Dredged Material Research Program

CONTRACT REPORT D-76-2

IDENTIFICATION OF RELEVANT CRITERIA AND SURVEY OF POTENTIAL APPLICATION SITES FOR ARTIFICIAL HABITAT CREATION

Volume II

SURVEY OF POTENTIAL APPLICATION SITUATIONS AND SELECTION AND DESCRIPTION OF OPTIMUM PROJECT AREAS

by

Coastal Zone Resources Corporation
Wilmington, North Carolina

October 1976

Final Report

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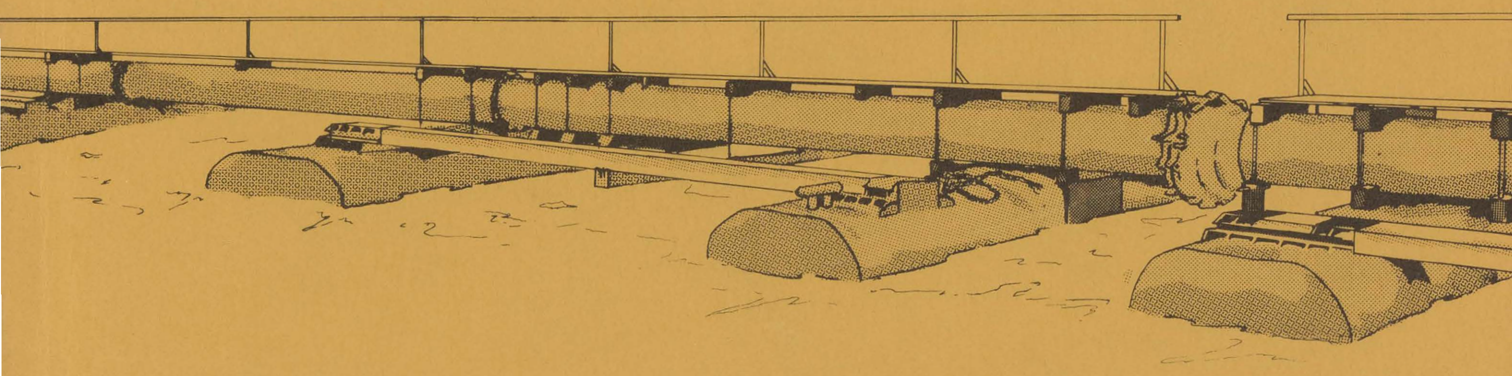

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This report develops a process for the selection of areas appropriate for artificial marsh construction using dredged material. By application of the methodology set forth, Engineer District personnel will be able to efficiently identify such areas.

In Volume I of the report, the biophysical and socioeconomic information needed to evaluate potential marsh creation sites

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is described and the rationale for the importance of such data is presented. A two-scaled approach to analyzing the information base typically available to the Engineer District is detailed. Specific kinds of problems that might arise and theoretical approaches to their solution are also discussed.

The selection rationale is tested in Volume II by the choice and description of 50 prime candidate project areas, 10 within each of five major coastal geographical regions. From this compilation, 10 optimum project areas, two in each geographical region, were selected and described further using data gathered in the project areas and from relevant Engineer Districts.

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CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
inches	2.54	centimetres
feet	0.3048	metres
yards	0.9144	metres
miles (U. S. statute)	1.609344	kilometres
square miles	2.58999	square kilometres
acres	4046.856	square metres
bushels (U. S.)	0.03523907	cubic metres
cubic feet	0.02831685	cubic metres
cubic yards	0.764555	cubic metres
tons (2000 lb)	907.185	kilograms
feet per second	0.3048	metres per second
knots	0.5144444	metres per second
cubic feet per second	0.02831685	cubic metres per second
cubic yards per hour	0.7645549	cubic metres per hour
Fahrenheit degrees	5/9	Celsius degrees or Kelvins*

* To obtain Clesius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

SECTION A

SELECTION OF 50 PRIME CANDIDATE PROJECT AREAS

The General Approach, as described in Volume I, represents a theoretical procedure which can be applied as a process of selecting sites for marsh creation. The relevant parameters which should be utilized in such a selection process are identified, defined, and organized into a decision-making process which, when followed to its conclusion, results in a go or no-go decision to create marsh habitat with dredged material. Since marsh creation is one of several alternative uses of dredged material, parameters affecting such a use were carefully defined and their inherent interactions described.

In a process of surveying a range of dredging projects and an even greater range of potential situations for marsh creation encompassed by the project's location, two scales of evaluation were viewed as essential in the application of the criteria which were developed. Reconnaissance-scale evaluation enables an initial identification of all potential projects and potential marsh situations therein, as well as an intuitive judgment as to the possibilities of marsh creation based on a preliminary application of criteria. Detailed-scale evaluation enables application of criteria in a more rigorous manner to those projects and situations which appear at the reconnaissance scale to be sound possibilities for marsh creation.

Even though the theory of the selection process is applicable in an Office of Dredged Material Research (ODMR), as well as a District Engineer, perspective, the true test of the methodology is at the District Engineer level. In testing the theory and General Approach in the real world, however, the perspective and objectives of ODMR guided the process by which the identified parameters were applied, namely: the selection of two optimum situations in five geographical (coastal) regions on the basis of their application as a research tool for so-called "test or pilot-scale projects." Therefore, diversity of potential marsh-creation situations and actual availability of sufficient dredged material within the scope of a project became of prime importance in surveying potential projects and selecting optimum projects and situations from among them.

1.0 Potential Site Screening

The basis for identification of all potential projects was an inventory of dredging projects compiled by OCE in 1971.* By using the inventory, a total picture

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* Section 123(i) of Public Law 91-611, dated 31 December 1970, authorized the Chief of Engineers to conduct a comprehensive program of research, study, and experimentation relating to dredged material. As an initial step in the study, it was considered essential to compile an inventory of all channel and harbor dredging projects. In Engineer Circular EC 1130-2-97, the information necessary to compile such an inventory was requested from all Divisions and Districts having Civil Works responsibility.

of dredging activity was available for each of the 17 Engineer Districts. The inventory provided very cursory information regarding: 1) name of project; 2) whether the project was maintenance or new work; 3) frequency of work; 4) annual quantity in cubic yards of dredged material; 5) type of dredge; 6) location and type of disposal; 7) type of dredged material; 8) pollution status; 9) degree of pollution; 10) conditions of local cooperation; 11) preliminary (pollution) abatement program; and 12) additional remarks.

1.1 Initial Screening

Over 1,030 dredging projects or individual dredging activities were listed in the OCE inventory. The application of the selection process, even at a reconnaissance scale, to such a large number of potential projects would be a complex and time-consuming application. Additional complexities are added because each individual project would have to be surveyed and screened on the basis of several situations for marsh creation within the scope of each individual project. For example, if each of the projects listed in the inventory had only three marsh creation situations associated with it, there would be over 3,000 situations to be studied. To alleviate such complexities, two general criteria in keeping with ODMR objectives were applied across the board as a means of screening projects to a workable level. This enabled an elimination of projects which would not offer, in the context of the General Approach, viable marsh-creation alternatives. The criteria were: the project must be maintenance work and the work must be performed by a hydraulic pipeline dredge.

The first criterion enabled the elimination of projects which were inactive and those which were indicated as new work. Projects in these two categories could not be considered as projects with potential to support ODMR field research since, particularly with inactive projects, there was no information on average annual volumes or dredging frequency. Without this most basic knowledge, it would be futile to attempt to determine the marsh habitat creation possibilities.

Numerous projects were listed as inactive with no associated average annual volume or frequency. An example is City Point Shoal Channel, a pipeline maintenance project in the Norfolk District which the inventory indicated had not required maintenance since 1949. This, and similar projects, could not be considered for selection as potential situations for marsh creation.

Similarly, those projects listed as new work were also eliminated on the same basis; that is, knowledge of volume and, particularly, frequency was absent. There were, for example, several projects listed as new work, but there was no indication as to their status (i.e., proposed or authorized); when they would be authorized; and, if authorized, whether the project would be a one-time project or would be a project requiring periodic maintenance. Further, some projects indicated as being new work had subprojects associated with them which were often indicated as maintenance work. The maintenance schedule was, however, contingent on the actual conduct of the proposed new work.

An example is Great Egg Inlet, New Jersey, in the Philadelphia District. Two projects categorized as new work were; the Channel (one-year duration and annual volume of 62,000 cu yd*), and the Deposition Basin (two-year duration and annual volume of 985,000 cu yd). Associated with the new work were two maintenance projects which would follow completion of the new work. The maintenance projects were the Channel (two-year frequency and annual volume of 5,000 cu yd) and the Deposition Basin (two-year frequency and an annual volume of 450,000 cu yd). The status, specific location, and therefore, the proximity of this project to potential marsh situations were all unknown. Such projects were not considered for selection as potential areas for research in marsh creation.

The listing of projects designated as new work eliminated a large number of projects, with considerable variation among the regions, from further consideration. In the New England geographical region, only 5 percent of all projects were eliminated as new work, but in the Gulf and Pacific regions, 21 percent and 24 percent respectively, were eliminated (40 percent in the Galveston District alone). Overall, more than 20 percent of all projects listed were eliminated because they were either inactive or new projects.

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* A table of factors for converting metric (SI) units of measurement to U. S. customary is presented on page xxi.

The second criterion enabled the elimination of all projects which did not use a hydraulic pipeline dredge. The use of a hydraulic pipeline permits accurate and predeterminable placement of dredged material at some distance from the actual dredging site. The use of hopper, sidecaster, clamshell, or dragline dredges severely limits the placement alternatives as well as the methods and situations for marsh creation. Combinations of dredges, such as hopper-pipeline or clamshell-pipeline could be viewed as possible alternatives for placement, but the mechanical complexities and economic costs serve to negate the use of such combinations.

The selection of projects which use a hydraulic pipeline dredge enabled the elimination of approximately half of all projects listed in the inventory. In the New England geographical region, for example, 85 percent of all projects were eliminated; while only a small number of projects were eliminated in the Middle Atlantic, South Atlantic, and Gulf geographical regions.

1.2 Locational Survey

On the basis of the initial screening, 48 percent of the total projects listed were selected as potential application situations. The next step, therefore, was to survey by identification and location the 490 selected projects and determine, in a preliminary manner, the marsh-creation situations which were available for each of the projects.

Employed in the locational survey were the inventory of dredging projects, project books for each of the 17 CE Districts, and National Ocean Survey Nautical Charts (NOS charts).

The focal point in the locational survey was to survey graphically, with preliminary data support, each of the 490 projects. In order to accomplish this, it was necessary to use the inventory of dredging projects as an identification tool and respective District project books as a location tool. The medium chosen for graphic representation was NOS charts at a scale of 1:80,000 for the Atlantic and Gulf coasts and a scale of 1:120,000 for the Pacific coast.

A mosaic was prepared for each of the five geographical regions using the NOS charts. Projects were identified using the inventory as a source for the project name, and that project was correlated to the respective CE District project book. This process of correlation, however, was not always a smooth one.

Difficulties experienced in the Wilmington District serve to illustrate a common problem in correlating the project name from the inventory (to which data on volumes, periodicity, etc., were project specific) to the same project as defined in the District's project book. A project named Meherrin River, N. C., was listed in the inventory as a maintenance project with an average annual volume of 12,000 cu yd. The Meherrin River project was not included in the District project book; therefore no locational or additional information was obtainable. For this reason, as well as the relatively small cubic yardage, the Meherrin River and similar projects were eliminated from further consideration.

Similar difficulties were experienced with sections of the Atlantic Intracoastal Waterway (AIWW) and the Long Island and Gulf Intracoastal Waterways. In the inventory, the AIWW sections in the Wilmington District were indicated as two projects, each including stretches of over 120 miles; the Through Channel from the Virginia-North Carolina line to the Neuse River, and the Through Channel from the Neuse River to the south boundary of the District at Little River. By direct communication with Wilmington District personnel, locations were available in shorter reaches and information concerning specific location, volumes, and periodicity for these shorter reaches of the AIWW was obtained. Direct communication was made with other Districts to obtain more specific information on Intracoastal Waterway projects within their jurisdictions. Information which enabled separation of sections of the Intracoastal Waterway in each District had the effect of raising the number of projects which could be considered. In the Wilmington District, for example, 25 projects were added for consideration.

It became apparent in the process of identifying and locating the various projects, that some could be screened on the basis of the length of the project, as it was defined by the inventory, and the range of tidal influence. Specifically, in regards to such projects occurring on river stretches, there was the further limiting factor of the lack of viable alternatives for situations which would be available for marsh creation.

An example of a project which was eliminated on this basis is the Apalachicola, Chattahoochie, and Flint Rivers Project in the Mobile District. This project met the criteria of a project involving maintenance work and hydraulic pipeline dredge, but upon identification and location, the project clearly did not meet the necessary requirements for potential marsh creation. The Apalachicola River section involves over 100 miles of river and, with the Chattahoochie section added, the entire length is over 250 miles with an associated 1,100,000 cu yd of material. Further, a majority of the river would not be considered tidal. This project and others like it were eliminated since there were other projects which were more clearly defined and which, if selected, could offer marsh-creation alternatives in an estuarine-river situation. Dalles Lock and Dam Project in the Portland District, the Narrows of Lake Champlain Project in the New York District, and similar projects were eliminated because all of the projects were in an inland situation.

As the projects were located and mapped, effective areas around each project were defined by circles with radii of 3,333 yd. This distance represented the most efficient area into which dredged material could be placed by use of a hydraulic pipeline dredge with no more than one booster pump. The benefit of such representation was two-fold: 1) potential situations for marsh creation were more readily identified and unsuitable situations could be more readily excluded; and 2) effective project areas, with combinations of two or more projects, were clearly defined. The term project area became useful, and in fact necessary, in describing the relationship among projects and the effective areas in which there would be situations where dredged material could be utilized in a program of planned marsh creation.

Combining two or more projects into a composite project area was achieved in each of the 17 Districts. Illustrative of the utility of this approach was the combination of 13 separately identified projects into one composite project area, the Beaufort-Morehead City Project Area, in the Wilmington District. In this manner, cubic yardage from various projects could be pooled, frequencies could be matched, and a greater number of alternative marsh-creation situations could be identified. Thus, a new dimension was available with the concept of a project area which would otherwise be absent if each individual project, as listed in the inventory, were studied separately. This representation enabled a synoptic view, District by District, of the interrelationships of all pipeline maintenance dredging activities within each geographical region.

2.0 Prime Candidate Project Area Selection

With project areas thusly indicated in graphic form, tabulations of average annual volumes and frequency of work were prepared for each project area in a given geographical region. Selection of 50 prime candidate project areas (prime project areas) representing viable marsh habitat situations became a process of comparing volumes and periodicities of all the mapped project areas to the various situations or opportunities for marsh-creation which had been identified.

Project areas for each geographical region were ranked in descending order according to the cumulative average annual volume of dredged material. Those project areas which ranked lowest in terms of average annual volume and had the least frequency of work were eliminated from consideration. Such projects, when compared to others within the respective District and geographical region, clearly had the least to offer in terms of timely availability of sufficient quantities of material for marsh creation.

Projects, such as Back Creek, a project in the Honga River in the Baltimore District with average annual volume of 250 cu yd and a frequency of 30 years, would not offer the type or number of situations for marsh creation as other project areas with higher volumes and greater frequencies. Furthermore, in areas such as the Gulf geographical region (approximately 80 project areas), those project areas with lower volumes and maintenance dredging frequencies and few habitat situations, had to be eliminated in favor of project areas with greater volumes, dredging frequencies, and numbers of marsh-creation situations.

Regional distinctions in marsh environments provided a backdrop against which project areas and situations for marsh creation could be viewed in terms of their utility for research. In the Pacific geographical region with narrow beaches, cliff headlands, and irregular bottoms, situations conducive to marsh creation are limited. In the northern areas of the Pacific coast, the ratio of marsh area to coastline is 0.07, while in the southern areas the ratio is 0.16. Therefore, project areas in the Pacific geographical region were screened primarily on the basis of areas which offered the best situations from among those areas which offered less desirable or viable situations for marsh creation. For example, the Channel Islands Project in the Los Angeles District did not offer ecologically viable marsh-creation situations because of, among other factors, the exposed nature of potential situations and the current use of the dredged material as beach nourishment.

In the same District, however, the Morro Bay Project was selected because of the relatively shallow water depth, the existing mud flats, and the presence of protected waters in the bay offered viable situations for artificial marsh creation.

Regional environmental distinctions played quite a different role in prime project area selection in the South Atlantic and Gulf geographical regions where the ratio of marsh to coastline was 2.8 and 3.7, respectively. Here, selection was guided more by the kinds of marsh-creation situations available. Distinctions in selecting between two project areas in the Wilmington District, Lockwood's Folly Inlet and New River Inlet, are illustrative. Basically, both project areas were composed of AIWW and inlet maintenance projects. Situations for marsh creation were limited, however, at the Lockwood's Folly Project Area because of the lack of sufficient open water and relatively narrow reaches behind the barrier islands. The New River Inlet Project Area offered various situations for marsh creation including open water, areas behind barrier islands, areas of existing marsh, and estuarine-river areas. In screening between these and other potential projects, the New River Inlet Project Area was selected as a prime project area.

Data on the 50 prime project areas were compiled which described the project area in general and the project or projects which were included; lengths and depths of the associated channels; cumulative volumes, sources of dredged material, and its characteristics; tidal ranges; current disposal practices; and general environmental setting.

In order to more clearly define and describe each project area and, more importantly, to facilitate selection of 10 optimum project areas, more information was necessary. The type and degree of information needed was basically that which is discussed in Volume I, Section B, as parameters for the reconnaissance-scale evaluation. To obtain necessary information, the most efficient approach was to conduct a mail survey of each of the 17 Districts. The letter of request, exhibited in Appendix A, outlined the research effort and selection process, described the selected prime project areas, and requested additional information in several categories. Responses ranged from brief letters to detailed descriptive material which included numerous documents, publications, and other pertinent information. Such data, as was available, were essential in describing the prime project areas in a reconnaissance-scale manner. Further, the descriptions resultant from the expanded data base facilitated the careful selection and further description of the 10 optimum project areas from among the 50 prime project areas.

SECTION B
DESCRIPTION OF PRIME CANDIDATE PROJECT AREAS

Reconnaissance-scale data concerning the selected 50 prime project areas were organized according to the General Approach. The following descriptive inventory includes data under the major categories of project area name and general setting; dredged material-receiving site description; and judgment of desirability.

Several information sources were used consistently throughout. The sources and the general information they provided were OCE's inventory of dredging projects, 1971 (cursory information on individual projects as described in Volume II, Section A); District project books (various dates) for each of the 17 Districts (channel dimensions and locational information); Volume 7 of the National Estuary Study, 1970 (information on governmental institutions and agencies); the National Wildlife Federation's Conservation Directory - 1974 (information on institutions and citizens' organizations); and NOS nautical charts (base maps and general information concerning site characteristics, such as water depths, existing marshes, and mud flats). The above references are not cited individually in the text. Data, publications, charts, and other material which were obtained from the Districts by use of the mail survey were used extensively and are cited as applicable.

The 50 prime project areas are categorized according to geographical regions and are ranked in descending order by the average annual cubic yardage generated in the particular project area. Location maps for each of the five geographical regions show the location of the 10 prime project areas in the respective geographical region. In addition, specific project area maps, based on NOS charts and District project books, are provided for each of the 50 prime project areas. The legend for all of the project area maps is presented in Figure 27.

1.0 New England Geographical Region

The New England geographical region includes the New England Division and the New York District. The boundaries of the geographical region extend from the St. Croix River in northeastern Maine to the Manasquan Inlet in middle New Jersey. The coastal states included in the New England geographical region are Maine, New Hampshire, Massachusetts, Rhode Island, New York, Connecticut, and northern New Jersey. The locations of the prime project areas are indicated in Figure 28.

During the collection and organization of reconnaissance-scale data, the New England Division (1972 and 1973a) noted that two projects which had been listed in the inventory as being pipeline dredge work had since been changed to sidecaster dredge work. These projects were the Chatham Harbor Project Area (1.10) and the Scarboro River Project Area (1.8). The change in dredge type negated the use of reconnaissance-scale data in surveying these prime project areas as candidates for optimum project areas for reasons previously discussed. The general setting of these project areas, however, is discussed. Further, there was no reconnaissance-scale

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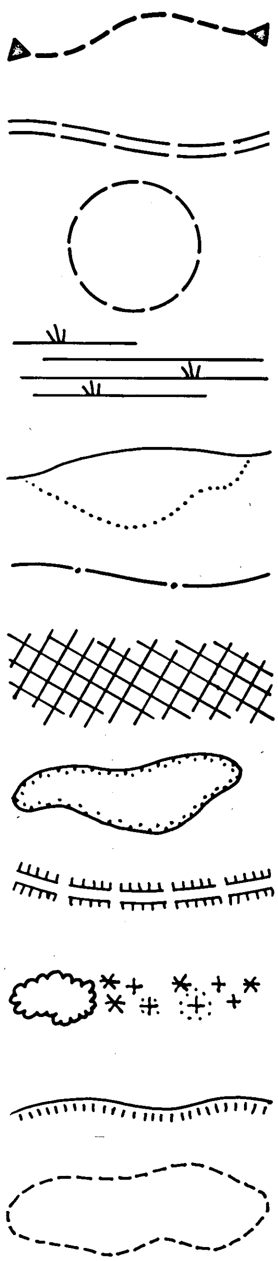
PROJECT AREA MAPS



PROJECT AREA CHANNELS

EXISTING CHANNELS

ESTIMATED MAXIMUM PUMPING DISTANCE

MARSH

TIDAL FLATS

STREAMS

URBAN AREAS

NON URBAN SHORELINE

DIKES

ROCKS

SLOPE OR EMBANKMENT

UNSURVEYED SHORELINE

FIG. 27

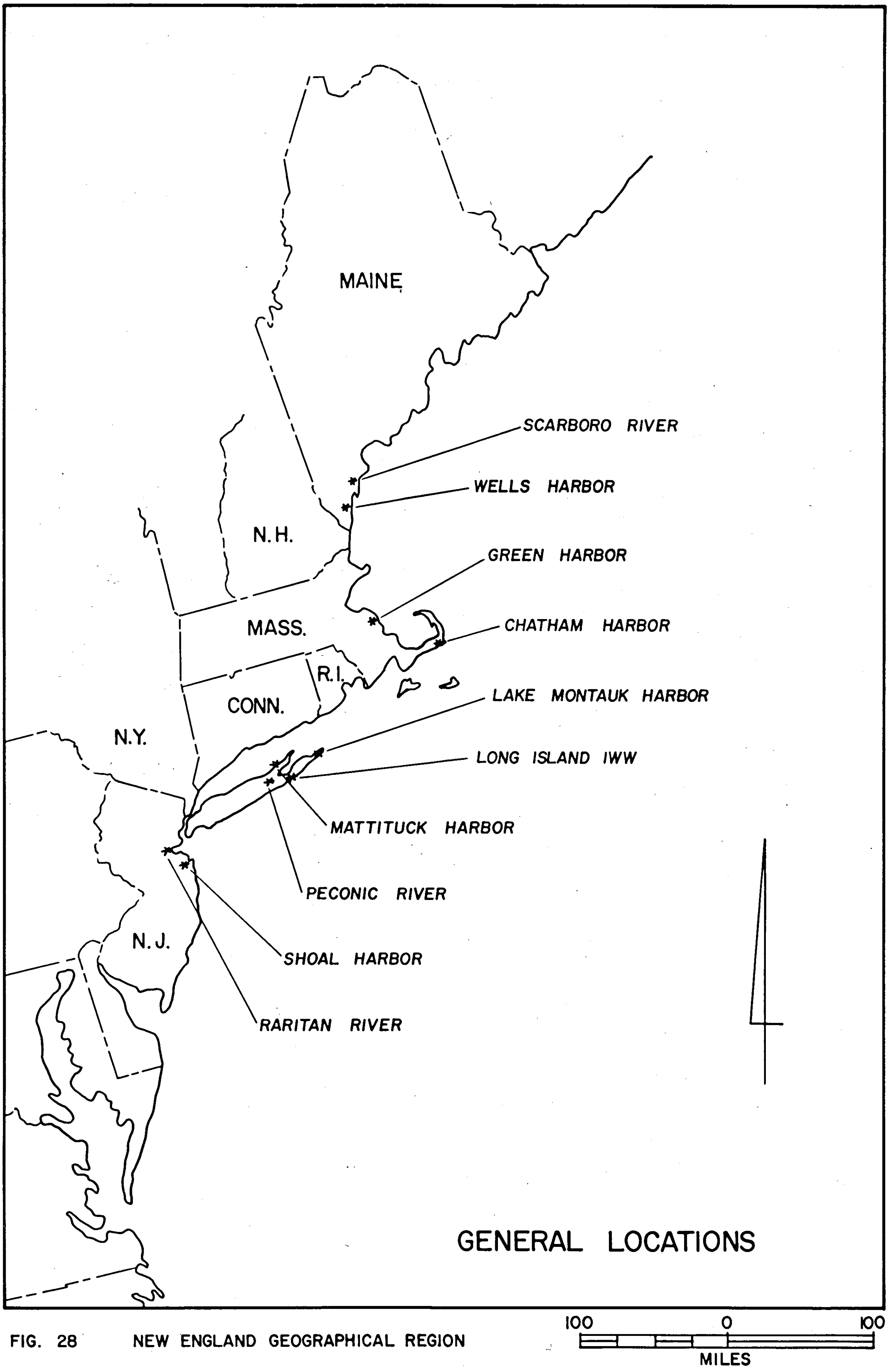


FIG. 28 NEW ENGLAND GEOGRAPHICAL REGION

information made available in regards to the Wells Harbor Project Area (1.7).

1.1 <u>Raritan River, New Jersey; New York District</u>

The Raritan River Project Area (Figure 29) is formed by the Raritan River project which begins at Washington Canal, New Jersey, and continues to Raritan Bay. The main channel is 25 ft deep and 300 ft wide from the turn in New York and New Jersey channels near the N.Y. and L.B. railroad bridge to the Raritan Arsenal wharf, thence 15 ft deep and 200 ft wide to Washington Canal. The south channel is 25 ft deep and 300 ft wide from its junction with the main channel north of the Titanium Pigment Company to a point just northwest of the Titanium Pigment Company, thence 15 ft deep and 150 ft wide to the Middlesex County Sewage Authority dock, thence 10 ft deep and 150 ft wide to east of the junction with the main channel at Crab Island.

The Raritan River Project Area generates annually an average of 311,800 cu yd of material. The Raritan River main channel project generates 73,900 cu yd of mud annually with a frequency of 84 months; while the south channel project generates 237,900 cu yd of mud annually with a 12-month frequency. Disposal is indicated as confined for the main and south channels (10-year life).

The mean tidal range at the project area is 5.1 ft at Perth Amboy (Raritan Bay and Raritan River convergence) and 5.2 ft at Sayreville (Washington Canal). The datum plane is mean low water (mlw) with mlw equal to 2.5 ft below mean sea level (msl).

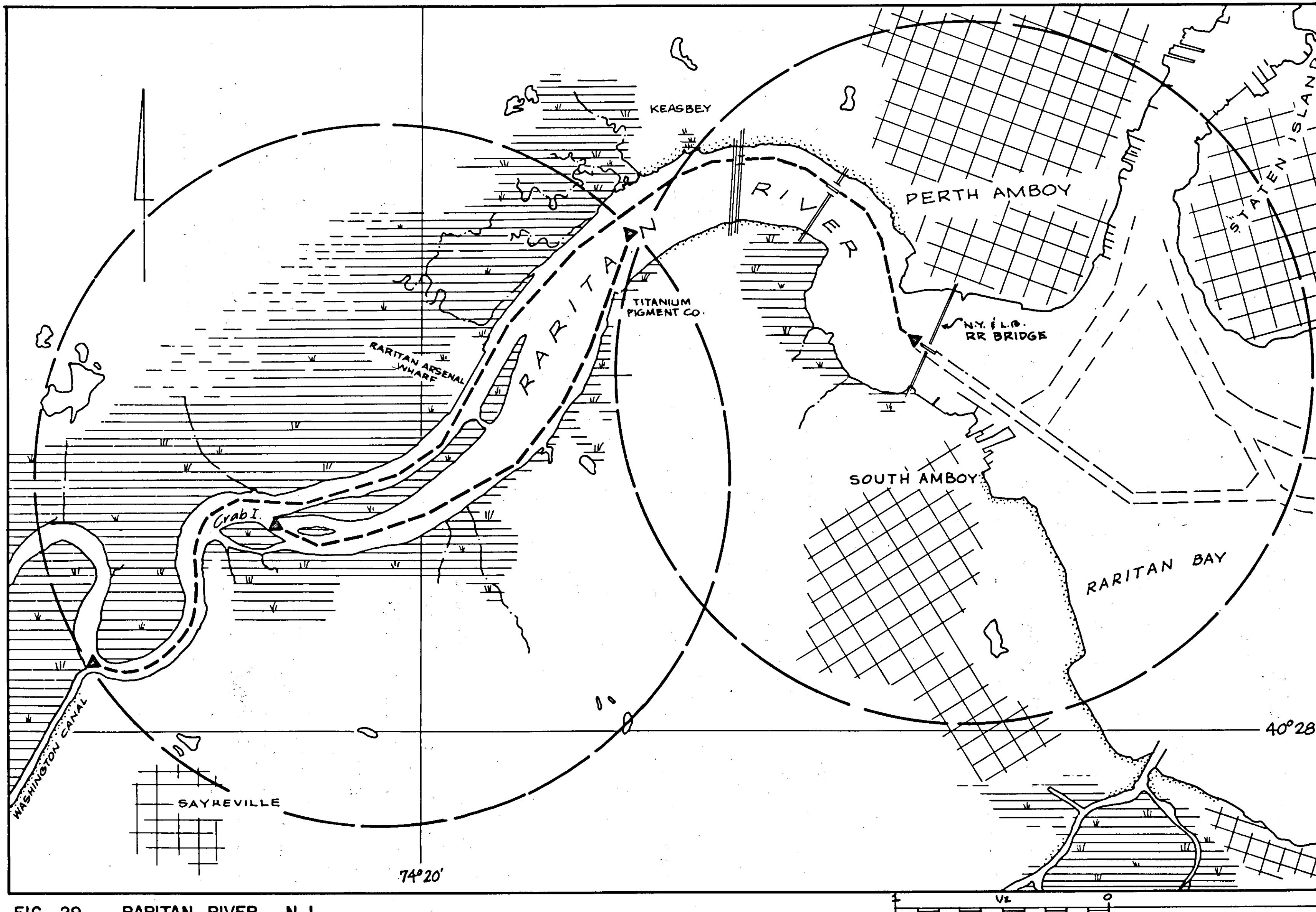


FIG. 29 RARITAN RIVER, N.J.

