1964 by the Chesapeake Bay Institute (Carter [illegible] 1965) involved the release of fluorescent dye, diffused in the upper [illegible] he water column in water depths of 30 ft, 66 ft, and 98 ft.

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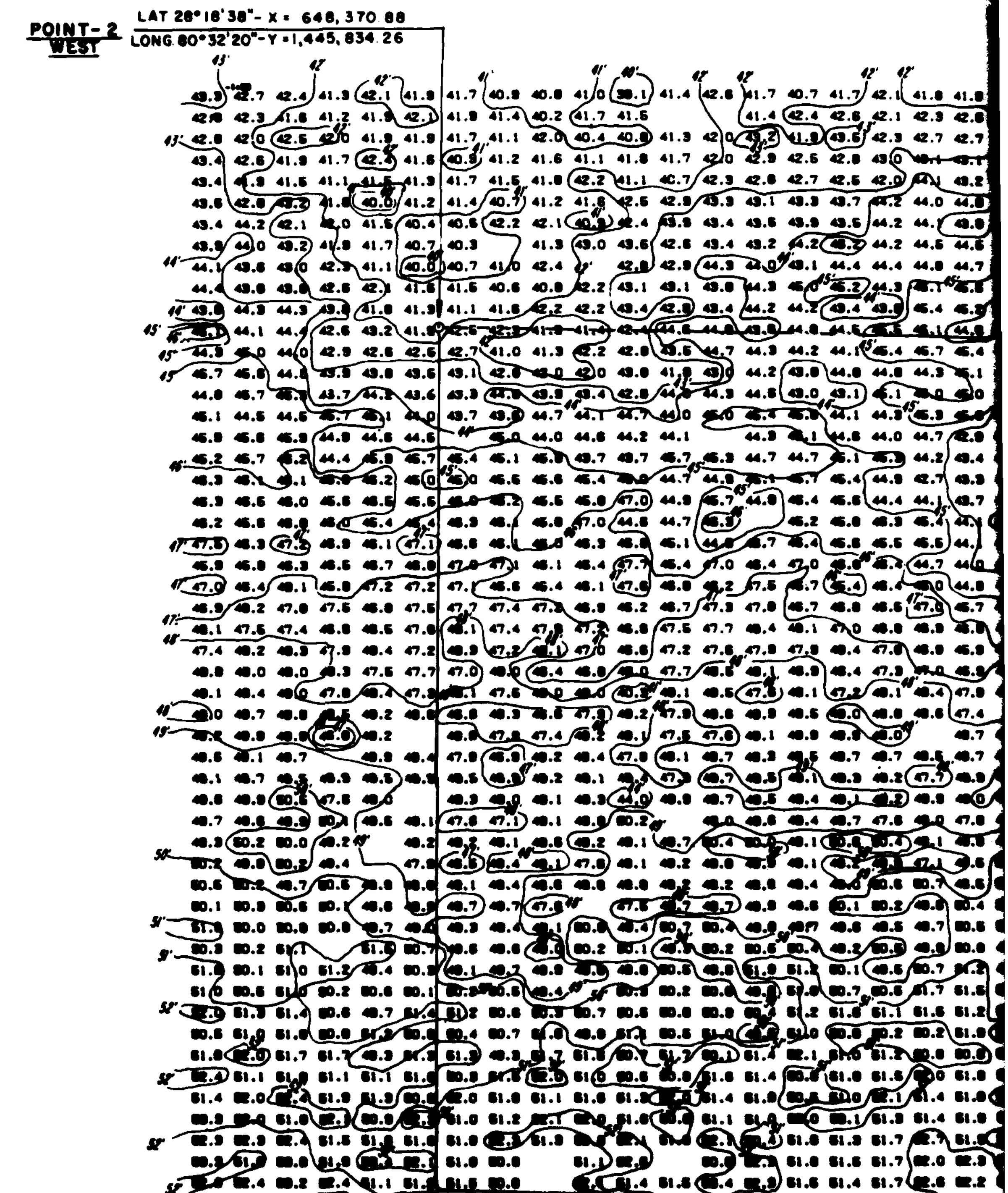
* Personal communication, David Williams, HL, WES.
** Personal communication, Edward Hands, CERC, Ft. Belvoir, Virginia.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WEST
LAT 28° 18' 38" - X = 648, 370.88
LONG 80° 32' 20" - Y = 1,445, 834.26
POINT-3
SOUTH
LAT. 28° 17' 38" - X = 656, 261.99
LONG. 80° 30' 52" - Y = 1,439, 502.64
DISPOSAL AREA

