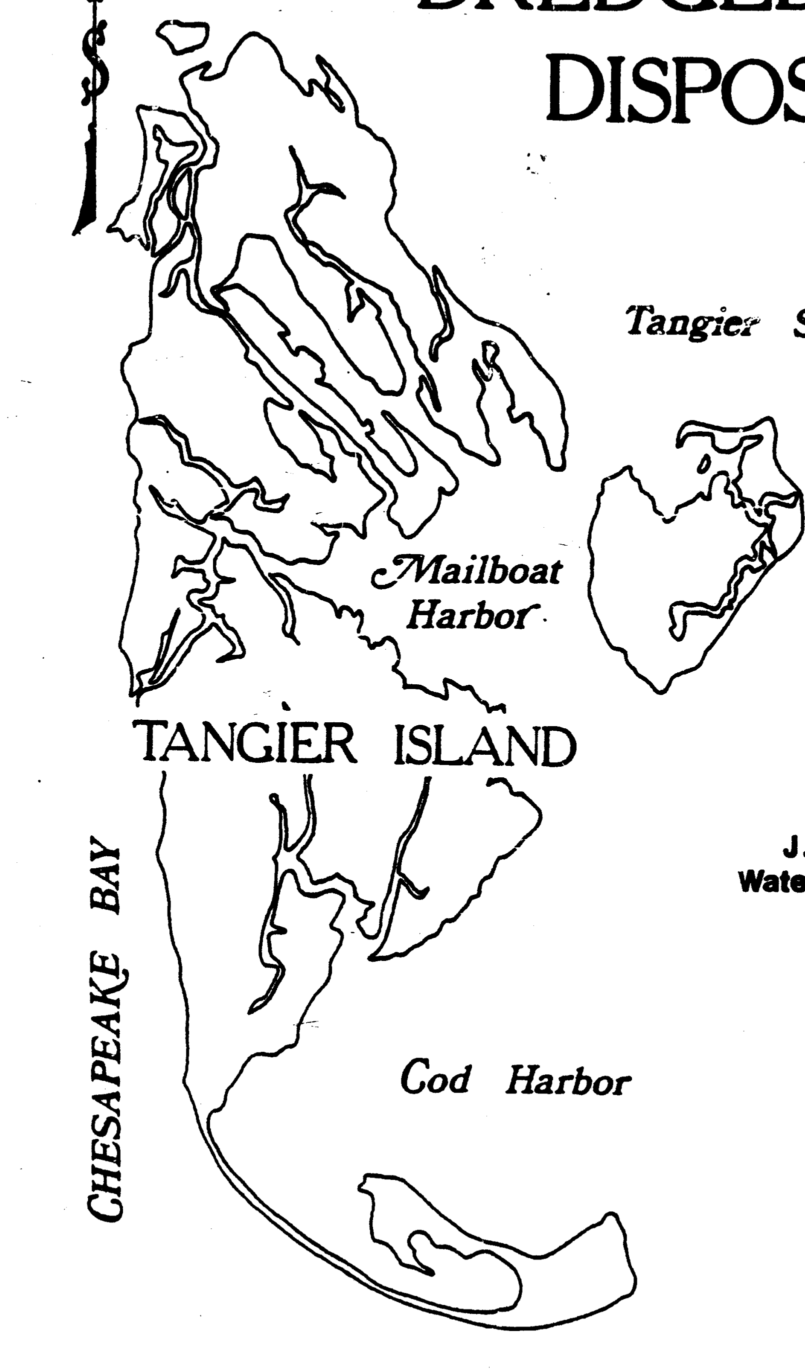
EVALUATION OF LONG-TERM DREDGED MATERIAL DISPOSAL

TANGIER ISLAND, VIRGINIA



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EXECUTIVE SUMMARY

Existing, up-land dredged material disposal areas on Tangier Island are insufficient for long term use. Expansion of these areas will unavoidably cover salt marsh wetlands and impact negatively on marine and wildlife habitats. Long-term disposal between the East and West Ridges on Tangier would eventually create additional up-land areas which could be developed. However, engineering, environmental, economic and social considerations make this impractical. Open-water disposal in nearby deep troughs would prevent beneficial use of the dredged material, but would be relatively easy to accomplish. Nearshore disposal along the west shore of Tangier would create a sacrificial buffer and mitigate erosion of the shoreline while still supplying a sediment source to the accreting spit at the southerly terminus of the island. This last option is recommended for further engineering evaluation and development of construction criteria for plans and specifications.

PREFACE

The purpose of this report is to present more definitive information on long-term dredged material disposal options at Tangier Island, Virginia. The work reported herein has resulted from a review of existing information furnished by the Norfolk District, Corps of Engineers, field inspections conducted by the authors and field investigations to gather hydrographic and topographic data.

The project was monitored by Mr. Samuel McGee, Project Manager, Dredging Management Branch, Norfolk District. Field investigations were supervised and directed by Mr. William C. Holton of Waterway Surveys & Engineering, Ltd. (WS & E, Ltd). Mr. J. W. Holton and Dr. Cyril Galvin conducted field investigations and wrote this report. Mrs. Patricia Carney supervised graphic presentations. The report was typed by Miss Karen Marcum.

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PART I: INTRODUCTION

Background

The Dredging Management Branch of the Norfolk District, Corps of Engineers has established a policy to review the long-term disposal requirements for each navigation project. The purpose of this policy is to more effectively utilize limited resources and to enable the timely performance of scheduled maintenance dredging. To accomplish this objective, local project sponsors in cooperation with the Corps of Engineers, State and other Federal agencies must provide 50-year disposal area solutions as a condition for future dredging.

This report presents the results of an engineering study to evaluate specific disposal alternatives for maintenance dredging of Tangier Island Project Channels.

Tangier Island is located in Accomack County, Virginia and is situated in the Chesapeake Bay just south of the Virginia-Maryland Boundary. The residents of the island are almost to a person lifelong, native born "Tangiermen". Every Tangierman's livelyhood is associated with work related to the islands unique situation - most of whom are "Watermen".

Tangier Sound, a portion of Chesapeake Bay, separates Tangier Island from the Eastern Shore of Virginia and Maryland. Most of the waterborn traffic takes this route rather than crossing the Chesapeake Bay proper to get to the mainland. Separate channels with different authorization however, serve to provide for traffic in both directions.

THE TANGIER CHANNEL TO TANGIER SOUND was authorized by the River and Harbor Act of 2 March 1919. It provides for a channel 8 feet deep, 100 feet wide in Tangier Sound and 8 feet deep, 60 feet wide and 4,800 feet long inside to a 400 foot square, 7 feet deep anchorage basin at the town.

THE TANGIER CHANNEL TO CHESAPEAKE BAY was approved in 1964 under Section 107 of the River and Harbor Act of 14 July 1960. It provides a channel 7 feet deep and 60 feet wide from the anchorage basin northwesterly through Tangier Creek to the 7 foot contour for an approximate length of 3,800 feet. A 300 foot land cut was required to open this channel.

Both the channels and the anchorage are complete and are now in an operations and maintenance status. Since periodic maintenance dredging is required, rather significant amounts of dredged material, about 40,000 cubic yards annually, must be placed at sites commonly referred to as "Disposal Areas". In reality, many of these areas became high land and have subsequently been developed or otherwise utilized. Those that have not are virtually inaccessible by land or boat.

The original high lands of Tangier are two distinct ridges of land perched atop an expanse of salt marshland. Much of the other highlands are the result of dredged material deposition. An example is the separate island located at the entrance of the TANGIER CHANNEL TO TANGIER SOUND. Since 1939, dredged material has been deposited at several locations on what most probably was salt marshland. Now, the material has been graded and landscaped to form a picturesque setting for a private hunt lodge (Klinefelter's).

With the fairly recent realization that destruction of salt marshland has adverse impacts on the marine ecology, new sites for future dredged material "disposal" on Tangier have all but disappeared.

The Corps, recognizing that a long-term dredging plan is needed for the Tangier projects, is seeking to identify their options for future dredged material disposal. While additional destruction of wetlands is not desirable, it cannot be ruled out. Other factors must be considered including social requirements, cost, and engineering feasibility.

This report describes a comprehensive investigation of previously used disposal sites and a search for and evaluation of potential sites for a long term disposal solution.

Objectives

The specific goals of this investigation were:

1. To evaluate 15 previously used dredged material disposal areas with respect to the feasibility for their future use;

2. To analyze four suggested long-term disposal alternatives;

3. To present a concept plan for a recommended 50 year disposal solution.

This report presents the results of field investigations, data evaluation and engineering analysis to achieve the above objectives.

PART II: EVALUATION OF PREVIOUSLY USED DISPOSAL AREAS

For the purpose of this study, the Corps has identified fifteen areas within the Tangier Island complex where dredged material has been deposited since 1922. All but three of the sites were on upland or marshland areas. All sites are shown and numbered on Figure 1. As can be seen, several sites overlap but from a field investigation, this overlap is not apparent.

The following discussion of each site is the result of an engineering inspection conducted on 6 and 8 November, 1981. Field information was also augmented through study and interpretation of aerial photography acquired on October 15, 1979 by the Corps.

Site 1

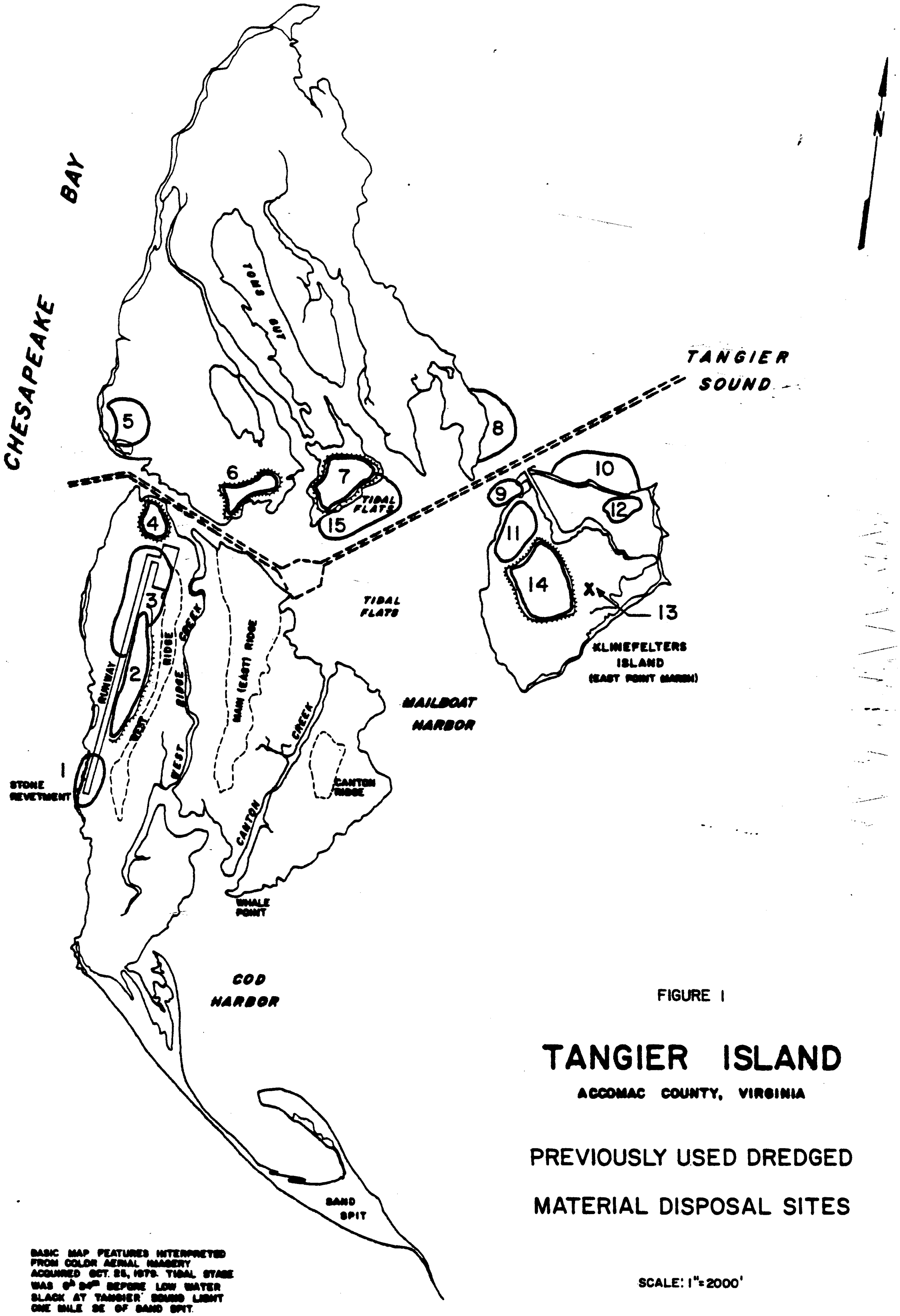
This area was used in 1977 to create a landfill for the airport runway extension. The area is currently surrounded by a rock revetment which protects the runway from erosion. This area is not suitable for future disposal due to its current use.

Site 2

Disposal in this area was also in 1977. Levees were constructed and later regraded to comply with FAA airport slope clearance requirements. The disposal area contributed to drainage problems on the West Ridge, however, construction of the runway was the initial factor in blocking the drainage from the ridge. Some additional material could be placed at this site, but considering FAA requirements, the low capacity and the drainage problem, this site in itself is not recommended for further use. Incorporation of this site into a larger site on the island will be discussed later in this report.

Site 3

This area encompasses what is currently the airfield and therefore, is not suitable for future disposal due to its current use.



BASIC MAP FEATURES INTERPRETED FROM COLOR AERIAL IMAGERY ACQUIRED OCT. 25, 1979. TIDAL STAGE WAS 6^h 34^m BEFORE LOW WATER SLACK AT TANGIER SOUND LIGHT ONE MILE SE OF SAND SPIT.

FIGURE 1

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

PREVIOUSLY USED DREDGED MATERIAL DISPOSAL SITES

SCALE: 1"=2000'

Site 4

This area was used in 1972. It is very small (2-3 acres) and is situated off the end of the airport runway. Any increase in elevation would undoubtably conflict with FAA requirements. The area is currently used as a town dump and is not suitable for future disposal.

Site 5

This small area was used in 1969. It is bordered by the Bay on the west face and salt marsh elsewhere. Expansion into the surrounding marshland would be the only practical means for utilziing this site for future disposal.

Site 6

This area, used in 1966, is now virtually inaccessible by land or water. Construction at the site would be expensive and would involve dredging an access channel and building a road across the marshland. Also, expansion of the site would involve significant destruction of the surrounding marshlands.

Site 7

Site 7 was used last in 1972. Like Site 6, it is inaccessible and would involve the same problems were it to be re-used. However, it appears more practical to reuse Site 7 than Site 6 because it is more isolated from the main commerce areas and access could be provided with the least disruption. The fine-grained sediments from the basin and navigation channels could reach this site with only short pump-out capability. Expansion of this site would also involve destruction of surrounding marshlands.

Site 8

It is assumed that this area, last used in 1929 was an open-water site. No vestige of any disposal site remains and it would be a very poor choice for disposal now, since re-entry of the sediments into the channel would be highly probable.

Site 9

This site is a small cove located behind a bulkheaded private entrance channel into the Klinefelter property. It was used in 1979 and is currently being used for deposit of sand dredged from Klinefelters entrance channel. It is not suitable for future disposal use due to size limitation and its proximity to the project channel.

Site 10

It is assumed that this area, last used in 1939, was an open-water site. It would be a very poor choice for future disposal since re-entry of the sediments into the dredged channel would be certain.

Site 11

This area, used in 1943, has been graded and landscaped for human habitation. It is not suitable for future disposal due to its current use.

Site 12

This small area, used in 1943, is overgrown with reed grass. No evidence of levees remains, and it may have been unconfined disposal on the marsh against the west ridge. In itself, this area is not suitable for future disposal due to size.

Site 13

Almost all of this area, last used in 1969, has reverted back to tidal marshland. The exception is the overlap area with Site 14. Further use of this site would involve destruction of large areas of wetlands.

Site 14

This area, last used in 1974, is diked all around. Levees appear in good shape and no foundation problems are evident. However, the area is at its maximum capacity unless the levees were raised considerably. The site material would be a source for further levee work, but for the long term, only a small percentage of the disposal requirements could be met by vertical expansion. Horizontal development would necessarily impact on the surrounding marshlands.

Site 15

Last used in 1939, this area is now a mud flat at about 0 MLW elevation. It was and is now a poor selection for disposal because of its proximity to the navigation channel and the degradation of the harbor water quality during the open-water disposal operation.

Based on the above analysis, it is concluded that re-use of any of the 15 specific sites investigated is either out of the question or not practical for long-term disposal. Sites 2, 5, 6, 7, and 14 could be expanded but this would necessitate destruction of marshland. Should this impact become acceptable, then a better procedure would be to plan a long-term disposal option at one centralized site such as the area between the West and East Ridges on the island proper.

PART III: EVALUATION OF OTHER DISPOSAL OPTIONS

Four potential options have been identified for long term disposal of dredged material from project dredging. Since re-use of the previously used individual sites is not deemed practical, additional methods of disposal must be considered. Of paramont importance in evaluating other options is beneficial use of the dredged material. The greatest beneficial use appears to be protection of the land and water resources on Tangier Island.