1.1.1 Dredged Material Receiving Site Description

1.1.1.1 Dredged Material Characteristics

The following sediment chemical parameters of the Raritan River Project Area equal or exceed Environmental Protection Agency (EPA) standards (New York District 1973): volatile solids, oil and grease, lead, zinc, and mercury.

Shoaling rates in the main channel are about one ft annually; in the south channel, about 10 ft annually. Mud is indicated as the primary material (New York District 1973).

1.1.1.2 Marsh Creation Situations

The following marsh-creation situations exist within the Project Area: land extension, as in the upper reaches of the south channel paralleling existing marsh islands and along parts of the shore on the south channel; open water paralleling channels; and open water in portions of Raritan Bay. Dredged material disposal between south channel and the marsh islands within the river could serve as a combined situation.

River currents within the Project Area average 2.5 feet per second (fps) (New York District 1974a). Water depths within the project area are usually less than 10 ft mlw, though some deep holes occur, especially in the bay.

Marsh borders much of the river through the project area and is probably a combination of salt and brackish marsh typical of northern temperate climates. Further, the marshes are probably heavily disturbed. Many areas appear to have been impacted in the course of past dredged material disposal.

Except for the remaining marshlands, the Raritan River Project Area is highly urbanized. Sayreville, South Amboy, Perth Amboy, and a portion of Staten Island are the major urban centers.

The largest disposal area currently used in the project area is located on uplands, northwest of the Titanium Pigment Company (New York District 1973). Islands separating the main and south channels may represent previous disposal areas.

1.1.2 Judgment of Desirability

1.1.2.1 Institutional Characteristics

Several New Jersey State agencies are concerned with estuarine areas:

Department of Environmental Protection
- Division of Environmental Quality
- Division of Fish, Game, and Shellfisheries
- Division of Marine Sciences
- Division of Water Resources

Tri-State Regional Planning Commission
Department of Community Affairs.

Conditions of local cooperation indicate economic support of disposal areas for the main channel and disposal areas with retaining dikes for the south channel. Disposal areas for the 15-ft channel are to be diked by local interests.

State as well as private ownership applies to areas below mean high water (mhw).

1.1.2.2 Benefits and Costs

It would appear that, due to highly polluted sediments, existing water-quality conditions in Raritan River and Bay could, in the course of marsh creation, be temporarily lowered by redispersal of some pollutants. On the other hand, viable marsh creation within this growing metropolitan center would be of great resource benefit if stricter water pollution control measures are instituted. Such benefits could be additional fishery resources, additional natural sewage treatment, and limited marsh-oriented recreation.

1.1.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following New Jersey citizens' groups:

New Jersey State Federation of Sportsmen's Clubs, Inc.

Association of New Jersey Environmental Commissions

New Jersey Audubon Society

New Jersey Conservation Foundation.

1.2 Shoal Harbor, New Jersey; New York District

The Shoal Harbor Project Area (Figure 30) consists of the Shoal Harbor and Compton Creek project which is approximately two miles in length. The channel begins north of Fishers Point and proceeds to Sandy Hook Bay and Compton Creek. Dredging consists of a channel 12 ft

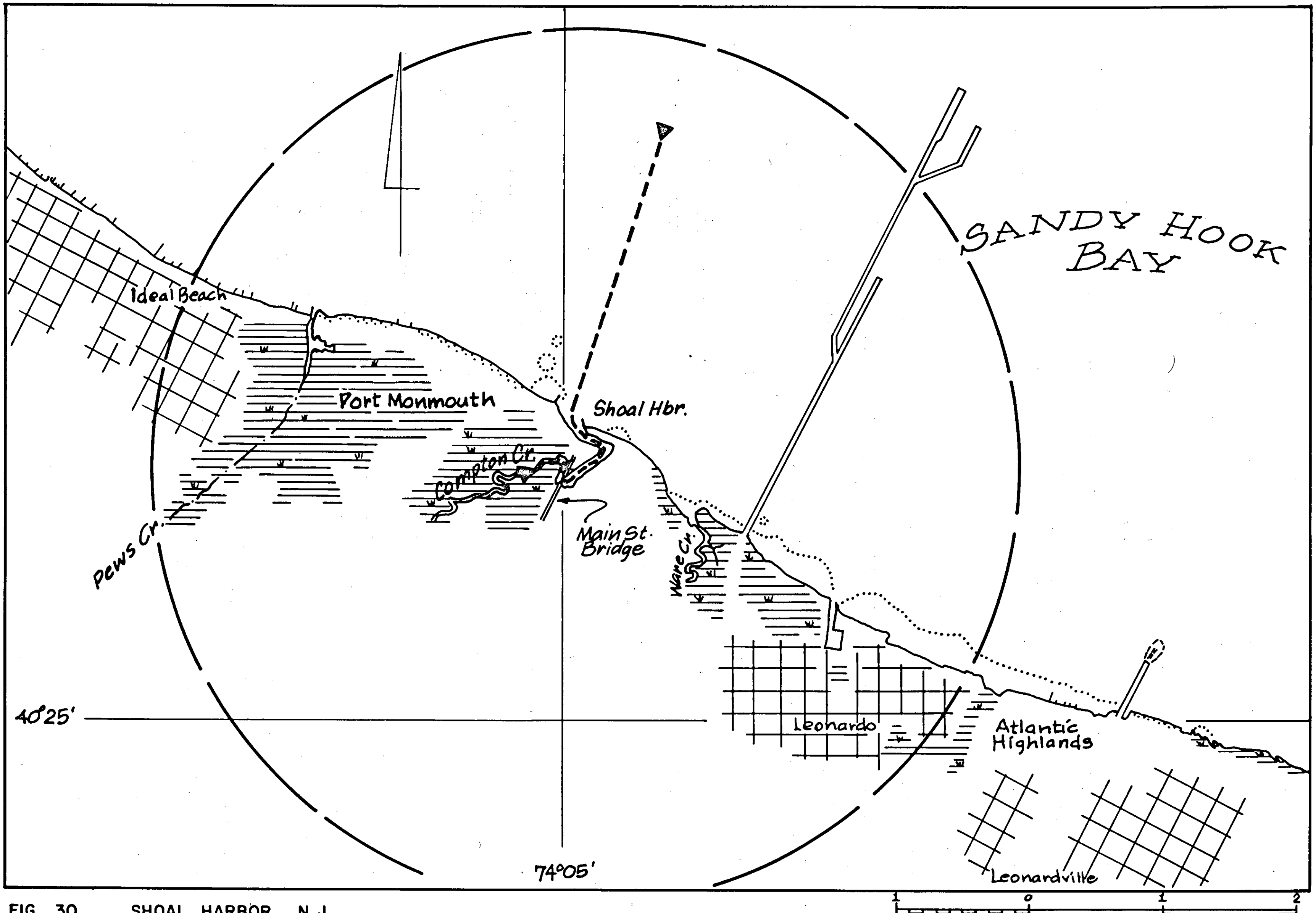


FIG. 30 SHOAL HARBOR, N.J.

deep and 150 ft wide at the mouth of Compton Creek, thence a channel eight ft deep and 75 ft wide to a point 1,000 ft above Main Street Bridge.

Projects within the Shoal Harbor Project Area generate 22,000 cu yd of mud and sand annually with a frequency of 36 months. Disposal is now in a confined site which has an effective life of 20 years.

The mean tidal range in the project area is 4.7 ft. The datum plane is mlw (-2.35 ft msl).

1.2.1 Dredged Material Receiving Site Description

1.2.1.1 Dredged Material Characteristics

Sediments in the Shoal Harbor Project Area are polluted (New York District 1974a).

1.2.1.2 Marsh-Creation Situations

The following marsh-creation situations may exist within the project area: marsh extension from upland sites and marsh; paralleling channel; and open water not paralleling channel.

Several small mud or sand flats occur just offshore from Port Monmouth. These may also serve as marsh-creation situations as land extension. Ruins of a pier are located just west of the channel, and this could serve as a stabilizing device in deposition of dredged material.

Water depths within the project area range from 0 to greater than 20 ft mlw. The extreme high tide is 12.3 ft mlw while the extreme low tide is -3.8 ft mlw.

Several piers related to recreational or commercial fishing activities are located along the shore from Point Comfort to Shoal Harbor. A pier associated with naval operations is located just east of the channel. The shorelines of the project area are occupied mostly by the greater regional urban complex.

1.2.2 Judgment of Desirability

1.2.2.1 Institutional Characteristics

Several New Jersey State agencies are concerned with estuarine areas:

- Department of Environmental Protection
  - Division of Environmental Quality
  - Division of Fish, Game, and Shellfisheries
  - Division of Marine Sciences
  - Division of Water Resources
- Tri-State Regional Planning Commission
- Department of Community Affairs.

State as well as private ownership applies to areas below mhw.

1.2.2.2 Benefits and Costs

Due to highly polluted sediments, existing water-quality conditions in Shoal Harbor could be temporarily lowered by redispersal of some pollutants in the course of marsh creation. If stricter water pollution control measures are instituted, benefits could be additional fishery resources, additional natural sewage treatment, and limited marsh-oriented recreation.

1.2.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following New Jersey citizens' groups:

New Jersey State Federation of Sportsmen's Clubs, Inc.

Association of New Jersey Environmental Commissions

New Jersey Audubon Society

New Jersey Conservation Foundation.

1.3 <u>Long Island IWW, New York; New York District</u>

The Long Island IWW Project Area (Figure 31) is composed of one section of the Long Island Intracoastal Waterway (LIWW). The project area is from a point in Bellport Bay south of Long Point to a point midway through Moriches Bay south of the town of Moriches. Dredging consists of a channel six ft deep, 100 ft wide.

The project area generates approximately 16,000 cu yd of sand annually with a frequency of 24 months (the entire LIWW project totals 53,400 cu yd annually). Disposal is mostly on the ocean beach with some in upland sites.

The mean tidal range of the LIWW is from 0.5 ft at Mastic Beach (western reach of waterway) to 2.4 ft at Shinnecock Inlet (bay side at eastern reach of waterway). The datum plane is mlw (-0.3 msl in the vicinity of Mastic Beach).

1.3.1 Dredged Material Receiving Site Description

1.3.1.1 Dredged Material Characteristics

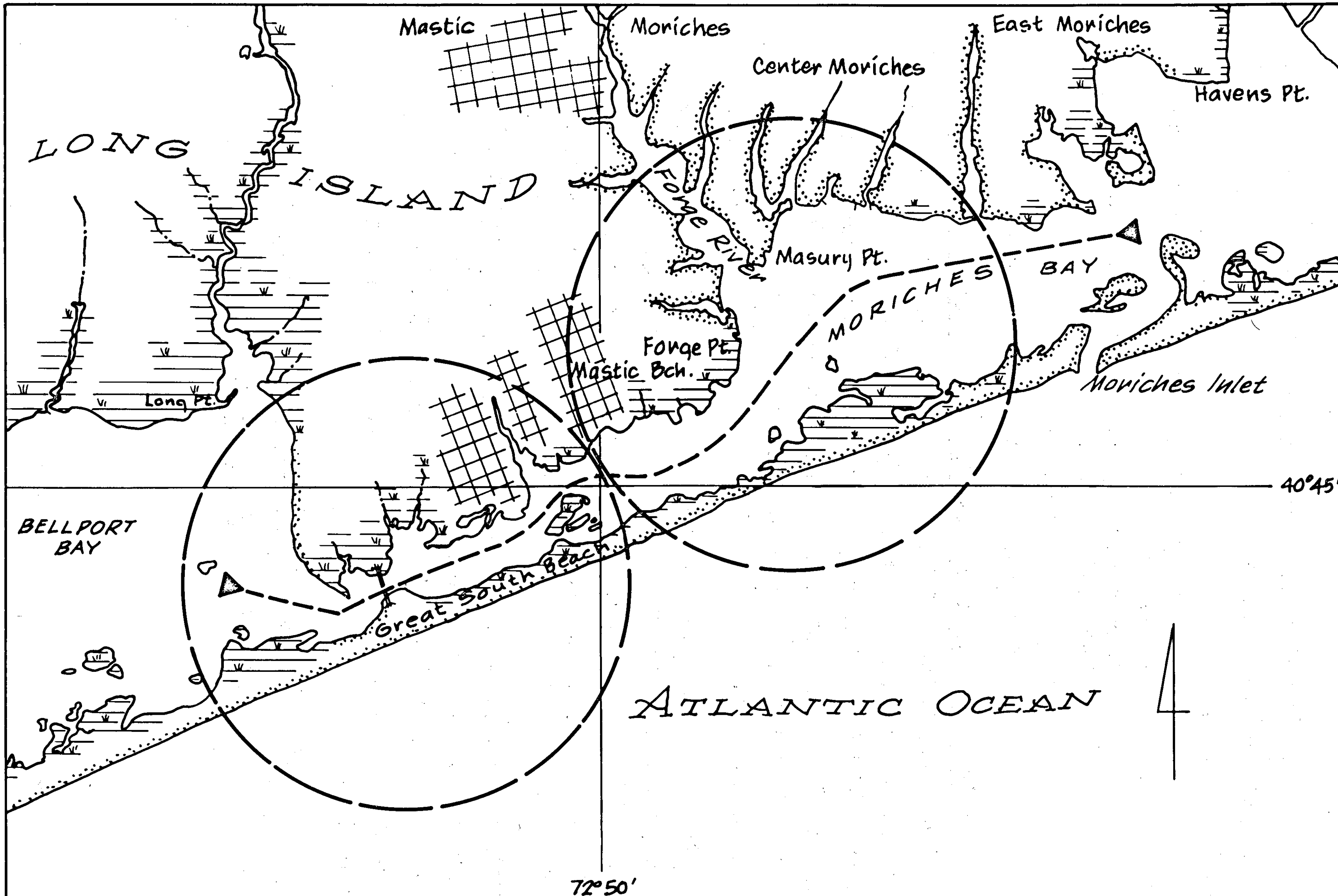


FIG. 31 LONG ISLAND I.W.W., N.Y.

1 0 1 2
NAUT. MI.

Sediments within the project area are polluted in excess of EPA standards (New York District 1974b).

1.3.1.2 Marsh-Creation Situations

The following situations may be available for marsh creation in the project area: estuarine creeks and rivers; paralleling LIWW channel; marsh extension as behind Great South Beach barrier island or Long Island; and open water away from the existing channel.

Tidal characteristics within the project area are complex due to the length of the dominant barrier island, Fire Island. Maximum surface water currents range from 1.0 to 1.5 fps at Smith Point Bridge. Tidal range varies between 0.7 and 1.5 ft (Norman Porter Associates 1967).

A considerable amount of salt and brackish marsh exists within the project area. These marshes are characteristic of the northeast coastal regions of the United States. Total acreage has decreased drastically as a result of development. The most extensive areas of marsh are located along estuarine rivers and creeks of the mainland and landward of Fire Island (O'Connor and Terry 1972).

The major urban centers in the general project area are Mastic, Mastic Beach, and Moriches. The bridge to Great South Beach crosses in the eastern half of the project area.

A portion of the dredged material derived from this section of LIWW is deposited on ocean beach as beach nourishment on Fire Island. The balance is placed on upland sites.

1.3.2 Judgment of Desirability

1.3.2.1 Institutional Characteristics

New York State Agencies concerned with estuarine areas are:

Bureau of Environmental Protection
Department of Environmental Conservation
 Division of Pure Waters
 Division of Fish and Wildlife
Office of Environmental Planning
State Fish and Wildlife Management Board.

Local cooperation is required for use of disposal areas. The Nassau-Suffolk Regional Marine Resources Council provides "guidelines for public policy, planning, decision and action ... in four marine related subject areas" having priority on Long Island: coast stabilization; dredging and disposal; integrated water supply and wastewater disposal; and wetlands management (Regional Marine Resources Council 1973).

Federal, state, local, and private concerns own land below mhw in New York.

1.3.2.2 Benefits and Costs

Possible use of dredged material in the project area for marsh creation considerably enhances its value. High pollution status of these sediments makes open-water disposal less feasible.

1.3.2.3 Public Attitudes

Public attitudes toward estuarine land use may be represented by the following New York citizens' groups:

New York State Conservation Council

Federation of New York State Bird Clubs, Inc.

The Nature Conservancy

New York State Association of Conservation Commissions, Inc.

Save Our Bays Association of Long Island.

1.4 Peconic River, New York; New York District

The Peconic River Project Area (Figure 32) is represented by the Peconic River project and is located south of Riverhead on Long Island, New York. Dredging consists of a channel six ft deep, 100 ft wide, extending from deep water in Great Peconic Bay (north of Red Cedar Point) for a distance of 1,100 ft, then at the same depth and a width of 75 ft through Flanders Bay to a point 1,100 ft below Peconic Avenue. Total project distance is approximately five miles.

The Peconic River Project Area generates 15,700 cu yd of mud annually with a frequency of 300 months. Disposal is listed as confined with the site having a 10-year life.

The mean tidal range of the project area is 2.9 ft. The datum plane is mlw (-1.2 ft msl at Sandy Hook, New Jersey).

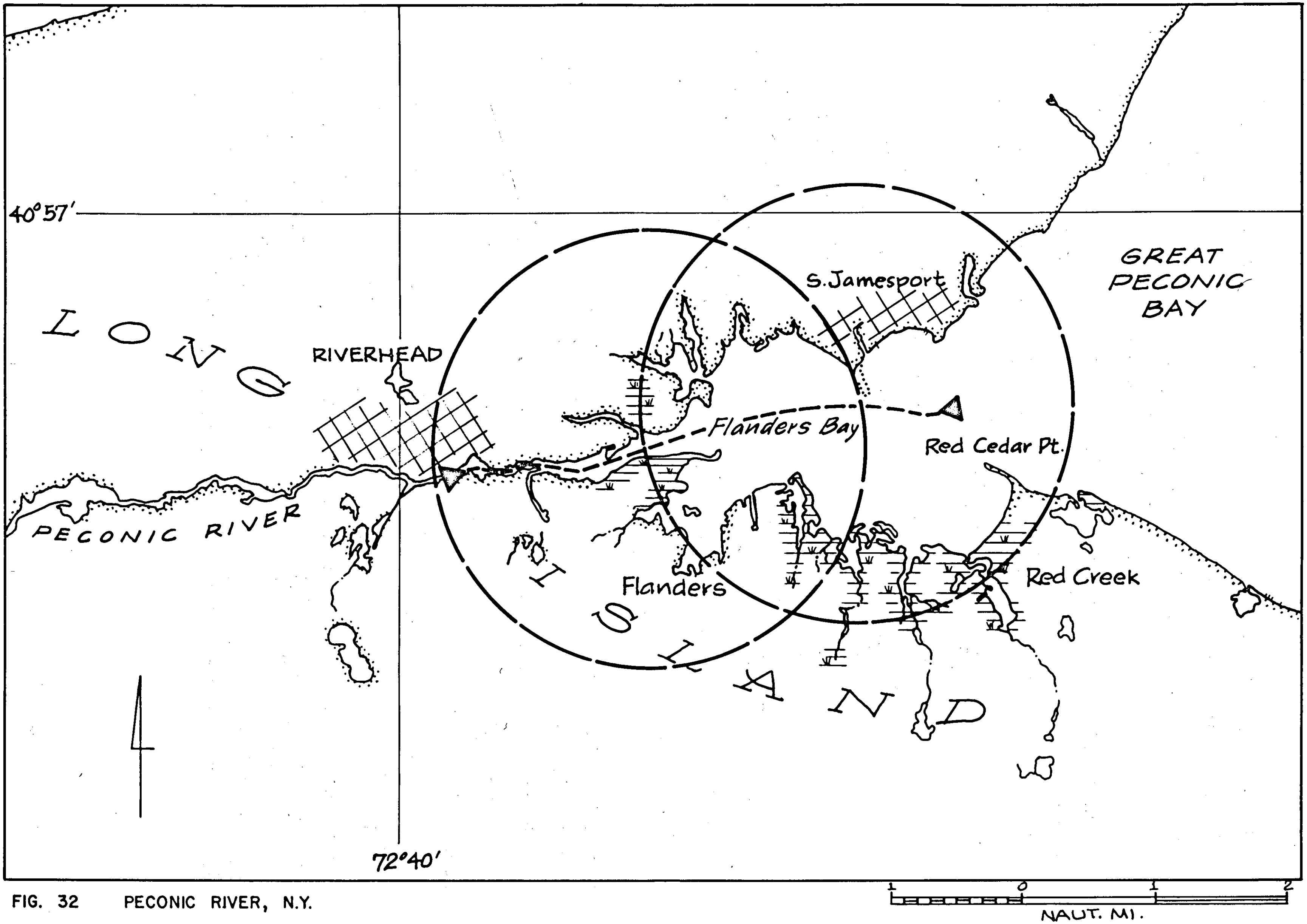


FIG. 32 PECONIC RIVER, N.Y.

1.4.1 Dredged Material Receiving Site Description

1.4.1.1 Dredged Material Characteristics

All sediment pollutant parameters within the Peconic River Project Area, except that for mercury, exceed EPA standards (New York District 1972). The origin of some of these pollutants is thought to be poultry or duck farms which, until recently, have not been required to process wastes before allowing them to flow into nearby streams.

1.4.1.2 Marsh-Creation Situations

Creation of marsh could be considered for the following situations: estuarine creeks and rivers in Peconic Bay; land extension in several areas, such as near the mouth of Red Creek and any of the marsh foreshores in Peconic Bay and Flanders Bay; and extension from upland areas, as in the South Jamesport area.

The mean tidal range in Peconic Bay and River is 2.9 ft, with a mean spring range of 3.4 ft. Extremes of +8.8 ft and -1.6 ft mlw have been experienced. Maximum and minimum velocities for flood and ebb tidal currents are 4.1 and 3.4 fps, respectively (New York District 1972). Within Flanders Bay, depths are usually less than 10 ft while depths of 20 ft or more occur in Great Peconic Bay.

The largely rural residential setting of the project area includes substantial acreages of swamp, marsh, and aquatic habitat which supports brackish and saltwater dependent species. In spite of pollution levels there is good habitat for commercially important species of fin and shellfish. Several species of migratory waterfowl also use these habitats (New York District 1972).

1.4.2 Judgment of Desirability

1.4.2.1 Institutional Characteristics

New York State agencies concerned with estuarine areas are:

- Bureau of Environmental Protection
- Department of Environmental Conservation
  - Division of Pure Water
  - Division of Fish and Wildlife
- Office of Environmental Planning
- State Fish and Wildlife Management Board.

Local cooperation is required for use of disposal areas.

The Nassau-Suffolk Regional Marine Resources Council provides "guidelines for public policy, planning, decision and action ... in four marine related subject areas" having priority on Long Island: coast stabilization and protection; dredging and disposal; integrated water supply and wastewater disposal; and wetlands management (Regional Marine Resources Council 1973).

Federal, state, local, and private concerns own lands below mhw in New York.

1.4.2.2 Benefits and Costs

Population statistics predict substantial increases in residential and recreational land use in the Peconic River Project Area (New York District 1972). With resultant decreases in estuarine dependent habitat and tighter water pollution controls, the use of dredged material for marsh creation could have substantial long-term benefits.

1.4.2.3 Public Attitudes

The towns of Flanders, Riverhead, and South Jamesport are small and their economic base is primarily poultry farming and commercial and recreational fishing. Combined populations for Flanders and Riverhead number less than 10,000 (New York District 1972).

Public attitudes toward estuarine land use may be represented by the following New York citizens' groups:

New York State Conservation Council

Federation of New York State Bird Clubs, Inc.

The Nature Conservancy

New York State Association of Conservation Commissions, Inc.

Save Our Bays Association of Long Island.

1.5 Green Harbor, Massachusetts; New England Division

The Green Harbor Project Area (Figure 33) consists of the Green Harbor project which is located southeast of Marshfield, Massachusetts, at the confluence of Green Harbor and Cut Rivers. Dredging consists of a channel, six ft deep (eight ft at entrance), 160 ft wide, and extending about 4,000 ft from deep water to the upstream limit, and a five-acre anchorage basin (six ft deep) near the town pier.

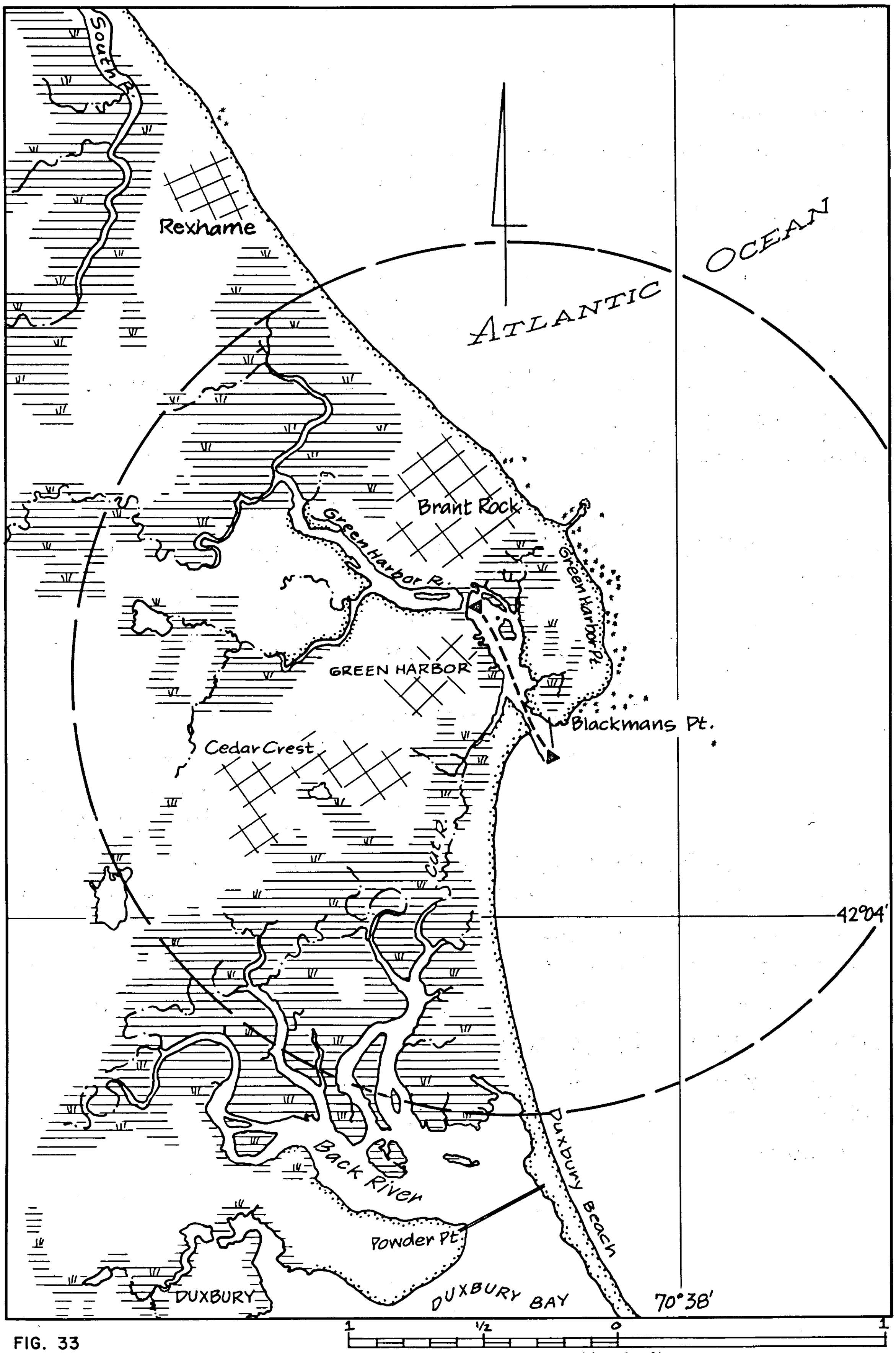


FIG. 33
GREEN HARBOR, MASS.

The Green Harbor Project Area annually generates 15,000 cu yd of mud and sand with a frequency of 36 months. Disposal is indicated as confined with the site having a 25-year life.

The mean tidal range at the project area is 9.0 ft. The datum plane is mlw.

1.5.1 Dredged Material Receiving Site Description

1.5.1.1 Dredged Material Characteristics

EPA standards for all major sediment parameters, except that for mercury, are exceeded in the anchorage area and the turning basin of the project area (New England Division 1973b). The largely silty texture of the sediment provides a large number of cation exchange sites which contributes to high pollutant levels. Sediment toward the inlet has lower pollution levels and contains material with larger particle sizes.

1.5.1.2 Marsh-Creation Situations

Areas where marsh may be created are limited to estuarine creeks and rivers, unless open water paralleling larger waterways proved to be of sufficient areal extent to create marsh. Situations within the former situation occur within the upper reaches of Back River to the south. Land extensions may also apply in this case.

Spring tide range averages 10.5 ft. At mlw, much of the harbor becomes exposed mud flat (New England Division 1973b).

Salt marsh surrounds most of the project area; however, the shellfishery within these marshes is closed because of high pollution levels. Softshell clams were of commercial importance prior to 1969. The marshes are also inhabited by several species of ducks and other marsh-dependent birds.

Existing confined disposal areas, in use since 1968, are located on sites just north of the project in pre-existing marshland.

1.5.2 Judgment of Desirability

1.5.2.1 Institutional Characteristics

Massachusetts State agencies concerned with estuarine areas are:

- Department of Natural Resources
  - Division of Marine Fisheries
  - Division of Conservation Services
  - Division of Law Enforcement
  - Division of Water Pollution Control
  - Division of Fisheries and Game
- Commission on Ocean Management
- Executive Office of Environmental Affairs.

The Department of Natural Resources controls coastal wetlands projects, while the Commission on Ocean Management is in charge of long-range planning in coastal and estuarine areas.

Local interests are indicated as favoring disposal of dredged material behind dikes.

Land in estuarine areas of Massachusetts below mlw is divided between state and private ownership.

1.5.2.2 Benefits and Costs

As with most of the projects in or near urban areas, the long-range benefits of marsh creation are governed, in part, by the success of reducing the pollution status of sediments to be redistributed within the estuarine system. Reduction in water pollution would allow reopening of the shellfishery in the bay and would considerably reduce the overall expenditure of public money by increasing returns from investments. Should marsh be created, additional fishery resources could be expected. These could also aid in balancing past losses of marshlands.