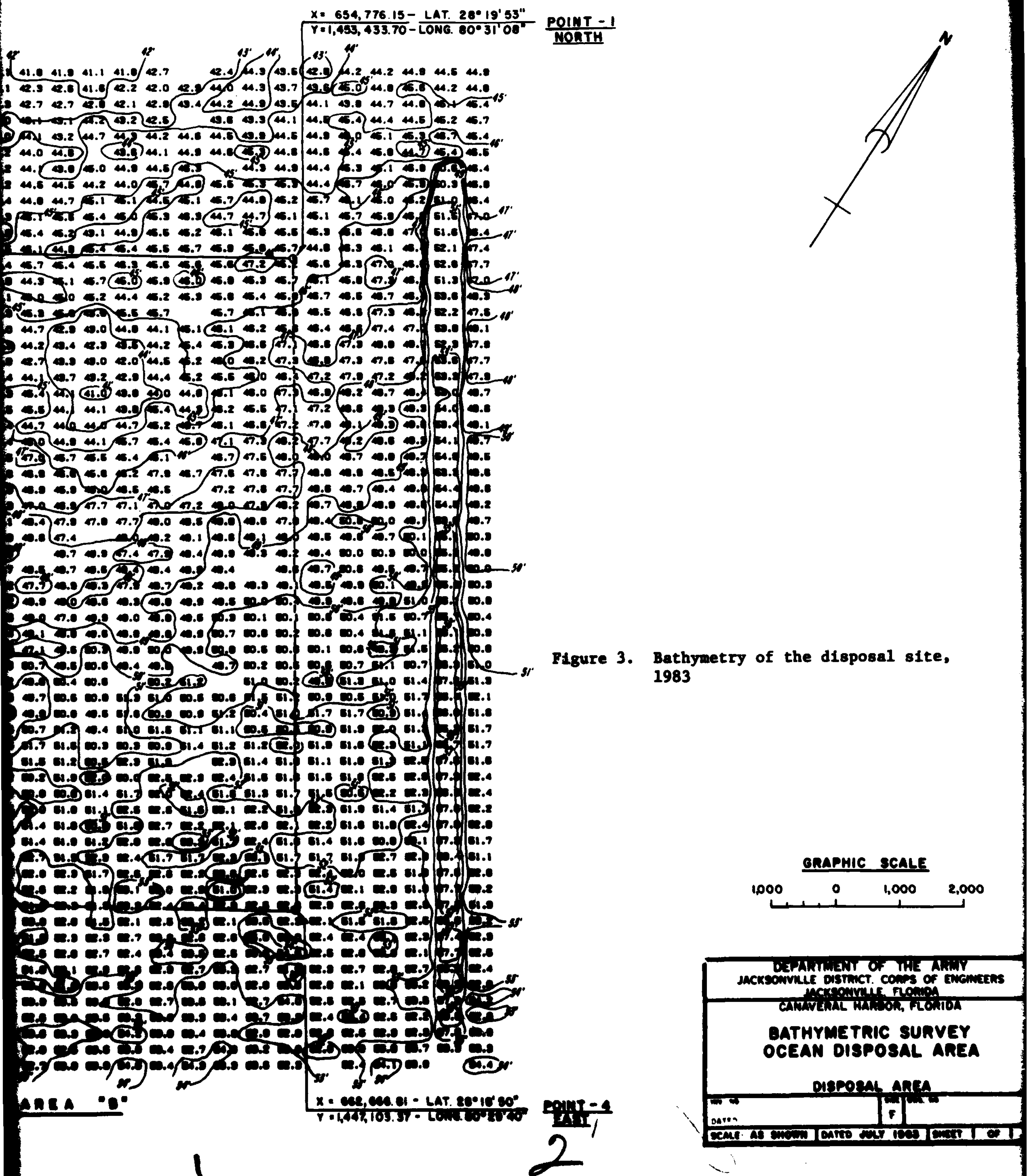

Figure 3. Bathymetry of the disposal site, 1983

Dye patches were traced for several days in sampling events during both March-April and August. In the March-April tests, the water column was not stratified so that vertical mixing was quite rapid. Movement of the dye patches during this period correlated closely with wind direction, in that northeast winds produced south-southwest currents and east-southeast winds produced northly currents. The August experiments were not so conclusive in this regard, which can most likely be related to the well-stratified water column that concentrated the tracer dye above the 33- to 49-ft thermocline. The general movement of the patch was to the south and depended on mass water movement rather than local wind direction.