The four options which this study addresses are:

1. Disposal Between East and West Ridges on Tangier Island
2. Open-Water Disposal along West Shore of Tangier Island
3. Expansion of Disposal Activities on Klinefelter's Island
4. Open-Water Disposal in Deep Nearshore Troughs

Each of the above options will be discussed and finally ranked according to engineering feasibility.

Disposal Between East and West Ridges on Tangier Island (Figure 2)

A potential disposal area identified as a site between the West and East Ridges on Tangier Island is dominated by tidal marshes, guts and town refuse. Tidal currents thru the area are weak due to a low, flat tidal basin, a small tidal prism, and stream meanderings. This area currently provides drainage from the East Ridge and to some degree from the west (developed) side of the West Ridge. Residents of the West Ridge have constructed makeshift culverts under the road to divert storm water which otherwise would be trapped between the road and the elongated disposal area east of the runway.

Use of the area between the ridges for disposal would aggravate already bad drainage problems without proper storm water management. One approach would be to relocate residents on the West Ridge, and then expand toward the east using the existing disposal area (Site 2) next to the runway. The existing tidal channel meandering between the ridges would have to be relocated by dredging a canal (approximately 4000 ft.) west of the East Ridge, thereby providing drainage for the new disposal as it progressed Eastward and for the East Ridge. Once the disposal has progressed several hundred

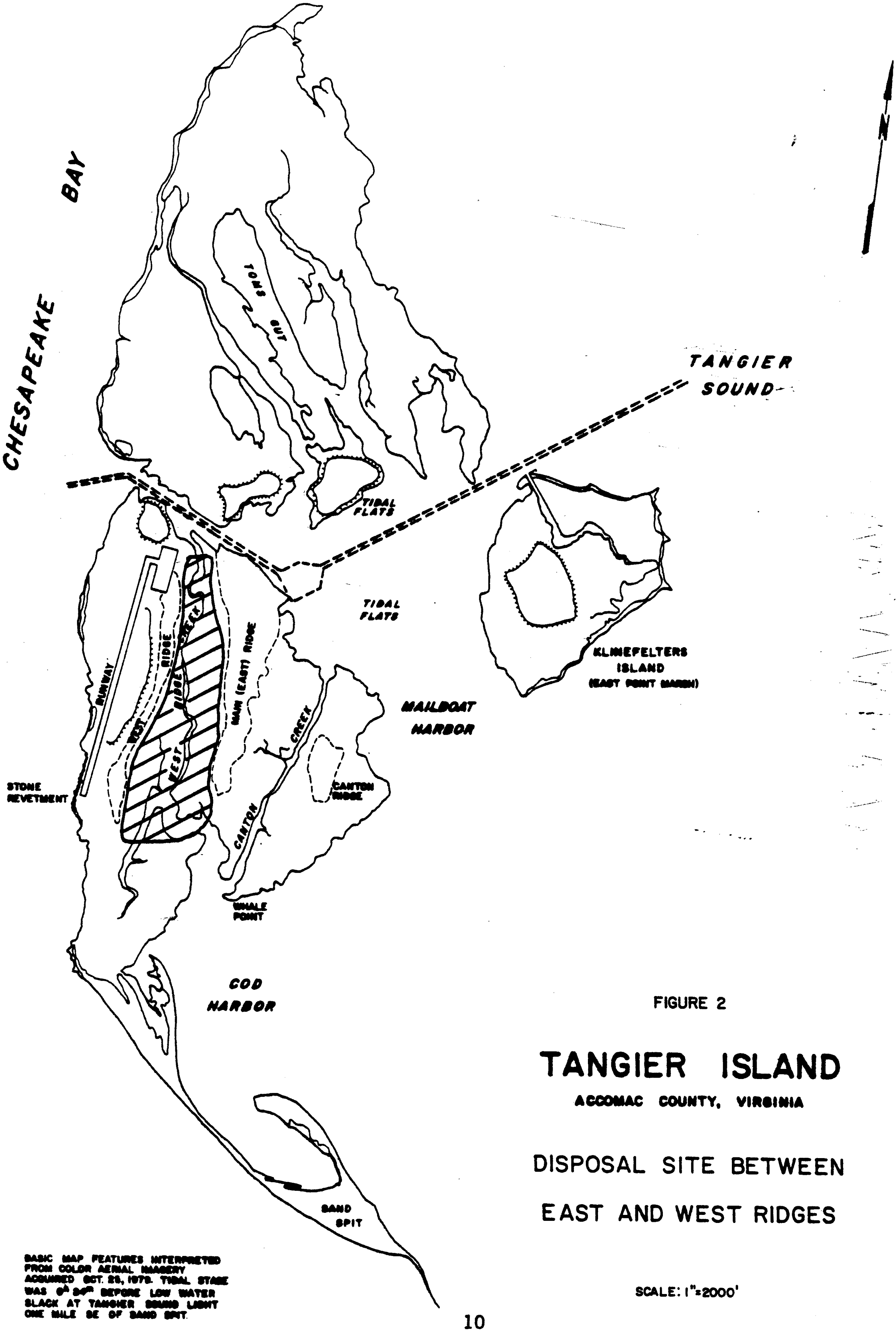


FIGURE 2

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

DISPOSAL SITE BETWEEN EAST AND WEST RIDGES

SCALE: 1"=2000'

feet eastward then the west ridge could be properly developed utilizing standard storm water management techniques and reinhabited. Assuming the area was eventually filled to an elevation of +12 feet MLW, then the capacity would be somewhere near 1,300,000 cubic yards or about 30 years of disposal. This could probably be improved on by consideration of material consolidation parameters, substrate compression and increased disposal height. However, other considerations are evident.

The proposed area between the ridges is currently a healthy salt marsh. The tidal guts are utilized by islanders for docking smaller boats and skiffs. The area is also used for sanitary disposal, although this factor would be eliminated if an adequate sanitary system were installed to service both ridges. A social problem would be expected to develop due to ownership of the area. It has been reported that ridge residents hold title to the marsh to the center of the main tidal tributary. Also drainage rights would have to be considered and provided for via the storm water management concepts mentioned above.

In summary, considering the overwhelming engineering, environmental, and social aspects (particularly that of dealing with multiple owners) of using the area between the ridges for dredged material disposal, it is recommended that this option not be considered viable.

Open-Water Disposal along West Shore of Tangier Island (Figure 3)

Evaluation of disposal of dredged material along the west shore must necessarily center around the impact on the eroding shoreline along the runway and south of the runway extension, and the ultimate fate of the dredged material particularly with respect to the potential of re-entry into the project channel and deposition on southerly shores.

The southern extremity of Tangier Island ends in an elongated "fish hook" sand spit approximately 6,000 feet long. The longitudinal axis of this formation is oriented northwest indicating the predominant direction of the long shore transport. The spit has undergone shape changes over the years but consistently maintains a spit geometry. Figure 4 indicates the net changes since 1942. Although the northwest orientation

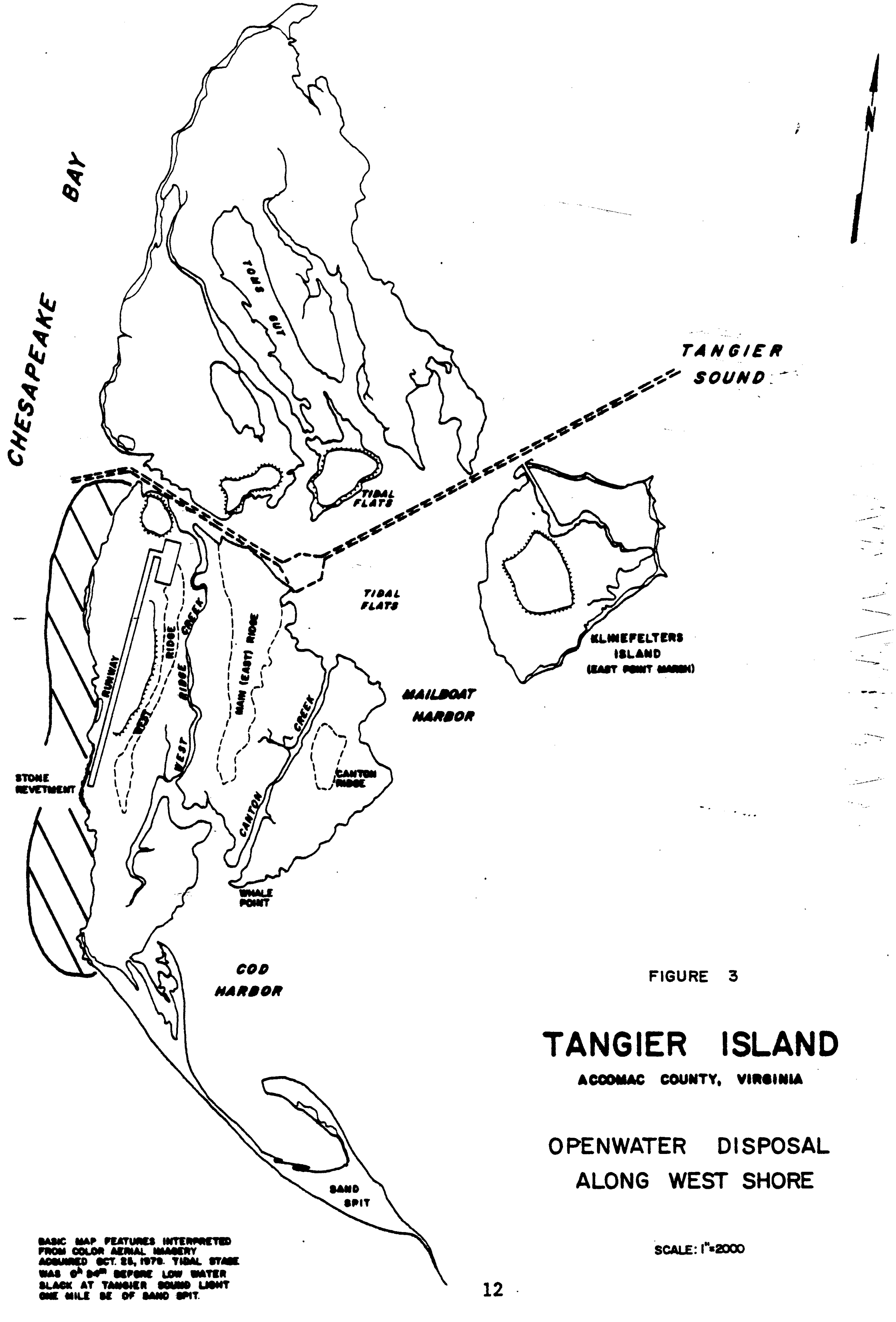


FIGURE 3

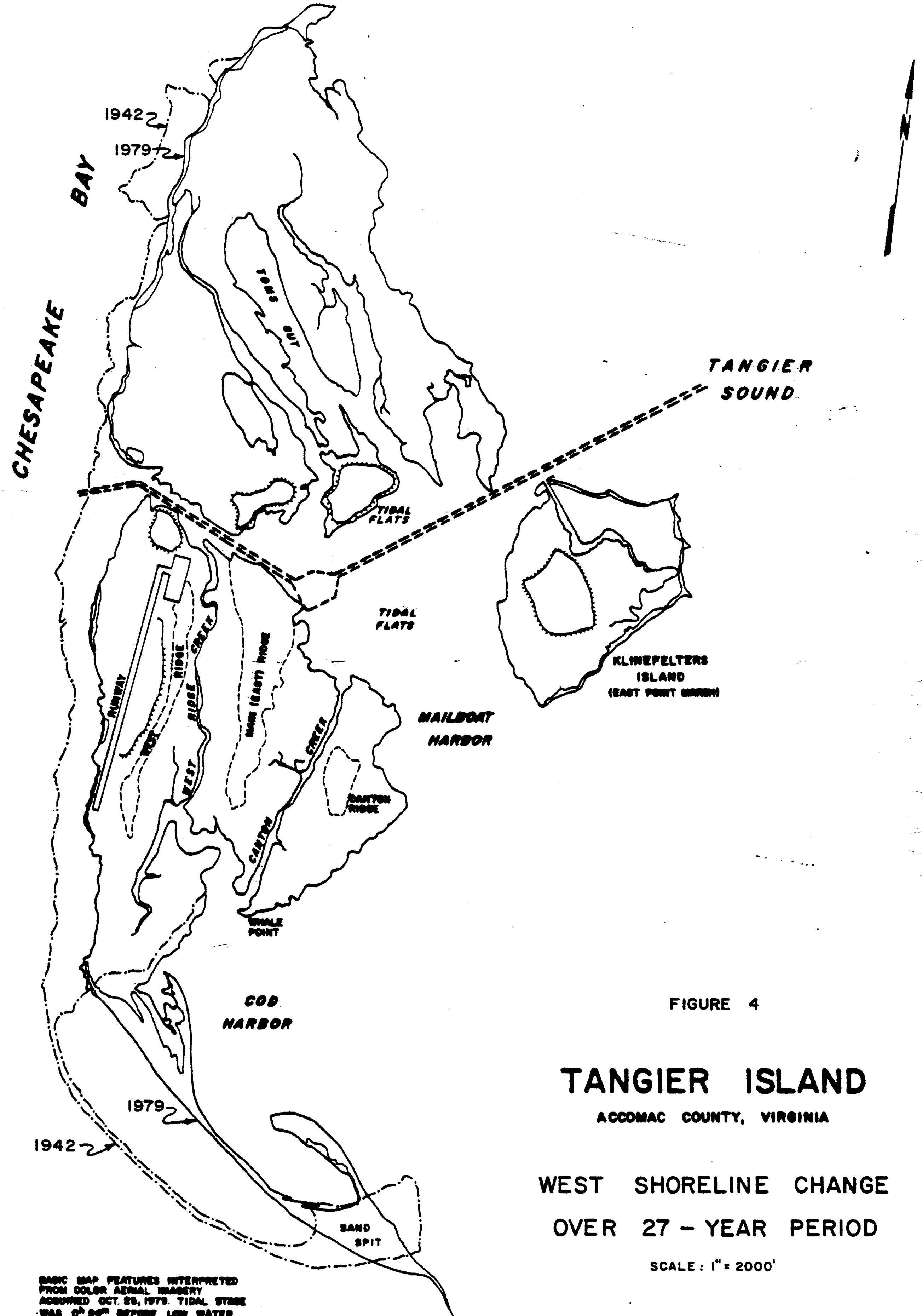
TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

OPENWATER DISPOSAL ALONG WEST SHORE

SCALE: 1"=2000

BASIC MAP FEATURES INTERPRETED FROM COLOR AERIAL IMAGERY ACQUIRED OCT. 25, 1979. TIDAL STAGE WAS 0h 24m BEFORE LOW WATER SLACK AT TANGIER SOUND LIGHT ONE MILE SE OF SAND SPIT.



BASIC MAP FEATURES INTERPRETED FROM COLOR AERIAL IMAGERY ACQUIRED OCT. 25, 1979. TIDAL STAGE WAS 0h 24m BEFORE LOW WATER SLACK AT TANGIER SOUND LIGHT ONE MILE SE OF SAND SPIT.

FIGURE 4

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

WEST SHORELINE CHANGE OVER 27 - YEAR PERIOD

SCALE: 1" = 2000'

has remained essentially the same, the south facing shore has migrated eastward on the order of 1000 feet. This migration is expected to continue as long as erosion along the west shore continues, because the spit is situated in the sheltered lee of this shore. Eastward migration of the spit would destroy active shellfish grounds located in Cod Harbor.

According to one native resident, islanders enjoy the summertime recreational opportunities the sandy spit offers. While it is held in private ownership, it is used as a public beach where organized events are held every year. In fact, in early November, islanders were seen roaming about the sand dunes and beach grass which characterized the naturally esthetic backshore areas. Occasionally, tourist to the island visit the area.

In summary, the geomorphology of the spit region is unique to the island. It provides shelter to Cod Harbor and provides a much needed recreational area for islanders. It undergoes natural geometric changes. However, it has remained welded to the main island since at least 1942 thereby, allowing easy access to residents.

North of the spit, the western shore is undergoing bank erosion at a reported rate of 20 feet per year.[1,2] The eroding shore, with the exception of the rock-armored runway extension, is backed by an old salt marsh perched on a sand substrate. Probing evidence suggests that the sandy marsh substrate is in turn underlayed by a more dense, hard pan stratum. Erosion takes place by wave action loosening large pieces of the marsh "tumps" thereby exposing more marsh to the repetative action. Predominant northwest winter winds have been observed to produce waves having a 1 to 2 foot significant height with short periods on the order of 2-3 seconds. The energy of these waves is demonstrated by observed displacement of 50-300 lb. rock armor units along the runway extension revetment.

The tumps broken away either end up on the back shore or are transported down drift where they are deposited along the sand shore of the spit. The eroding sand underlayer for the marsh is the obvious source of material contributing to the developing sand spit formation. Structural measures such as shore revetments to arrest this erosion phenomena may eliminate this major source of sand to the spit and if so, cause spit deterioration.

Figure 5 shows the location of beach and nearshore sections measured for this study and of sand samples which have been analyzed by the Norfolk District. The sample analyses are presented in Appendix 1.

Figures 6 through 11 present the sections in graphical form. It is important to note that along the eroding marsh, low sand berms have been "thrown" up just behind the exposed face. This is characteristic of erosion due to high energy wave action on a wetland shore where sand is scarce. Tidal currents appear too low to cause sand transport.