1.5.2.3 Public Attitudes

The harbor itself is used for anchorage and docking by commercial and sports fishing boats. Lobster is the primary commercial product (New England Division 1973b).

Brant Rock and Cedar Crest are typical of the communities along this coast. These small towns, as well as the smaller communities surrounding them, are mainly fishing and vacation centers for visitors from large metropolitan areas, such as Boston.

Public attitudes concerning estuarine land use may be represented by the following Massachusetts citizens' groups:

Massachusetts Wildlife Federation

Council of Sportsmen's Clubs of Massachusetts

Massachusetts Association of Conservation Commissions

Massachusetts Audubon Society

The Trustees of Reservations.

1.6 Lake Montauk Harbor, New York; New York District

The Lake Montauk Harbor Project Area (Figure 34) consists of the Lake Montauk Harbor project and is located northeast of Montauk, New York, at the Block Island Sound entrance into Lake Montauk. Dredging consists of a channel 12 ft deep and 150 ft wide from the 12-ft contour in Block Island Sound to the same depth in the existing yacht basin east of Star Island; and a boat basin 10 ft deep, 400 ft wide, and 900 ft long located west of Star Island.

The Lake Montauk Project Area generates 10,900 cu yd of sand and gravel annually with a frequency of 48 months. Disposal is indicated as unconfined on the beach.

The mean tidal range at the project area is 1.9 ft. The datum plane is mlw (-1.0 ft msl).

1.6.1 Dredged Material Receiving Site Description

1.6.1.1 Dredged Material Characteristics

According to the New York District (1974a), sediment pollutants in Lake Montauk Harbor do not exceed EPA standards. This is probably due to the large particle size of the sediments (sand and shell) and to the low population density around the project area.

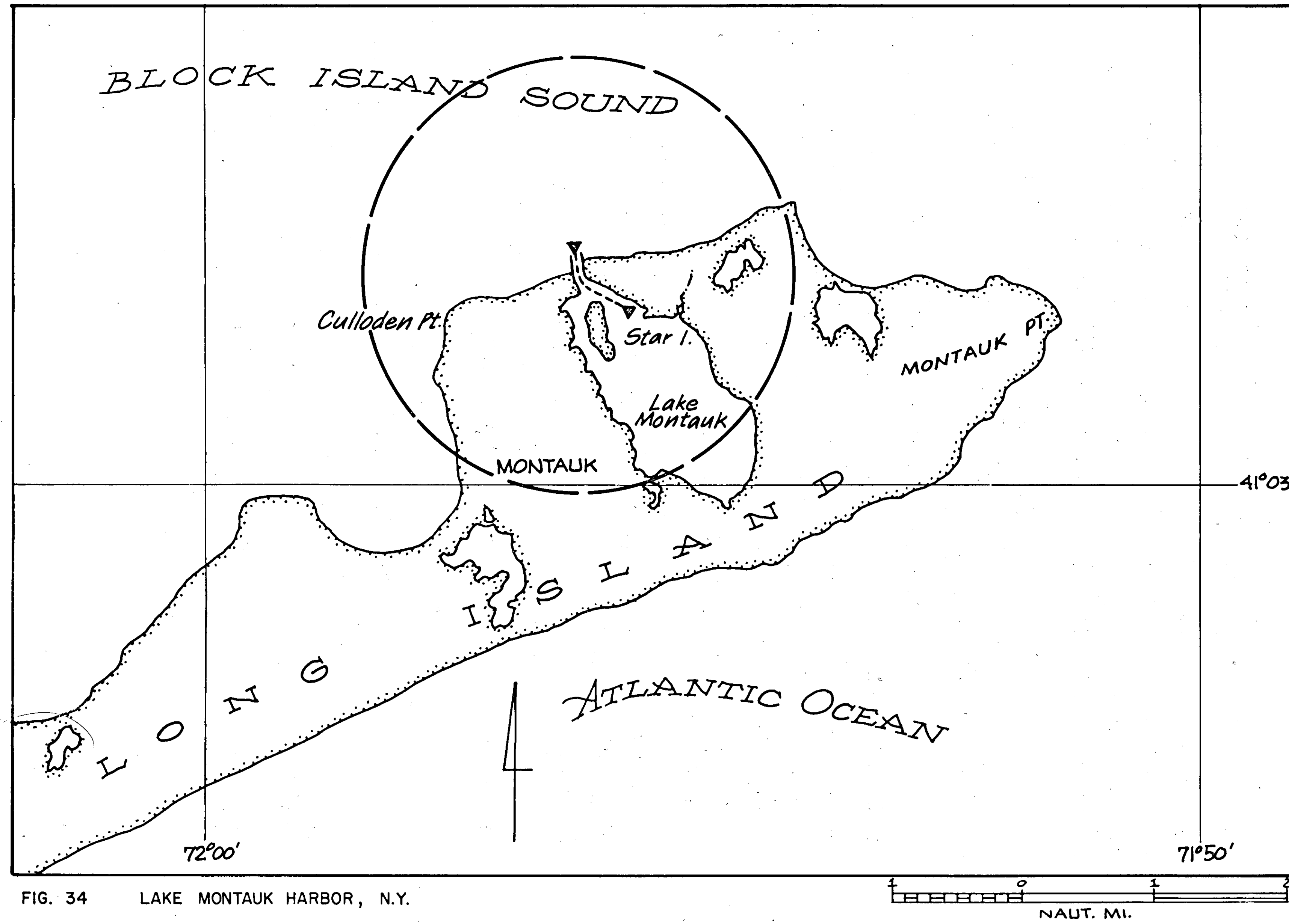


FIG. 34 LAKE MONTAUK HARBOR, N.Y.

1.6.1.2 Marsh-Creation Situations

The following situations may be available for marsh creation: land extensions from Star Island or the upland margins of the harbor; estuarine bays outside of the harbor; land extension in Long Island Sound; and scattered islands within Lake Montauk Harbor.

The extreme high tide is 0.9 ft mlw while the extreme low tide is -2.0 ft mlw. There is a long wind fetch from the north.

Only two major areas of salt marsh occur in Lake Montauk Harbor (O'Connor and Terry 1972). These and the existing estuarine bottoms probably support a biota similar to that for the Mattituck Harbor Project Area (1.9).

1.6.2 Judgment of Desirability

1.6.2.1 Institutional Characteristics

New York State agencies concerned with estuarine areas are:

Bureau of Environmental Protection
Department of Environmental Conservation
Division of Pure Water
Division of Fish and Wildlife
Office of Environmental Planning
State Fish and Wildlife Management Board.

Local cooperation is required for use of disposal areas.

The Nassau-Suffolk Regional Marine Resources Council provides "guidelines for public policy, planning, decision and action ... in four marine related subject areas" having priority on Long Island: coast stabilization and protection; dredging and disposal; integrated water supply and wastewater disposal; and wetlands management (Regional Marine Resources Council 1973).

Federal, state, local, and private concerns own land below mhw in New York.

1.6.2.2 Benefits and Costs

The benefits of marsh creation in this area could be great if the aquatic areas utilized were not more productive than the resultant marsh.

1.6.2.3 Public Attitudes

Public attitudes toward estuarine land use may be represented by the following New York citizens' groups:

New York State Conservation Council

Federation of New York State Bird Clubs, Inc.

The Nature Conservancy

New York State Association of Conservation Commissions, Inc.

Save Our Bays Association of Long Island.

1.7 Wells Harbor, Maine; New England Division

The Wells Harbor Project Area (Figure 35) is represented by the Wells Harbor project and is located southwest of the Kennebunk River and north of Ogunquit. The harbor is formed by the Webhannet River flowing from the west. The project consists of a channel 100 to 150 ft wide, extending from deep water in the Atlantic Ocean to

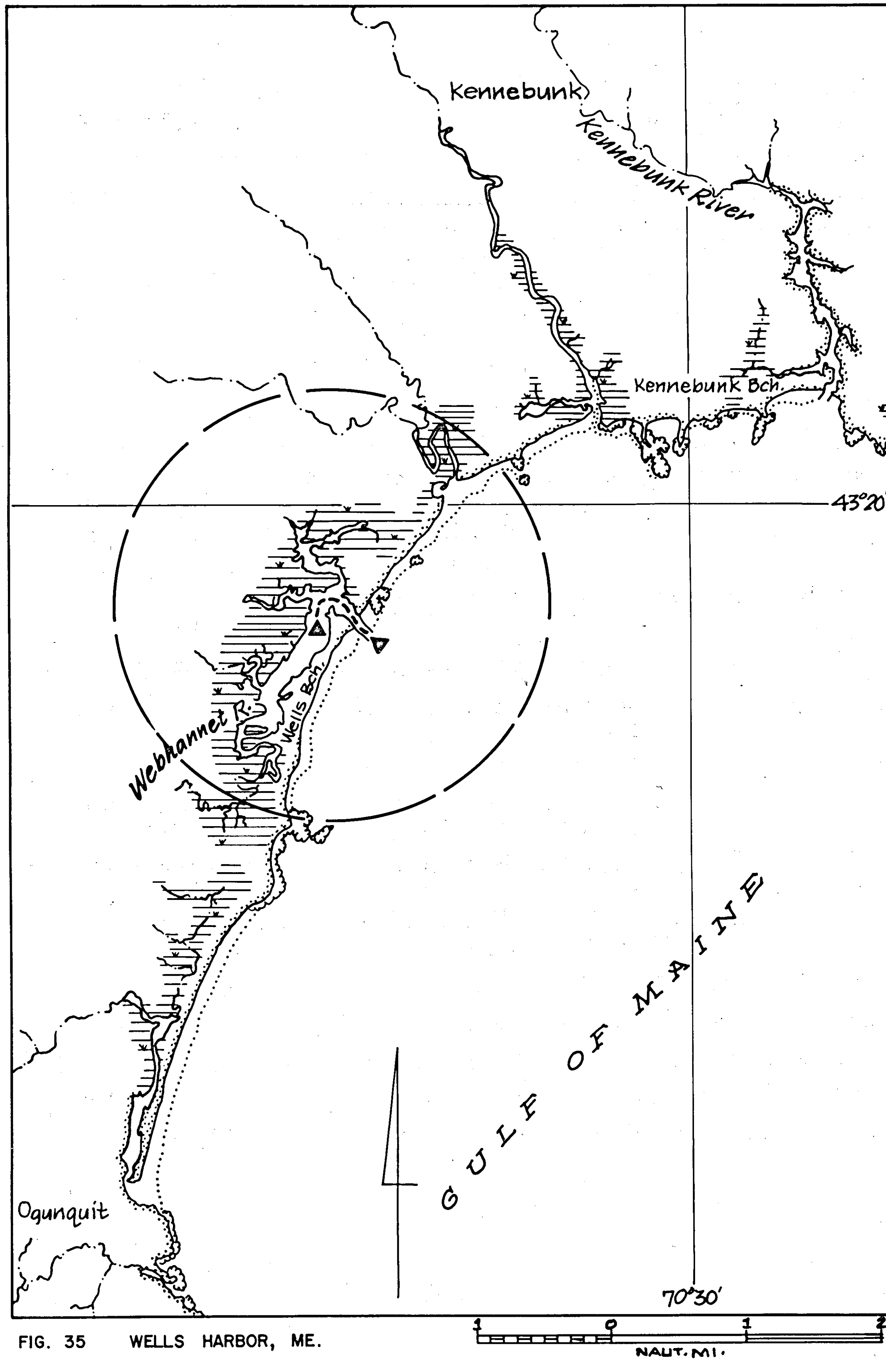


FIG. 35 WELLS HARBOR, ME.

the inner end of the anchorage basin with the seaward section being eight ft deep and the harbor section six ft deep. The anchorage basin is 7.4 acres in area and six ft in depth.

The Wells Harbor Project Area generates 10,000 cu yd of sand annually with a frequency of 36 months. Disposal is indicated as confined with the site having a 25-year life.

The mean tidal range at the project area is 8.7 ft. The datum plane is mlw.

1.7.1 Dredged Material Receiving Site Description

1.7.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

1.7.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

1.7.2 Judgment of Desirability

1.7.2.1 Institutional Characteristics

The following Maine State agencies are concerned with estuarine areas:

Department of Marine Resources
Department of Natural Resources.

1.7.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

1.7.2.3 <u>Public Attitudes</u>

Public attitude concerning estuarine use may be represented by the following Maine citizens' groups:

Natural Resources Council of Maine

Maine Association of Conservation Commissions

Maine Audubon Society

Maine Coast Heritage Trust

The Maine Chapter of the Nature Conservancy.

1.8 <u>Scarboro River, Maine; New England Division</u>

The Scarboro River Project Area (Figure 36) is represented by the Scarboro River project and is located south of Portland, Maine. The mouth of Scarboro River, just behind Prouts Neck, is formed by Jones Creek, Nonesuch River, and Libby River. The project consists of a channel across the bar at the entrance 200 ft wide and eight ft deep, and a channel 2,400 ft long, 100 ft wide, and six ft deep to an anchorage of the same depth, 1,350 ft long, and 300 ft wide.

The Scarboro River Project Area generates 10,000 cu yd of sand annually with a frequency of 48 months. Disposal is indicated as unconfined.

The mean tidal range at the project area is 8.8 ft. The datum plane is mlw.

1.8.1 <u>Dredged Material Receiving Site Description</u>

The dredge work, as indicated by the New England Division (1973a) has been changed to a sidecaster dredge

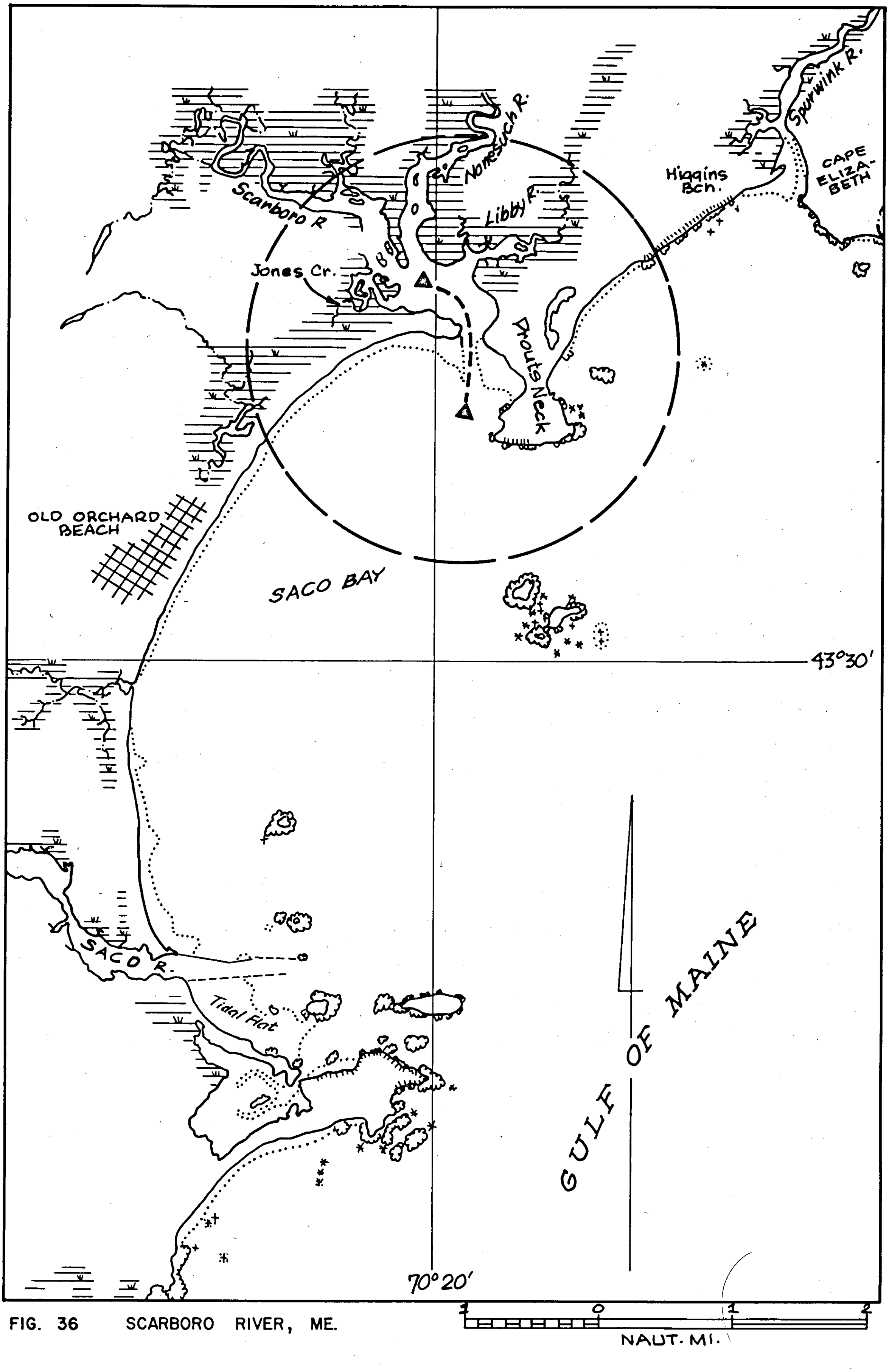


FIG. 36 SCARBORO RIVER, ME.

and, therefore, no further information was obtained.

1.8.2 Judgment of Desirability

Project changed to sidecaster dredge and no further information was obtained.

1.9 Mattituck Harbor, New York; New York District

The Mattituck Harbor Project Area (Figure 37) is formed by the Mattituck Harbor project which is located on the north shore of Long Island, New York, approximately two miles southwest of Duck Pond Point and two miles west of New Suffolk. The project consists of a two-mile long channel, seven ft deep from Long Island Sound to the Village of Mattituck, 100 ft wide at the entrance, 80 ft wide thereafter to an anchorage area which is 460 by 570 ft.

The Mattituck Harbor Project Area generates 6,200 cu yd of sand annually with the frequency being 74 months.

The mean tidal range at the project area is 4.9 ft at the entrance and 5.1 ft at the Old Mill Bridge (one mile from the entrance). The datum plane is mlw (-2.06 ft msl).

1.9.1 Dredged Material Receiving Site Description

1.9.1.1 Dredged Material Characteristics

Sediment requiring maintenance dredging in Mattituck Harbor is largely sand. The sediment becomes more silty toward the head of the harbor (New York District 1974a).

Analysis of pollutants contained in the

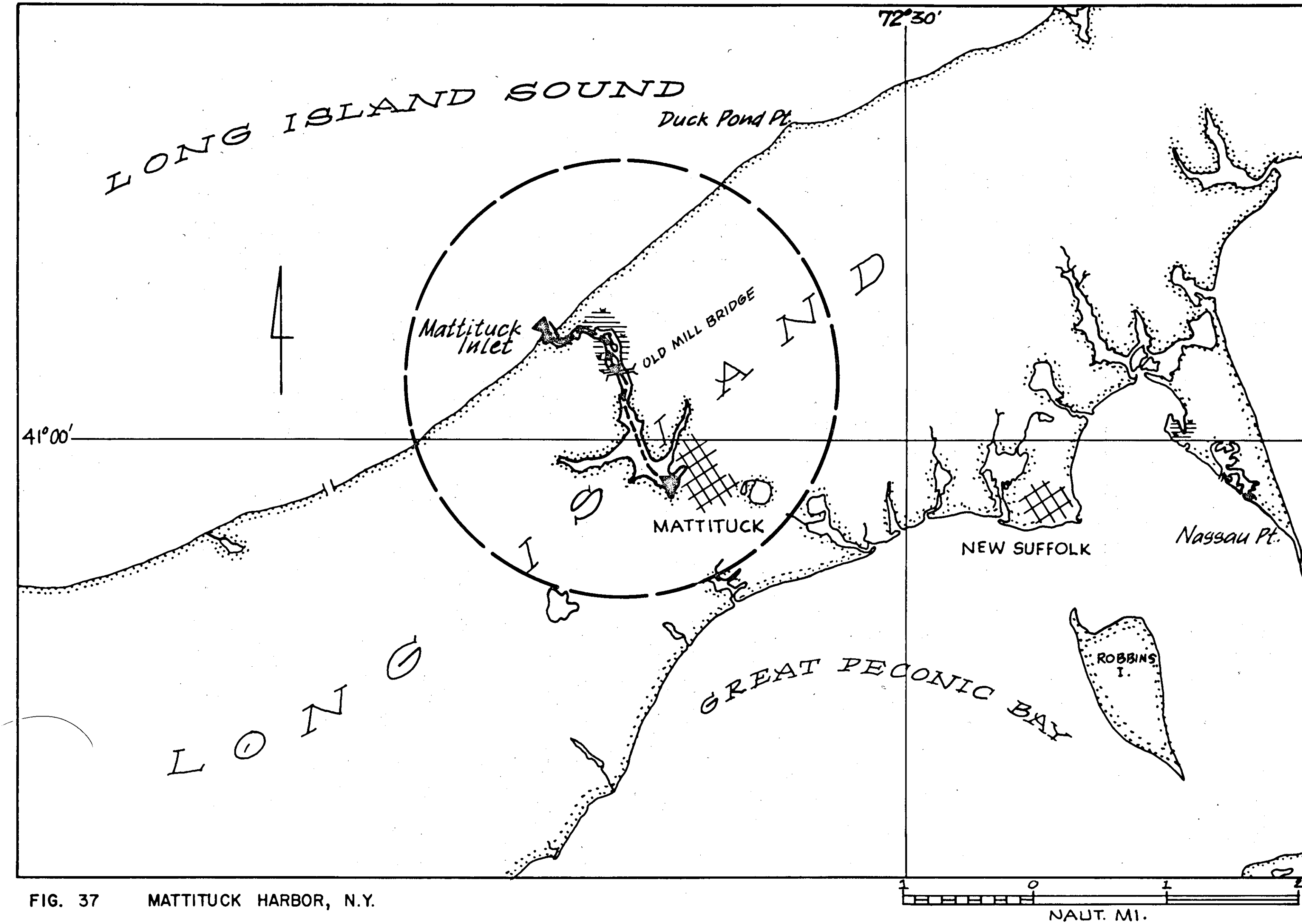


FIG. 37 MATTITUCK HARBOR, N.Y.

sediments indicate all parameters exceed EPA standards at one place or another (New York District 1974a). Pollutants originate from several sources including untreated or poorly treated sewage and boat motor exhaust effluents (New York District 1974a).

1.9.1.2 Marsh-Creation Situations

The following marsh-creation situations may be possible in Mattituck Harbor: estuarine creeks of limited areal extent; land extension from both upland and marshland; and linear configurations paralleling the main channel and connected to the adjacent land. Marsh creation in Long Island Sound is effectively a situation behind a barrier island. The long northwesterly wind fetch could cause erosion.

Tidal ranges in Mattituck Harbor are influenced mainly by the ebb and flood of waters from Long Island Sound, not by freshwater flow into the harbor from adjacent uplands. Tides pass through two cycles daily (New York Conservation Department 1969). Extreme high tide is 11.5 ft mlw and extreme low tide is -2.2 ft mlw at the entrance of the bay.

The 45 acres of salt marsh in Mattituck Harbor are dominated by smooth cordgrass (O'Connor and Terry 1972). These areas support a variety of resident and transient bird species at various times of the year (North Fork Audubon Society 1974). Shellfish (New York Conservation Department 1969) and several species of commercial and sport finfish (New York District 1974a) are dependent upon habitat within the bay, although shellfish have not been harvested recently in commercial quantities.

At the present time, dredged material is placed on the beach east of the east jetty.

1.9.2 Judgment of Desirability

1.9.2.1 Institutional Characteristics

New York State agencies concerned with estuarine areas are:

Bureau of Environmental Protection
Department of Environmental Conservation
  Division of Pure Water
  Division of Fish and Wildlife Management
Office of Environmental Planning
State Fish and Wildlife Management Board.

Local cooperation is required for use of disposal areas.

The Nassau-Suffolk Regional Marine Resources Council provides "guidelines for public policy, planning, decision and action ... in four marine related subject areas" having priority on Long Island: coast stabilization and protection; dredging and disposal; integrated water supply and wastewater disposal; and wetlands management (Regional Marine Resources Council 1973).

Federal, state, local, and private concerns own lands below mhw in New York.

1.9.2.2 Benefits and Costs

Due to limited areal extent of aquatic environments and polluted sediments, marsh creation might not be feasible. Creation of marsh in Long Island Sound as marsh extension would probably not be practical due to long wind fetch and erosion.

1.9.2.3 Public Attitudes

The town of Mattituck is located at the southern end of the harbor. Several marine facilities service largely summer pleasure boats traveling in Long Island Sound. The population of the town is approximately 1,350 (New York Conservation Department 1969). Goods and services supplied are probably dependent upon this summer traffic.

Public attitudes toward estuarine land use may be represented by the following New York citizens' groups:

- New York State Conservation Council
- Federation of New York State Bird Clubs, Inc.
- The Nature Conservancy
- New York State Association of Conservation Commissions, Inc.
- Save Our Bays Association of Long Island.

1.10 Chatham Harbor, Massachusetts; New England Division

The Chatham Harbor Project Area (Figure 38) is represented by the Chatham (Stage) Harbor project, and is located south of Chatham, Massachusetts. Stage Harbor is the convergence of Oyster Pond River and Mitchell River. Dredging consists of a channel 10 ft deep, 150 ft wide, and two miles in length from Chatham Roads to the upper harbor.

The Chatham Harbor Project Area generates 6,000 cu yd of sand annually with a frequency of 72 months.

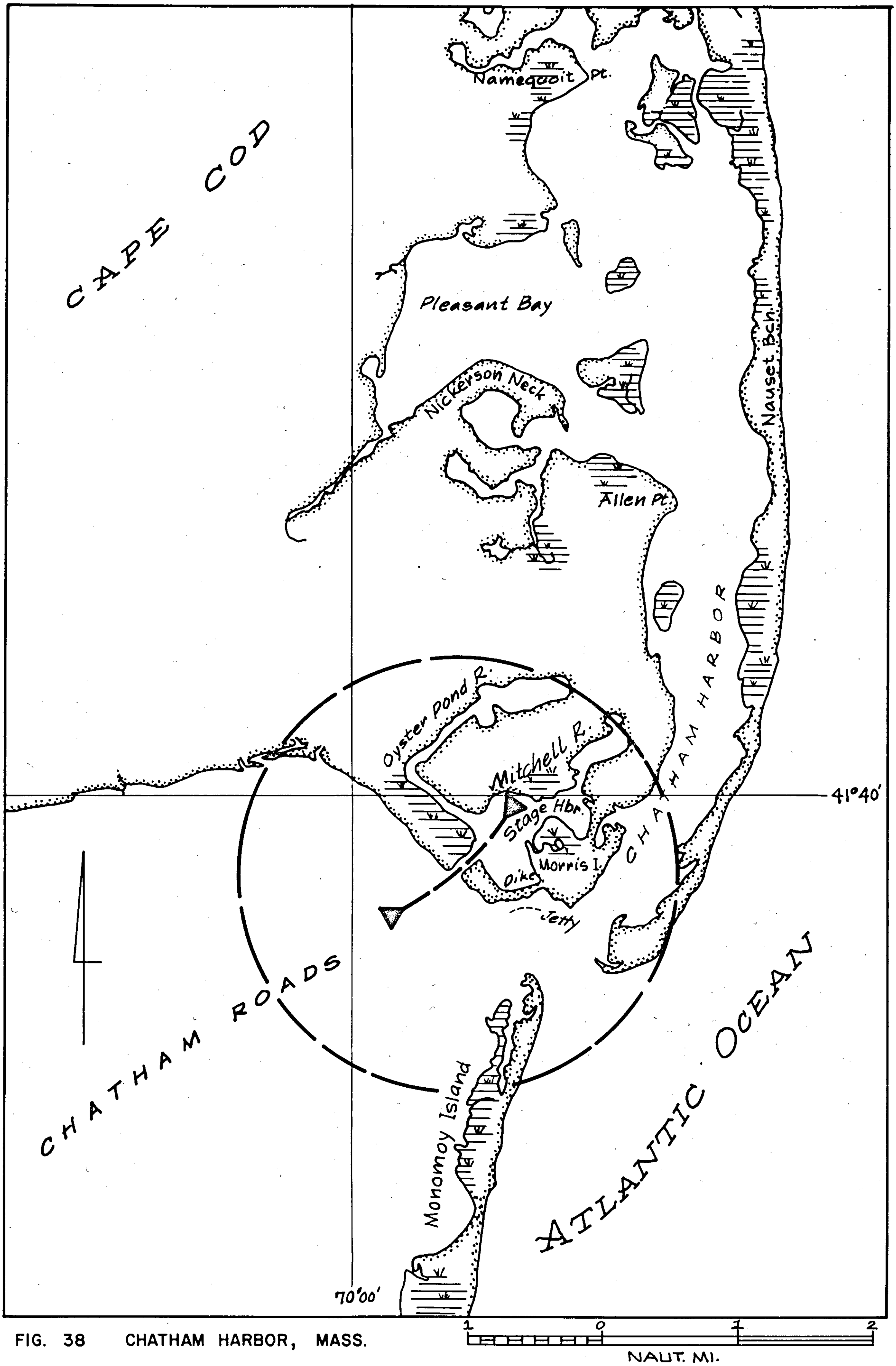


FIG. 38 CHATHAM HARBOR, MASS.

The type of disposal is listed as confined with the site having a 50-year life.

The mean tidal range at the project area is 3.6 ft. The datum plane is mlw.

1.10.1 Dredged Material Receiving Site Description

The dredge work, as indicated by the New England Division (1972), has been changed to sidecaster dredge, and therefore, no further information was obtained.

1.10.2 Judgment of Desirability

Project changed to sidecaster dredge and no further information was obtained.

2.0 Middle Atlantic Geographical Region

The Middle Atlantic geographical region includes the Philadelphia, Baltimore, and Norfolk Districts. The boundaries of the geographical region extend from the Manasquan Inlet in the north, to the Virginia-North Carolina state line in the south. The coastal states included in the Middle Atlantic geographical region are New Jersey (southern), Pennsylvania, Delaware, Maryland, and Virginia. The locations of the prime project areas are indicated in Figure 39.

During the collection and organization of reconnaissance-scale data, the Philadelphia District noted that the Corson Inlet Project Area (2.1) was not an active project under the District's jurisdiction. Information gathered from ODMR files (November 12, 1973) indicated that the channels of the Corson Inlet project consisted of maintenance work utilizing a hydraulic pipeline dredge. The Philadelphia District (1974) indicated that the work at Corson Inlet was not an existing District project. This negated the use of reconnaissance-scale data in surveying the Corson Inlet Project Area as a candidate for an optimum project area.