20. Important conclusions can be derived from the Carter and Okubo study. First, the direction of movement is seasonal, sometimes heavily dependent on the wind. Second, no measurable quantity of dye diffused to the beach, even in those tests where dye was released relatively close to the beach. Movement seemed to be alongshore, in a general north-south orientation, and along bathymetric contours. Third, in water deeper than 33-49 ft, three currents, each quite distinct from the other, resulted: a bottom current, an intermediate depth current, and a surface current. Finally, these experiments traced movement of surface-intermediate waters from which one can infer suspended sediment transport direction but not necessarily bottom sediment movement.

21. In experiments carried out during the same time periods as Carter and Okubo's work, Bumpus (1964) measured water movement by surface drift bottles, sea bed drifters, drogued transponding buoys, and moored current meters. Results from the various methods supported one another in revealing a predominantly northerly drift during the March-April period of approximately 0.4 ft/sec (0.23 knots) and a southerly drift during the August period of approximately 0.2 ft/sec (0.08 knots). Currents in March-April were closely associated with the wind direction, while during August the relationship between currents and the lower velocity winds was not obvious. These data support the finding of Carter and Okubo (1965) which also indicated a seasonal current direction related to wind velocity and direction.

22. Studies conducted at Ft. Pierce, Florida, during May-July 1976 (Kerr 1980) using current meters moored in 33-ft, 66-ft, 131-ft, and 394-ft water depths provided interesting results. The mean velocities for selected meters are given in the tabulation below (Kerr 1980). Although these results seem

almost random, one trend is evident. Current velocities in the alongshore direction (north-south) are consistently greater than those in the on/offshore direction (east-west). Again, it is important to note that these data are from surface meters only and bottom sediment transport cannot necessarily be inferred from these data.

Current Meter Station	Depth, ft	Location	Mean Velocity Component (cm/sec) and Direction *
MS	66	Surface	8.8 to north, 1.8 to east
GS	33-66	Surface	2.8 to north, 1.6 to west
AS	33	Surface	3.1 to south, 1.4 to west

* North-south is alongshore, and east-west is across-shelf transport.

23. Another study (Smith 1982) conducted in the shelf waters off Ft. Pierce provides data on circulation patterns as well as response of shelf waters to a hurricane. Current meters were moored in 33- and 85-ft water depths, approximately 14 miles and 1.5 miles from the shore, respectively. The outer station is influenced by the Gulf Stream and had a net northward flow of 0.7-0.8 ft/sec. Cross-shelf currents were slightly onshore at 0.3 ft/sec, recorded at 7 ft above the bottom. At the 33-ft station (1.5 miles from shore), current velocities were relatively weak (0.3-0.5 ft/sec), with a slight southerly dominance. Cross-shelf motion at the 33-ft station was generally less than 0.2 ft/sec, which is not considered reliable due to limits of the current meter. Passage of the hurricane created (a) an increase in current velocities by a factor of two; (b) an initial onshore transport of shelf water, followed by offshore transport and then a return to onshore transport as the storm passed. No general statements can be made about response of shelf waters to hurricanes due to the varied courses that storm centers may follow. At both current meter stations during nonstorm conditions, alongshore current velocities were at least twice those of cross-shelf currents.

24. Walton (1973) has used the Summary of Synoptic Meteorological Observations (SSMO) data to obtain wave height, wave period, and predominant wave direction for the area offshore of Cape Canaveral. The majority of waves have periods of 7.5 sec and deepwater wave heights of less than 9 ft and approach from south 80 deg east. It is necessary to point out that these data

do not account for the effects of shoaling and refraction as the waves move from deep to shallow water.

25. Data from plansheets for the Port Canaveral project (SAJ 1979) indicate that swells were out of the northeast 13 percent of the year for the period 1932-1942 and out of the southeast 13 percent of the time for the same period. Northeast swells tended to be 6-12 ft in height, while southeast swells tended to be 1-6 ft in height. Calm conditions prevailed 14 percent of the year. Discrepancies between these data and those calculated by Walton are most likely due to effects of shoaling and refraction around Cape Canaveral and its associated shoals. Wind diagrams (SAJ 1979) show dominant winds to be 12-20 mph, out of the southeast.