Figure 11 is a repeat survey of a cross-section measured by the Norfolk District in 1979. It is important to note that severe toe erosion is indicated at the airport revetment. While the design of the revetment is not reviewed in this report, it is suggested that its structural integrity might be jeopardized due to this action.

In summary, erosion process along the west shore of Tangier have created, and subsequently nourished, the sand spit formation at the southern terminus of the island. It is desirable to arrest erosion processes along the west shore to prevent future land loss, destruction of the airport, loss of wetlands and adverse impacts on a planned sewerage plant in the vicinity. It is also desirable to maintain the geomorphology of the spit for social, esthetic, economic and wildlife reasons. Structural erosion control measures along the west shore would have to be planned to prevent or resist the erosion observed at the existing structures necessitating a costly project. They would also tend to starve the downdrift spit formation leading to its decay. Deposition of dredged material along the west shore will provide a sacrificial buffer that can eliminate wave induced marsh erosion while at the same time providing continued nourishment to the spit between dredging cycles. This is further discussed in the section on Gross Longshore Transport contained in PART V of this report.

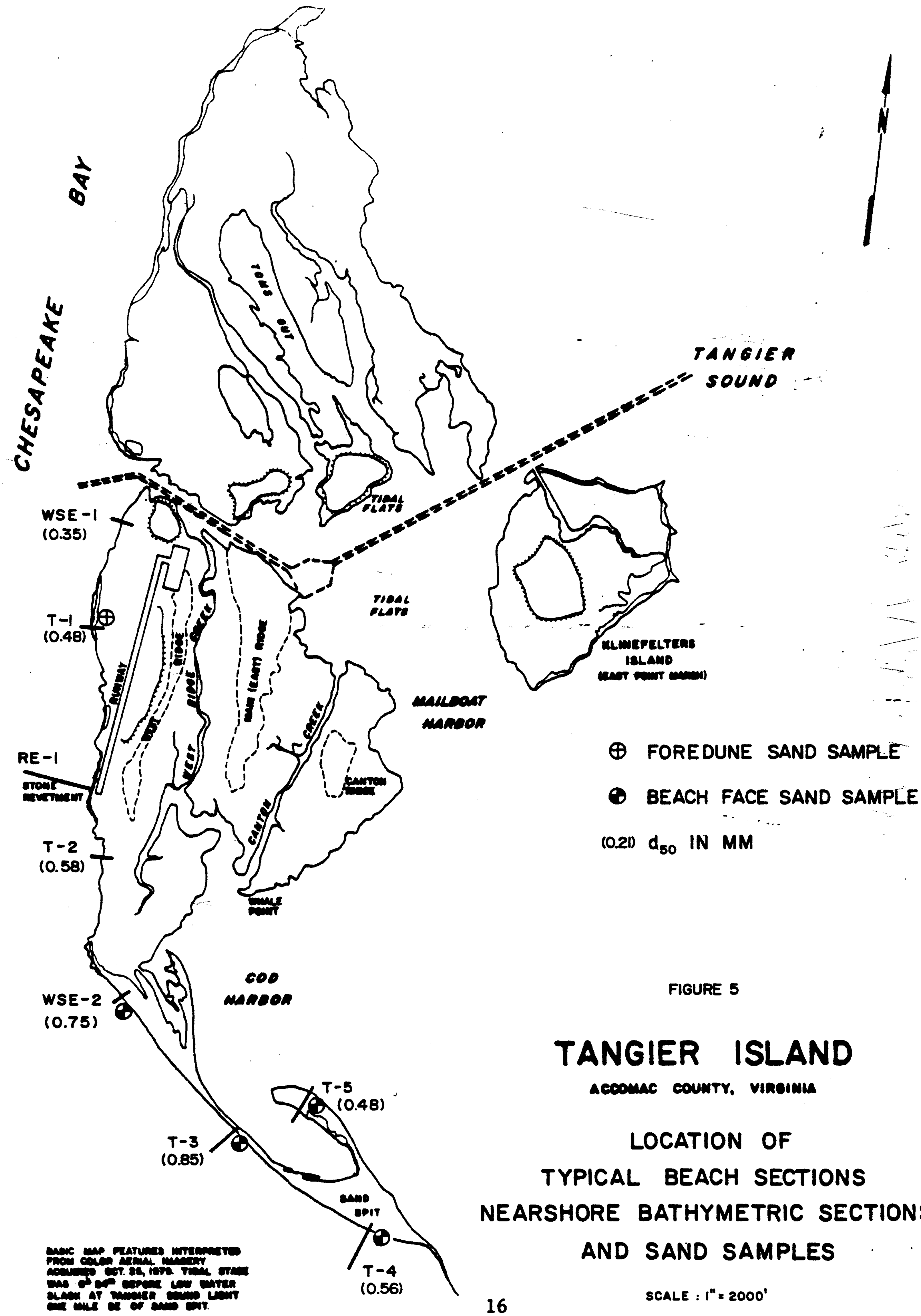


FIGURE 5

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

LOCATION OF
TYPICAL BEACH SECTIONS
NEARSHORE BATHYMETRIC SECTIONS
AND SAND SAMPLES

SCALE : 1" = 2000'

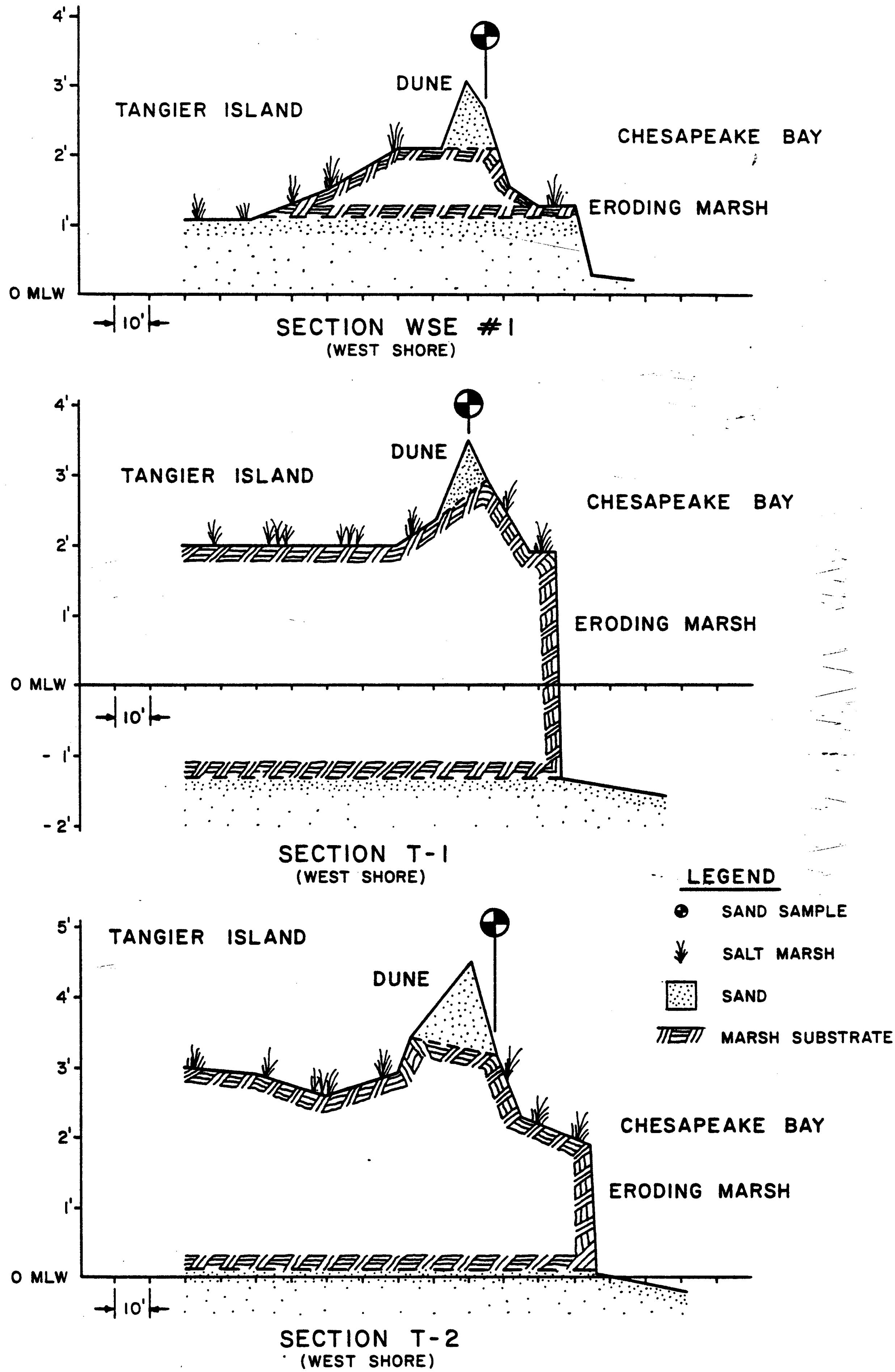
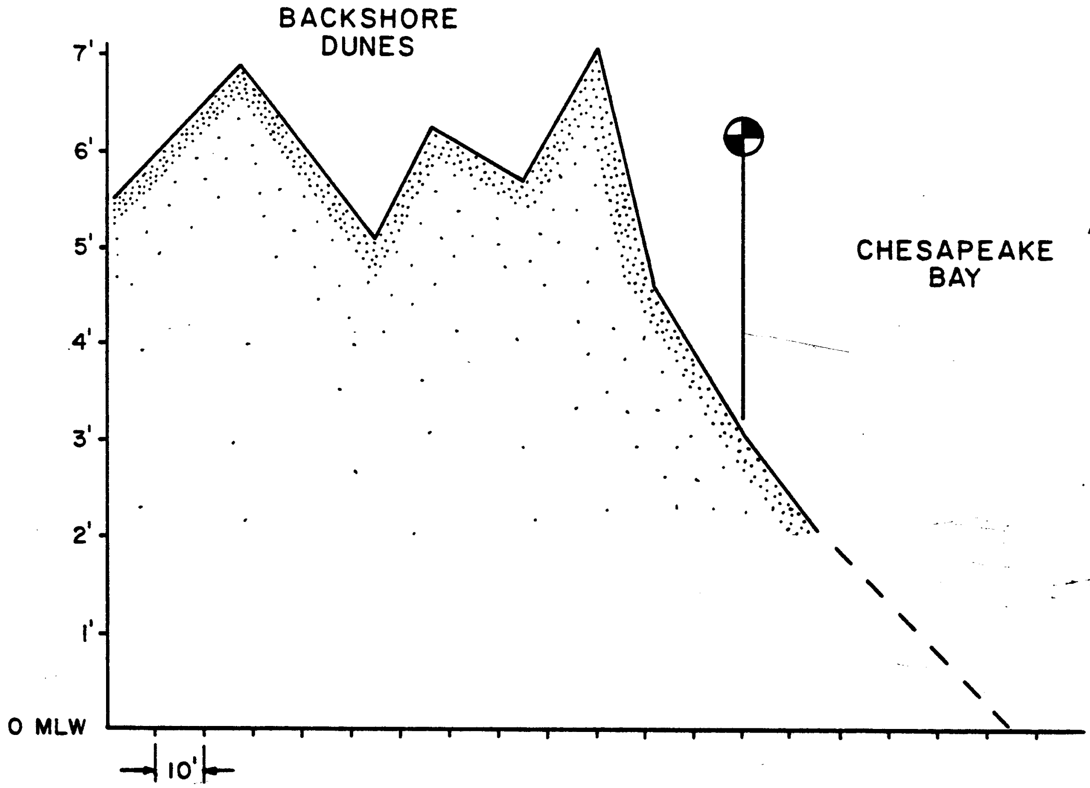

4'
3'
2'
1'
0 MLW
DUNE
TANGIER ISLAND
CHESAPEAKE BAY
ERODING MARSH
10'
SECTION WSE #1
(WEST SHORE)
4'
3'
2'
1'
0 MLW
- 1'
- 2'
DUNE
TANGIER ISLAND
CHESAPEAKE BAY
ERODING MARSH
10'
SECTION T-1
(WEST SHORE)
LEGEND
SAND SAMPLE
SALT MARSH
SAND
MARSH SUBSTRATE
5'
4'
3'
2'
1'
0 MLW
TANGIER ISLAND
DUNE
CHESAPEAKE BAY
ERODING MARSH
10'
SECTION T-2
(WEST SHORE)

FIGURE 6



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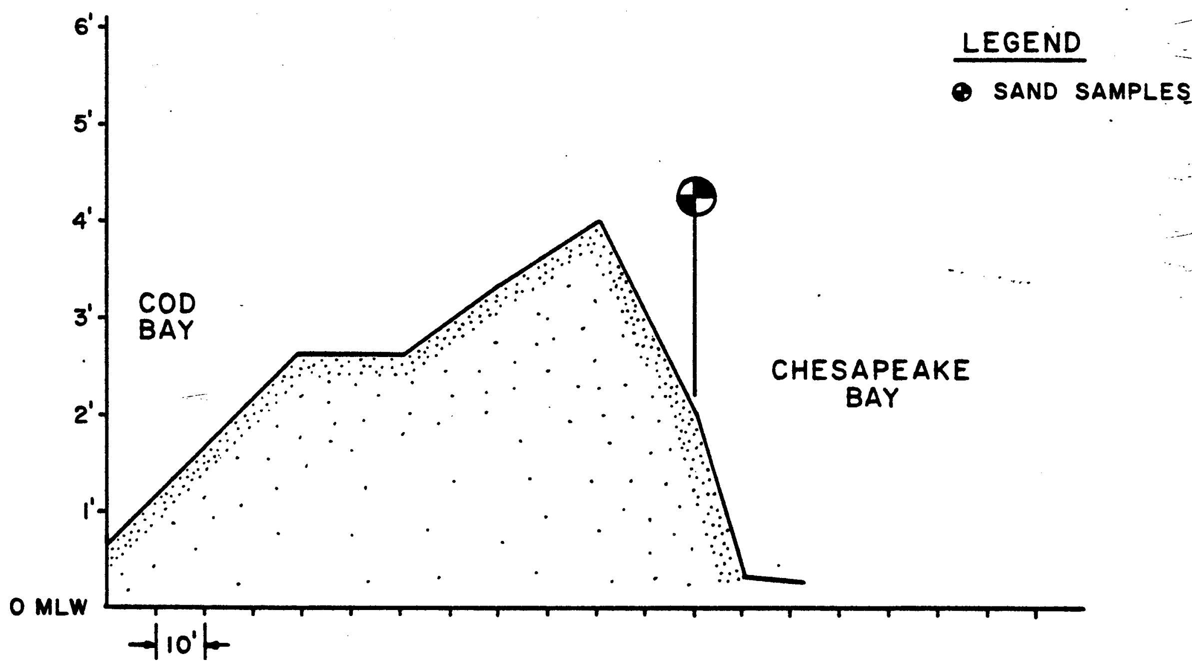
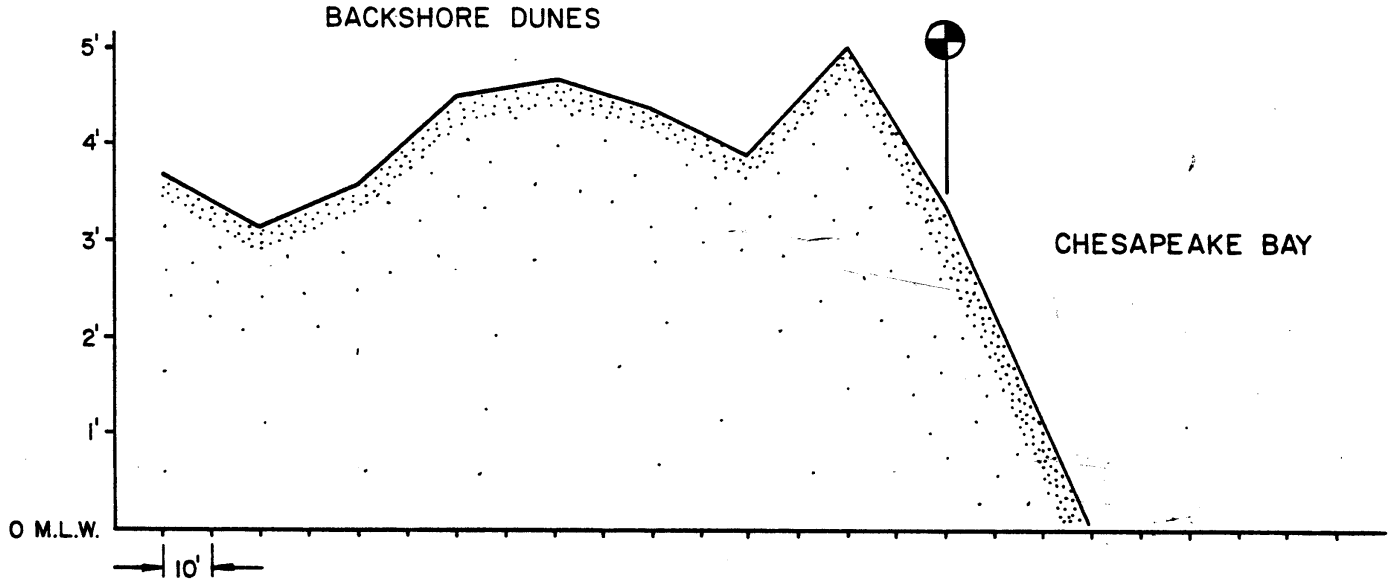
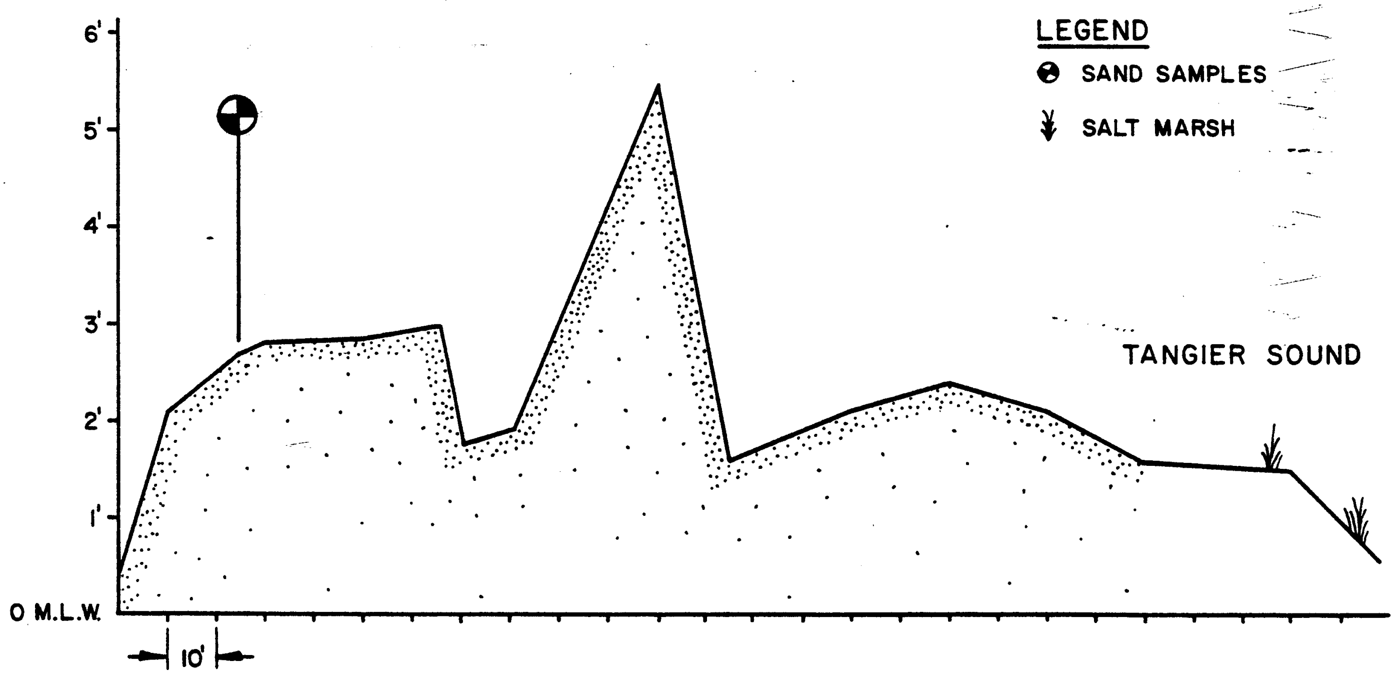