No additional reconnaissance-scale information was made available in regards to the Broad Thorofare Project Area (2.7) or the Absecon Creek Project Area (2.8).

2.1 Corson Inlet, New Jersey; Philadelphia District

The Corson Inlet Project Area (Figure 40) is formed by four projects at Corson Inlet, New Jersey. Information on the four projects in Corson Inlet was

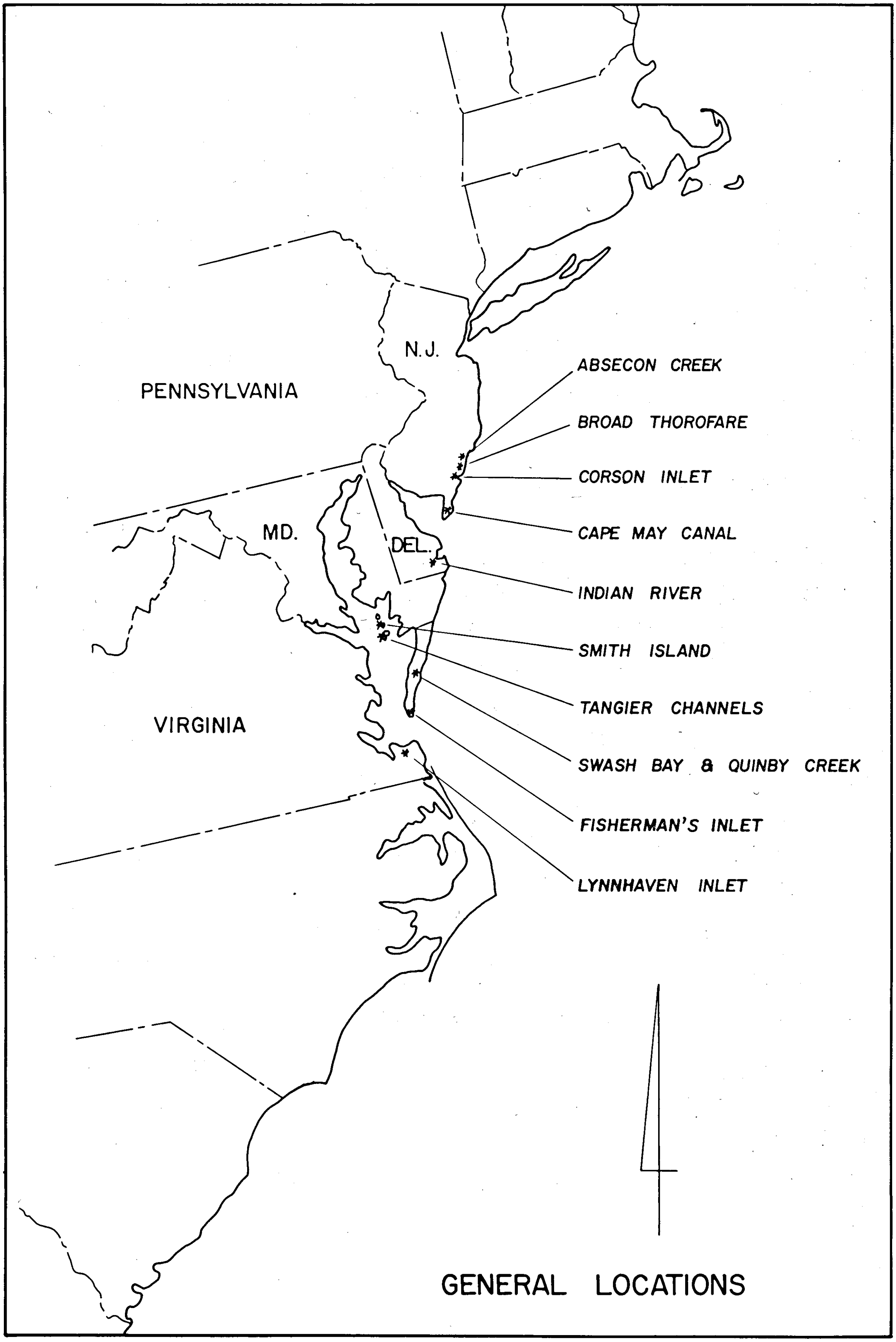


FIG. 39 MIDDLE ATLANTIC GEOGRAPHICAL REGION

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MILES

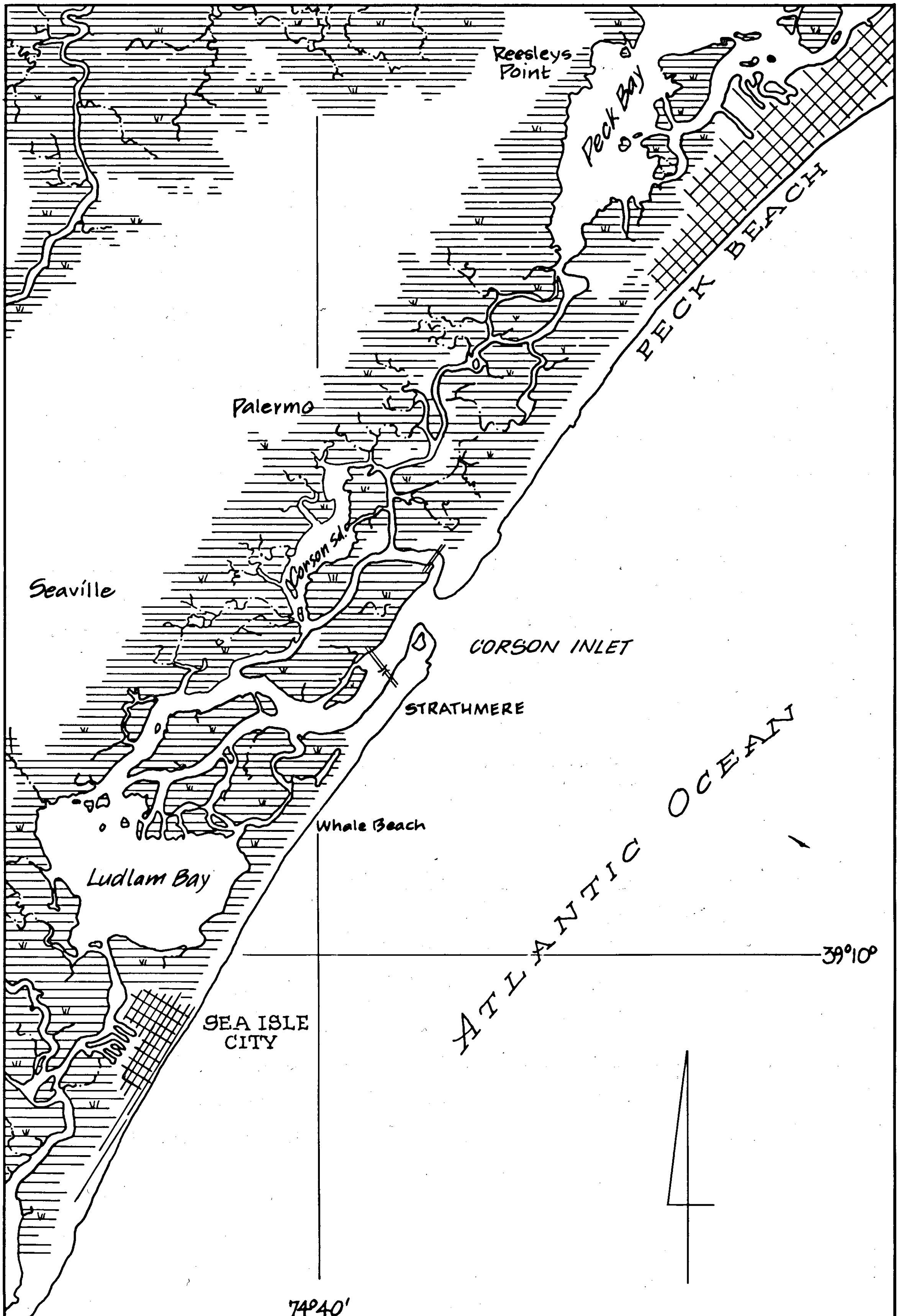

FIG. 40 CORSON INLET, N.J.

obtained from ODMR files. The project area is located north of Sea Isle City in the vicinity of Corson Inlet.

The four projects in the Corson Inlet Project Area were located by ODMR according to latitude and longitude; their location, annual cubic yardage, and frequency were as follows: 39°14'30", 55,000 cu yd, 108 months; 39°13'45", 55,000 cu yd, 108 months; 39°13'18", 12,743 cu yd, 108 months; 39°12'08", 23,246 cu yd, 36 months.

The cumulative annual volume for the Corson Inlet Project Area is approximately 146,000 cu yd of sand with a frequency ranging from 48 to 108 months.

2.1.1 Dredged Material Receiving Site Description

The Corson Inlet Project Area is indicated by the Philadelphia District as an inactive project; therefore, no further reconnaissance-scale information was gathered.

2.1.2 Judgment of Desirability

No further reconnaissance-scale data were gathered.

2.2 Lynnhaven Inlet, Virginia; Norfolk District

The Lynnhaven Inlet Project Area (Figure 41) is represented by the Lynnhaven Inlet project, which is located west of Cape Henry and east of Chesapeake Bay Bridge near Seashore State Park. Lynnhaven Inlet includes Lynnhaven Bay and Broad Bay on Long Creek. Dredging consists of an entrance channel 10 ft deep and 100 ft wide from that depth in the Chesapeake Bay

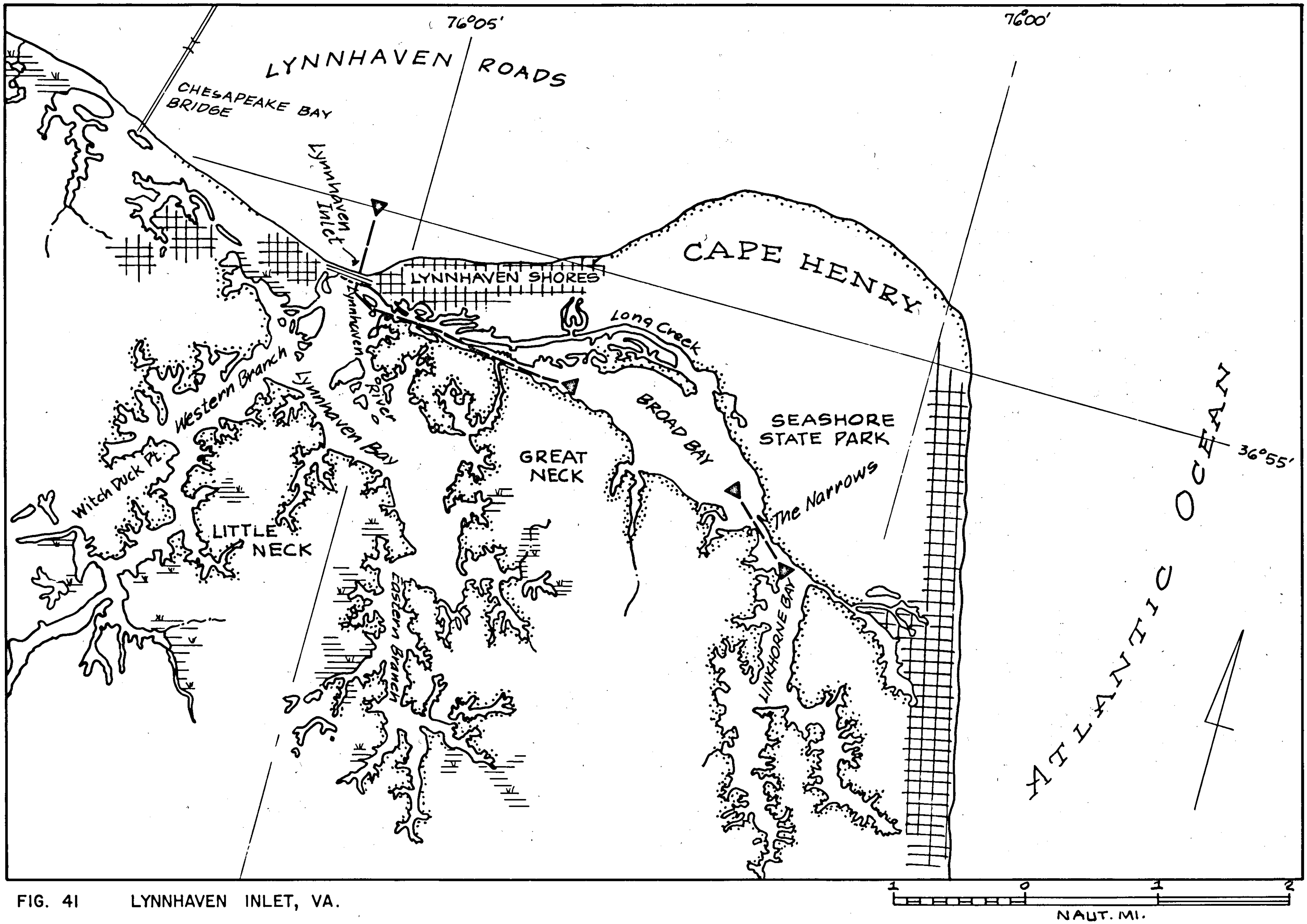

FIG. 41 LYNNHAVEN INLET, VA.

to a mooring and turning basin 10 ft deep, 1,250 ft long, and 700 ft wide in Lynnhaven Bay; a channel nine ft deep and 90 ft wide from the mooring and turning basin to Broad Bay near the Long Creek-Broad Bay canal; and a channel six ft deep and 90 ft wide through the Narrows connecting Broad Bay and Linkhorne Bay.

The Lynnhaven Inlet Project Area annually generates 190,000 cu yd of sand with a frequency of 26 months. Disposal is indicated as confined and the site has a four-year life.

The mean tidal range at the project area is 1.8 ft at the Lynnhaven entrance and 1.0 ft at Broad Bay. The datum plane is mlw.

2.2.1 <u>Dredged Material Receiving Site Description</u>

2.2.1.1 <u>Dredged Material Characteristics</u>

According to the inventory, sediment within the Lynnhaven Inlet Project Area is not polluted. The sediment consists mainly of fine to medium, non-plastic sand with a trace of organic material (Norfolk District 1974).

2.2.1.2 <u>Marsh-Creation Situations</u>

The following situations may be available for marsh creation: within Lynnhaven Inlet adjacent to or as extensions of existing marsh or upland areas; open water paralleling channels; and scattered open water areas away from channels.

Strong north-northeast winds affect tides above the stated means and prolong flood tides. Northeast winds have a fetch of 12 miles. Water depths range up to 12-15 ft (Norfolk District 1974).

In past maintenance work, dredged material has been used to partially combat beach erosion west of the project area (Norfolk District 1974).

Where urban land use has not displaced more natural habitat, marsh and other biotic types are characteristic of mid-Atlantic marine and estuarine habitat complexes.

Seashore State Park is located on Cape Henry in the eastern portion of the project area.

2.2.2 Judgment of Desirability

2.2.2.1 Institutional Characteristics

Virginia State agencies concerned with estuarine areas are:

- Commission of Outdoor Recreation
- Department of Conservation and Economic Development
  - Division of Parks
  - Salt Water Sport Fishing Program
- Marine Resources Commission
- State Water Control Board.

Local cooperation is required for use of diked disposal areas. State and private interests maintain ownership of lands below the low water mark.

2.2.2.2 Benefits and Costs

Long-term benefits of marsh creation to local commercial and sports fisheries should exceed costs of upland placement of dredged material because sediments are not thought to be polluted and marsh is a diminishing resource.

2.2.2.3 Public Attitudes

Many residential areas in the project area are associated, directly or indirectly, with water-oriented recreation.

Public attitudes concerning estuarine land use may be represented by the following Virginia citizens' groups:

Virginia Wildlife Federation
Conservation Council of Virginia
Virginia Division, Izaak Walton League of America, Inc.
The Nature Conservancy
Virginia Society of Ornithology.

2.3 Indian River, Delaware; Philadelphia District

The Indian River Project Area (Figure 42) is represented by two projects in Indian River Bay: Indian River Bay project and a section of Atlantic Intracoastal Waterway (AIWW), which is the Indian River Inlet to Rehoboth Bay project. The Indian River Bay section of the project area begins south of Burton Island and continues westward for approximately two miles. The channel dimensions are nine ft in depth and 100 ft in width. The channel for the AIWW begins west of Burton Island at the Indian River project, and continues northward through Long Neck to Rehoboth Bay. This channel is six ft in depth and 100 ft in width.

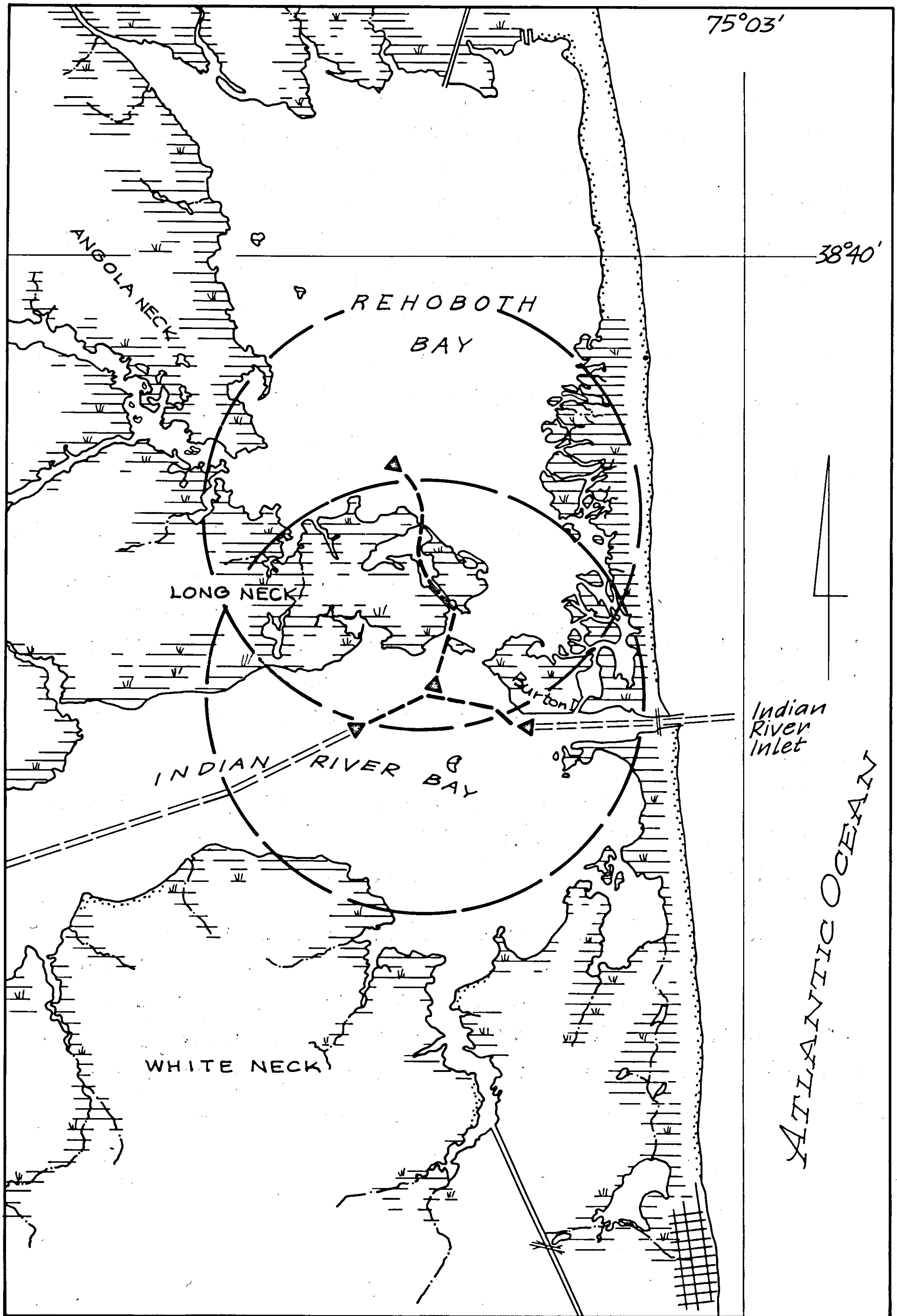

FIG. 42 INDIAN RIVER, DEL.

The Indian River Project Area generates an annual volume of 76,500 cu yd (AIWW section contributes 1,500 cu yd) of silt and sand in the case of the Indian River section and mud, silt, and clay in the case of the AIWW section. The frequency of dredging for both sections in the project area is 36 months. Disposal of material from the Indian River section is indicated as overboard, while that of the AIWW section is indicated as confined.

The mean tidal range for the project area is 0.5 ft in Rehoboth Bay and 0.9 ft in Indian River Bay. The datum plane is mlw.

2.3.1 Dredged Material Receiving Site Description

2.3.1.1 Dredged Material Characteristics

Sediments within the project area are not considered polluted beyond EPA standards, but existing water-quality trends may adversely influence this situation in the near future (Philadelphia District 1973).

Texture types are silt and sand. Ratios are not known, but undoubtedly vary with seasonal currents, climate, and runoff fluctuations.

2.3.1.2 Marsh-Creation Situations

The following situations may be available for marsh creation in the project area: open water disposal in Indian River and Bay in numerous places; land extension from marsh in the bay portion of the barrier foreshore; paralleling the channel (exclusive of the AIWW channel); and marsh extension from Long Neck into Rehoboth or Indian River Bay.

Indian River Bay may be described as a drowned river valley, while Rehoboth Bay is a lagoonal feature formed by net landward migration of the barrier island complex. Both are examples of formations along subsiding coastlines. A nine-in. net rise of sea level has occurred in the last 60 years (Philadelphia District 1973). Natural filling behind the barrier is occurring rapidly.

Additional tidal measurements in the project area show a 3.8 ft range at the ocean inlet, and a 2.4 ft range at the bridge crossing the inlet. Tidal currents average about 3.4 fps through the inlet (Philadelphia District 1973).

The surrounding marshes are typical of northern temperate regions. The plant species of mid-Atlantic marshes are present as low, middle, and high marsh dominants. Several indicator species of brackish marsh conditions may also be found along drainages into the bay. Migratory and resident estuarine dependent bird species abound. Shellfish are harvested extensively (Philadelphia District 1973).

Major existing disposal sites known within the project area are located in open water adjacent to the Indian River Bay Channel. These have been placed over an area subject to natural tidal delta formations south of the Burton Island segment (Philadelphia District 1973).

There are no major urban centers in the project area. Ocean View, the nearest town, is located approximately four miles south.

2.3.2 Judgment of Desirability

2.3.2.1 Institutional Characteristics

The following Delaware State agencies are concerned with estuarine areas:

Department of Natural Resources and Environmental Control

- Division of Environmental Control
- Division of Fish and Wildlife
- Division of Parks, Recreation, and Forestry
- Division of Soil and Water Conservation

Delaware State Planning Office.

An overall plan of development in estuarine areas is included in a comprehensive state land use plan as prepared by the State Planning Office.

Local cooperation is required to provide disposal areas.

Federal, state, and private interests maintain ownership of lands below mhw.

2.3.2.2 Benefits and Costs

It appears that Delaware has strong interests in multiple use of dredged material and its disposal. One use, viewed as an attractive alternative to present disposal methods, is in habitat construction (Philadelphia District 1973).

Considering the unpolluted status of the sediment material, the general interest in marsh creation in the area, and the numerous situations available for creation, there appear to be substantial long-term benefits.

2.3.2.3 Public Attitudes

The following Delaware citizens' groups may represent public attitudes concerning estuarine land use:

Delaware Wildlife Federation

Delaware Nature Education Center, Inc.

Delaware Conservation Education Association

Delaware Wild Lands, Inc.

2.4 Swash Bay and Quinby Creek, Virginia; Norfolk District

The Swash Bay and Quinby Creek Project Area (Figure 43) is represented by two projects: the Swash Bay-White Trout Creek section of the Delaware Bay-Chesapeake Bay Waterway and the Quinby Creek project. The project area is located west of Parramore Island and east of Quinby, Virginia. The Swash Bay-White Trout Creek section consists of a channel six ft deep and 60 ft wide through Swash Bay; the Quinby Creek project (just to the west) consists of a channel eight ft deep and 80 ft wide from that depth in Upshur Bay to within approximately 600 ft of Quinby Landing, thence 60 ft wide to Quinby Landing, and a mooring and turning basin eight ft deep, 200 ft wide, and 400 ft long.

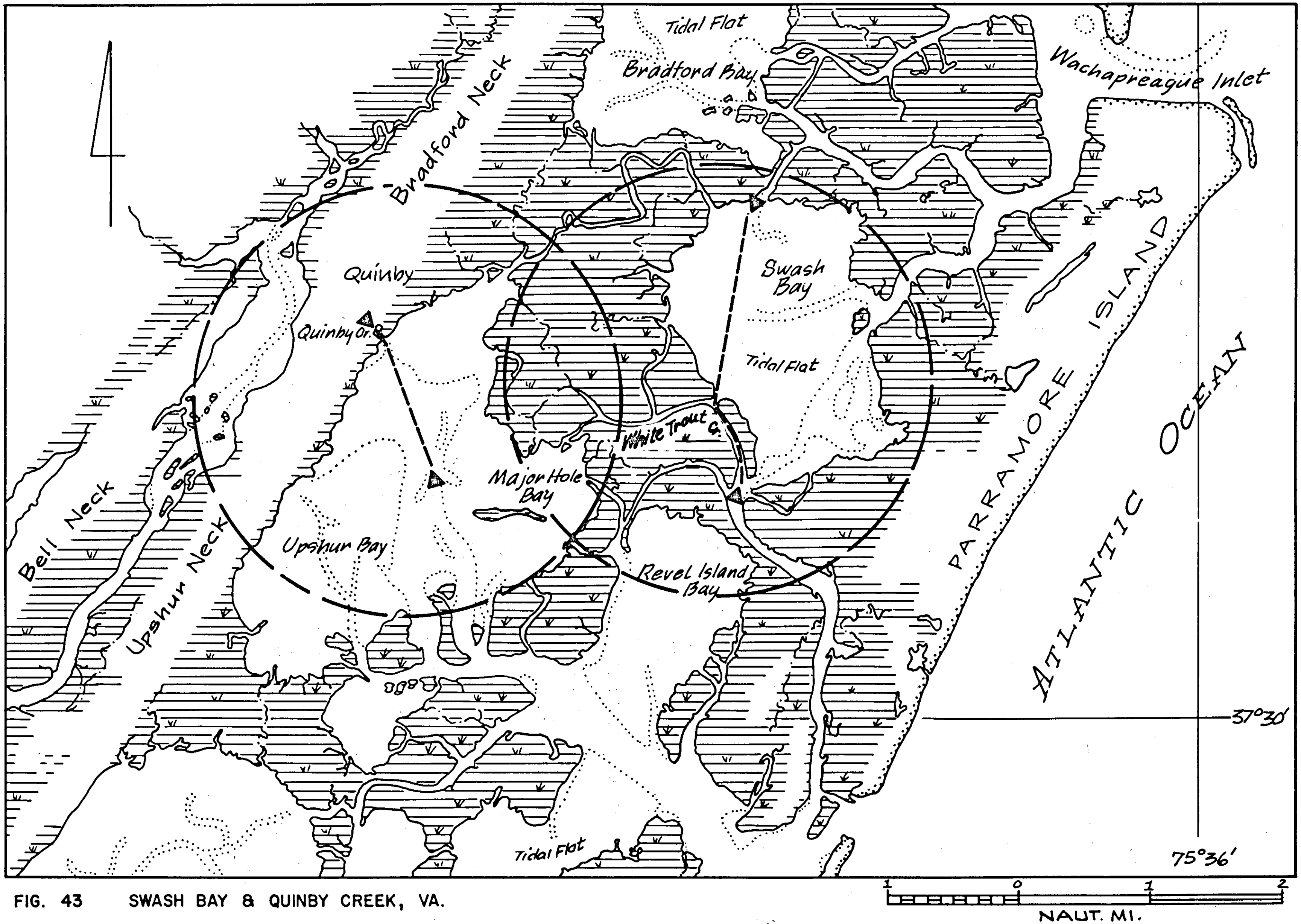

FIG. 43 SWASH BAY & QUINBY CREEK, VA.

These combined projects annually generate 59,000 cu yd of mud (39,000 cu yd from the Swash Bay section). Frequencies range from 50 months at Quinby Creek to 60 months at Swash Bay. Disposal is identified as overboard.

The mean tidal range at the project area is 4.4 ft at Quinby Creek and approximately 3.9 ft at Swash Bay. The datum plane is msl.

2.4.1 Dredged Material Receiving Site Description

2.4.1.1 Dredged Material Characteristics

Sediments in the Swash Bay portion of the project area are polluted in excess of EPA standards with respect to total Kjeldahl nitrogen, chemical oxygen demand, and zinc. Chemical characteristics of sediment in Quinby Creek are not known (Norfolk District 1974).

The majority of the material within the Swash Bay area is clayey silt. Those within the Quinby Creek portion of the project consist of medium sands, silt, and oyster shells (Norfolk District 1974).

2.4.1.2 Marsh-Creation Situations

The following marsh creation situations may be available in Swash Bay and Quinby Creek Project Area: over mud flats extending away from existing marsh; extension of existing marsh into open water; and in estuarine creeks paralleling channels.

The project area is situated between two barrier dune systems in marsh-slough-mud flat physiography; the eastern system is active, while the western is relict. Depths of open water are usually less than

10 ft mlw, but in some areas natural channels are deeper. Mud flats are usually exposed at low water and abandoned dredged material disposal areas are scattered throughout.

Tides are semi-diurnal. Greater mean ranges than 3.9 ft and 4.4.ft for Swash Bay and Quinby Creek, respectively, are induced by winds from easterly (northeast, east, southeast) directions.

2.4.2 Judgment of Desirability

2.4.2.1 Institutional Characteristics

Virginia State agencies concerned with estuarine areas are:

Commission of Outdoor Recreation

Department of Conservation and Economic Development

Division of Parks

Salt Water Sport Fishing Program

Marine Resources Commission

State Water Control Board.

State and private interests maintain ownership of lands below the low water mark.

2.4.2.2 Benefits and Costs

Benefits of marsh creation in an area already supporting an abundance of marsh may be less than that in areas supporting a paucity of marsh.

2.4.2.3 Public Attitudes

Virginia citizens' groups which may represent public attitudes concerning estuarine land use are:

Virginia Wildlife Federation

Conservation Council of Virginia

Virginia Division of Izaak Walton League of America, Inc.

The Nature Conservancy

Virginia Society of Ornithology.