26. Net littoral transport in the beach and nearshore regions is considered to be to the south (SAJ 1979; Field and Duane 1974) as evidenced by the continual trend of erosion south of the entrance channel jetties and accretion north of the jetties (Hunt 1980). Reversals in transport occur in these regions during the summer months when wave climate is conducive to northward and onshore transport (SAJ 1978). Discrepancies between net littoral transport measured in the nearshore region and the currents measured on the inner shelf (Bumpus 1964; Carter and Okubo 1965; Kerr 1980; Smith 1982) may be due to variations in circulation around Cape Canaveral. No data were obtained which measured currents in both regions during the same period of record. Without such data, conclusive statements about net transport direction are tenuous.

Sediment Sample Analysis

27. Surface sediment samples (119 total) were taken with a Smith-McIntyre grab sampler along six transects through and adjacent to the disposal area (Figure 4) by the Environmental Protection Agency under the direction of SAJ in March 1983. Sampling sites were 0.5 mile apart. Triplicate samples were taken at the sites to determine variability of the method. Transects were extended 0.5 mile in the north, east, and south directions beyond the outer boundary of the disposal site (Figure 4). Three transects extended to the west approximately 3 miles. Grid sampling intensity was increased in a westerly direction based on a reference (National Aeronautic and Space Administration 1979) that indicated sediment transport shoreward from out to

depths of 59 ft. It was hoped that increased numbers of samples would allow detection of this transport of sediment because Bumpus' (1964) original study

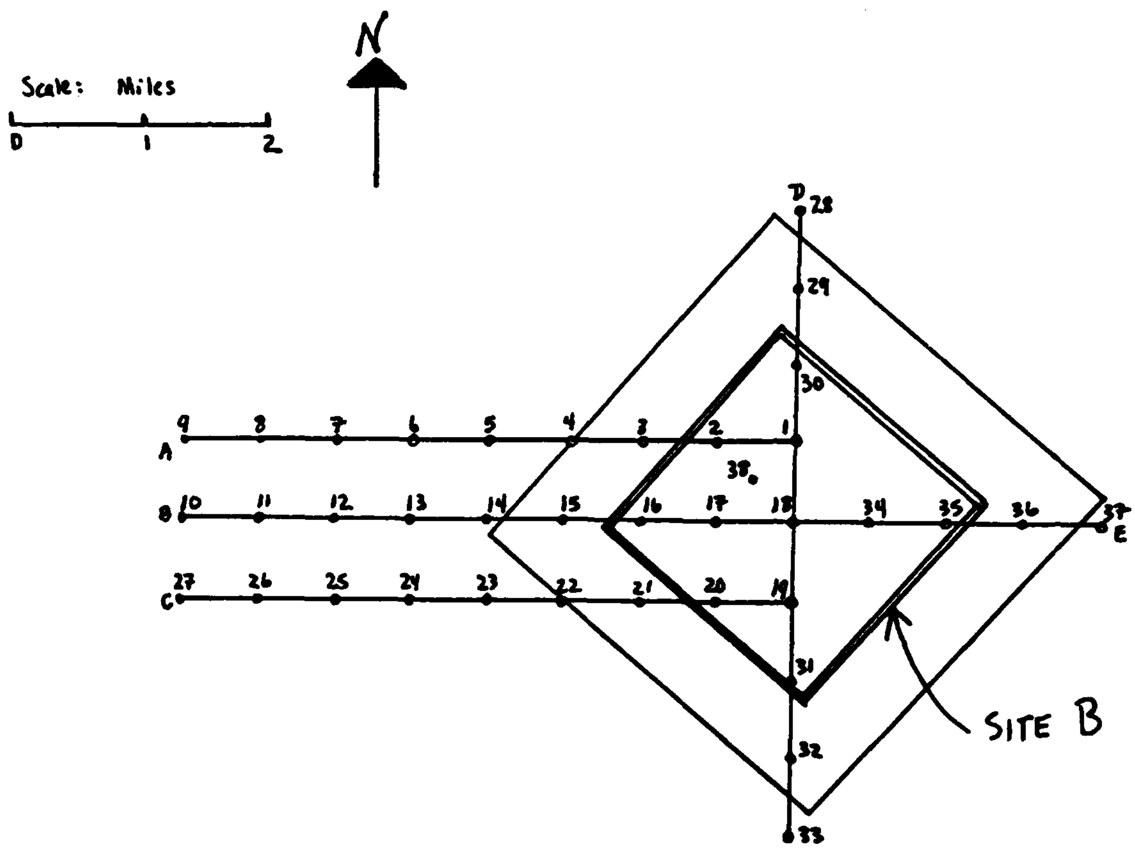

Figure 4. Locations of sediment sample sites

did not present conclusive data about onshore transport. It is important to note that the sampling grid may bias the results; hence, caution should be exercised in interpretation of the following analytical results.