SECTION T-3
(ACROSS SPIT NECK)

FIGURE 7

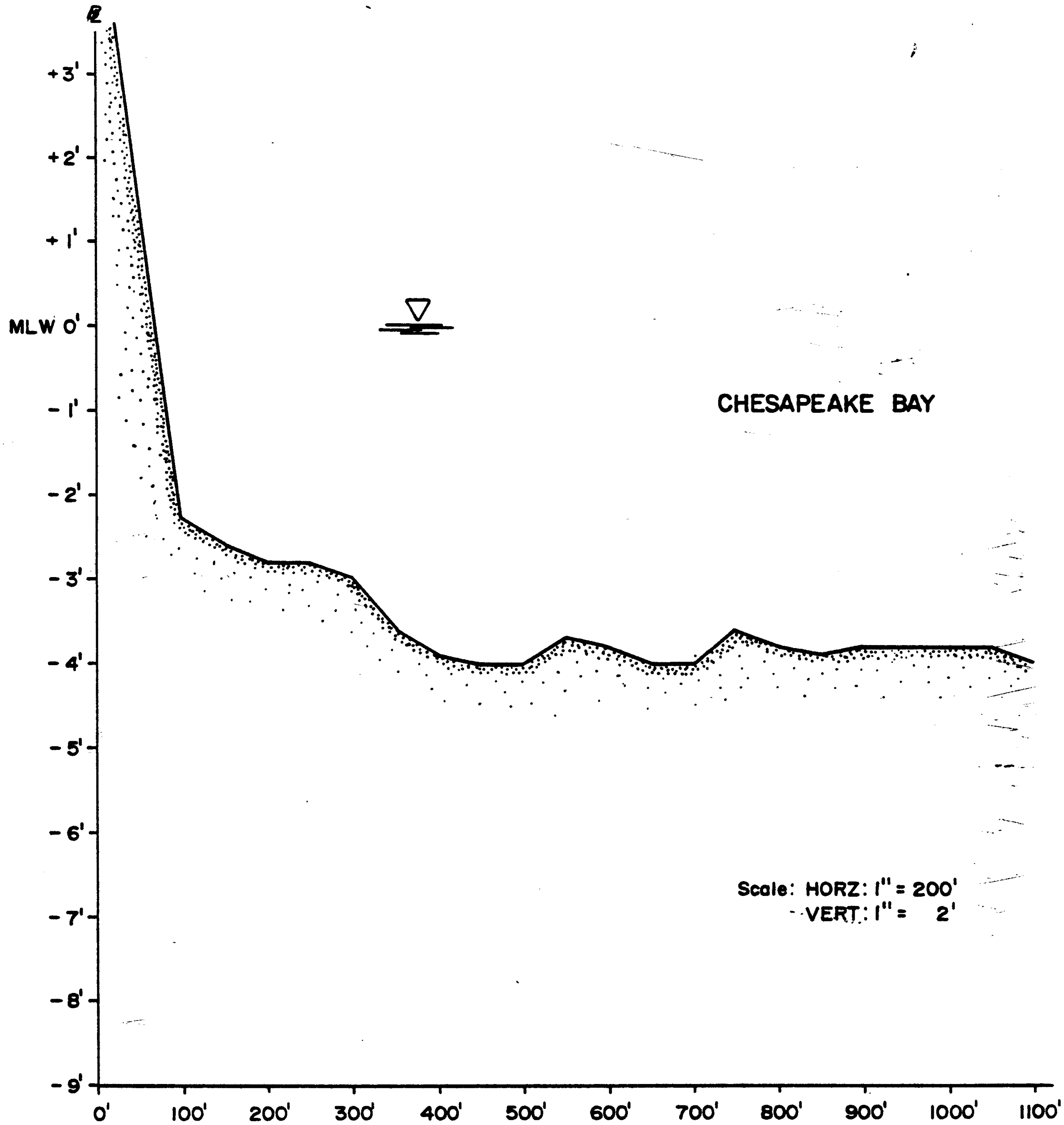


SECTION T–4



SECTION T–5
(ACROSS FISHOOK)

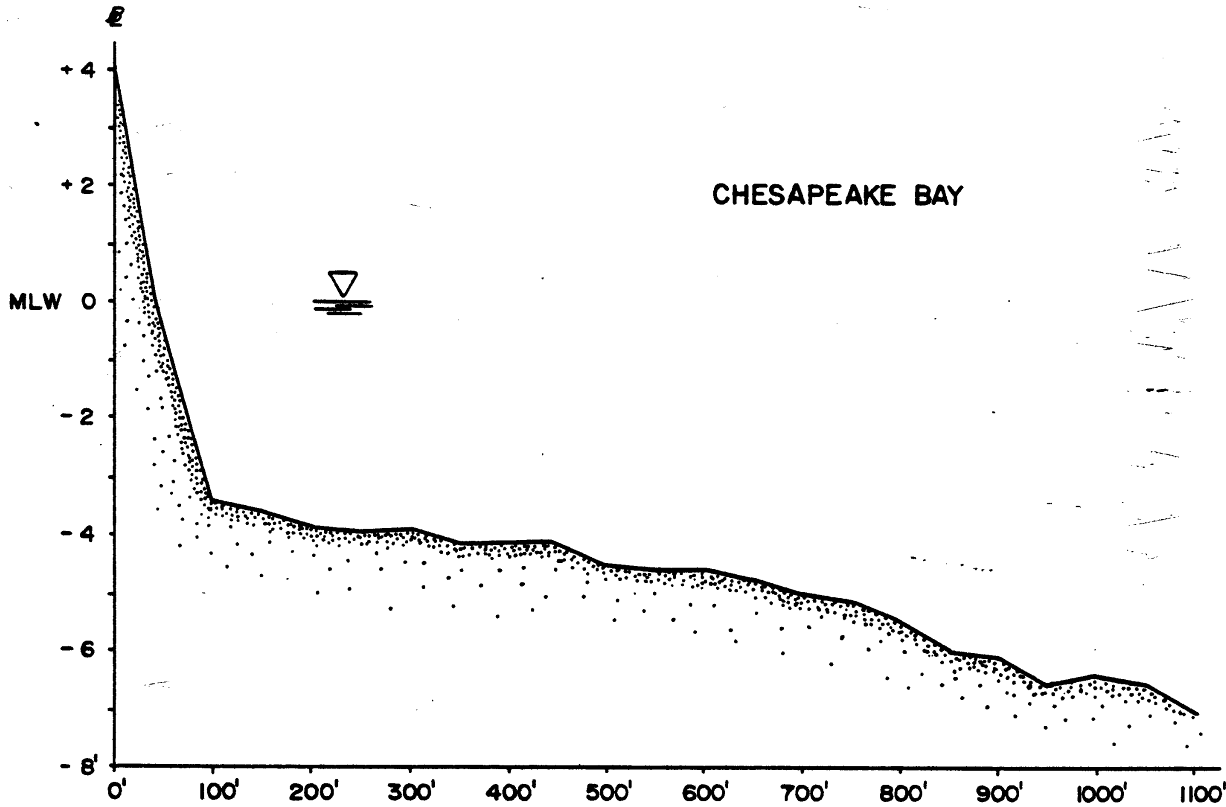
FIGURE 8



SECTION T-4

FIGURE 9

NEARSHORE BATHYMETRY



SECTION. T-3
(NEAR SPIT NECK)

FIGURE 10

NEARSHORE BATHYMETRY

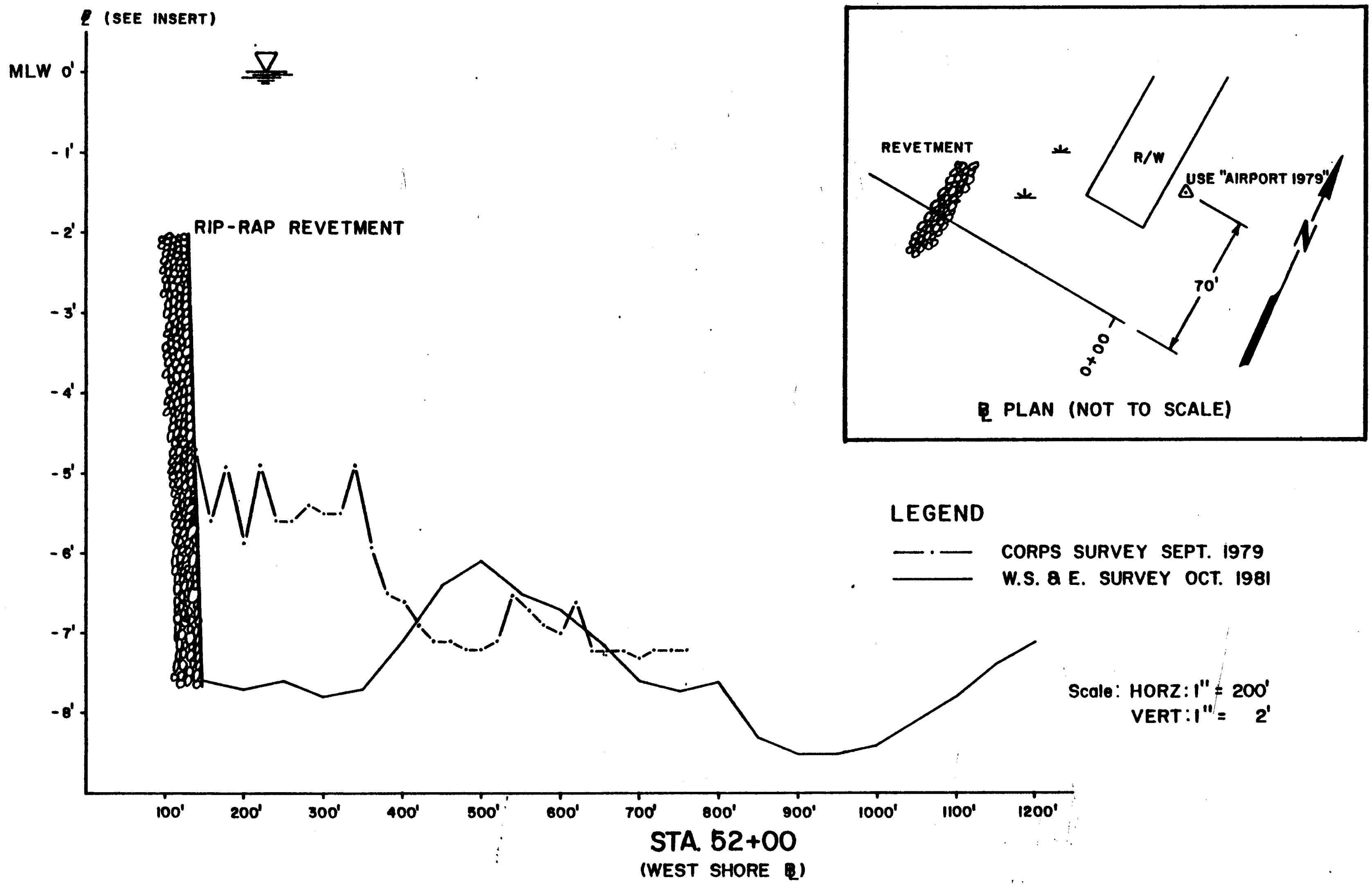


FIGURE 11

NEARSHORE BATHYMETRY

Expansion of Disposal Activities on Klinefelter's Island (Figure 12)

Disposal of dredged material on Klinefelter's Island dates back to 1934. These activities have resulted in the conversion of approximately 40 acres of salt marsh to upland. Of this 40 acres, about one half is utilized by the hunt club. The most recently used area on the island, shown on Figure 12, has reached its maximum capacity without considerable dike elevation. Along the northwesterly side, the sandy dredge material has been deposited right up to the top of the dike.

Expansion of disposal on Klinefelter's Island would necessitate additional conversion of salt marsh wetlands. There is still at least 70 acres of salt marsh remaining on the island, however, aside from its value as a marine habitat, it serves to attract wildfowl to the hunt club property.

Not withstanding the obvious adverse impacts, conversion of the salt marsh to a long term dredged material disposal area would require 7,000 linear feet of dike, 20 feet high. Phased dike construction could be planned to utilize the available dredged material and to take advantage of gradual foundation consolidation. An extensive foundation investigation would be required to determine bearing capacities around the perimeter of the marsh and the gain in capacity under existing dikes.

In summary, expansion of disposal activities on Klinefelter's Island would cover approximately 70 acres of salt marsh and remove a valuable asset to the hunt club. Construction of proper dikes would be costly but more economical than similar work accomplished at multiple sites. The owner has indicated a willingness to accept some more material but has some stipulations on placement which might prevent a long-term solution. The above suggests that expansion of this site is not practical if another alternative can be found.

Open-Water Disposal in Deep Nearshore Troughs (Figure 13)

It was beyond the scope of this study to develop accurate bathymetry of potential nearshore open-water disposal sites. Probably the most significant impact of placement of the dredged material in deep troughs would be the inability to use the material to any worthwhile advantage. Other impacts would have to be addressed particularly with respect to the fate of the material after deposit.