2.5 Fisherman's Inlet, Virginia; Norfolk District

The Fisherman's Inlet Project Area (Figure 44) is represented by the Fisherman's Inlet section of the Delaware Bay-Chesapeake Bay Waterway. Fisherman's Inlet is located at the southern tip of Cape Charles and connects Chesapeake Bay with Magothy Bay. Dredging consists of a channel six ft deep, 100 ft wide, and 4,000 ft long from the six-ft contour in Chesapeake Bay to Fisherman's Inlet Bridge: thence a channel at the same depth, 60 ft wide, and 18,650 ft long to the six-ft contour in Magothy Bay just northeast of Skidmore Island.

The Fisherman's Inlet Project Area annually generates 58,000 cu yd of sand with a frequency ranging from 14 to 28 months. Disposal is indicated as overboard.

The mean tidal range at the project area is 3.5 ft at Magothy Bay. The datum plane is mlw.

2.5.1 Dredged Material Receiving Site Description

2.5.1.1 Dredged Material Characteristics

Sediments within the Fisherman's Inlet Project Area are thought to be sand and silt (Norfolk District 1974). These materials are not polluted according to the inventory.

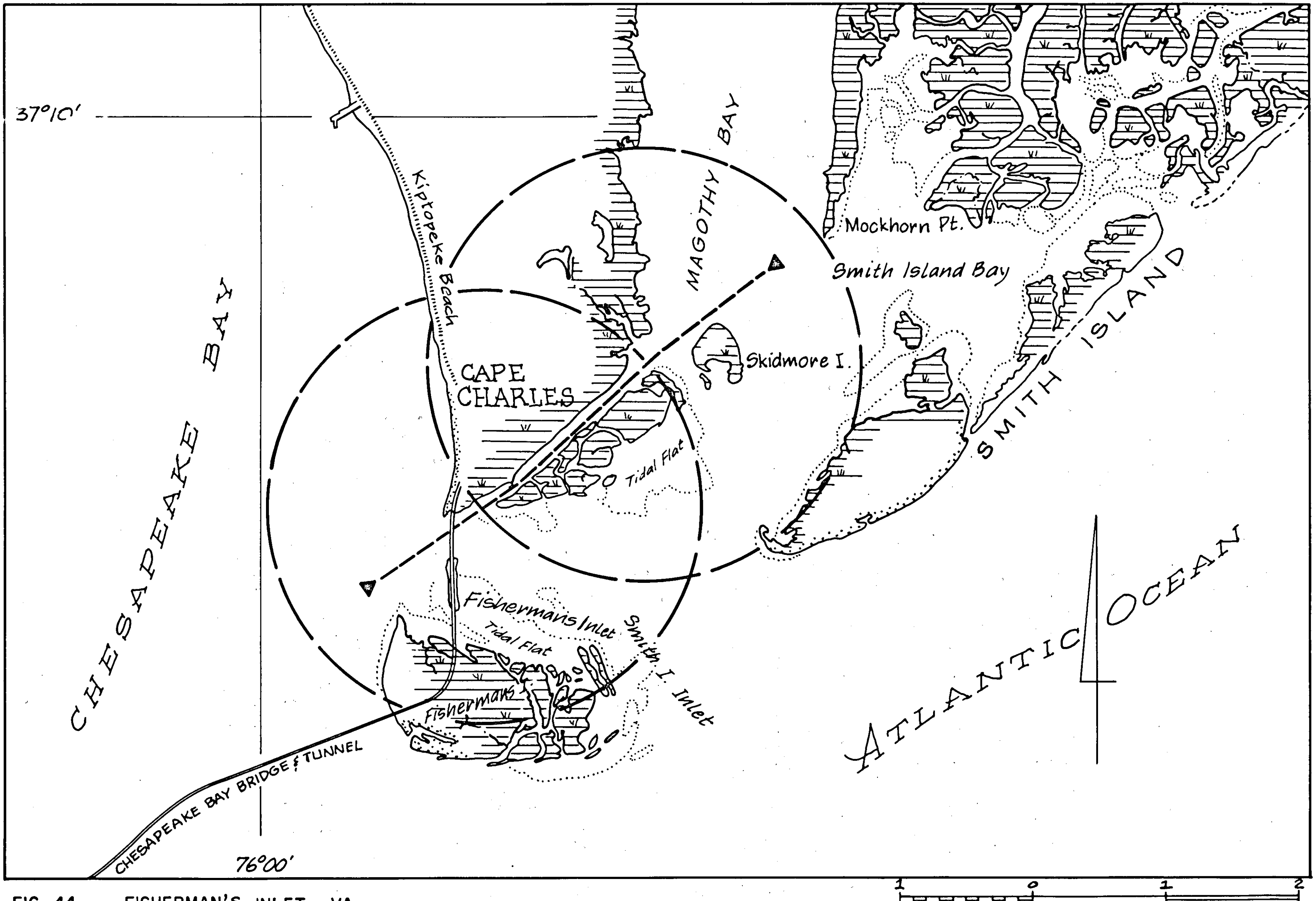

FIG. 44 FISHERMAN'S INLET, VA.

2.5.1.2 Marsh-Creation Situations

The following situations may exist for marsh creation: extensions into open water or over mud and sand flats, as in areas north and south of Fisherman's Inlet and around Cape Charles and Skidmore Island; and open water in several areas, such as Fisherman's Inlet.

Strong winds from west through southwest origins prolong the tidal flood cycle and also affect extreme high water within the project area. These winds have a maximum fetch of 15 miles. In addition, waves from the Atlantic Ocean affect the Magothy Bay area. Depths in undredged portions of the project area seldom exceed -5.0 ft msl (Norfolk District 1974).

A combination of maritime habitat types in the project area is broken by agricultural lands. Marsh, dune, and aquatic biota are typical of those for the mid-Atlantic region.

An existing dredged material disposal island extends southeasterly from the Chesapeake Bay Bridge-Tunnel into Fisherman's Inlet. A second disposal area is located at the southwest corner of Fisherman's Island. Dredged material in Magothy Bay has been deposited adjacent to Skidmore Island.

2.5.2 Judgment of Desirability

2.5.2.1 Institutional Characteristics

The following Virginia State agencies are concerned with estuarine areas:

Commission of Outdoor Recreation

Department of Conservation and Economic Development

Division of Parks

Salt Water Sport Fishing Program

Marine Resources Commission

State Water Control Board.

State and private interests maintain ownership of lands below the low water mark.

2.5.2.2 Benefits and Costs

Fisherman's Island is a National Wildlife Refuge. Benefits of additional marsh habitat in near proximity to a National Wildlife Refuge may equal or surpass long-term costs of creation. Presently, dredged material is being used to enlarge Fisherman's Island, stabilize beach erosion, protect the bridge causeway, as well as serving to enhance the wildlife refuge (Norfolk District 1974). Some favorable estuarine waterfowl habitat has already developed as a result.

2.5.2.3 Public Attitudes

Virginia citizens' groups which may represent public attitudes concerning estuarine land use are:

Virginia Wildlife Federation

Conservation Council of Virginia

Virginia Division, Izaak Walton League of America, Inc.

The Nature Conservancy

Virginia Society of Ornithology.

2.6 Cape May Canal, New Jersey; Philadelphia District

The Cape May Canal Project Area (Figure 45) is represented by Cape May Canal project of the New Jersey Intracoastal Waterway (NJIWW). The project area is located at the southern tip of Cape May, New Jersey, and connects Delaware Bay to Cape May Harbor. Dredging consists of a channel 12 ft deep and 100 ft wide from approximately 1,000 ft into Delaware Bay, to a point in Cape May Harbor approximately 1,500 ft from the fixed bridge.

The Cape May Canal Project Area annually generates approximately 45,000 cu yd of material with a dredging frequency of 12 months.

The mean tidal range at the project area is 4.6 ft. The datum plane is mlw.

2.6.1 Dredged Material Receiving Site Description

2.6.1.1 Dredged Material Characteristics

Dredged material consists mainly of sand and silt. Portions of the Cape May Canal have been closed to shellfishing due to the high degree of pollution from industrial and municipal sources. Other pollution sources are boat discharges, septic tank seepage, and agricultural runoff (Philadelphia District 1972).

2.6.1.2 Marsh-Creation Situations

There are not a wide variety of marsh-creation situations available in the Cape May Canal Project Area. Possible situations are: open water in Delaware Bay to the west; in Cape May Harbor to the east;

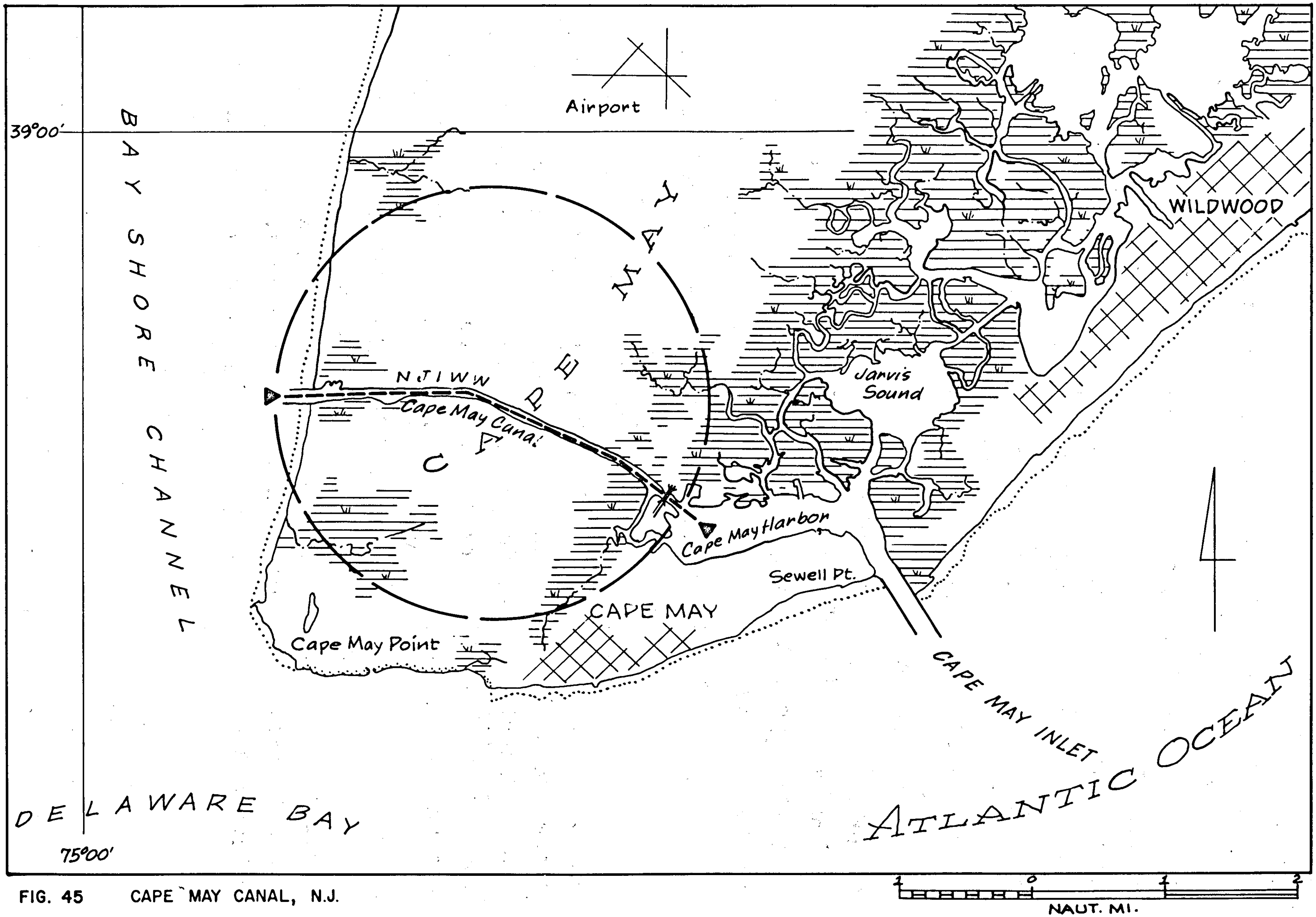

FIG. 45 CAPE MAY CANAL, N.J.

and an estuarine creek situation along the channel in Cape May Canal.

Tides are semi-diurnal, and the mean range is 4.1 ft with the highest tide on record being +7.6 msl (Philadelphia District 1972).

The project area is in a nonurban setting with some low-lying marsh areas around Cape May Point and on the shores of the Delaware Bay and Cape May Harbor.

2.6.2 Judgment of Desirability

2.6.2.1 Institutional Characteristics

The following New Jersey State agencies are concerned with estuarine areas:

Department of Environmental Protection
- Division of Environmental Quality
- Division of Fish, Game, and Shellfisheries
- Division of Marine Services
- Division of Water Resources.

2.6.2.2 Benefits and Costs

Due to the polluted nature of the sediments, the benefits of marsh creation may be very limited.

2.6.2.3 Public Attitudes

The following New Jersey citizens' groups may represent public attitudes concerning estuarine land use.

New Jersey Federation of Sportsmen's Clubs

Association of New Jersey Environmental Commissions

New Jersey Audubon Society.

2.7 Broad Thorofare, New Jersey; Philadelphia District

The Broad Thorofare Project Area (Figure 46) is represented by the Broad Thorofare section of the New Jersey Intracoastal Waterway (NJIWW). The Broad Thorofare Project Area begins at Great Egg Harbor Bay at Ocean City and continues to near Lakes Bay. Dredging consists of a channel 12 ft deep and 100 ft wide.

The Broad Thorofare Project Area generates approximately 30,000 cu yd of material annually.

2.7.1 Dredged Material Receiving Site Description

2.7.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

2.7.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

2.7.2 Judgment of Desirability

2.7.2.1 Institutional Characteristics

The following New Jersey State agencies are concerned with estuarine areas:

Department of Environmental Protection
- Division of Environmental Quality
- Division of Fish, Game, and Shellfisheries
- Division of Marine Services
- Division of Water Resources.

2.7.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

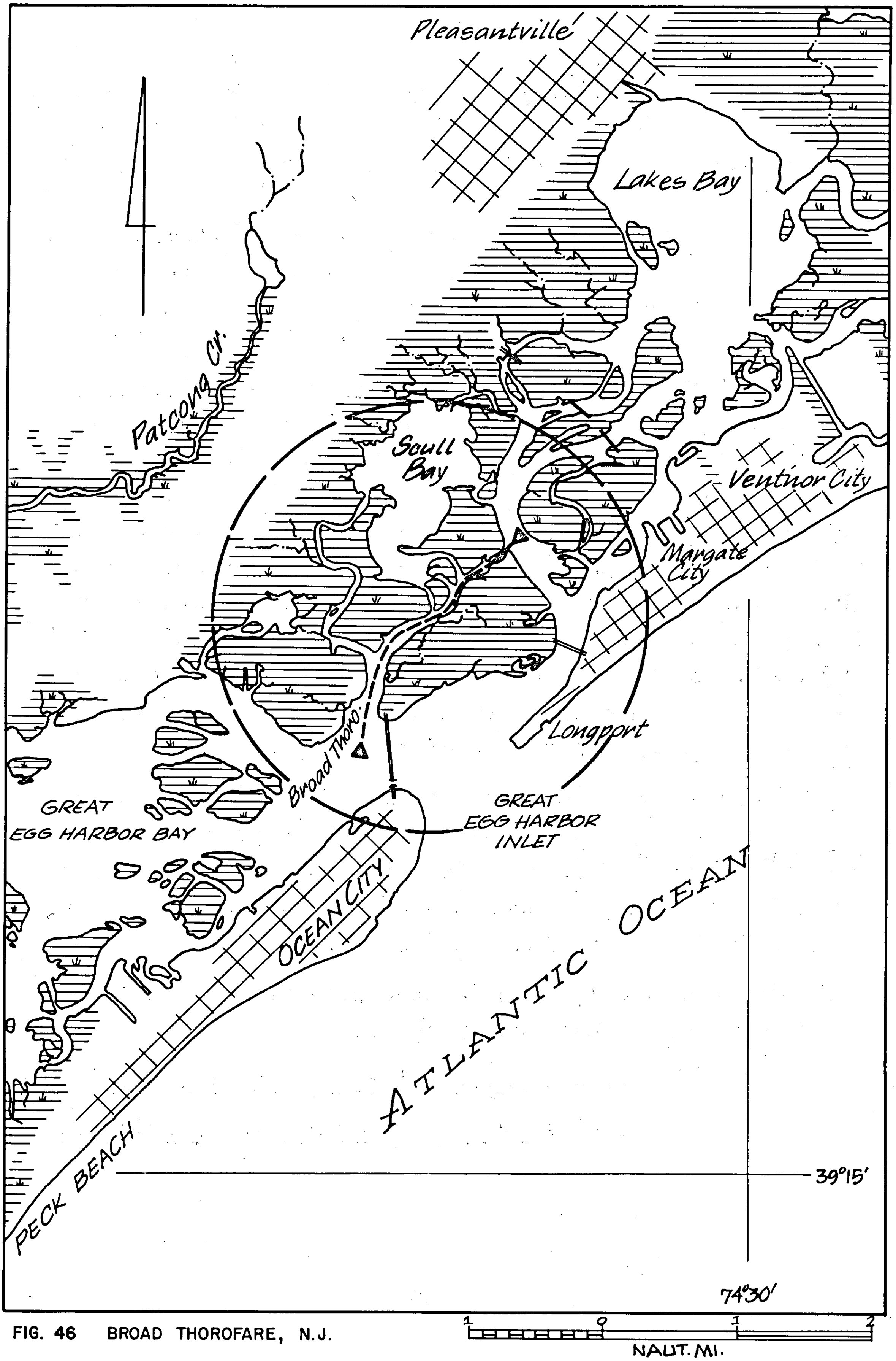

FIG. 46 BROAD THOROFARE, N.J.

2.7.2.3 Public Attitudes

The following New Jersey citizens' groups may represent public attitudes concerning estuarine land use:

New Jersey Federation of Sportsmen's Clubs

Association of New Jersey Environmental Commissions

New Jersey Audubon Society.

2.8 Absecon Creek, New Jersey; Philadelphia District

The Absecon Creek Project Area (Figure 47) is represented by the Absecon Creek project which is located adjacent to Absecon, New Jersey, and continues to the east of Absecon into Absecon Bay. The project consists of an entrance channel and a channel and turning basin. The entrance channel begins just west of Spiders Island in Absecon Bay at a depth of five ft, a width of 80 ft, and continues to the mouth of Absecon Creek. The remaining section is a channel five ft deep and 50 ft wide to the turning basin just east of Absecon, New Jersey.

The Absecon Creek Project Area annually generates 28,000 cu yd of sand and silt (25,000 cu yd from the entrance channel section) with frequencies ranging from 60 months for the entrance channel to 240 months for the remaining channel to Absecon, New Jersey.

The mean tidal range for the project area is 1.7 ft at Absecon Bay. The datum plane is mlw.

2.8.1 Dredged Material Receiving Site Description

2.8.1.1 Dredged Material Characteristics

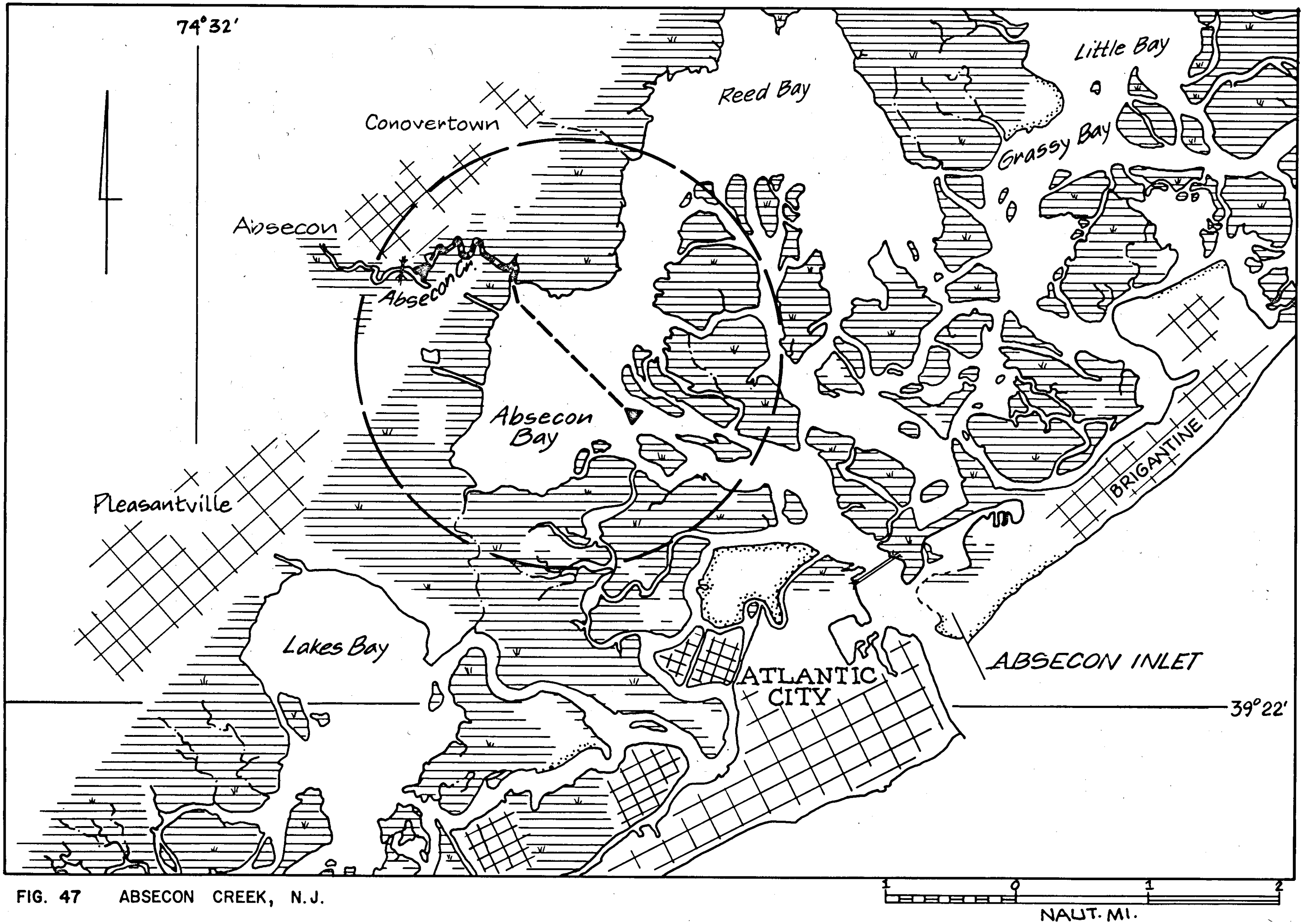

FIG. 47 ABSECON CREEK, N.J.

No further reconnaissance-scale data were available.

2.8.1.2 <u>Marsh-Creation Situations</u>

No further reconnaissance-scale data were available.

2.8.2 <u>Judgment of Desirability</u>

2.8.2.1 <u>Institutional Characteristics</u>

The following New Jersey State agencies are concerned with estuarine areas:

Department of Environmental Protection
- Division of Environmental Quality
- Division of Fish, Game, and Shellfisheries
- Division of Marine Services
- Division of Water Resources.

2.8.2.2 <u>Benefits and Costs</u>

No further reconnaissance-scale data were available.

2.8.2.3 <u>Public Attitudes</u>

The following New Jersey citizens' groups may represent public attitudes concerning estuarine land use:

New Jersey Federation of Sportsmen's Clubs

Association of New Jersey Environmental Commissions

New Jersey Audubon Society.

2.9 <u>Tangier Channels, Virginia; Norfolk District</u>

The Tangier Channels Project Area (Figure 48) is represented by two sections of the Tangier Channels project: Tangier Sound Channel and Chesapeake Bay Channel.

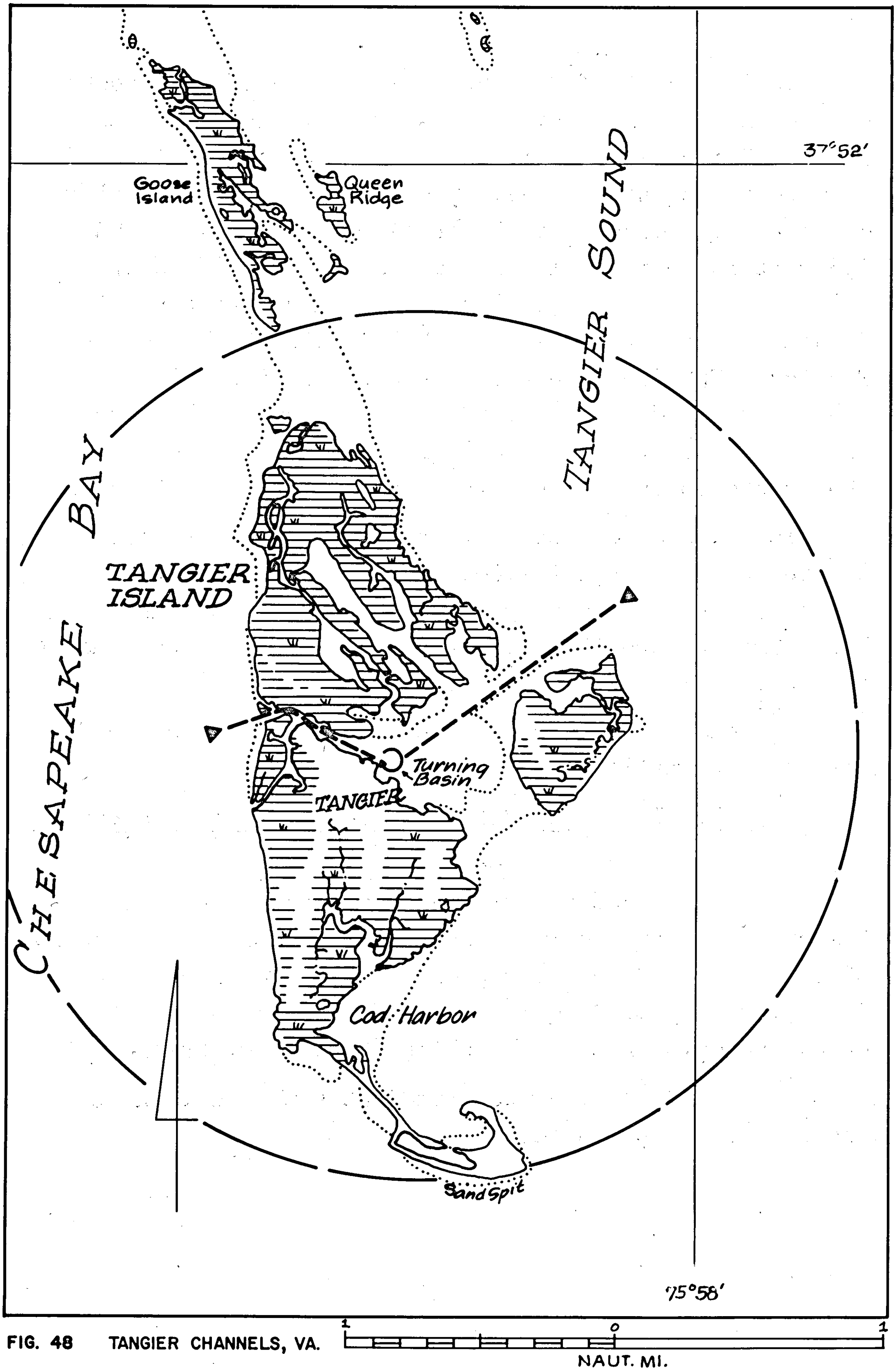

FIG. 48 TANGIER CHANNELS, VA.

The Tangier Channels Project Area is located just south of the Maryland-Virginia state boundary and traverses Tangier Island in the Chesapeake Bay connecting Tangier Sound with Chesapeake Bay. The Tangier Sound Channel consists of a channel eight ft deep, 100 ft wide, and 1,300 ft long in Tangier Sound; thence eight ft deep, 60 ft wide, and 4,800 ft long to an anchorage basin 400 ft square and seven ft in depth adjacent to the town of Tangier. The Chesapeake Bay Channel consists of a channel seven ft deep and 60 ft wide from the turning basin at Tangier, Virginia, through Tangier Creek to that depth in Chesapeake Bay; a total length of 3,820 ft.

The Tangier Channels Project Area annually generates 20,000 cu yd of sand (17,000 cu yd from Tangier Sound Channel) with a frequency of 48 months for the Tangier Sound Channel and 42 months for the Chesapeake Bay Channel. Disposal is identified as unconfined.

The mean tidal range of the project area is 1.6 ft. The datum plane is mlw.

2.9.1 Dredged Material Receiving Site Description

2.9.1.1 Dredged Material Characteristics

Sand and silt are the major sediment textures requiring maintenance dredging in both segments of the Tangier Channels Project Area. The channel to Chesapeake Bay may require further realignment due to excessive maintenance scheduling (Norfolk District 1974).

The inventory indicates the sediment to be dredged is not polluted.

2.9.1.2 Marsh-Creation Situations

The following marsh-creation situations may exist within the project area: extension of existing marsh into open water and over mud flats; paralleling certain portions of the channels, as along Tangier Sound Channel; and estuarine creeks north of Tangier.

The characteristic Atlantic salt-marsh biotype and physiography are well represented, though occasionally broken by dredged material disposal areas used in the past. The small town of Tangier occupies the center of the marsh-island complex.

Tides are semi-diurnal with a mean range of 1.6 ft. Greater fluctuation occurs as a result of winds, and during spring tides (mean range 1.9 ft) (Norfolk District 1974).

As is true of the Smith Island Project Area (1.10), there may be considerable wind erosion of marshy foreshores along the west side of the island. This, combined with dredged material disposal practices and urban land use, has probably caused loss of an appreciable amount of salt-marsh habitat.

2.9.2 Judgment of Desirability

2.9.2.1 Institutional Characteristics

The following Virginia State agencies are concerned with estuarine areas:

Commission of Outdoor Recreation

Department of Conservation and Economic Development

Division of Parks

Salt Water Sport Fishing Program
Marine Resources Council
State Water Control Board.

Local cooperation is required for disposal of dredged material for the Tangier Sound channel.

2.9.2.2 Benefits and Costs

Tangier inhabitants depend on seafood fisheries and, to a lesser extent, recreational boating for income (Norfolk District 1974).

Compensation for marsh habitat loss could serve as a benefit to the seafood industry in Tangier.

2.9.2.3 Public Attitudes

The following Virginia citizens' groups may represent public attitudes concerning estuarine land use:

Virginia Wildlife Federation
Conservation Council of Virginia
Virginia Division, Izaak Walton League of America, Inc.
The Nature Conservancy
Virginia Society of Ornithology
Northern Virginia Conservation Council.