28. Grain-size analyses were accomplished by standard sieve and hydrometer methods. Results were presented on graphic gradation curves, from which weight percents were taken to compute statistics on major sedimentologic parameters. In most cases, the results of grain-size analyses for triplicate samples were in agreement. In those cases where two of the three sample results agreed, the third was disregarded and parameters were calculated on the basis of the two similar results. Statistical parameters of mean grain

size, standard deviation, and skewness were calculated (Folk 1974) to quantitatively describe the gradation curves.

29. Results of the calculations are presented graphically (Figures 5, 6, and 7) by contouring similar samples and thus displaying trends. Mean grain-size data (Figure 5) show a relatively homogeneous distribution of size within and around the disposal area. The maximum (0.24 mm, fine sand) and minimum

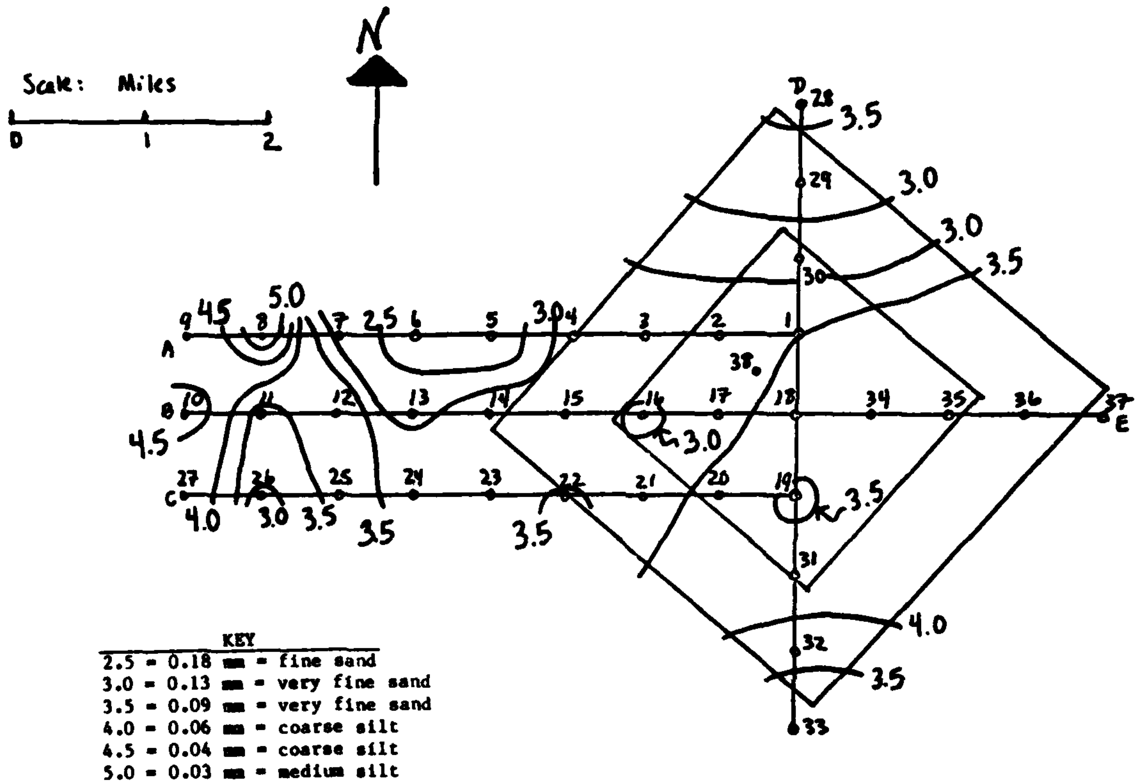

Figure 5. Mean grain-size (mm) distribution map

(0.028 mm, medium silt) of sample means occur outside and west of the disposal area, presumably reflecting indigenous shelf material. Including these extremes, the samples are similar in their size distributions in that no sample contained a significant amount of coarse sediment (particles greater than 1 mm). Similarity of samples is easily detected by looking at the occurrence of very fine sand (0.125-0.063 mm) at the endpoints of each transect through the disposal site.