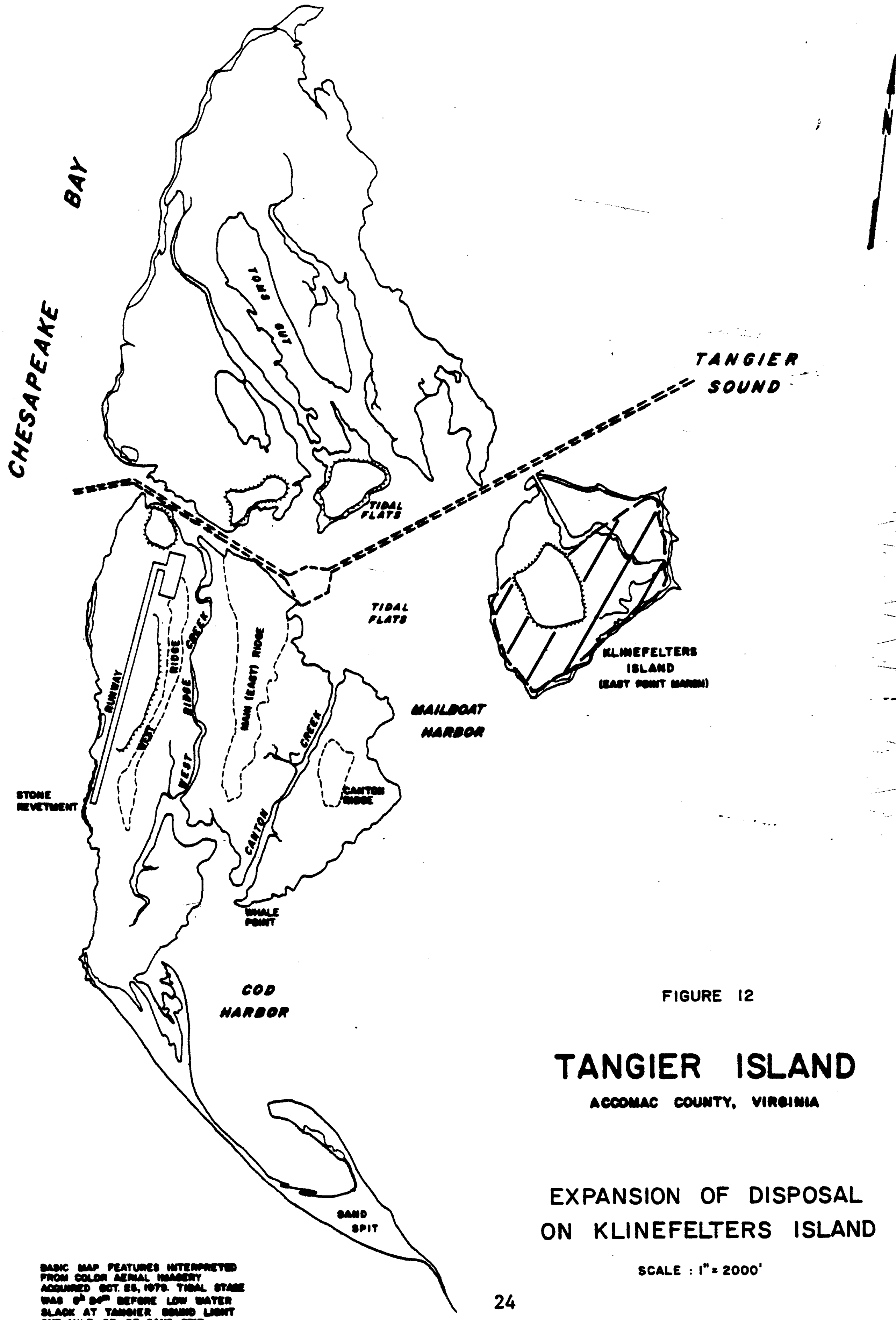


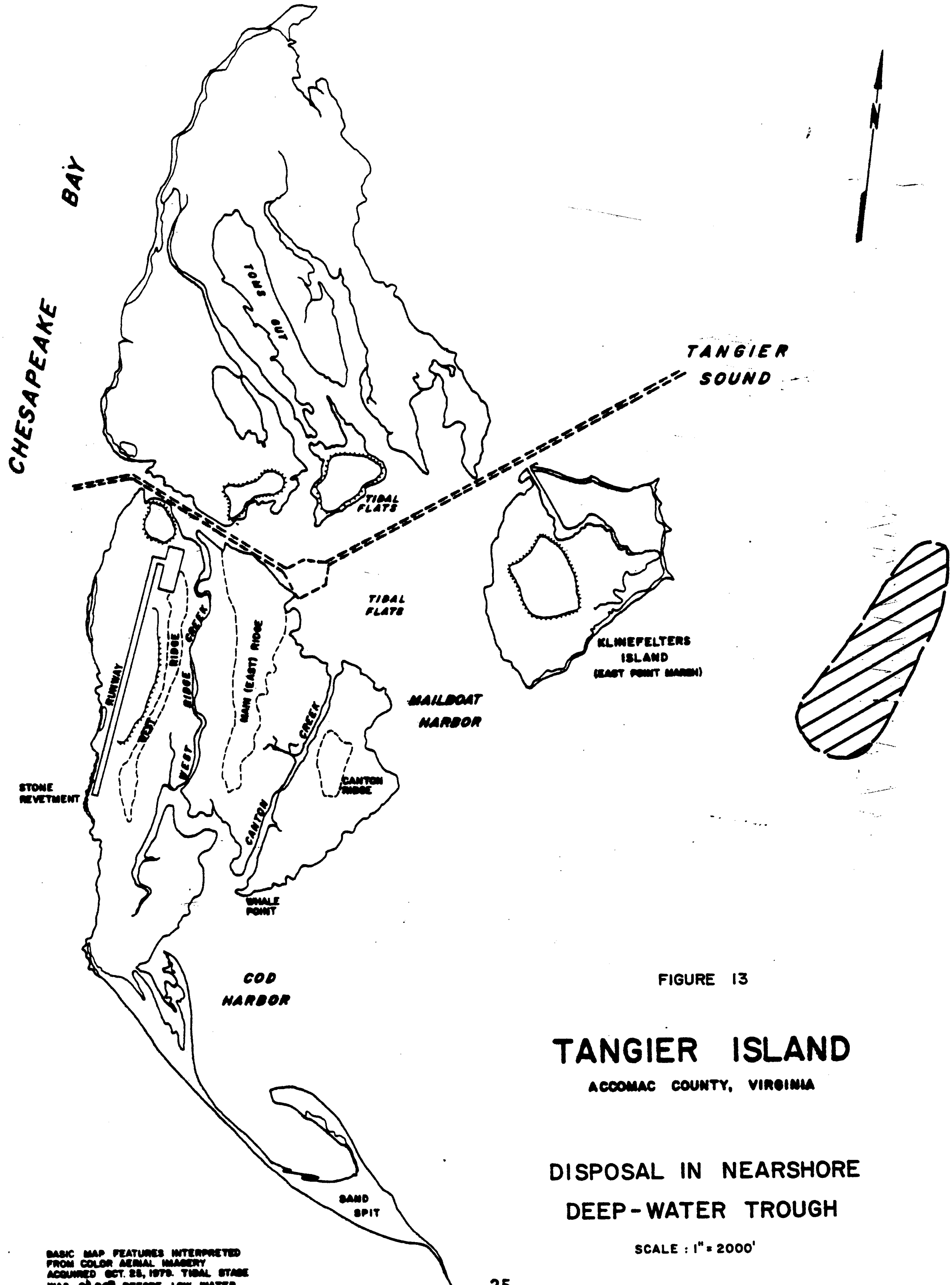
FIGURE 12

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

EXPANSION OF DISPOSAL ON KLINEFELTERS ISLAND

SCALE : 1" = 2000'



BASIC MAP FEATURES INTERPRETED FROM COLOR AERIAL IMAGERY ACQUIRED OCT. 25, 1979. TIDAL STAGE WAS $0^h 24^m$ BEFORE LOW WATER SLACK AT TANGIER SOUND LIGHT ONE MILE SE OF SAND SPIT.

FIGURE 13

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

DISPOSAL IN NEARSHORE DEEP-WATER TROUGH

SCALE : 1" = 2000'

Analysis of the available bathymetry in the recommended site suggests that eroded material would be directed away from the island's shores and not contribute to shoreline nourishment. On the other hand, it would not be expected to re-enter the project channels either.

Extreme pumping distances are on the order of 3 miles to the deep water site. This is slightly more than that required to place material along the west shore.

In summary, open-water disposal in the deep troughs would not allow for beneficial use of the dredged material. Pumping distances are great and even exceed those required for placement along the west shore. This appears to be a viable option only after any potential for beneficial use of the material has been eliminated.

PART IV: RESULTS AND CONCLUSIONS

Maintenance dredging of the Tangier Channels results in a requirement for disposal of dredged material. The annual rate of sediment deposition in the channels is on the order of 42,000 cubic yards. Over a 50 year period this amounts to 2,100,000 cubic yards. A large percentage of the sediments are sand as shown on Figure 14. Table 1 presents typical sand size data at boring locations shown on Figure 14. The coarest sand size in this table (0.18 mm) come from near the seaward ends of the East and West navigation channels, and probably reflect the action of waves and currents at these locations.

TABLE 1: TANGIER CHANNEL SEDIMENT SIZE

Channel Station	d_{50} size (mm)
38 + 00 W	0.18
11 + 00 W	0.17
5 + 00 E	0.11
30 + 00 E	0.12
38 + 00 E	0.18
35 + 00 E	0.15

A primary objective of any long-term disposal plan is beneficial use of the dredged material. Of the disposal options investigated, only two hold promise for meeting this objective. Well planned disposal between the East and West Ridges on Tangier would eventually create usuable land that residents could build on or otherwise enjoy. Social and environmental problems associated with this option would make it difficult to accomplish. Drainage and other engineering problems would probably make it cost prohibitive.

Unconfined disposal along the west shore of Tangier has the potential for mitigating or stopping erosion of the shoreline. Construction of a sacrificial buffer with dredged material appears to be feasible.

Re-use of existing upland disposal areas is not recommended for long-term disposal planning. Expansion of disposal activities on Klinefelter's Island would cover considerable salt marsh, negatively impacting marine

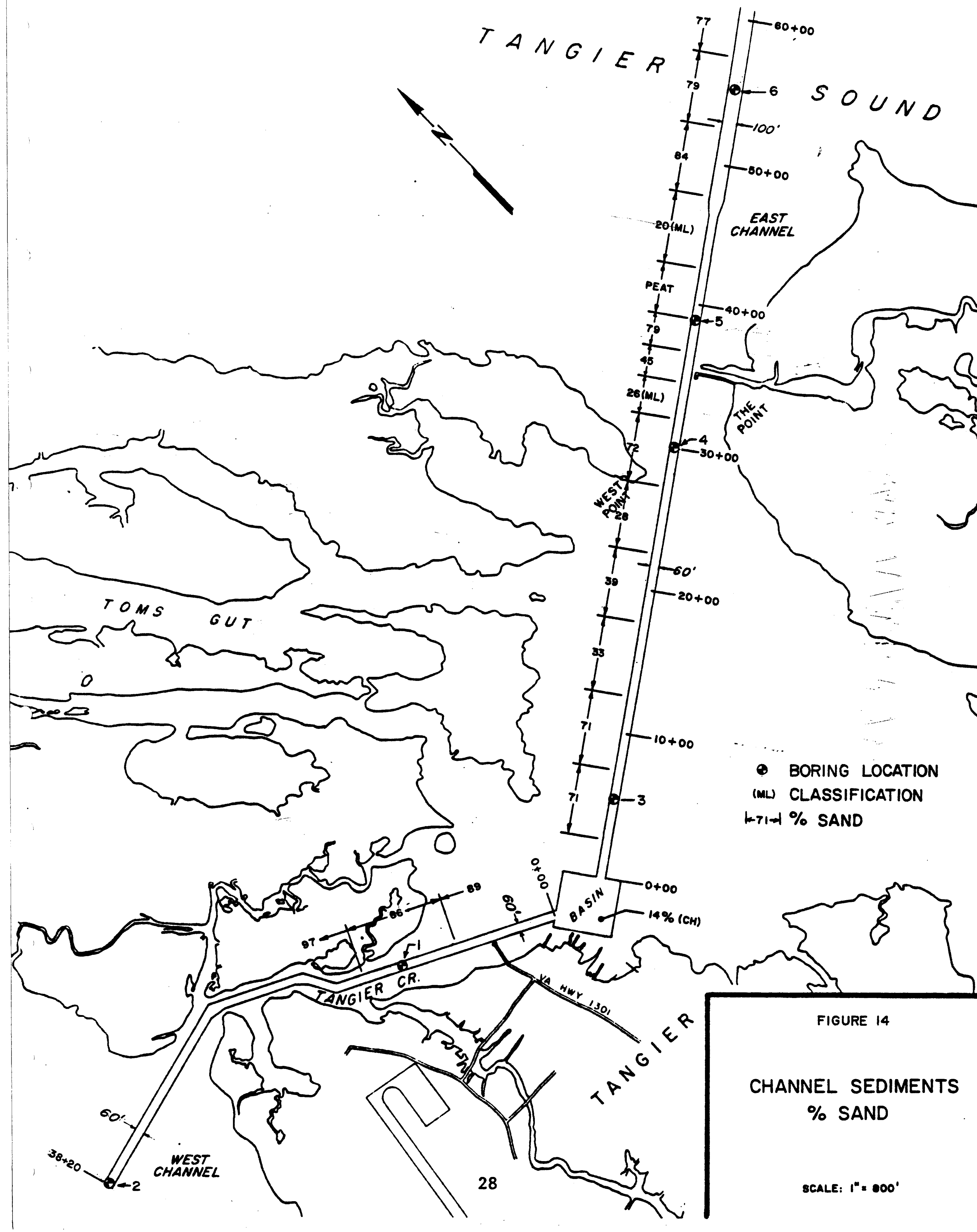


FIGURE 14

CHANNEL SEDIMENTS
% SAND

SCALE: 1" = 800'

and wildfowl habitats. Open-water disposal in deep, nearshore troughs would preclude beneficial use of the dredged material, but compared to the upland options, open-water disposal has a more acceptable environmental impact. The cost of this option would be about the same as disposal along the west shore.

In conclusion, the best option for long-term dredged material disposal is to use this material as a sacrificial buffer along the west shore of Tangier Island. This option has the potential for:

1. Reducing erosion along the west shore;
2. Providing a sand source to maintain the spit formation on the south terminus of Tangier;
3. Solving the long-term problem of dredged material disposal.

The feasibility of achieving these three objectives is analyzed in the next section, which examines the fate of the dredged materials under the action of coastal processes affecting the west shore of Tangier Island.

PART V: COASTAL PROCESSES - WEST SHORE OF TANGIER ISLAND

Wind Climate

Field inspection and general exposure of the west side of Tangier Island suggests that the dominant transport is from north to south along the west shore. The reason for this is the dominant winds for a west-facing coast in these latitudes are those that blow from north or north-west after the passage of a low-pressure system.

It is only the higher winds that are effective in generating waves that transport significant quantities of sediments. Examination of wind data collected at Dahlgren, Virginia, shows that winds there blow between 13 and 24 miles per hour (MPH) around 5% of the time from SW, and 7% of the time from NW. Winds over 24 MPH occur only around 0.2% of the time from the SW and around 1% of the time from the NW. In other words, NW winds in the 13 - 24 MPH range are 40% more frequent than SW winds. NW winds greater than 24 MPH are roughly 500% more frequent than SW winds. Winds from the NW or SW are more common than winds from the N, W, or S, the only other compass points affecting the west shore of Tangier. Even from these quadrants, it is clear that north winds predominate over south. Table 2 below is constructed from the Dahlgren data.

TABLE 2: WIND CLIMATE - WEST SHORE OF TANGIER

Wind Velocity	N	NW	W	SW	S
20 MPH	3.7%	7.7%	2.4%	5.5%	2.0%
30 MPH	0.3%	1.1%	0.2%	0.2%	0.1%

The Dahlgren data in Table 2 is increased by 10% to account for the fact that they were obtained in a more sheltered location, 68 miles to the NW on the Potomac River. Only two wind speeds are included in Table 2: 20 MPH and 30 MPH, representing the range 15 to 30 MPH. It is assumed that winds higher than 35 MPH are too rare to be significant, and that the more common winds significantly less than 15 MPH generate such small waves that they are ineffective in moving sediment.

The effective fetch is controlled by the overwater distances on Chesapeake Bay. The nearest point of mainland facing the west side of Tangier is 13 miles away; this is the Smith Point - Reedville, Virginia area just south of the mouth of the Potomac River. Smith Island is less than 10 miles to the north. All other fetches considerably exceed these values, with the possibility of an 80-mile fetch through a relatively narrow window in the NNW direction up Chesapeake Bay. Table 3 presents the fetches that are adopted here, although longer values prevail in specific directions.

TABLE 3: ADOPTED FETCHES - WEST SIDE OF TANGIER

Direction	Fetch (miles)
N	10
NW	20
W	13
SW	20
S	20

Wave Climate

Based on the winds and fetches in Tables 2 and 3, a wave climate has been constructed using shallow-water wave forecasting curves from the SHORE PROTECTION MANUAL (SPM) Tables 3-28, 1977 edition. A 30-foot average depth is assumed for the wave generating area over Chesapeake Bay. The resulting waves appear in Table 4.

TABLE 4: WAVE CLIMATE - WEST SHORE OF TANGIER

FETCH (miles)	20 MPH		30 MPH	
d = 30 miles	H (feet)	T (sec)	H (feet)	T (sec)
10	2.2	3.1	3.2	3.7
13	2.3	3.2	3.5	3.9
20	2.5	3.4	3.8	4.2

These are assumed to be the waves significant in moving sediment on a year-round basis at the west side of Tangier Island. They have typical heights of 2 to 4 feet and periods of 3 - 4 seconds.

Gross Longshore Transport

This section estimates the gross longshore transport rate on the west shore of Tangier using equation 4-44 in the SPM. Gross longshore transport is the amount of longshore transport, without regard to the direction it is moving. The equation requires an estimate of the mean annual wave height, $\bar{H}$.

This height is estimated from the product of the wind frequencies in Table 2 with the resulting wave heights in Table 4. The net result is a $\bar{H} = 0.56$. Using equation 4-44, the equivalent gross longshore transport is 62,000 cubic yards of sand. This is a potential transport value, assuming an abundant sand supply exists on the west shore of Tangier which it does not.