2.10 Smith Island, Maryland; Baltimore District

The Smith Island Project Area (Figure 49) is represented by three projects traversing Smith Island: Tangier Channel (in Twitch Cove), Big Thorofare River-Chesapeake Canal, and the channel from Rhodes Point to Tylerton. The project area is located just north of the Virginia-Maryland state boundary and connects Chesapeake Bay with

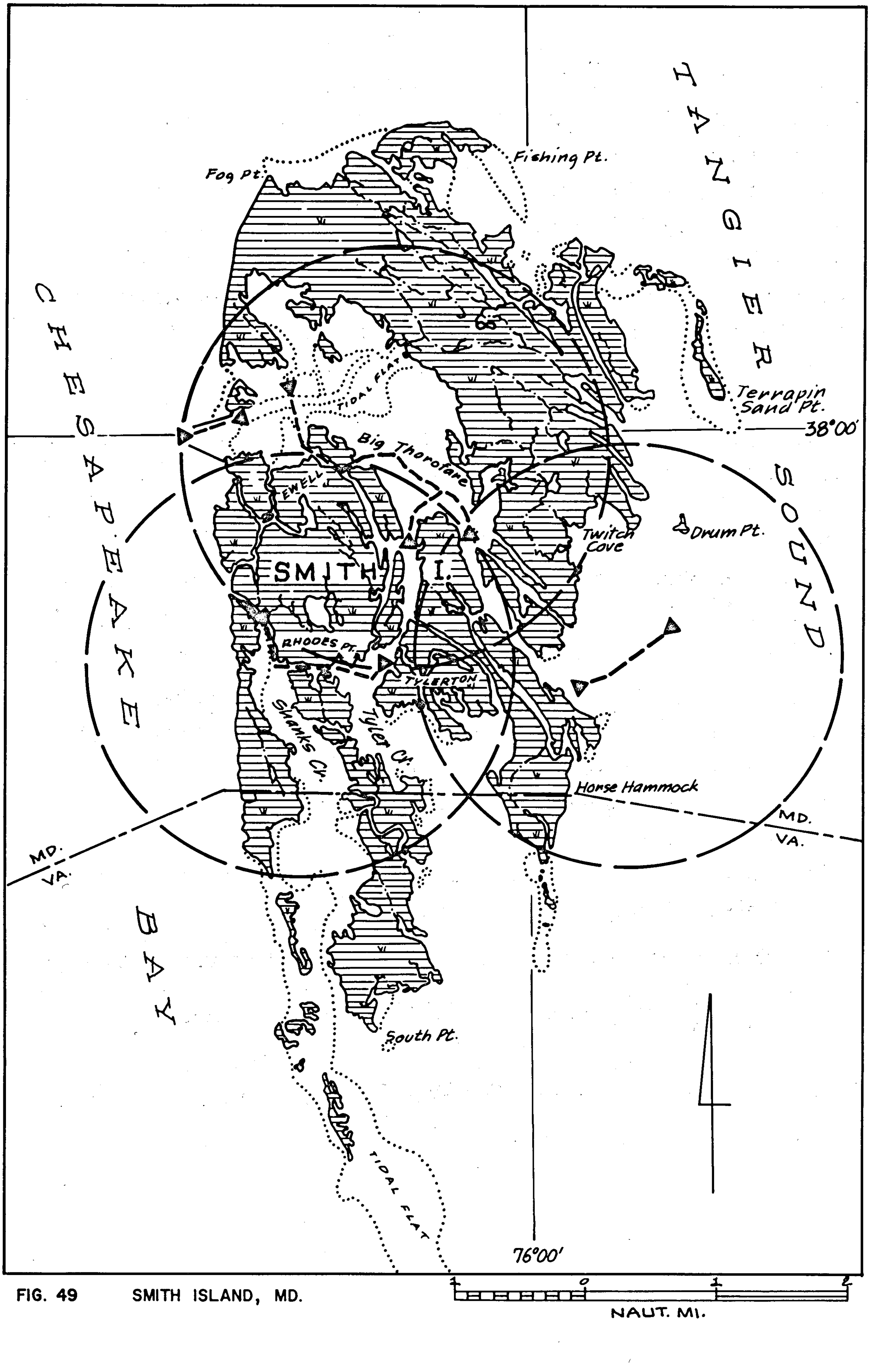

FIG. 49 SMITH ISLAND, MD.

Tangier Sound through Smith Island. The Tangier Sound project consists of a channel seven ft deep, 100 ft wide, beginning northwest of the Tangier Channel, thence through Big Thorofare River to Ewell, and to a point approximately 0.5 miles northwest of Ewell; including an anchorage basin of the same depth and 100 by 700 ft; with the Chesapeake Channel being seven ft deep and 100 ft wide to deep water in Chesapeake Bay. The Rhodes Point to Tylerton section includes an anchorage basin 100 by 400 ft, six feet deep at the town of Rhodes Point, which connects to a channel of the same depth, 50 ft wide that passes around Rhodes Point and proceeds toward Tylerton, stopping south of the end of a second channel six ft deep and 50 ft wide that connects with a second anchorage basin of the same depth, 100 by 400 ft, at Tylerton.

The project area annually generates 19,000 cu yd of sand and silt (10,000 cu yd from the Big Thorofare-Chesapeake project and 3,000 cu yd from the Rhodes Point to Tylerton section) with a frequency of 24 months. Disposal is indicated as overboard in the case of Tangier Sound Channel, and unconfined in the case of Big Thorofare-Chesapeake Channel and the Rhodes Point to Tylerton Channel.

Mean tidal range is 1.6 ft. The datum plane is mlw.

2.10.1 Dredged Material Receiving Site Description

2.10.1.1 Dredged Material Characteristics

Sediments within the project area are not polluted beyond EPA standards (Baltimore District 1968). In addition, shellfisheries in the area have never been closed because of high pollution levels (Baltimore District 1974).

Sand and silt constitute the bulk of the sediment, but sand alone is found in the Tangier Sound portion of the project.

2.10.1.2 Marsh-Creation Situations

Three major situations may be available for marsh creation in the Smith Island Project Area: open water, as in Chesapeake Bay, Tangier Sound, or Twitch Cove; estuarine creeks like those of Big Thorofare; and land extensions to a limited extent. An additional consideration may be possible land extensions on tidal flats, as in those areas between existing marsh islands, in the wider portions of Big Thorofare, Tyler Creek, or Shanks Creek south of Rhodes Point and to the south of the entire Smith Island complex toward Tangier Island.

Tidal currents average 1.5 fps at ebb tide as measured near the northern tip of Smith Island. Ebb and flood tides move from north to south and south to north, respectively. Shorelines are subject to wave erosion, which is most strongly influenced by the long fetch from northerly and westerly directions.

Waters within the project area are generally shallow, usually less than five ft, within the Smith Island complex. Water depths to the west of the island reflect long fetch and increased tidal currents of the Chesapeake Bay. Depths here exceed 12 ft. Water quality is good (Baltimore District 1974).

The customarily low-lying, marsh-tidal flat physiography of Smith Island is broken by a number of dredged material disposal sites, such as the one on Swan Island.

The Martin National Wildlife Refuge occupies the northern and eastern portion of Smith Island.

Population centers within the project area are limited to the small fishing villages on Smith Island. These are Tylerton, Rhodes Point, and Ewell (Baltimore District 1968).

2.10.2 Judgment of Desirability

2.10.2.1 Institutional Characteristics

Maryland State agencies concerned with estuarine land use activities are:

Department of Natural Resources
Fisheries Administration
Natural Resource Policy Force
Maryland Environmental Service
Department of State Planning.

Planning at the comprehensive scale for estuarine environments is carried out by the Department of Natural Resources. Maryland now has a complete wetlands inventory (Metzgar 1973).

Martin National Wildlife Refuge, northeast of the project area, is administered by the U. S. Department of the Interior.

Areas below mhw are owned by both state and private interests.

Local cooperation is required for use of disposal areas and retaining dikes with respect to the Rhodes Point to Tylerton portion of the project and disposal areas only with respect to the two other sections of the project.

2.10.2.2 Benefits and Costs

Shellfish and finfish fisheries are abundant throughout the project area. Relative benefits of marsh creation to the inhabitants of Smith Island and to the commercial fisheries industry in the project area should be great. Benefits should far exceed costs, considering the rate of loss of marshland due to wave erosion.

2.10.2.3 Public Attitudes

Maryland citizens' groups which may represent public attitudes concerning estuarine land use are:

Maryland Wildlife Federation

Chesapeake Bay Foundation, Inc.

Conservation Education of Maryland

Maryland Environmental Trust

Maryland Division, Izaak Walton League of America, Inc.

Maryland Ornithological Society.

3.0 South Atlantic Geographical Region

The South Atlantic geographical region includes the Wilmington, Charleston, Savannah, and Jacksonville Districts. The boundaries of the geographical region extend from the North Carolina-Virginia state border in the north, around the southern tip of Florida to Apalachee Bay just west of the Aucilla River in the Gulf of Mexico. The coastal states included in the South Atlantic geographical region are North Carolina, South Carolina, Georgia, and Florida to Apalachee Bay. The locations of the prime project areas are indicated on Figure 50, South Atlantic Geographical Region.

In the South Atlantic geographical region, there were some instances in which only portions of particular projects were included in a given project area. Where this occurred, a percentage of that project's annual cubic yardage was included in the cumulative cubic yardage estimates for that project area. The New River Inlet Project Area (3.9) is an example.

3.1 Savannah Harbor, Georgia; Savannah District

The Savannah Harbor Project Area (Figure 51) is represented by several projects in the Savannah Harbor area. Two projects are in Savannah Harbor proper: Middle Inner Harbor and Lower Inner Harbor. Four projects are sections of the Atlantic Intracoastal Waterway (AIWW): Fields Cut, Elba Cut, St. Augustine Creek, and Wilmington River. The Savannah Harbor section of the project begins on Front River and continues through Savannah, Georgia, to the Savannah River and the Atlantic Ocean. The AIWW complement

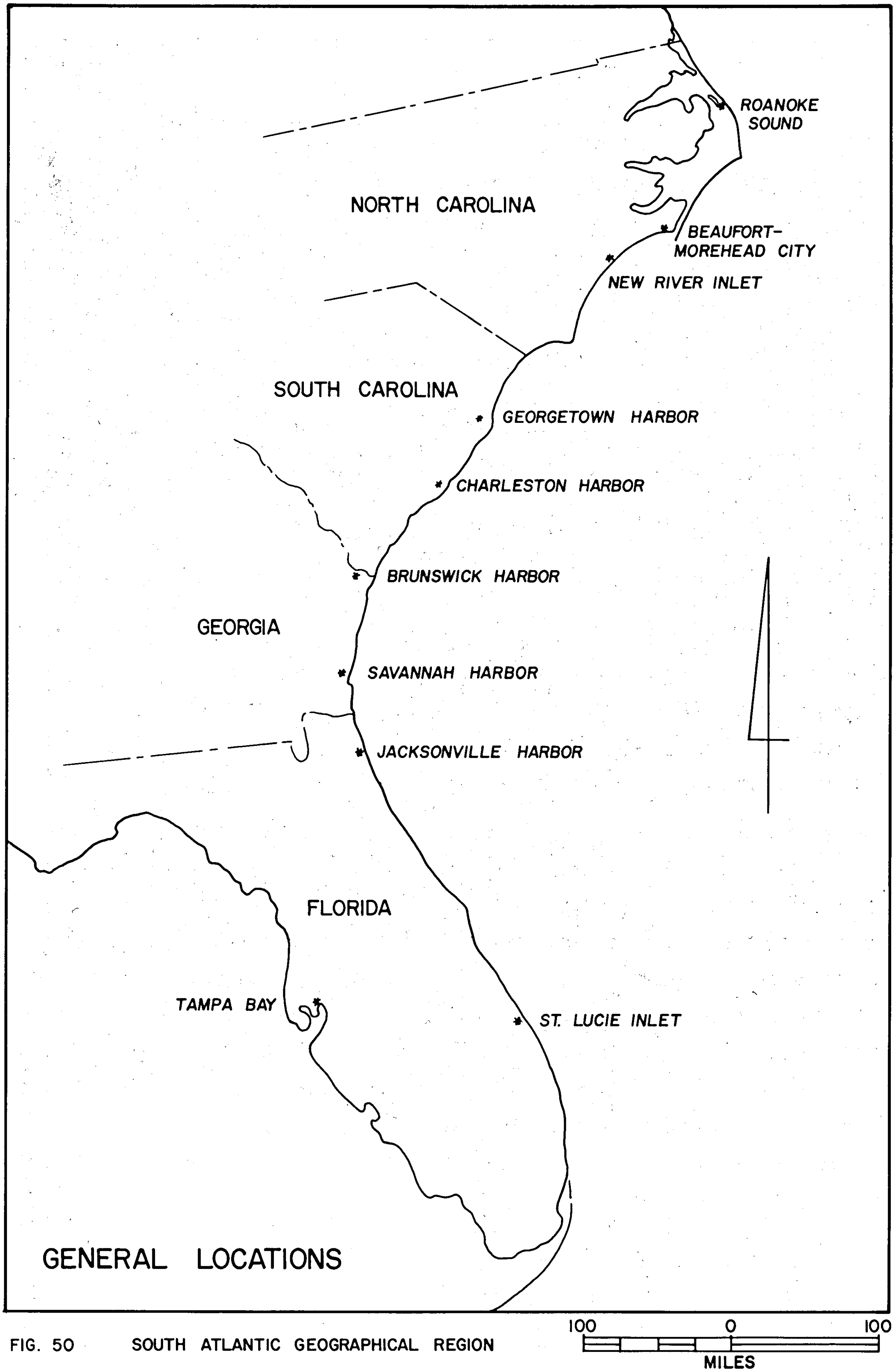

FIG. 50 SOUTH ATLANTIC GEOGRAPHICAL REGION

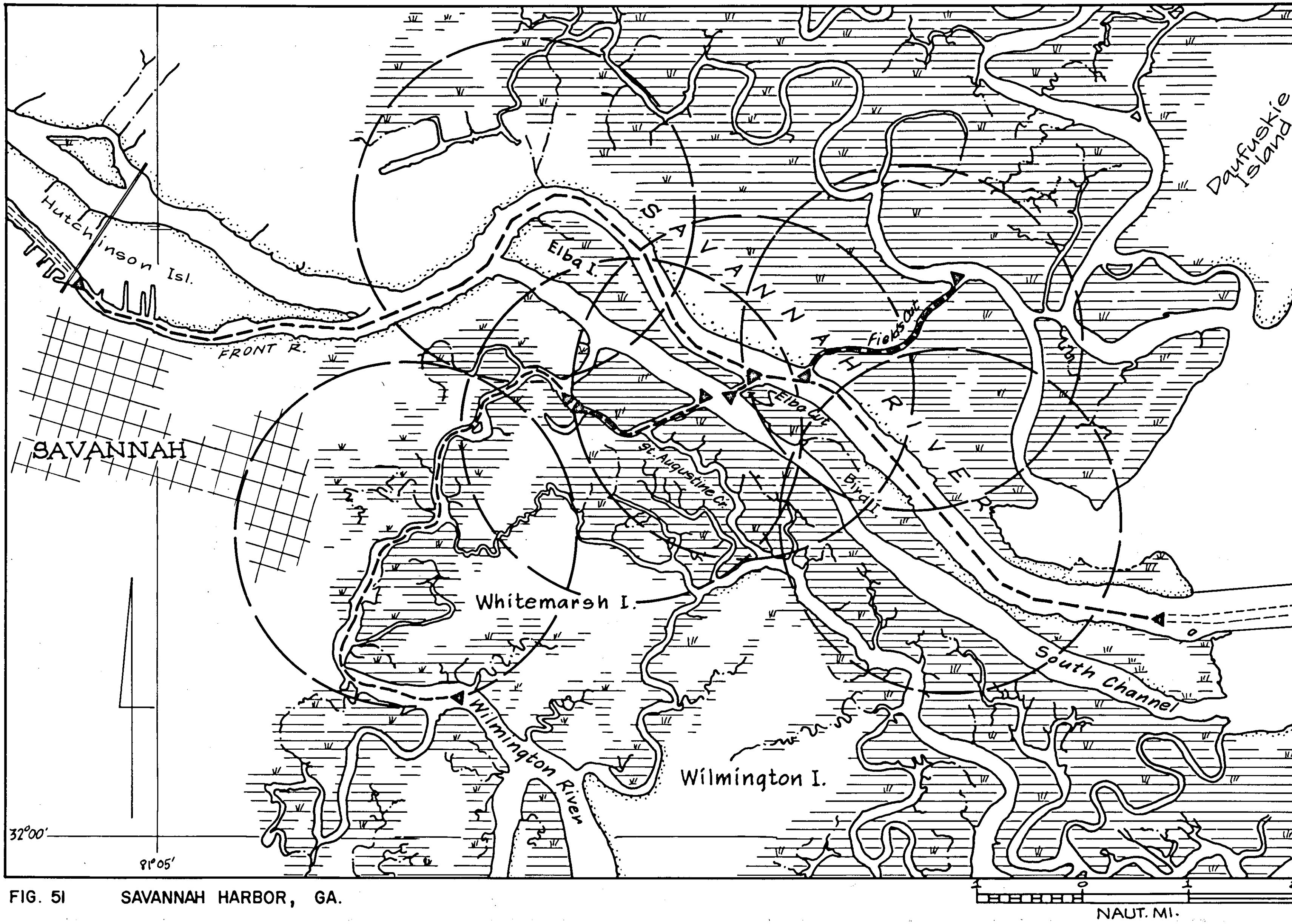

FIG. 51 SAVANNAH HARBOR, GA.

includes, from north to south, Fields Cut just north of Savannah River; Elba Cut, between Elba and Bird Islands; and St. Augustine Creek and Wilmington River to just south of Whitemarsh Island. The channels of the Middle Inner and Lower Inner Harbor sections of Savannah Harbor range from 38 ft deep and 500 ft wide for the Middle Inner Harbor section to 38 ft deep and 400 ft wide for the Lower Inner Harbor section. The AIWW sections consist of channels 12 ft deep and 150 ft wide for approximately 12 miles, from north to south.

The Savannah Harbor Project Area annually generates approximately 5,312,000 cu yd of material varying from clay to sand with a frequency ranging from six to 60 months. The annual cubic yardage and frequencies of the various sections within the project area are: Savannah-Middle Inner Harbor, 4,000,000 cu yd and 6 months; Savannah-Lower Inner Harbor 1,100,000 cu yd and 36 months; Fields Cut, 6,000 cu yd and 60 months; Elba Cut, 6,000 cu yd and 60 months; St. Augustine Creek, 90,000 cu yd and 12 months; and Wilmington River, 110,000 cu yd and 20 months. Disposal as indicated ranges from unconfined for most of the sections to confined for the Lower Inner Harbor and St. Augustine Creek sections.

The mean tidal range for the project area varies from 6.6 to 7.9 ft. The datum plane is mlw.

3.1.1 Dredged Material Receiving Site Description

3.1.1.1 Dredged Material Characteristics

Sediment in the main channel of the Savannah River below Savannah was sampled for textural characteristics and pollutants prior to recent dredging construction to widen and deepen Savannah Harbor (Savannah District 1973a). The sediment included silt, soft blue clay, gravel, and coarse to fine sand and was determined to be polluted. Future material resulting from maintenance dredging will likely be finer, because the above-mentioned textures refer to a mixture of new and maintenance dredging materials. Heavily polluted sediments exceeding EPA standards are expected to increase because of the greater percentage of fine material to be encountered in future maintenance operations.

Sediment from the AIWW sections of the Savannah Harbor Project Area is not polluted and contains mostly sands and silts, though some clay may be found in the St. Augustine Creek area.

3.1.1.2 Marsh-Creation Situations

Marshlands dominate the Savannah Harbor Project Area. The greatest number of potential marsh-creation situations may occur in estuarine streams and rivers. Dredged material could be placed in some segments of cutoffs of oxbows and backwater areas paralleling channels. In addition, areas of existing marshland at stream confluences could be extended, but loss and re-deposition of material would be a hazard. General depths of these areas range from less than one ft to more than 30 ft in unmaintained channels.

Segments of the South Channel, used for deposition in the past, would appear to be suitable for marsh creation along with some provisions for preservation of navigable channels. Water depths are usually less than 10 ft in areas just northeast and southwest of the AIWW at Elba Cut. The South Channel is a potential cutoff, and it may eventually become naturally filled with sediment. Other situations may exist for marsh creation along minor tidal creeks or paralleling the main North Channel.

Tidal flux at Savannah Harbor is 7.4 ft, while maximum ebb tide velocities may approach 4.0 to 5.0 fps (Savannah District 1973b).

Urban areas in the project area consist of a few small communities and Savannah. The east side of Savannah is the major urban center near the project area.

3.1.2 Judgment of Desirability

3.1.2.1 Institutional Characteristics

The following Georgia State agencies are concerned with estuarine areas:

- The State Planning Bureau
- Department of Natural Resources
  - Environmental Protection Division
  - Game and Fish Division
  - Earth and Water Division
- Georgia Natural Areas Council.

Local cooperation is required for use of disposal areas with retaining dikes.

3.1.2.2 Benefits and Costs

It has been theorized that the natural productivity value of marshland may greatly outweigh any other land uses mutually exclusive of marsh productivity

(Gosselink et al. 1973). This may or may not apply to artificially created marsh composed of polluted sediments. Where pollutants such as heavy metals are reintroduced directly into the aquatic system of estuaries, more long-term damage may be initiated than if these sediments are placed in terrestrial systems. However, many factors are not known about migation of chemical pollutants from dredged sediments; therefore, summary judgments should not be made at this time.

3.1.2.3 Public Attitudes

The following Georgia citizens' groups may represent public attitudes concerning estuarine land use:

Georgia Wildlife Federation
The Georgia Conservancy, Inc.
Save America's Vital Environment.

3.2 Georgetown Harbor, South Carolina; Charleston District

The Georgetown Harbor Project Area (Figure 52) includes one project, the Inside Channel in Georgetown Harbor at, and southeast of, Georgetown, South Carolina. The project area is in Winyah Bay, which is at the convergence of the Pee Dee, Sampit, and Waccamaw Rivers. Dredging area consists of a channel 27 ft deep and varying in width from 400 to 600 ft.

The project area annually generates 1,400,000 cu yd of silt with a frequency of 12 months. Disposal is identified as confined with the site having a 10-year life.

The mean tidal range at the project area is 3.3 ft at Georgetown and 4.0 ft at the entrance bar. The datum plane is mlw.

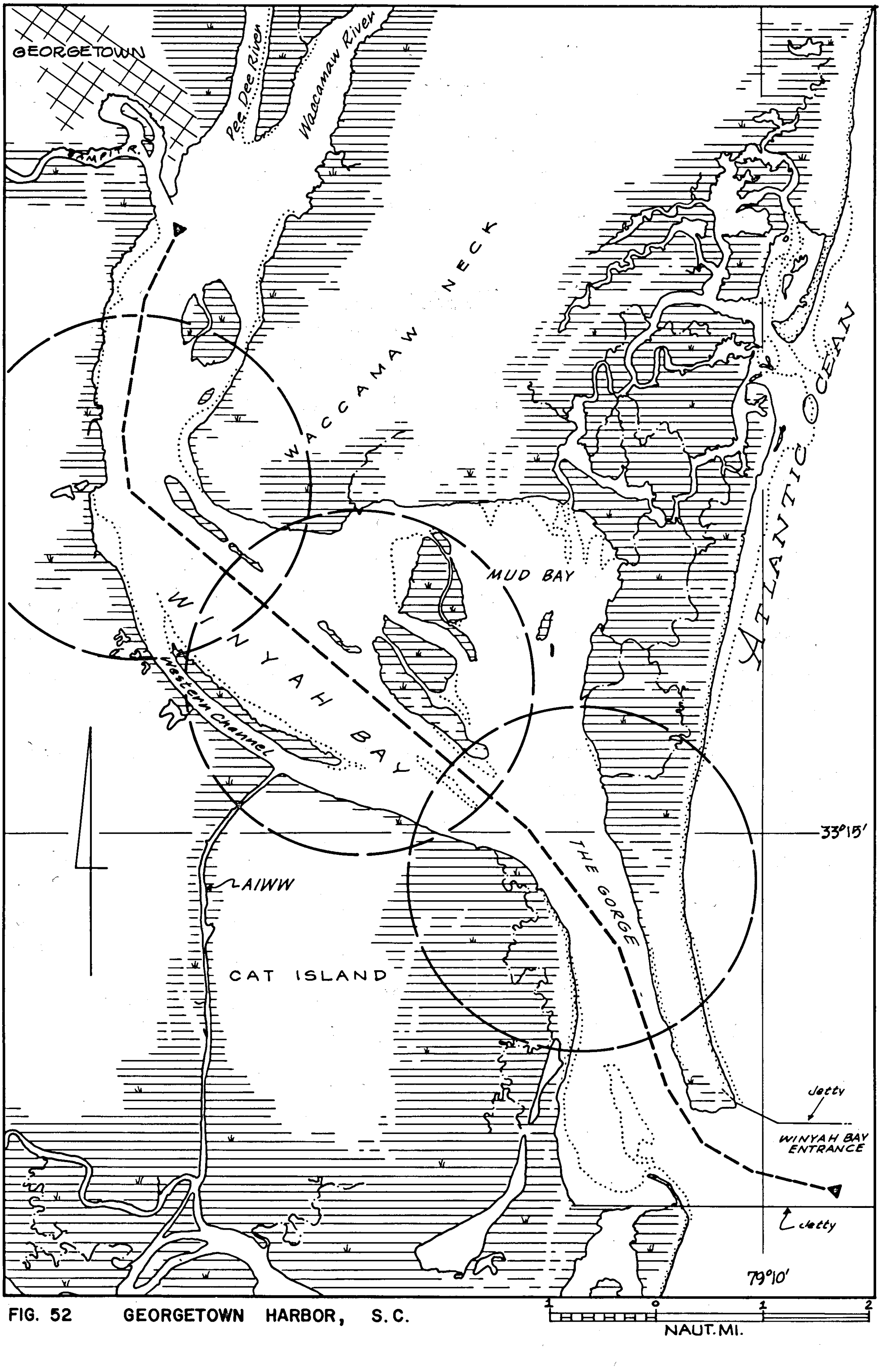

FIG. 52 GEORGETOWN HARBOR, S.C.

3.2.1 Dredged Material Receiving Site Description

3.2.1.1 Dredged Material Characteristics

Sediment in Winyah Bay is largely silt. The silt is not considered polluted according to the inventory.

3.2.1.2 Marsh-Creation Situations

Shallow, open estuarine waters protected from open ocean energy effects and subject to highly variable salinity regimes may be available for marsh creation in the project area. Dredged material disposal could also parallel the existing inside channel.

Marsh-creation situations may be possible adjacent to existing deposits of dredged material or natural islands or new isolated deposits may be developed. In addition, situations may exist along marshy extensions of the mainland in shallow water frequently less than five ft above mhw.

There are no major urban centers near the project area. Small communities occur within upland portions, but Georgetown is the nearest urban-industrial center.

3.2.2 Judgment of Desirability

3.2.2.1 Institutional Characteristics

The following South Carolina State agencies are concerned with estuarine areas:

Water Resources Commission
State Land Resources Commission
Wildlife Resources Department

Division of Marine Resources

Department of Parks Recreation and Tourism.

Local cooperation is required for use of disposal areas.

State and private interests control the land below the high water mark along South Carolina's coast.

3.2.2.2 Benefits and Costs

Marsh complexes, both brackish and salt, are abundant within the project area (Coastal Zone Resources Corp. 1973). Marsh habitats have already been inadvertently created in Winyah Bay as a result of past dredged material disposal.

Benefits to be gleaned as a result of increasing marsh would probably not reach a maximum in this project area unless a combined program of land management involved the creation of marsh and new upland habitat.

3.2.2.3 Public Attitudes

The South Carolina Wildlife Federation is the largest environmentally oriented, organized citizens' group in the State.

3.3 Charleston Harbor, South Carolina; Charleston District

The Charleston Harbor Project Area (Figure 53) is formed by one section of the Charleston Harbor project, the turning basin located southeast of Charleston, South

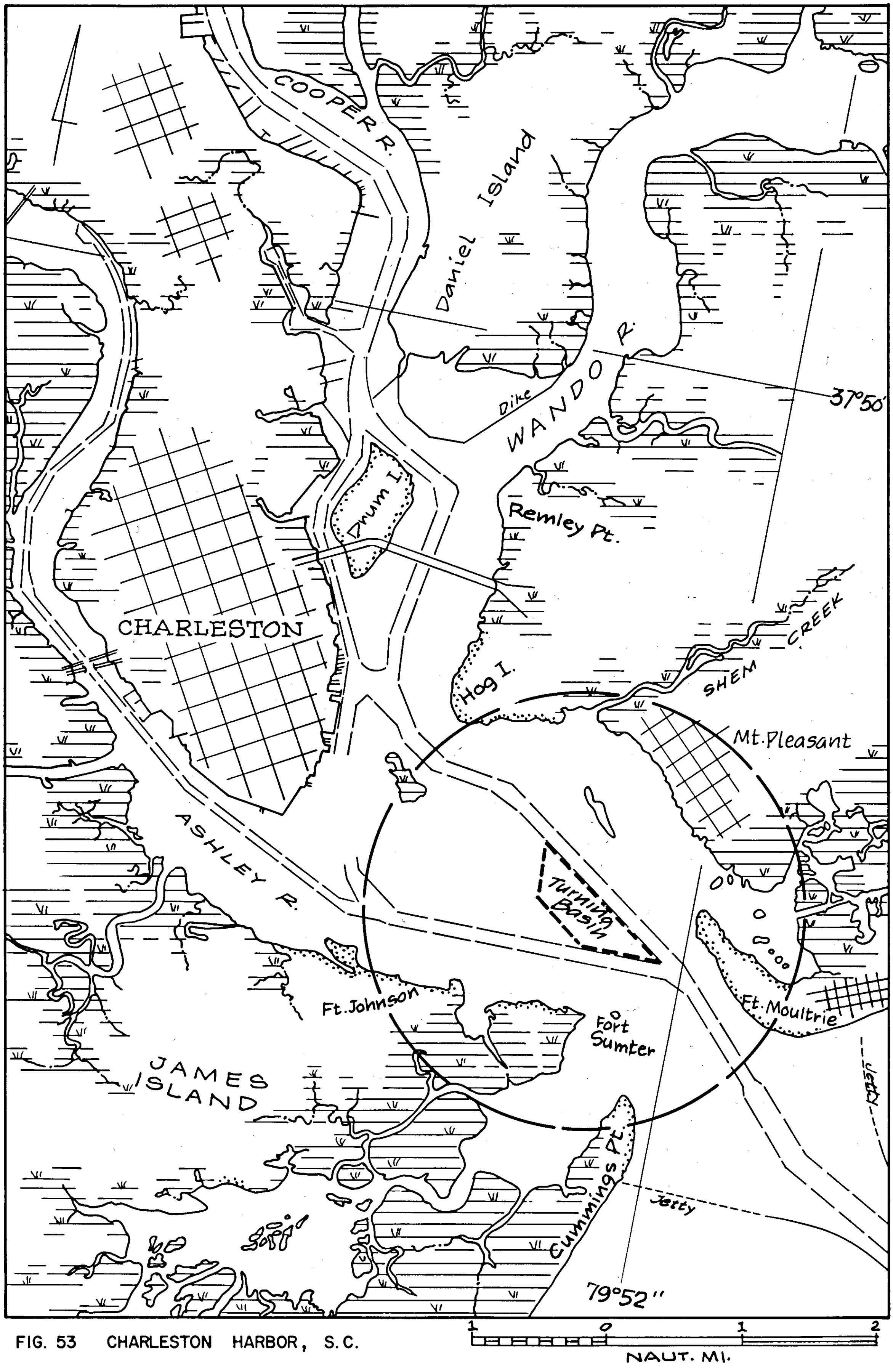

FIG. 53 CHARLESTON HARBOR, S.C.