30. Standard deviation (Figure 6) is a good measure of sorting, or the range of sediment sizes present in the sample. The data indicate variations which may or may not be related to the dredge disposal material. There is a

trend toward moderately well-sorted sediment near the center of the site and moderately and poorly sorted material over much of the remaining area. Without more specific grain-size data for the sediment which was actually placed there, it is difficult to interpret this "trend," except to say that transport off-site is not indicated.

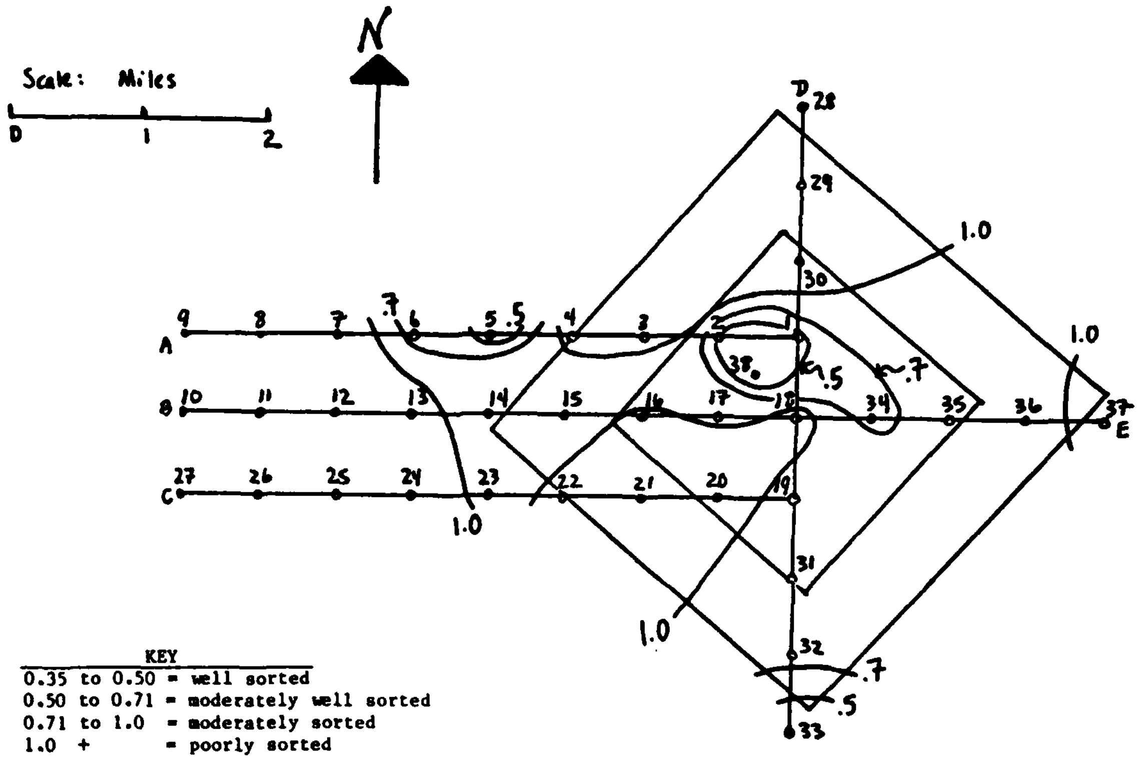

Figure 6. Standard deviation distribution map

31. Skewness measures the degree of asymmetry of the sediment gradation curve and determines whether there is an excess of fine (positively skewed) or coarse (negatively skewed) sediment in the sample. Skewness can be useful in tracing sediment distributions in a region, especially if there are two modes or sources. Results from the sample data (Figure 7) indicate slightly coarser sand in the western quadrant of the disposal area. Because much of the material deposited on the site is reported to be silt and clay, it is not clear whether this trend reflects sampling of the actual dredged material, or the indigenous shelf sediments. A coarse-skewed sample could result if some of the fine fraction were winnowed out by currents, for instance; but there are no data to suggest that currents would be active in such a localized portion of the area.