Analysis of the wind directions in Table 2 suggests that about 65% of the transport is directed south; 35% north. The net is about 30% of 62,000 cubic yards to the south, or 18,600 cubic yards/year. This should be the rate at which the south spit is accreting, if sand were abundant on the west shore. It (18,600 yd^3/yr) is also the rate at which sand must be replaced to stabilize the west shore. Since dredging will average 40,000 yd^3/yr, its use as a beach fill on the west shore will provide more than enough sediment volume, although it will be significantly finer in size than the existing sand on the west shore of Tangier. Thus, the available dredged volume is adequate to cover the long-term erosion potential (18,600 cubic yards/year), possibly with the difference in sediment size.

The analysis also suggests that dredged material should be deposited during the summer months along the southerly end of the west shore (near the end of the runway) to prevent re-entry into the project channel. During the winter months, disposal could be along the middle of the west shore between the south end of the runway and the project channel.

In summary, disposal along the west shore of Tangier will provide the volume of sediments to cover the net erosion potential along that shore. This volume would substitute for the volume currently being eroded from the marsh substrate. The volume would also provide the sandy material required to continue spit accretion at the predicted tate of 18,600 cubic yards per year. Since the predicted erosion rate of the dredged material is less than accretion in the channels, it is expected that continuous shore protection would be provided between successive dredgings.

PART VI: RECOMMENDED CONCEPT DISPOSAL PLAN

As explained in PART V, winds during the summer months tend to create a northerly longshore transport along the west side of Tangier. For this reason, deposit of dredged material during this time along the west shore should be away from the project channel. Conversely, during winter months, material could be placed closer to the channel since the predominant sand movement is southerly.

Assuming a 40,000 cubic yard channel accretion rate and a 4-year dredging cycle, then 160,000 cubic yards of channel sediments would be available to construct a buffer along the west shore. The existing bottom configuration off the west shore would be expected to be as shown on Figure 15. Survey data suggests a nearshore bottom slop of 1:150 which would provide a design parameter for development of the typical section shown on Figure 15. Assuming the deposit would mound to -1.0 foot in elevation, then a buffer containing a volume of 75 cubic yards per foot could be constructed. This would dictate a 2,000 foot long buffer. Figures 16 and 17 show the suggested buffer construction plan for disposal during summer and winter months respectively. Depending on the amount of dredged material available just prior to construction, the crest elevation of the buffer might be raised to +1.0 feet. This would provide more effective protection from wave action, however, the height vs. length of shore protection must be carefully considered.

Additional investigations should be accomplished to develop the final design and to establish construction criteria for plans and specifications. Among these are included new nearshore bathymetric surveys along the west shore and the sand spit region, refinement of the coastal processes and development of a placement methodology based on new channel sediment data. Finally, a monitoring plan should be considered to provide actual data which could be used to make long-term improvements to the plan.

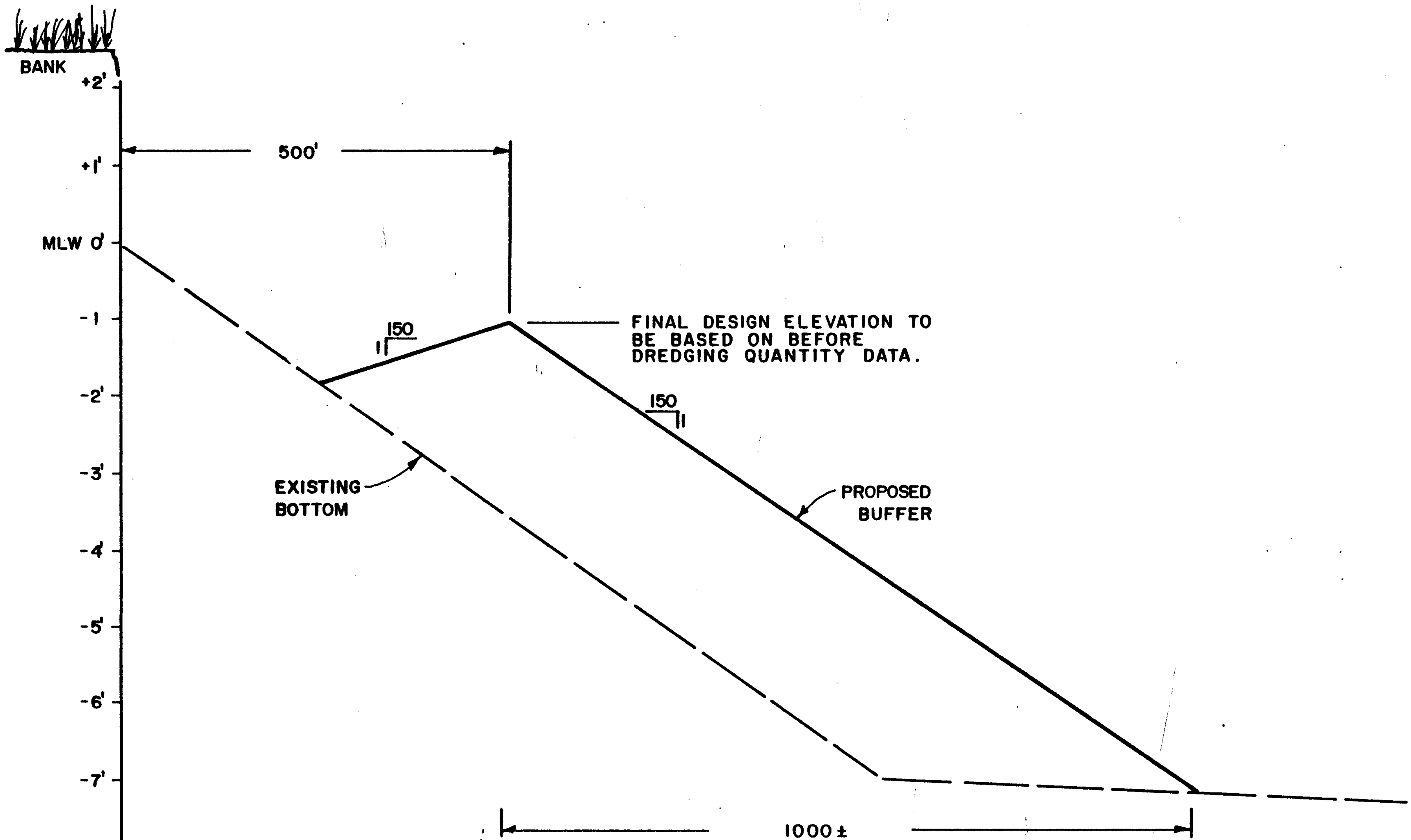


FIGURE 15

TYPICAL BUFFER GEOMETRY

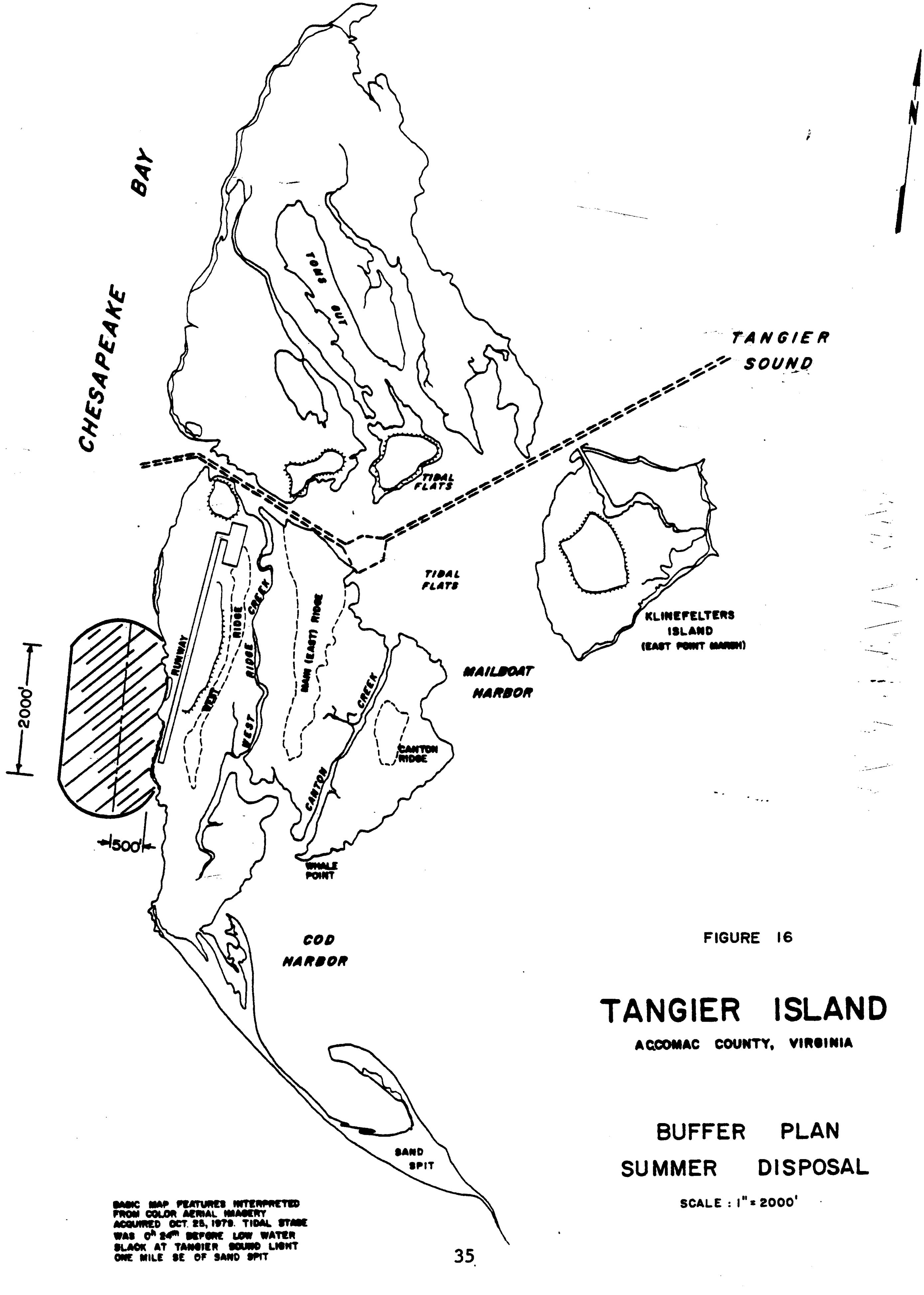


FIGURE 16

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

BUFFER PLAN
SUMMER DISPOSAL

SCALE : 1" = 2000'

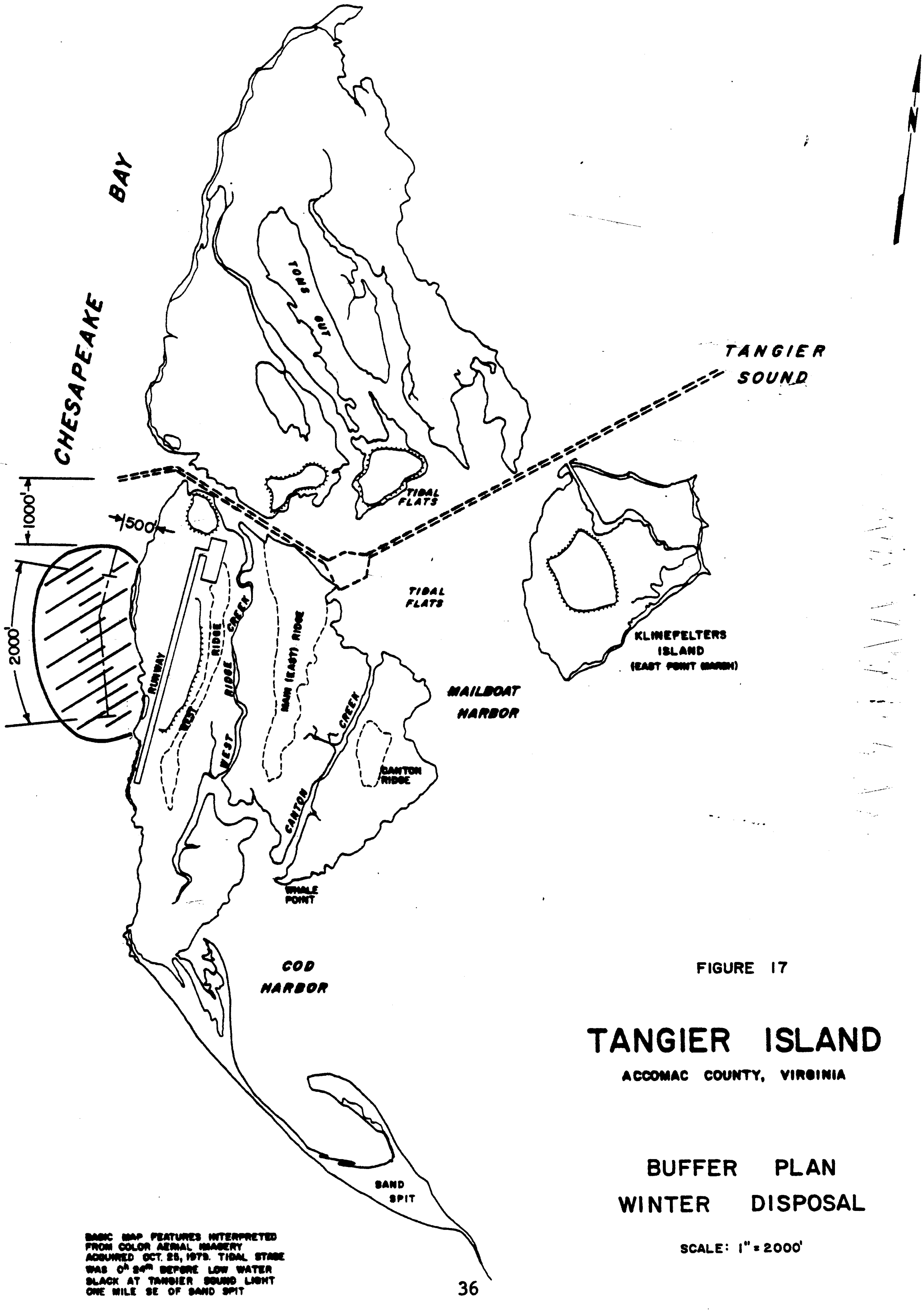


FIGURE 17

TANGIER ISLAND

ACCOMAC COUNTY, VIRGINIA

BUFFER PLAN
WINTER DISPOSAL

SCALE: 1" = 2000'

BASIC MAP FEATURES INTERPRETED FROM COLOR AERIAL IMAGERY ACQUIRED OCT. 25, 1979. TIDAL STAGE WAS 0h 24m BEFORE LOW WATER SLACK AT TANGIER SOUND LIGHT ONE MILE SE OF SAND SPIT

REFERENCES

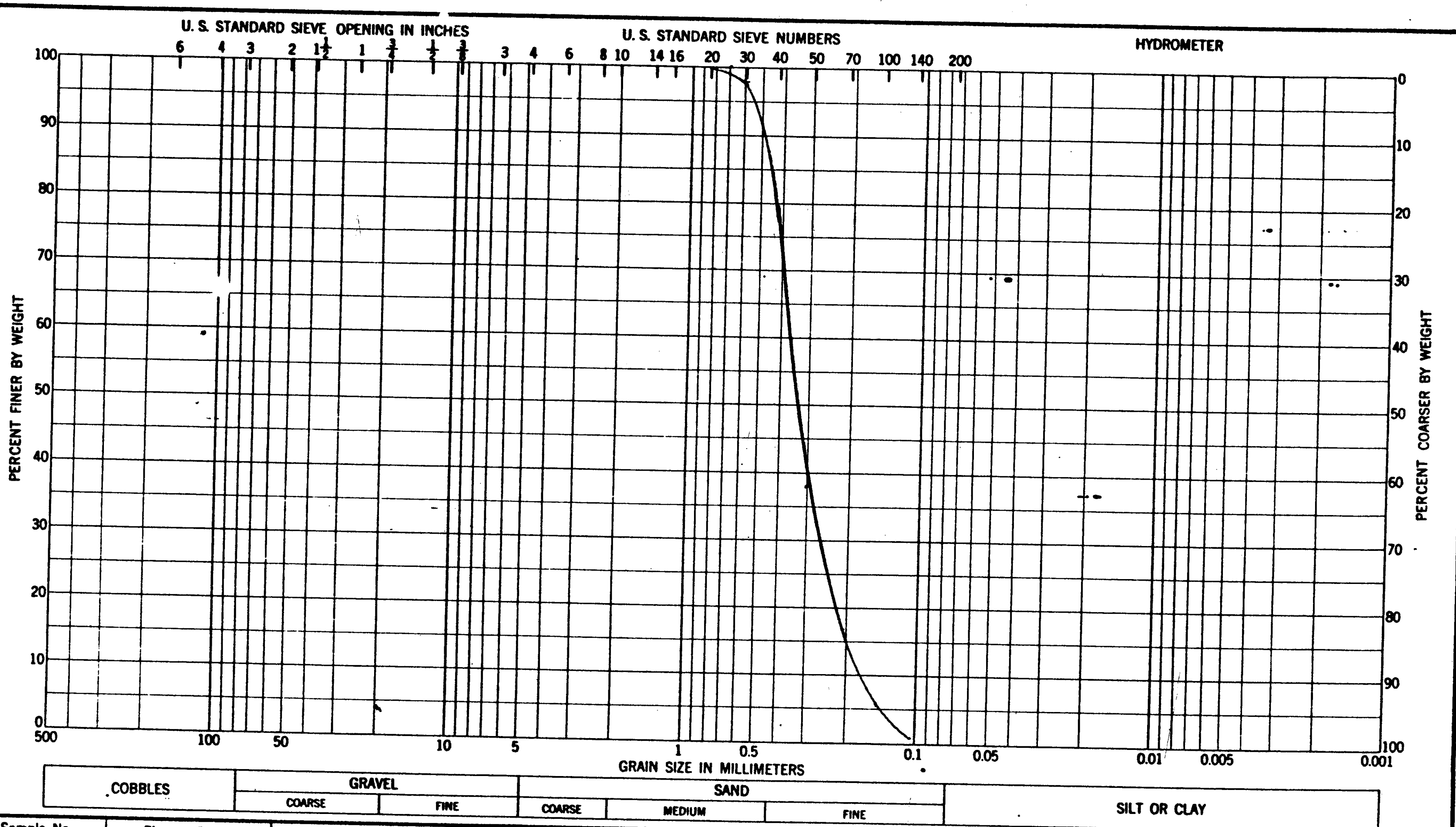
1. Shepard, Joseph P., Norfolk District, Corps of Engineers, Verbal Communication

2. Virginia Institute of Marine Science, "Comments on the Disposal of Spoil From Tangier Island Channel Dredging", December 9, 1976.