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Carolina, and north of Fort Sumter. The project area consists of an anchorage basin 35 ft in depth and approximately one mile in length.

The project area annually generates 950,000 cu yd of silt and sand at a frequency of 12 months. Disposal is indicated as confined with the site having a 20-year life.

Mean tidal range is 5.2 ft. The datum plane is mlw.

3.3.1 Dredged Material Receiving Site Description

3.3.1.1 Dredged Material Characteristics

Silt and sand to be dredged from the anchorage basin are polluted with reference to EPA standards. Material dredged is derived from both riverine and oceanic sources. The finer particulates emanating primarily from continental sources will carry the heaviest pollution load.

3.3.1.2 Marsh-Creation Situations

Potential marsh-creation situations may exist behind spits formed at the entrance to Charleston Harbor, at Cummings Point and Fort Moultrie. Marshes are abundant in these areas.

Other options for marsh situations may exist in open waters paralleling the inside channels westward toward Charleston from the anchorage basin. A transitional brackish-salt-marsh habitat could be created at the mouth of Shem Creek north of the project area. With the exception of open water, the most readily available situations for creating marsh would be extension of existing marsh.

Several tank-storage areas are located within the project area. Vessels traveling the AIWW must cross open water in the harbor. The needs for access to these areas could considerably limit marsh-creation options within the designated project area.

3.3.2 Judgment of Desirability

3.3.2.1 Institutional Characteristics

The following South Carolina State agencies are concerned with estuarine areas:

Water Resources Commission.

State Land Resources Commission.

Wildlife Resources Department.

Division of Marine Resources.

Department of Parks, Recreation, and Tourism.

Local cooperation is required for use of disposal area.

3.3.2.2 Benefits and Costs

The benefits gained by marsh creation within the project area could be negated by interference with access to the AIWW and tank-storage areas. In addition, the effects of redispersal of polluted material in the estuarine system could further increase the long-term costs of marsh creation.

3.3.2.3 Public Attitudes

The South Carolina Wildlife Federation is the largest environmentally oriented, organized citizens' group in the state.

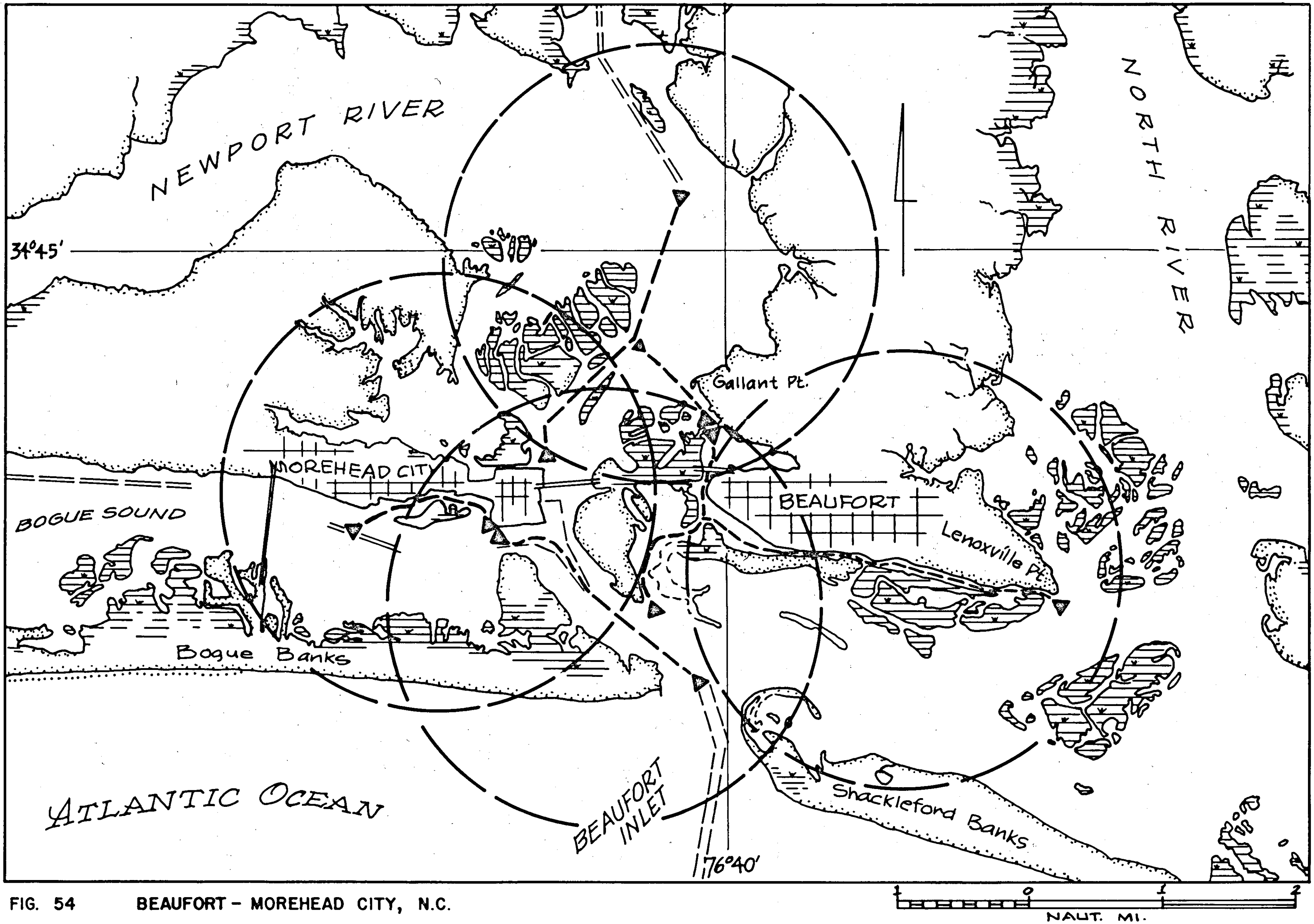

FIG. 54 BEAUFORT - MOREHEAD CITY, N.C.

3.4 Beaufort-Morehead City, North Carolina; Wilmington District

The Beaufort-Morehead City Project Area (Figure 54) consists of several sections of three main projects: Beaufort Harbor, Morehead City, and sections of the Atlantic Intracoastal Waterway (AIWW). Those projects and their sections are: Beaufort Harbor-Bulkhead Channel; Gallant Channel to Gallant Point; Gallant Channel from Gallant Point to the AIWW; channel to Town Creek basin; basin in Town Creek; Taylors Creek Channel to three miles east of Beaufort and Taylors Creek from three miles east of Beaufort to Lenoxville Pt.; basin in front of Beaufort; Morehead City-Inside Channel; turning basin; connecting channel to 6th Street basin and connecting channel to Bogue Sound; and AIWW-Newport River section. Dredging consists of various channels at various depths and widths.

The Beaufort-Morehead City Project Area annually generates a total of approximately 900,000 cu yd of material, mainly sand, with frequencies ranging from 12 to 72 months. Disposal is, for the most part, either overboard or unconfined.

The mean tidal range of the project area is 2.5 ft at Morehead City and 3.5 ft at the inlet. The datum plane is mlw.

3.4.1 Dredged Material Receiving Site Description

3.4.1.1 Dredged Material Characteristics

Sediment considered for marsh construction in the Beaufort-Morehead City Project Area is classified as nonpolluted.

Current velocities affecting movement of bottom sediments range from 3.4 to 4.2 fps (Wilmington District 1974).

3.4.1.2 Marsh-Creation Situations

The following marsh-creation situations may exist within the project area: extension of existing marshlands, as in the area northeast of Morehead City; in open water, as in the shallow portions of Newport River, behind the Bogue or Shackleford Banks barrier islands; and along existing channels, such as the AIWW.

Limitations to marsh creation could be interference with existing navigation, loss of shallow open waters (which are usually very productive for finfish and shellfish), and lack of feasible routes for location of a hydraulic pipeline.

3.4.2 Judgment of Desirability

3.4.2.1 Institutional Characteristics

The following North Carolina State agencies are concerned with estuarine areas:

Department of Natural and Economic Resources
- Division of Water Management
- Division of Water Quality
- Office of Marine Affairs

Department of Water and Air Resources
- Division of Waterways and Seashores
- Division of Commercial and Sport Fisheries
- Wildlife Resources Commission.

North Carolina recently enacted the Coastal Area Management Act of 1974 and guidelines are being prepared.

Estuarine areas below mhw are under State as well as private ownership.

Local cooperation is required for disposal areas with or without retaining dikes.

3.4.2.2 Benefits and Costs

Costs for feasible routing of hydraulic pipelines in the project area for marsh creation might be great. Marsh is already abundant in the project area making creation of additional marsh less desirable.

3.4.2.3 Public Attitudes

The following North Carolina citizens' groups may represent public attitudes concerning estuarine land use:

North Carolina Wildlife Federation
Conservation Council of North Carolina
Carolina Bird Club.

3.5 Brunswick Harbor, Georgia; Savannah District

The Brunswick Harbor Project Area (Figure 55) includes the East River section of the Brunswick Harbor project and two sections of the Atlantic Intracoastal Waterway (AIWW), St. Simons Sound and Jekyll Creek. The location of the project area is from East River, adjacent to and west of Brunswick, Georgia, to St. Simons Sound in the east. The AIWW sections are from the southwest tip of St. Simons Island and south to Jekyll Creek.

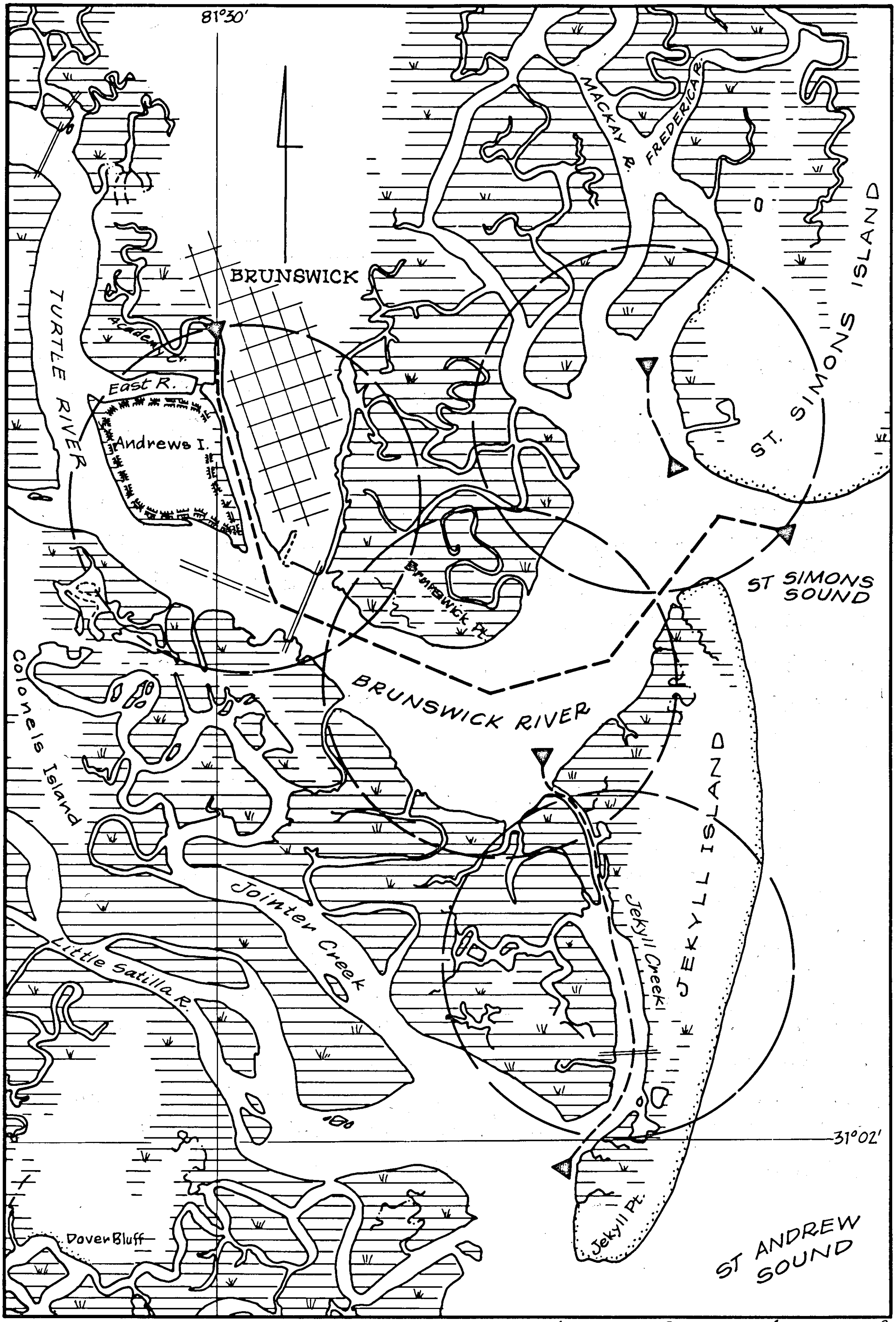

FIG. 55 BRUNSWICK HARBOR, GA.

For the East River section of the Brunswick Harbor project, dredging consists of a channel 30 ft deep and 400 ft wide; while the AIWW sections are channels 12 ft in depth and 150 ft in width.

The project area annually generates 712,000 cu yd of dredged material with a frequency from six to 60 months. The material from the East River section is mostly silt and clay and that from the St. Simons Sound and Jekyll Creek is sand and silt, respectively. The annual cubic yardage and frequencies for the various sections of the project area are: East River, 400,000 cu yd and six months; St. Simons Sound, 16,000 cu yd and 60 months; and Jekyll Creek, 296,000 cu yd and 12 months. Disposal is identified as confined for the East River section and unconfined for the AIWW sections.

The mean tidal range at the project area is 7.3 ft at East River and 6.6 ft near St. Simons Lighthouse. The datum plane is mlw.

3.5.1 Dredged Material-Receiving Site Description

3.5.1.1 Dredged Material Characteristics

Sediment within East River is polluted with respect to certain standards set by EPA. Skidaway Institute of Oceanography (1973) found that standards for the following parameters were exceeded near the southern tip of Andrews Island: volatile solids, chemical oxygen demand, oil and grease, and total Kjeldahl nitrogen. Total silt and clay sediment accumulations in the East River should decrease below those indicated in the inventory due to recent installation of diversion structures across East River and Academy Creek north of the northeast tip of Andrews Island. These structures will divert flows from Academy Creek and discourage present flows from Turtle River via the upper end of East River into the lower reaches of East River (Savannah District 1973c).

The AIWW segment of the project area near St. Simons Island is not thought to contain polluted sediment (sand), but silt sediment in the Jekyll Creek segment of the AIWW is polluted. The degree of pollution for the AIWW section is indicated as light.

3.5.1.2 Marsh-Creation Situations

The following possibilities for marsh-creation may exist in the Brunswick Harbor Project Area: inlets; open water behind barrier islands; open water along maintained channels; estuarine creeks and rivers; and land extensions.

A special consideration in the East River area would be disposal in the upper, barricaded portion of the East River. Flow diverted from Academy Creek could be passed through the created marsh, thereby reducing some of the pollution of that creek before release into Turtle River.

Open-water deposition and marsh-extension situations may exist, respectively, along the central channel and along the north shore of the Brunswick River, where currents are slower than along the south side.

The major urban center in the project area is Brunswick. Jekyll Island is largely developed by resort and vacation residences and facilities. Most of the water-land margins consist of marshy and sandy shores and mouths of small tidal creeks.

3.5.2 Judgment of Desirability

3.5.2.1 Institutional Characteristics

The following Georgia State agencies are concerned with estuarine areas:

The State Planning Bureau
Department of Natural Resources
  Environmental Protection Division
  Game and Fish Division
Georgia Natural Areas Council.

Local cooperation for disposal areas is not required for the AIWW sections.

3.5.2.2 Benefits and Costs

Benefits and costs would be difficult to ascertain due to the pollution status in the project area and the extensive existing marsh areas.

3.5.2.3 Public Attitudes

The following Georgia citizens' groups may represent public attitudes concerning estuarine land use:

Georgia Wildlife Federation
The Georgia Conservancy, Inc.
Save America's Vital Environment.

3.6 Jacksonville Harbor, Florida; Jacksonville District

The Jacksonville Harbor Project Area (Figure 56) consists of channels in the Jacksonville Harbor project (St. Johns River) and a section of the AIWW at Pablo Creek. The channels of the Jacksonville Harbor project, up to but not including the Terminal Channel, range from 38 to 34 ft in depth. The AIWW section of Pablo Creek, which begins at the Jacksonville Harbor channel and continues southeast, consists of a channel 12 ft in depth.

The Jacksonville Harbor Project Area annually generates a total of approximately 660,000 cu yd of silt, sand, and shells (645,000 cu yd from Jacksonville Harbor sections). The dredging frequency is 24 months for the Jacksonville Harbor sections and 12 months for the AIWW-Pablo Creek section. Disposal is indicated as being mainly confined.

The mean tidal range for the project area is from 5.3 ft at the entrance to 1.1 ft at Jacksonville. The datum plane is mlw.

3.6.1 Dredged Material Receiving Site Description

3.6.1.1 Dredged Material Characteristics

Sediment in the St. Johns River is polluted. Accumulation of sediment necessitating maintenance will probably increase considerably beyond the amounts approximated in the inventory.

Moderate pollution of some of the present, as well as future, sediment could be a hazard in open-water disposal areas where many pollutants, including

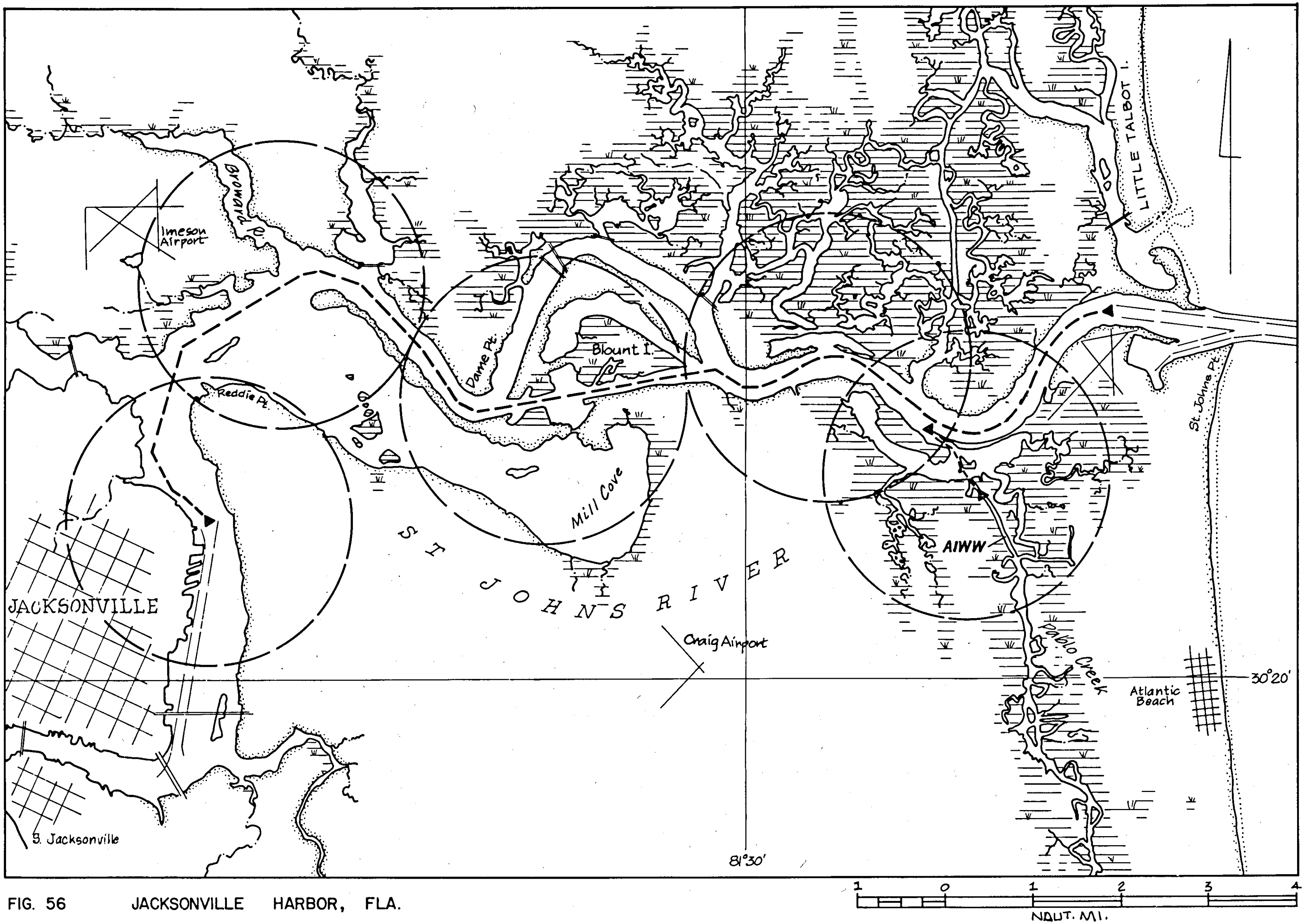

FIG. 56 JACKSONVILLE HARBOR, FLA.

heavy metals, could reenter active estuarine biotic cycles.

3.6.1.2 Marsh-Creation Situations

Possibilities for marsh creation may exist in the following situations: open water; estuarine creeks and rivers; and land extensions.

Cutoffs or oxbows north of Blount Island and the small shallow bay formed by Mill Cove may be considered as additional situations.

Tidal current velocities within the project area vary between 5.1 fps at the mouth of the St. Johns River, and 2.1 fps at the municipal terminals. Backwater currents should be considerably lower. The average net flow is 5,447 cubic feet per second (cfs) in the St. Johns River, and tidal range varies between 4.9 ft at its mouth and 2.0 ft at the municipal terminals. Storm winds are capable of increasing water level by two ft (Jacksonville District 1974).

Jacksonville is the major urban area within the project area. Other small towns are largely suburbs or resort extensions of this greater urban complex.

3.6.2 Judgment of Desirability

3.6.2.1 Institutional Characteristics

Florida State agencies concerned with estuarine areas are:

Department of Natural Resources
- Division of Marine Resources
- Division of Recreation and Parks

Department of Pollution Control
Coastal Coordinating Committee.

3.6.2.2 Benefits and Costs

Sediment pollution is a major deterrent to marsh creation in an open-water situation. Proposed new channel construction in the St. Johns River would result in displacement of 108 acres of aquatic habitat by dredged material (Jacksonville District 1972). The long-term costs of such placement in aquatic habitats may negate the short-term benefits.

3.6.2.3 Public Attitudes

Public attitudes regarding estuarine land use have been represented by local and statewide citizens' groups. The Citizens Committee of 100 was the greatest critic to the proposed channel construction in Jacksonville Harbor (Jacksonville District 1972).

Other active organizations which may represent public attitude concerning estuarine land use are:

Florida Wildlife Federation
Florida Conservation Council
Florida Audubon Society
Florida Defenders of the Environment, Inc.
Florida Division, Izaak Walton League of America, Inc.
Nature Conservancy
Southeastern Environmental Council, Inc.

3.7 Tampa Bay, Florida; Jacksonville District

The Tampa Bay Project Area (Figure 57) is represented by one project in Tampa Bay, the Hillsborough Bay

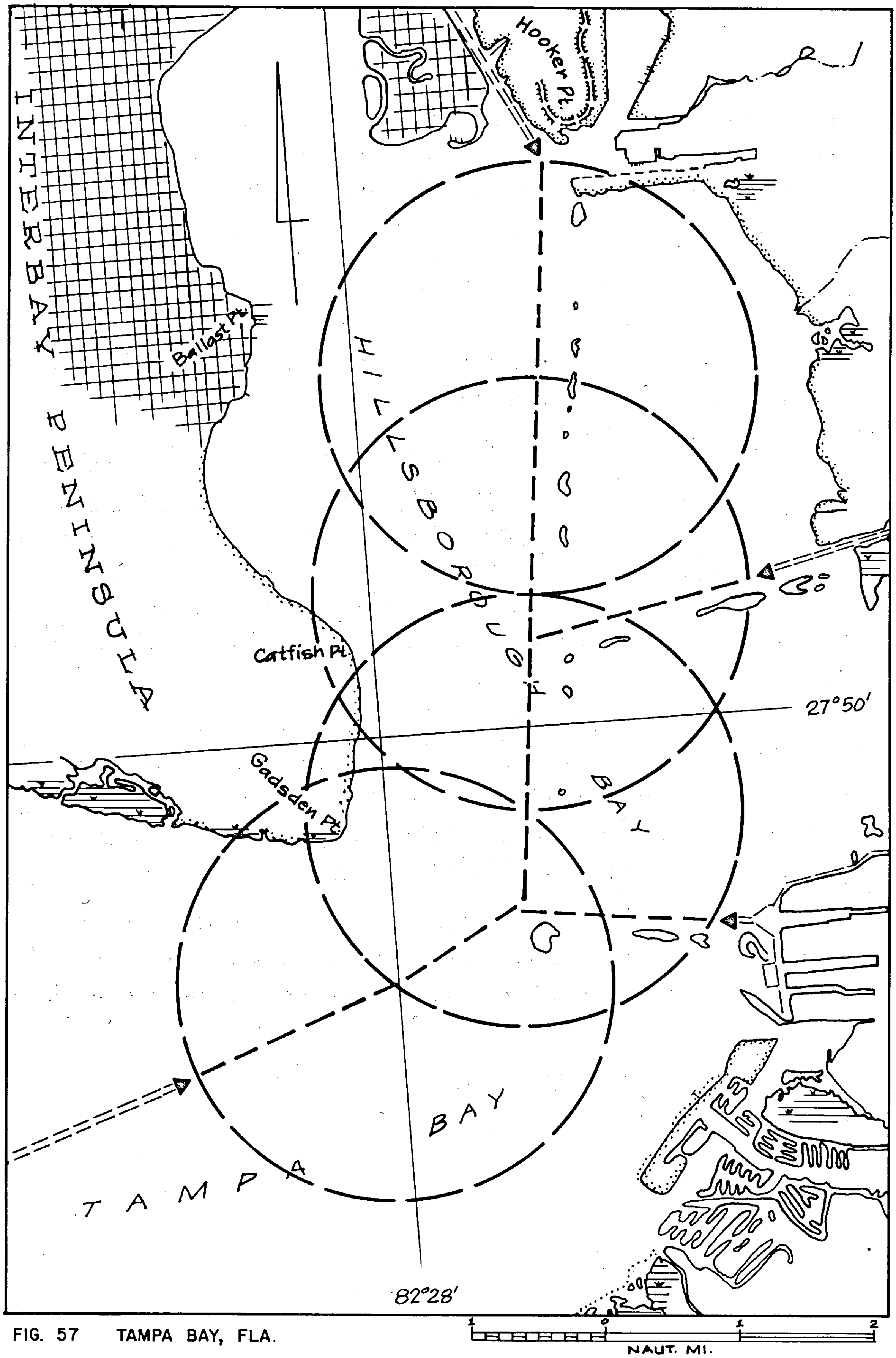

FIG. 57 TAMPA BAY, FLA.

Channel. The location of the project area is Hillsborough Bay from a point approximately three miles south of Interbay Peninsula and continues northward to Hooker Point. Depth of the Hillsborough Bay Channel is 32 ft.

The project area annually generages 500,000 cu yd of silt with a 24-month frequency. Disposal is indicated as unconfined.

The mean tidal range at the project area is 1.5 ft in Tampa Bay. The datum plane is mlw.

3.7.1 Dredged Material Receiving Site Description

3.7.1.1 Dredged Material Characteristics

Heavily polluted silt comprises the major sediment type in the Tampa Bay Project Area. In some samples, levels of volatile solids and high chemical oxygen demand exceed EPA standards by a factor of three (South Atlantic Division Laboratory 1971).

3.7.1.2 Marsh-Creation Situations

Few favorable marsh-creation situations exist within the project area. Open-water disposal along the channel or in separate islands or island complexes would be the most feasible situation.

Open-water marsh creation would not be visually pleasing; though once mangrove was well established, the artificial island's aesthetic appearance could increase.

The urban area of Tampa surrounds the project area.

3.7.2 Judgment of Desirability

3.7.2.1 Institutional Characteristics

Florida State agencies concerned with estuarine areas are:

Department of Natural Resources
  Division of Marine Resources
  Division of Recreation and Parks
Department of Pollution Control
Coastal Coordinating Council.

3.7.2.2 Costs and Benefits

In spite of the heavy pollution, long-term benefits of marsh creation could outweigh the immediate costs related to the highly urban surroundings of the project area.

3.7.2.3 Public Attitudes

Florida citizens' groups which may represent public attitudes concerning estuarine land use are:

Florida Wildlife Federation
Florida Conservation Council
Florida Audubon Society
Florida Defenders of the Environment, Inc.
Florida Division, Izaak Walton League of America, Inc.
Nature Conservancy
Southeastern Environmental Council, Inc.