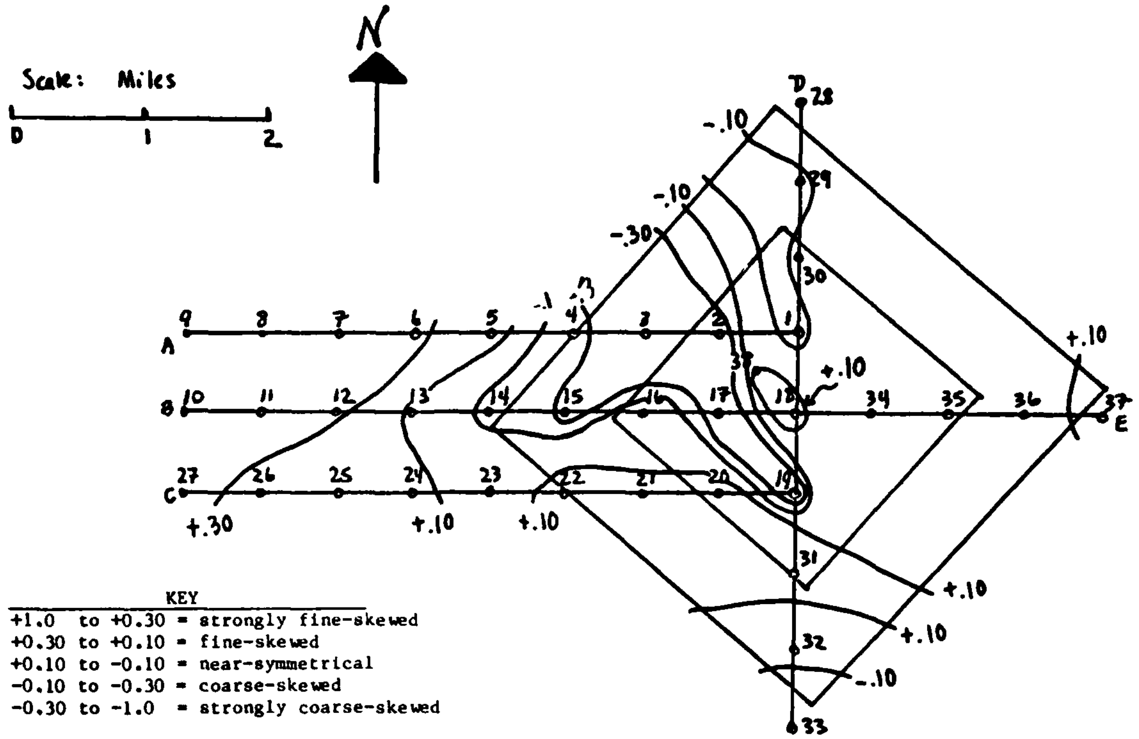

Figure 7. Skewness distribution map

32. Original research plans for this study included detailed microscopic and petrographic examination of the grab samples to attempt to detect a natural tracer in the dredged sediments. Suitable tracers, such as heavy minerals and specific biogenic components, are often identifiable in significant quantities. If such a tracer were detected, proportions found at the disposal site could be compared statistically with proportions found in the indigenous shelf sediments (using predisposal data from the ICONS research). Comparison of these proportions would indicate the direction and the distance that the dredged material had been transported from the site. However, this method depends on there being two substantially different sources of material, so that texture and/or composition differences are distinct. Since both the channel and disposal site are on the inner shelf in proximity to each other, it was determined that mineral composition was not a satisfactory criterion for determining sediment transport patterns.

Side-Scan Sonar Profiles

33. Side-scan sonar profiles were run over the disposal area in March of

1983 by the Environmental Protection Agency under the direction of the SAJ. Examination of these data revealed a relatively ubiquitous sediment surface with scattered features, many of which may be sand ridges, and a few depressions. The ridge-like features are generally 150-300 ft by 25-75 ft in dimension and are uniformly oriented northeast-southwest. Occasionally, sand waves can be seen on the flanks of these ridges, oriented perpendicular to the trend of the ridge. Features of this form, though generally larger in magnitude, are not unusual on the inner shelf (Meisburger and Duane 1971).