APPENDIX 1

SAND SAMPLE ANALYSES

WEST SHORE

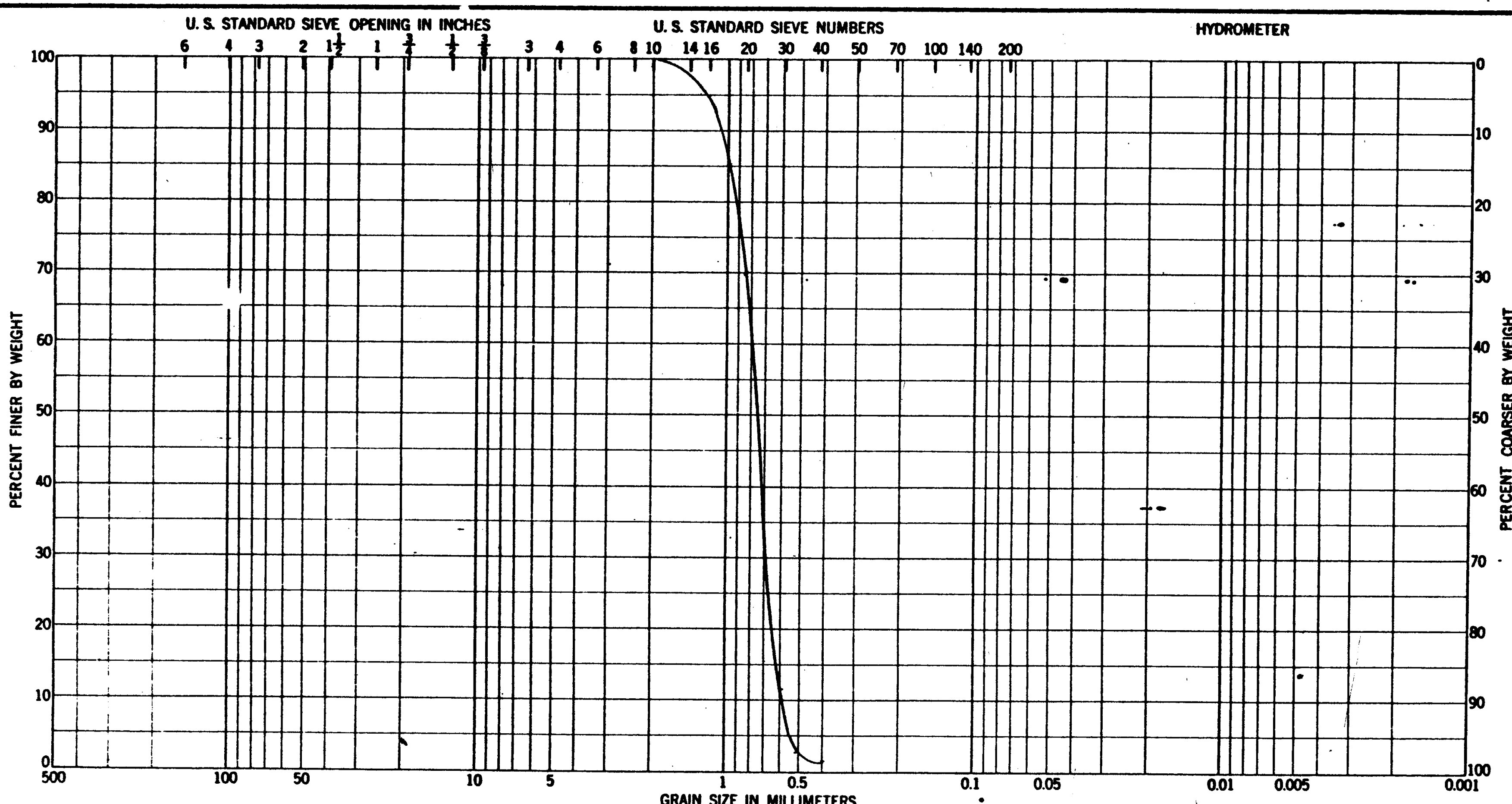


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) fine to med. SAND				

Project	TANGIER ISLAND
Area	
Boring No.	WSE - 1
Date	11-24-81

GRADATION CURVES

ENG FORM 1 MAY 63 2087



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) med. SAND				

Project: TANGIER ISLAND

Area:

Boring No.: WSE - 2

Date: 11-24-81

GRADATION CURVES

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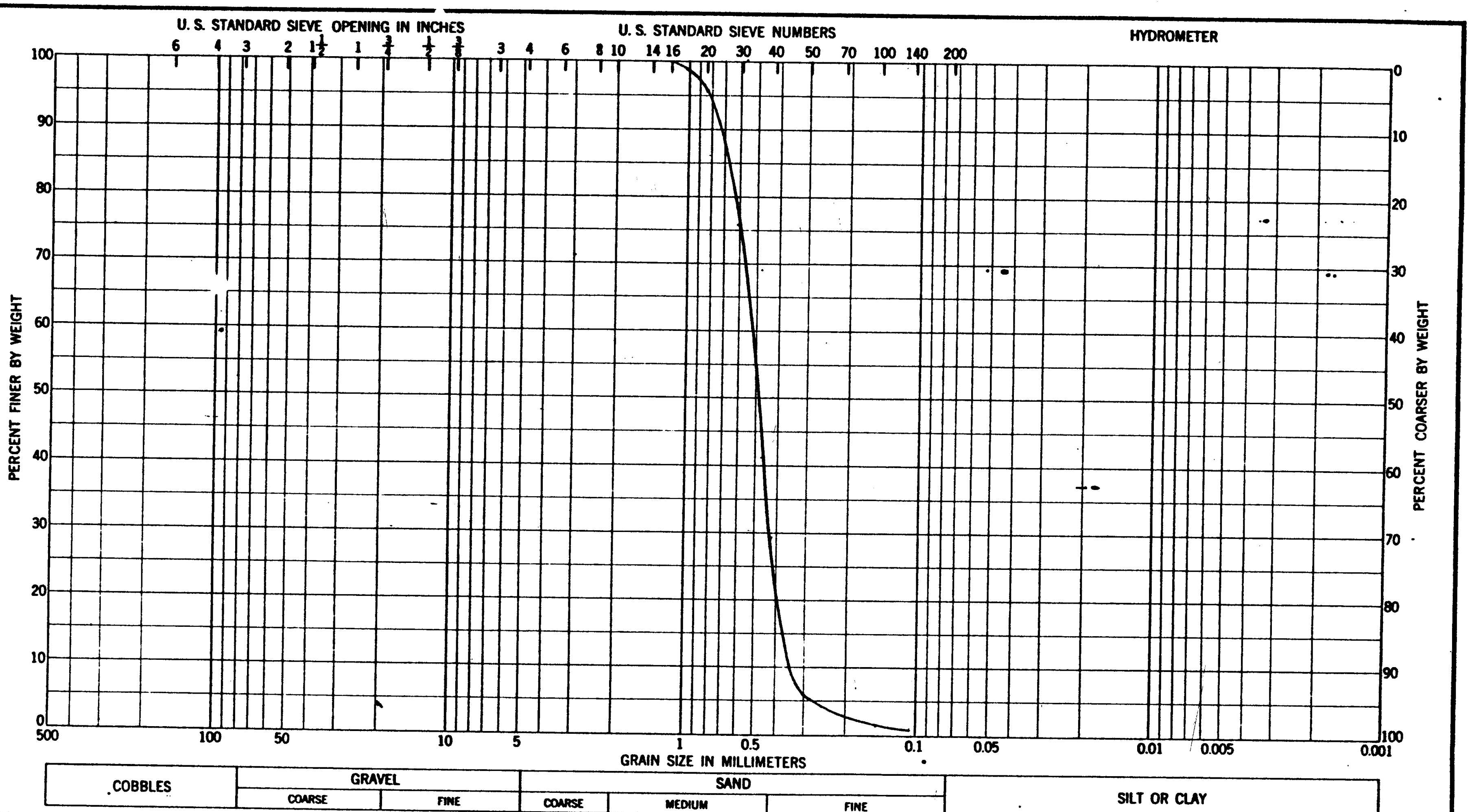


Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) fine to med. SAND				

Project TANGIER ISLAND

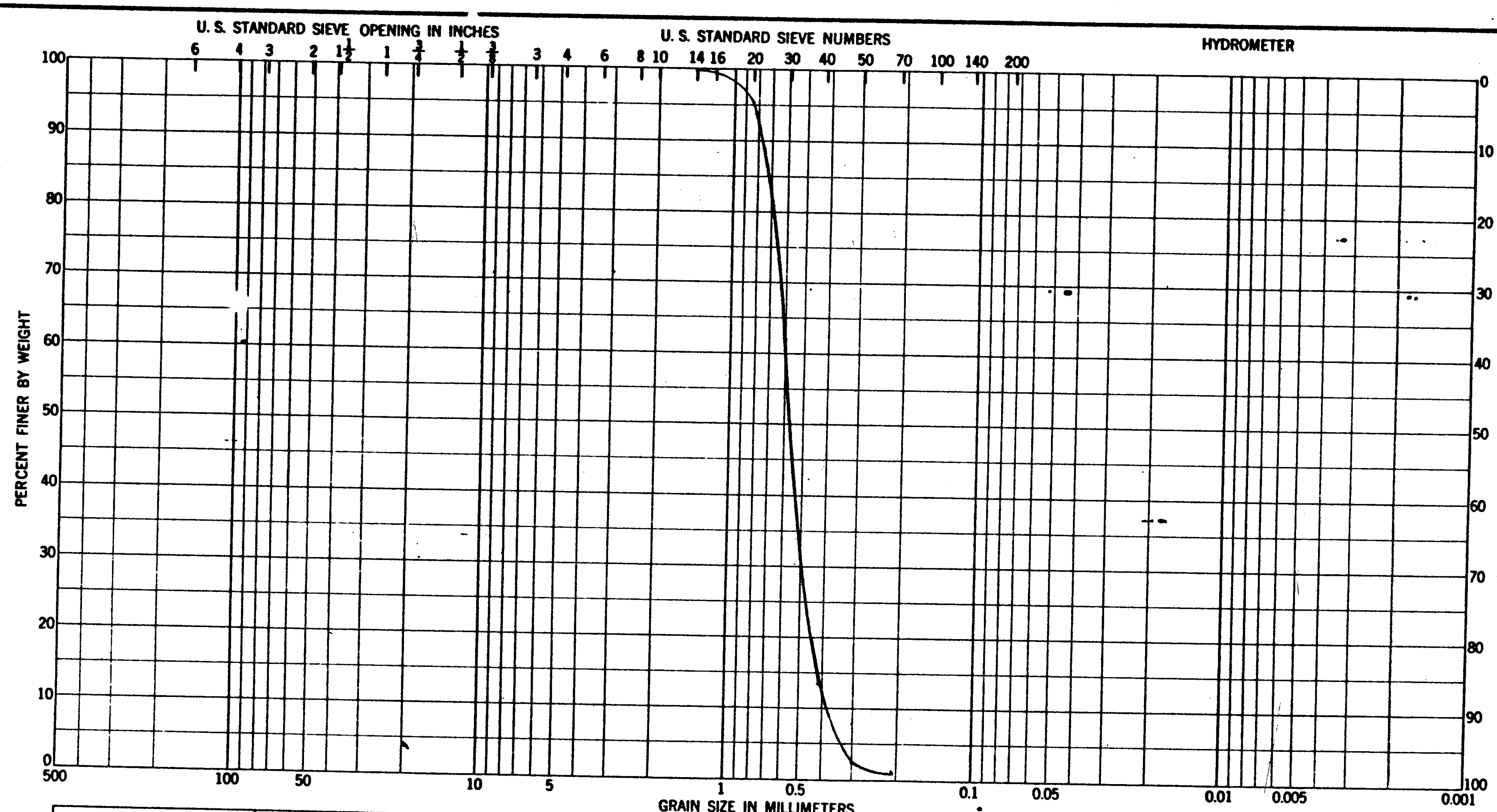
Area

Boring No. T-1

Date 11-24-81

GRADATION CURVES

ENG FORM 1 MAY 63 2087



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) med. SAND				

Project: TANGIER ISLAND

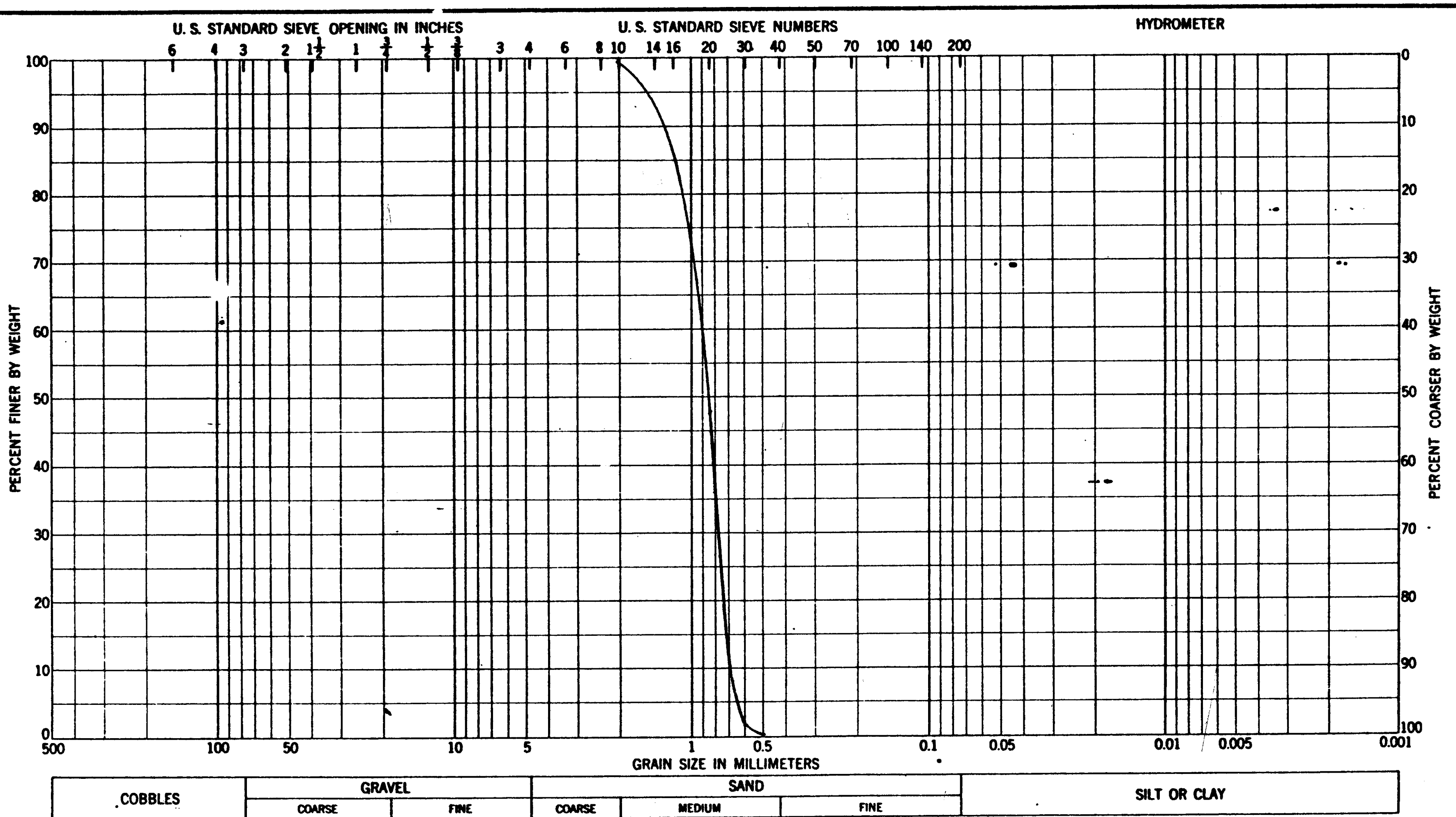
Area:

Boring No.: T - 2

Date: 11-24-81

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) med. SAND				

Project: TANGIER ISLAND

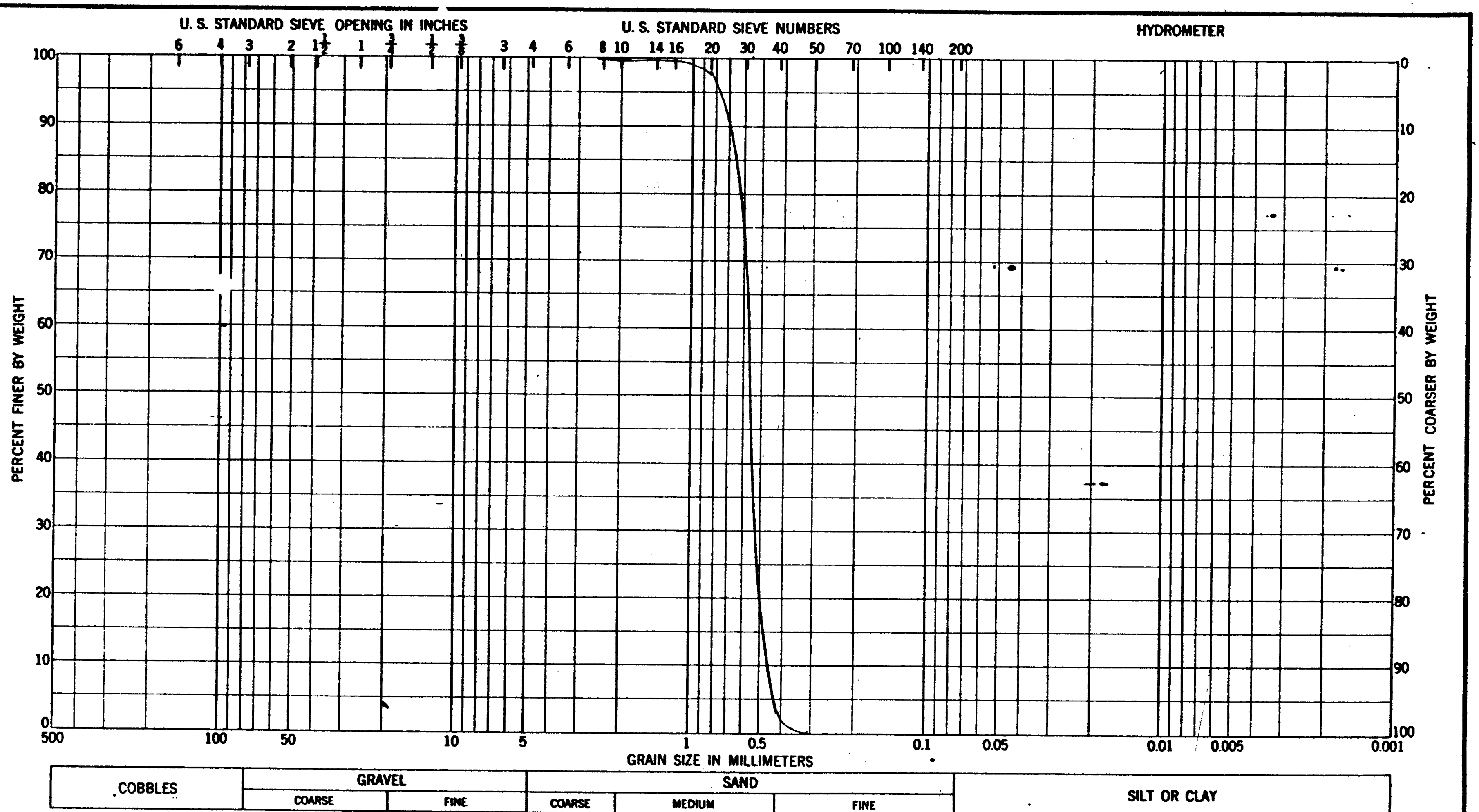
Area:

Boring No.: T-3A

Date: 11-24-81

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) med. SAND				

Project: TANGIER ISLAND

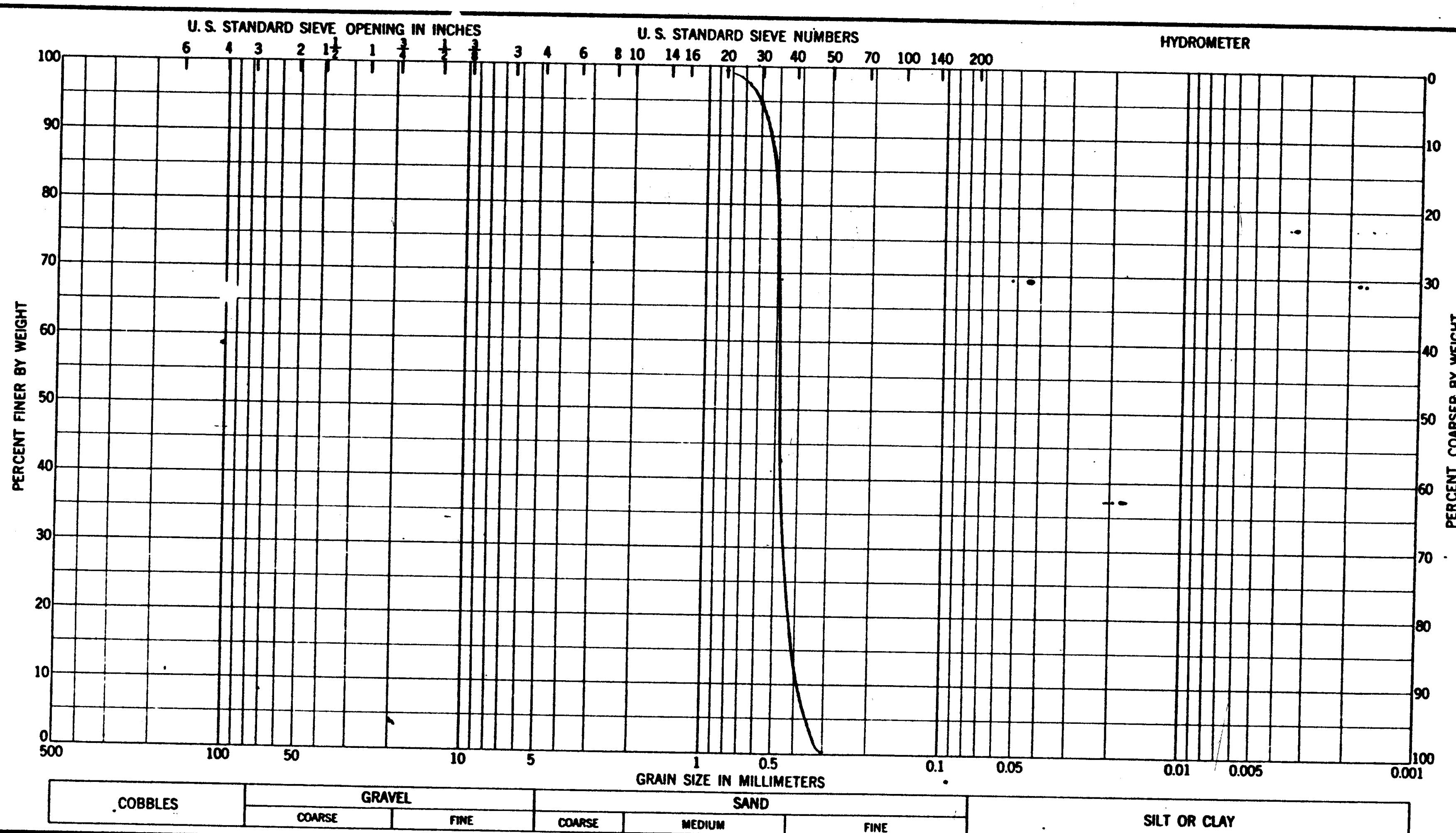
Area:

Boring No.: T-4

Date: 11-24-81

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
		(SP) med. SAND				

Project: TANGIER ISLAND

Area:

Boring No.: T-5

Date: 11-24-81

GRADATION CURVES

ENG FORM 1 MAY 63 2087

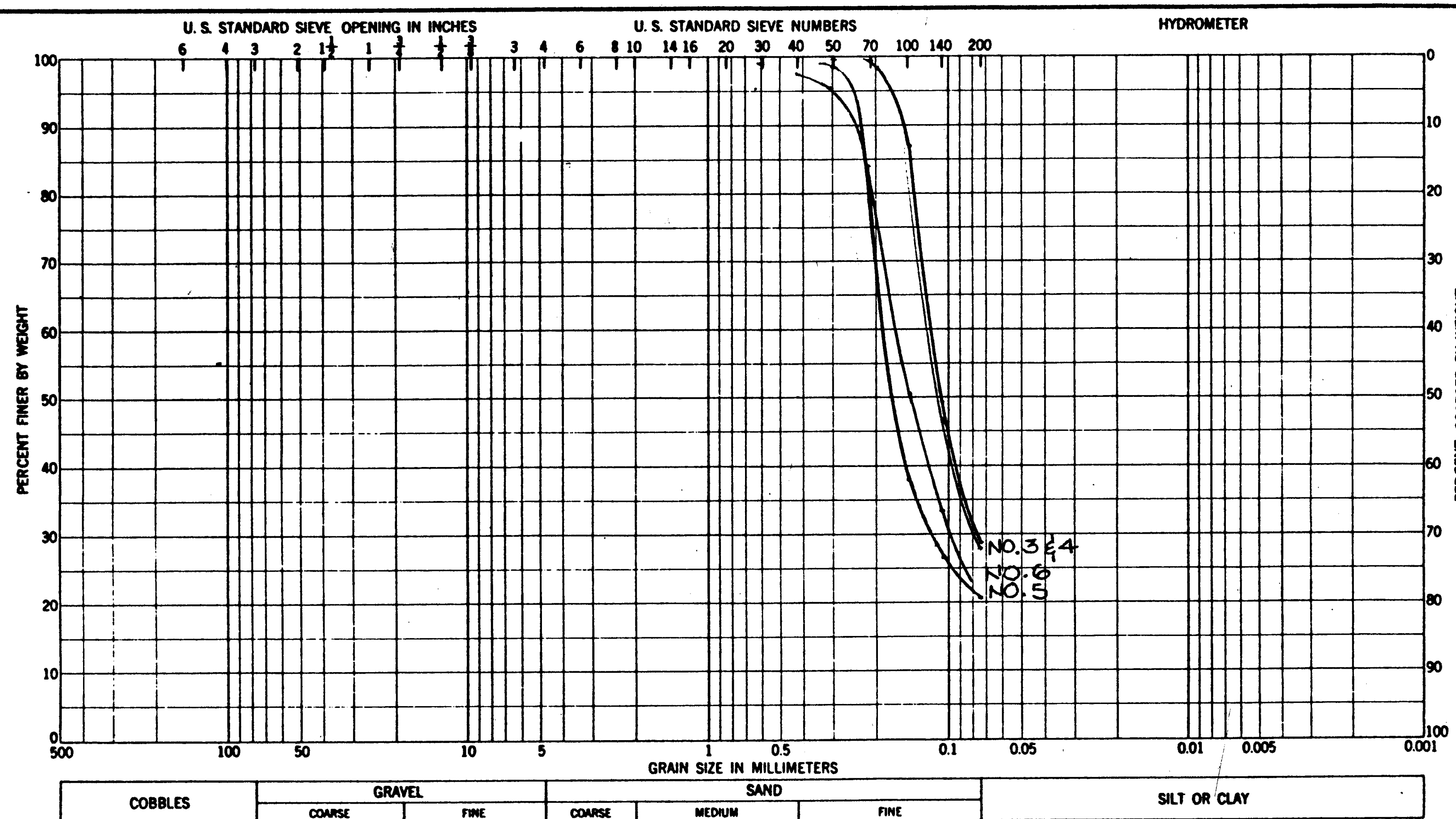
APPENDIX 2

PROJECT CHANNEL SEDIMENTS

TANGIER CHANNEL

STA. NO	SAND	LL	PI	SYM	CLASSIFICATION
4+00 WEST	89%			(SP-SM)	fine SAND, little silt
11+00	86%			(SM)	fine SAND, little silt *
33+00	97%			(SP)	fine SAND *
38+00	97%				
-1+00 EAST	14%			(CH)	sl. org. CLAY & SILT, little fn. sand.
-3+00 EAST	13%				
5+00	71%			(SM)	fine SAND, some silt *
10+00	71%				
15+00	33%			(ML)	sl. org. SILT & CLAY w/ some to and sand.
20+00	39%	36	7		
25+00	28%				
30+00	72%			(SM)	fine SAND, some silt *
34+00	26%			(ML)	sl. org. SILT & CLAY some fn. sand
35+00	45%			(ML)	sl. org. SILT & CLAY and fn. sand
38+00	79%			(SM)	fine SAND, some silt *
40+00				(PT)	ROOT MATTER
45+00	20%			(ML)	sl. org. SILT & CLAY some fn. sand
50+00	84%			(SM)	fn. to med SAND, little silt
55+00	79%				fine SAND, some silt *
60+00	77%				

* SEE GRADATION CURVES.



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	5+00 E.	(SM) fine SAND				
4	30+00 E.	some silt,				
5	38+00 E.					
6	55+00 E.					

Project TANGIER CHANNEL
- EAST -

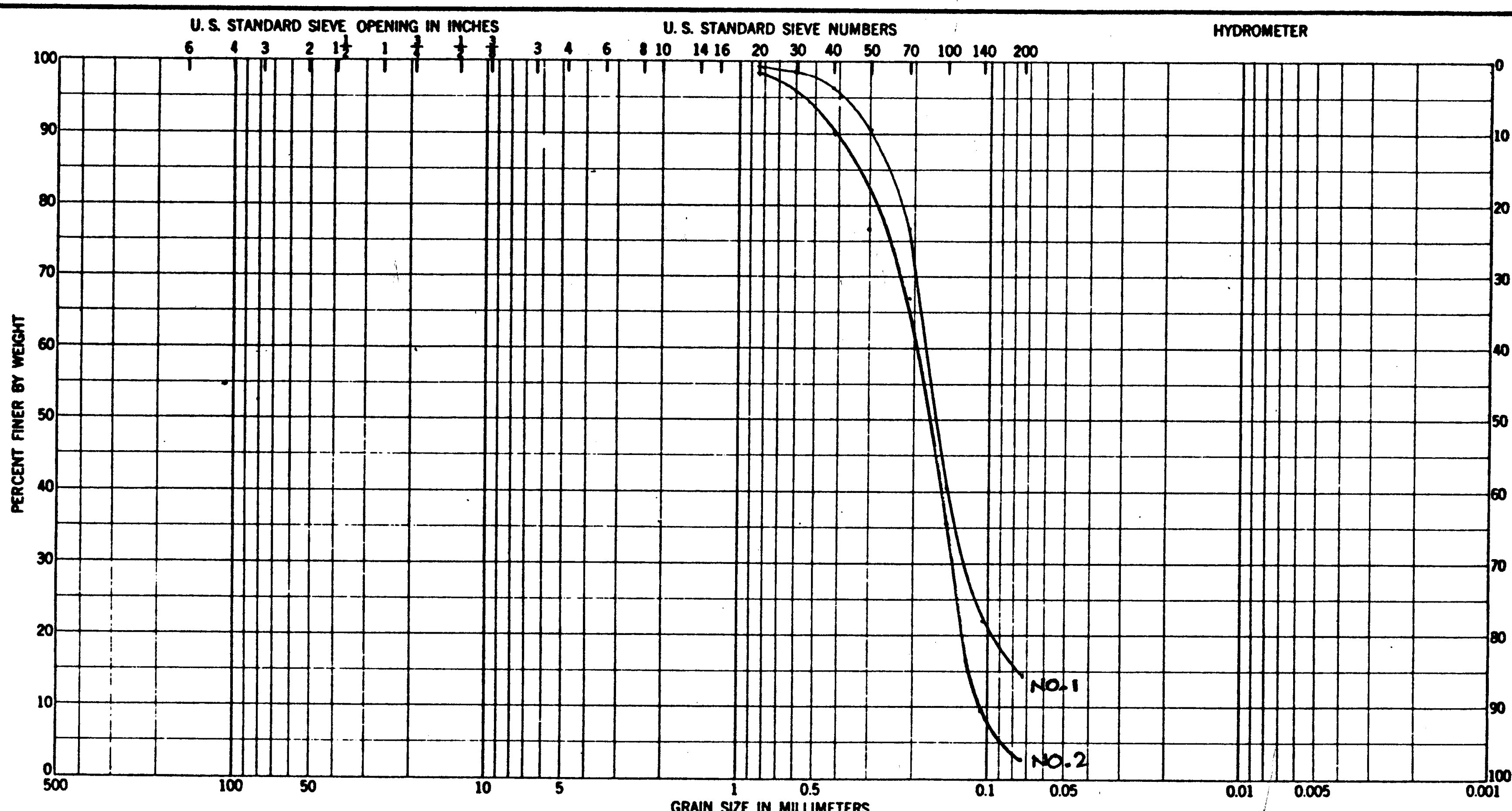
Area

Boring No.

Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	~~Elev or Depth~~	Classification	Nat w %	LL	PL	PI
1	11+00 W	(SM) fn. SAND, little silt.				
2	38+00 W	(SP) fn. to med. SAND.				

Project: TANGIER CHANNEL – WEST –

Area

Boring No.

Date

GRADATION CURVES

ENG FORM 1 MAY 63 2087