34. The side-scan data indicate a northeast-southwest orientation for the ridge features, following the general trend of the bathymetric contours. Correlation between individual ridges and the bathymetric data (Figure 3) proved unsuccessful in that the ridges are of a smaller scale than the majority of contoured mounds. It is sometimes possible to detect gross changes in sediment size using tonal changes on high-resolution side-scan data, but the generally small range of mean grain size (medium silt-fine sand) in the disposal area precludes such delineation. The occurrence of sand waves on the flanks of the ridges does indicate currents, which appear to be reworking the surficial sediments. Higher resolution (500-kHz frequency, as compared to 100-kHz used in this study) data would be necessary to accurately discuss the magnitude of these sand waves and the current velocities which would be necessary to generate them (Williams 1982).

PART IV: DISCUSSION AND CONCLUSIONS

35. Analysis of grain-size distribution is often employed to determine patterns of sediment transport across a region. An accurate analysis depends on the satisfaction of two important criteria: (a) an unbiased sampling scheme and (b) a quantifiable difference between the sediments of interest, in this case the dredge disposal material and the indigenous shelf. Data are then plotted on contour maps of the major sedimentological parameters (mean grain size, standard deviation, and skewness). Distinctions between various samples will ideally be independently indicated on several of the contour maps. The sediment analysis data (Figures 5, 6, and 7), when compared, show no obvious patterns. Maximum and minimum values of the parameters do not coincide to create a trend which might indicate sediment transport in a particular direction.

36. If the characteristics of the sediments are too similar, or if the source of each is essentially the same as is the case in this study, distribution trends may not be readily discernible. Greater intensity of sampling could potentially resolve subtle patterns. However, if the sediment samples analyzed are representative of the material in the area, a more intense sample grid may not yield any additional information. This would indicate that a different method of analysis (such as moored current meters or suspended sediment samplers) is required to determine sediment transport from the disposal area. It is important to note that the absence of obvious patterns on the contour maps (Figures 5, 6, and 7) is not conclusive evidence to support a statement of lack of transport.

37. Previous research conducted to establish current patterns on the inner shelf has indicated that net movement (for both velocity and frequency of occurence) for the region is in the alongshore direction, or approximately north-south (Carter and Okubo 1965; Smith 1982). Subtleties of these currents have not been delineated to date, due to the complexity of the system and the number of variables which require consideration. There are data to support the idea that currents can be correlated to local winds, at least on a seasonal (Carter and Okubo 1965; Bumpus 1964) or storm-related (Smith 1982) basis. Geomorphic features, such as sand waves on the flanks of the ridges and sediment accumulation on the north sides of the jetties at Port Canaveral, also provide support for dominantly alongshore currents.

38. Current velocity information is limited, especially for those currents which are active at the sediment-water boundary which would remove sediment from the bottom and then transport it out of the area. The presence of sand waves on the sediment surface, as seen in the side-scan profiles, is indicative of significant current and wave activity, but it is not clear what the frequency or duration of such events might be. The action of waves in suspending material allows a slower velocity current to transport material that would not ordinarily be eroded by that same current velocity (Weggel 1972). For a given sediment size, calculations can be made to determine the fluid stress, hence the velocity of currents, necessary to remove that sediment particle from the bottom. However, in regions of varied sediment regimes, such as sand combined with cohesive mud and varied bathymetry, these calculations become extremely complicated and yield uncertain results (Bokuniewicz 1982).

39. Volumetric calculations based on a single bathymetric survey are of limited value for those reasons discussed above. Should predisposal bathymetric data become available, gross estimations of the percent of the total dredged material deposited on, and still remaining at, Site B could be calculated. These calculations would be useful in determining the volume of sediment transported--if any was transported--out of the area since disposal and would therefore indicate the amount of current activity in the region.

40. The preceding data have been presented to show what is known about the processes active at the disposal area and the adjacent inner shelf. The limited amount of data has made it difficult to correlate these results with other research that has been completed. Generalizations derived from (a) current meter results from several months of record at one location, (b) wind and wave statistics for a 10-year period, and (c) sedimentologic data from another study could prove faulty. The reconnaissance nature of this study and the dearth of data available do not allow for a conclusive statement about sediment transport from the disposal site. Transport patterns probably cannot be ascertained to an acceptable confidence level without a concerted effort to collect detailed site-specific data. The data could then be used in conjunction with existing numerical models to provide quantitative estimates of the sediment transport occurring within the study region. These quantitative estimates, which would require considerable amounts of time and resources, were beyond the scope of this investigation.

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