3.8 Roanoke Sound, North Carolina; Wilmington District

The Roanoke Sound Project Area (Figure 58) includes the Manteo (Shallowbag) Bay project and several of its sections. The project area is located in Roanoke Sound

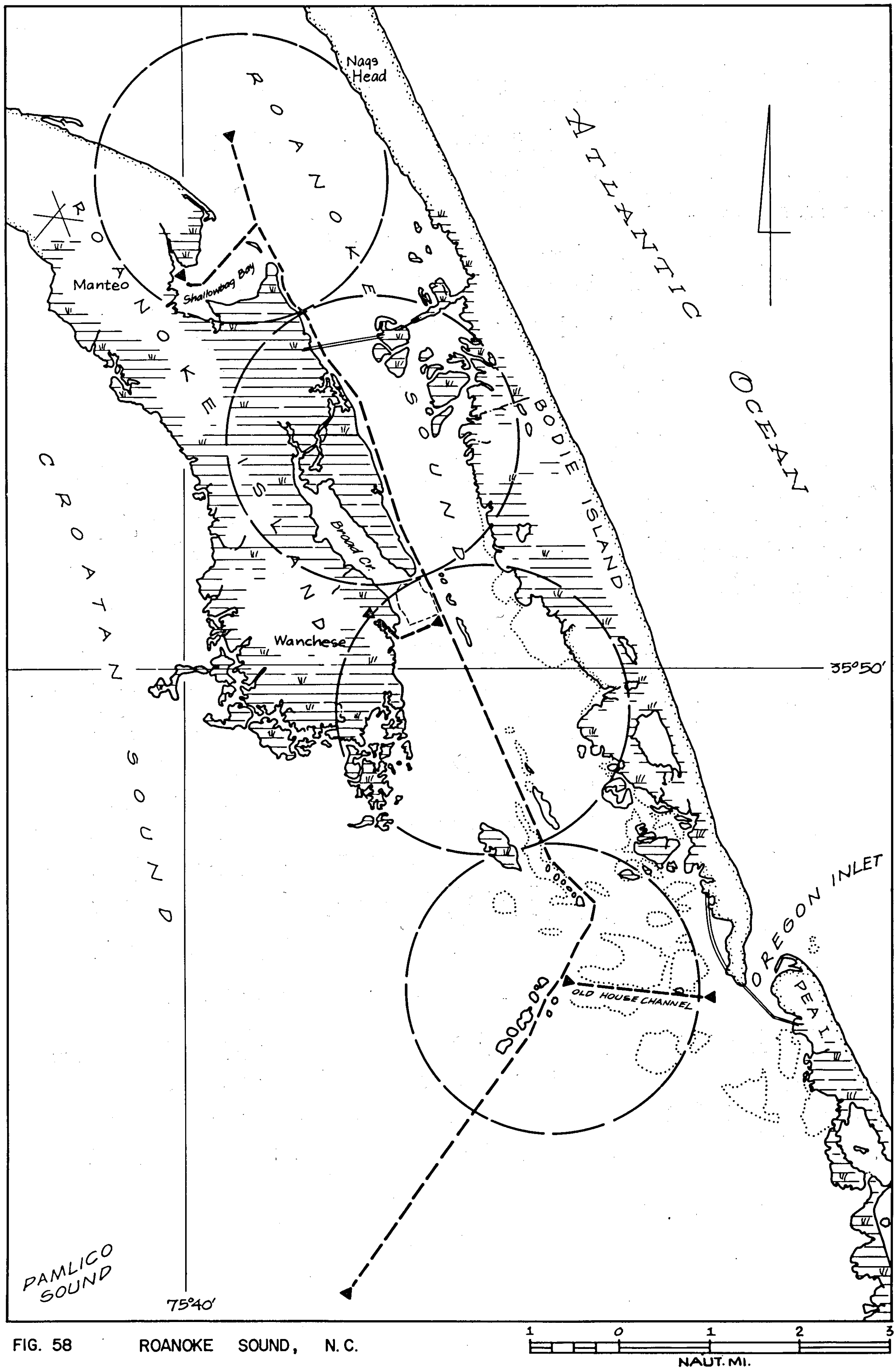

FIG. 58 ROANOKE SOUND, N.C.

between Bodie and Roanoke Islands and includes some areas of Pamlico Sound and Oregon Inlet. The sections of the project and their dimensions are: Old House Channel, 100 ft wide by 12 ft deep; Inside Channel from Oregon Inlet to Manteo, 120 ft wide by 12 ft deep; side channel at Wanchese, 120 ft wide by 12 ft deep; portions of connecting channel to Albermarle Sound, 100 ft wide by 10 ft deep; turning basin at Manteo, 600 ft long by 200 ft wide; and the 15 acre turning basin at Wanchese.

The Roanoke Sound Project Area annually generates a total of 225,000 cu yd of sand with a frequency of 12 months. Disposal is indicated as controlled effluent, containment within dikes, and open water.

The mean tidal range for the project area is 1.8 ft at Oregon Inlet. The datum plane is mlw.

3.8.1 Dredged Material Receiving Site Description

3.8.1.1 Dredged Material Characteristics

Sands within the project channels do not show excessively high volatile solids content or high chemical oxygen demand. In only three areas are levels equal to or in excess of EPA standards: Manteo Harbor-Shallowbag Bay; at bridge crossing Roanoke Sound (U. S. 64); and at Wanchese Harbor (Wilmington District 1974).

Total volatile solids on a percent dry weight basis in the project area range from 6.0 to 21.0. Chemical oxygen demand on a mg/g dry basis ranges from 62.0 to 270.0 (Wilmington District 1974).

3.8.1.2 Marsh-Creation Situations

Several types of marsh-creation situations may exist: open water behind barrier island; open water paralleling channels; estuarine creeks and rivers; land extensions; and alternately exposed and inundated tidal flats inside Oregon Inlet.

Tides in the Roanoke Sound Project Area are primarily wind generated except at Oregon Inlet, where there is a 1.8 ft lunar tide. Current velocities are variable with that for Old House Channel being 3.4 fps (Wilmington District 1974).

Water depths within the project area are shallow (generally less than 5.0 ft mlw), except where tidal currents from Oregon Inlet act in maintaining greater depths. Depths in Roanoke Sound north of Shallowbag Bay are somewhat deeper than 5.0 ft mlw.

3.8.2 Judgment of Desirability

3.8.2.1 Institutional Characteristics

The following North Carolina State agencies are concerned with estuarine areas:

Department of Natural and Economic Resources
- Division of Water Management
- Division of Water Quality
- Office of Marine Affairs

Department of Water and Air Resources
- Division of Waterways and Seashore
- Division of Commercial and Sport Fisheries

Wildlife Resources Commission.

North Carolina recently enacted the Coastal Area Management Act of 1974 and guidelines are being prepared.

The southern half of Bodie Island is part of the United States National Seashore System.

Estuarine lands below mhw are under State as well as private ownership.

3.8.2.2 Benefits and Costs

Urban centers within the project area are limited to Manteo, Nags Head, and Wanchese. Manteo and Nags Head are largely resort towns; while Wanchese is primarily a fishing village. While existing marsh areas are extensive, the low pollutional levels of the sediment would enable very beneficial results to accrue.

3.8.2.3 Public Attitudes

The following North Carolina citizens' groups may represent public attitudes in regards to estuarine land use:

North Carolina Wildlife Federation
Conservation Council of North Carolina
Carolina Bird Club.

3.9 New River Inlet, North Carolina; Wilmington District

The New River Inlet Project Area (Figure 59) includes three sections of the Atlantic Intracoastal Waterway (AIWW): a section traversing New River Inlet; a section in Chadwick Bay; and a section at Cedar Point. The project area is located southeast of Jacksonville,

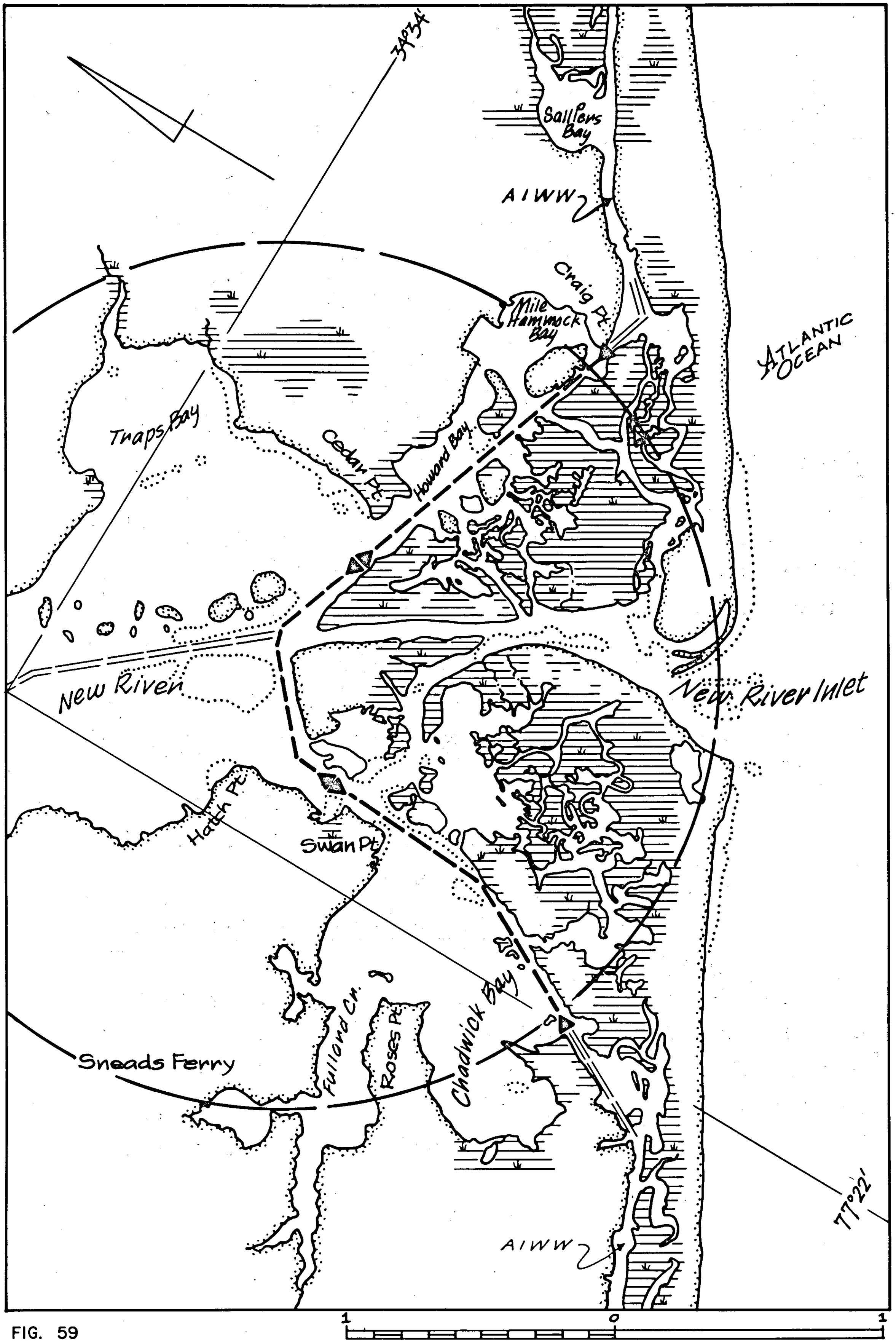

FIG. 59
NEW RIVER INLET, N.C.

North Carolina, at the mouth of the New River.

The New River Inlet Project Area annually generates approximately 180,000 cu yd of material with a frequency ranging from six to 48 months. The annual cubic yardage was approximated by calculated percentage of the total for those sections in the project area. The AIWW sections, their approximated cubic yardage, and frequencies are: AIWW traversing New River Inlet, 160,000 cu yd and six months; and AIWW at Chadwick Bay, 15,000 cu yd and 48 months. Disposal is indicated as overboard.

The mean tidal range at the New River Inlet Project Area varies from 2.0 to 3.0 ft. The datum plane is mlw.

3.9.1 Dredged Material Receiving Site Description

3.9.1.1 Dredged Material Characteristics

Coarse sand is the primary component of the dredged sediment. Sediment within the New River Inlet Project Area was not excessively polluted beyond EPA standards (Wilmington District 1974). Total volatile solids on a percent dry weight basis ranged from 1.1 to 6.0. Chemical oxygen demand on a mg/g dry basis ranged from 2.5 to 36.0.

3.9.1.2 Marsh-Creation Situations

Several situations may exist for marsh creation: tidal creeks behind barrier islands; open water paralleling AIWW channel; land extensions of existing marsh; several possible combinations of the above; and open water in existing bays (Chadwick Bay for example).

Two diked disposal areas near the intersection of the New River Inlet Channel to Jacksonville and the AIWW are presently used for dredged material disposal.

Normal tidal range varies from 2.0 to 3.0 ft and the current speed is approximately 3.4 fps. Existing water depths are generally less than 10 ft above mhw in areas not subject to dredging.

There are no major urban centers in near proximity to the project area; however, the city of Jacksonville and Camp Lejeune (USMC) are located several miles upstream.

Mud flats, alternately inundated and exposed, exist just west of the portion of the project area traversing New River Inlet.

3.9.2 Judgment of Desirability

3.9.2.1 Institutional Characteristics

The following North Carolina State agencies are concerned with estuarine areas:

- Department of Natural and Economic Resources
  - Division of Water Management
  - Division of Water Quality
  - Office of Marine Affairs
- Department of Water and Air Resources
  - Division of Waterways and Seashore
  - Division of Commercial and Sport Fisheries
- Wildlife Resources Commission.

North Carolina recently enacted the Coastal Area Management Act of 1974 and guidelines are currently being prepared.

Estuarine areas below mhw are under State as well as private ownership.

Local cooperation is required for disposal areas.

3.9.2.2 Benefits and Costs

Opportunities for benefits from marsh creation in this project area are probably low due to the relatively extensive existing marsh and the relatively low volume of material which is dredged annually.

3.9.2.3 Public Attitudes

The following North Carolina citizens' groups may represent public attitude toward estuarine land use:

North Carolina Wildlife Federation
Conservation Council of North Carolina
Carolina Bird Club.

3.10 St. Lucie Inlet, Florida; Jacksonville District

The St. Lucie Inlet Project Area (Figure 60) includes the St. Lucie project (Outer Cut) and a section of the Atlantic Intracoastal Waterway (AIWW) which crosses the inlet. The project area is located between Hutchinson and Jupiter Islands at the convergence of the Indian and St. Lucie Rivers near Stuart, Florida.

The project area annually generates 105,000 cu yd of mostly sand and shell (70,000 cu yd from AIWW section)

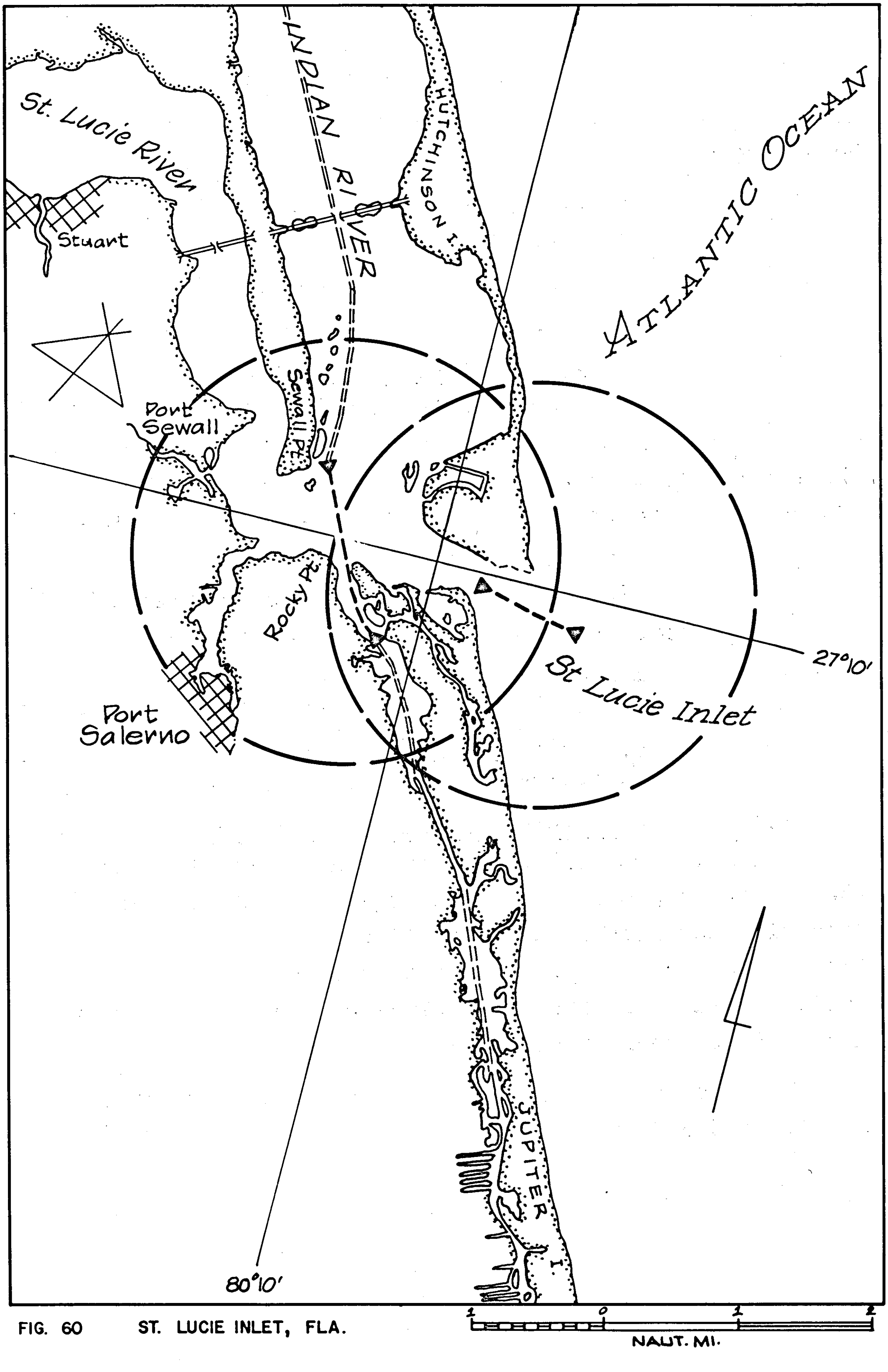

FIG. 60 ST. LUCIE INLET, FLA.

with frequencies ranging from six months for the St. Lucie section (Outer Cut) and 12 months for the AIWW section. Disposal is indicated as unconfined for St. Lucie Inlet and confined for the AIWW section.

The mean tidal range for the St. Lucie Inlet Project Area is 2.6 ft outside the inlet and 1.0 ft inside. The datum plane is mlw.

3.10.1 Dredged Material Receiving Site Description

3.10.1.1 Dredged Material Characteristics

Dredged material pollution levels in the project area are generally well within EPA standards. Samples taken in relation to the proposed new construction in St. Lucie Inlet show Kjeldahl nitrogen levels only slightly higher than EPA standards (Jacksonville District 1973a). Samples from the AIWW section of the St. Lucie Project Area show no levels above EPA standards (South Atlantic Division Laboratory 1972).

3.10.1.2 Marsh-Creation Situations

The following mangrove-creation situations may exist within the St. Lucie Inlet Project Area: open water inside St. Lucie Inlet; open water in Indian River behind Jupiter or Hutchinson Islands; open water in the Indian or St. Lucie Rivers or any of their tributaries (Indian River is not a true river); extensions of existing mangroves (as behind Jupiter Island); and paralleling cut channels.

Much of the dredged material obtained from past maintenance in the Outside Cut at St. Lucie Inlet has been used as beach nourishment on Jupiter Island. Urban areas in the project area are limited to Port Sewall and Port Salerno, small fishing and resort towns, and scattered residential areas, such as on Rocky Point and Sewall Point.

St. Lucie State Park occupies the northern end of Jupiter Island.

Water depths in the project area are usually less than 15 ft. Littoral drift outside the inlet is from north to south and the inlet is subject to heavy seas, particularly during strong ebb tides (Jacksonville District 1973b).

Surrounding estuarine littoral vegetation is largely mangrove. Many areas have been drained and/or diked for mosquito-control development or have been used as disposal areas.

Past dredged material disposal has been used in beach nourishment programs, placed in open water paralleling channels, confined in diked upland sites, or placed in open mangrove.

3.10.2 Judgment of Desirability

3.10.2.1 Institutional Characteristics

Florida State agencies concerned with estuarine areas are:

Department of Natural Resources
Division of Marine Resources

Division of Recreation and Parks
Department of Pollution Control
Coastal Coordinating Council.

Estuarine lands below ordinary high tide are owned by Federal, State, local, and private concerns.

3.10.2.2 Benefits and Costs

Because of the generally unpolluted condition of the sediment, dredged material would not significantly contribute to the dispersal of any highly toxic compounds in water. Creation of mangrove stands with these sediments as substrates would, to some extent, mitigate past losses of natural habitat. The general area of Martin County is developing rapidly. Establishment of viable mangrove stands would contribute toward re-creating areas of original mangrove which would have been present without human intervention in this area and would serve to enhance aesthetic attractions to tourist trade. Development of wildlife habitat would be particularly important in time because of the close proximity of St. Lucie State Park.

3.10.2.3 Public Attitudes

Florida citizens' groups which may represent public attitudes concerning estuarine land use are:

Florida Wildlife Federation
Florida Conservation Council
Florida Audubon Society
Florida Defenders of the Environment, Inc.
Florida Division, Izaak Walton League of America, Inc.

Nature Conservancy
Southeastern Environmental Council, Inc.

4.0 Gulf Geographical Region

The Gulf geographical region includes the Mobile, New Orleans, and Galveston Districts. The boundaries of the geographical region extend from just east of the St. Marks River in Florida, westward to the United States-Mexico border at Texas. The coastal states included in the region are northwest Florida, Alabama, Mississippi, Louisiana, and Texas. The locations of the prime project areas are indicated in Figure 61.

In the Gulf geographical region, there are some instances in which the reaches of particular projects extend for long distances. Where this occurred and portions of such a project were included in a project area, a percentage of that project's annual cubic yardage was included in the cumulative cubic yardage estimates for that project area. The Mississippi-Gulf Project Area (4.1) and the Galveston Bay Project Area (4.4) are examples.

No additional reconnaissance-scale information was made available in regards to the Terrebonne Bay Project Area (4.6), the Sabine-Neches Canal Project Area (4.7), and the Mobile Harbor Project Area (4.10).

4.1 Mississippi-Gulf, Louisiana; New Orleans District

The Mississippi-Gulf Project Area (Figures 62 and 63) includes two sections of the Mississippi River-Gulf Outlet project southeast of New Orleans: southeastern portion of Mississippi-Gulf Outlet and the Breton Sound section. These two sections form a continuous channel for approximately 30 miles. The project area is smaller

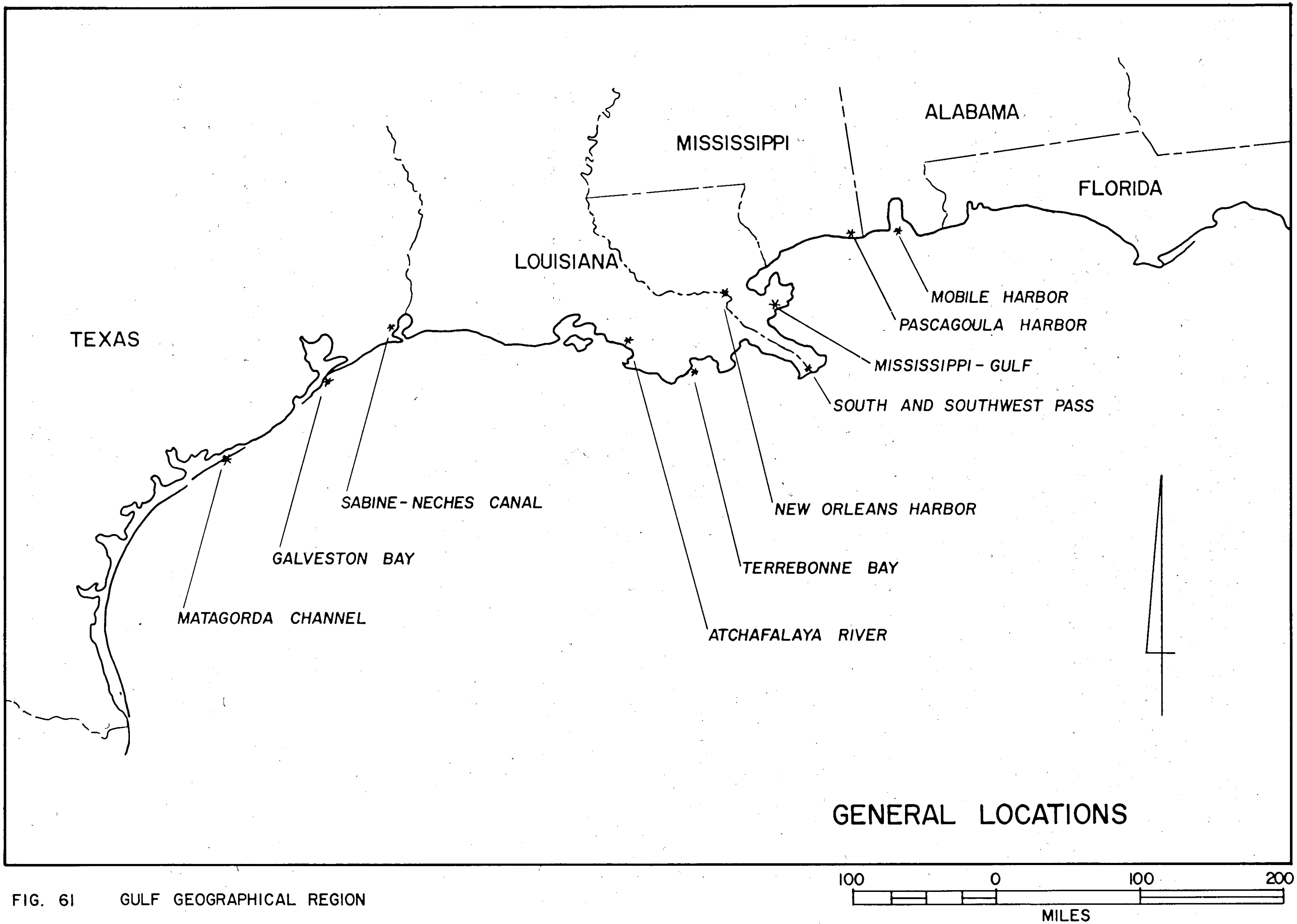

FIG. 61 GULF GEOGRAPHICAL REGION

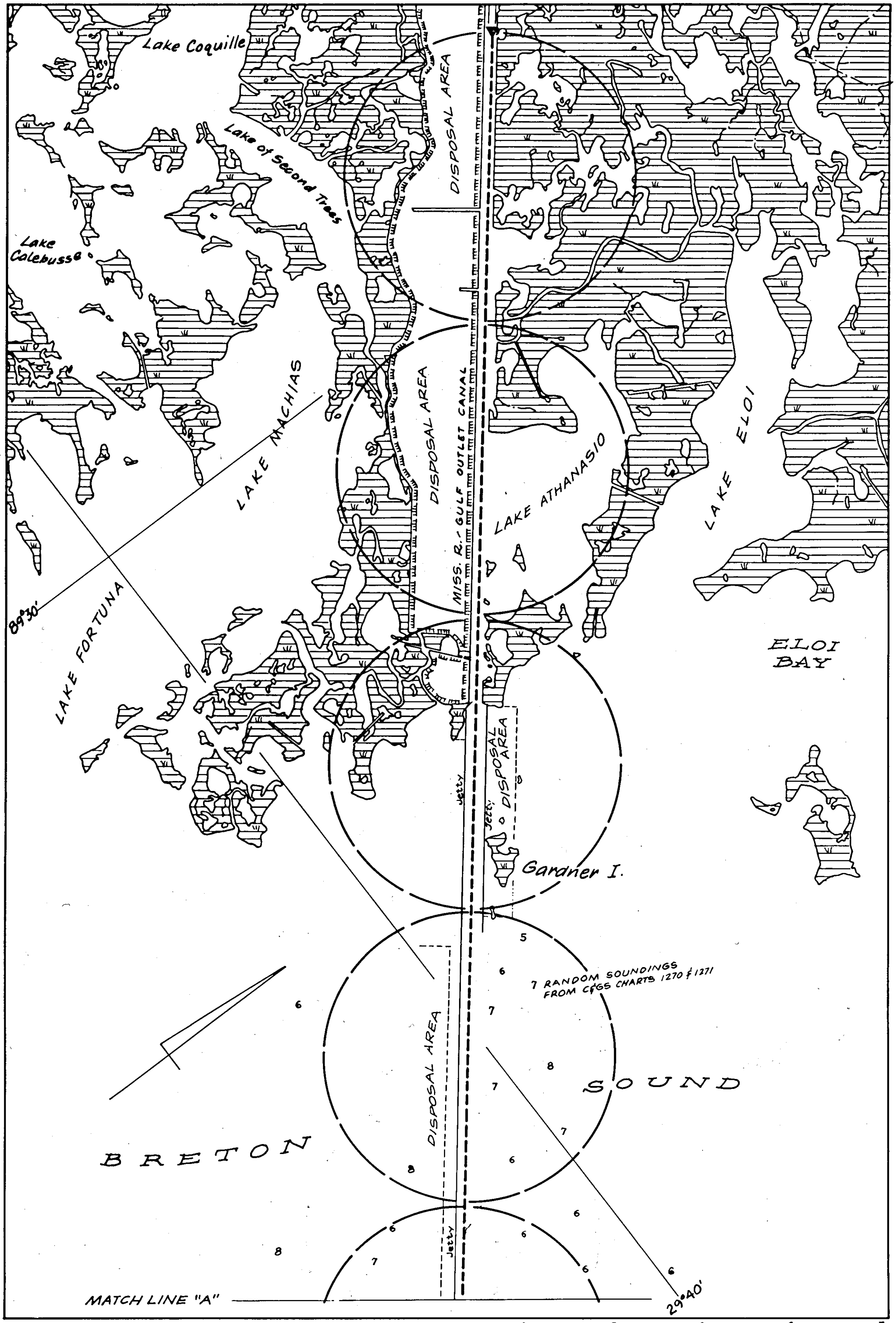

FIG. 62 MISSISSIPPI-GULF, RIVER OUTLET SECTION, LA.

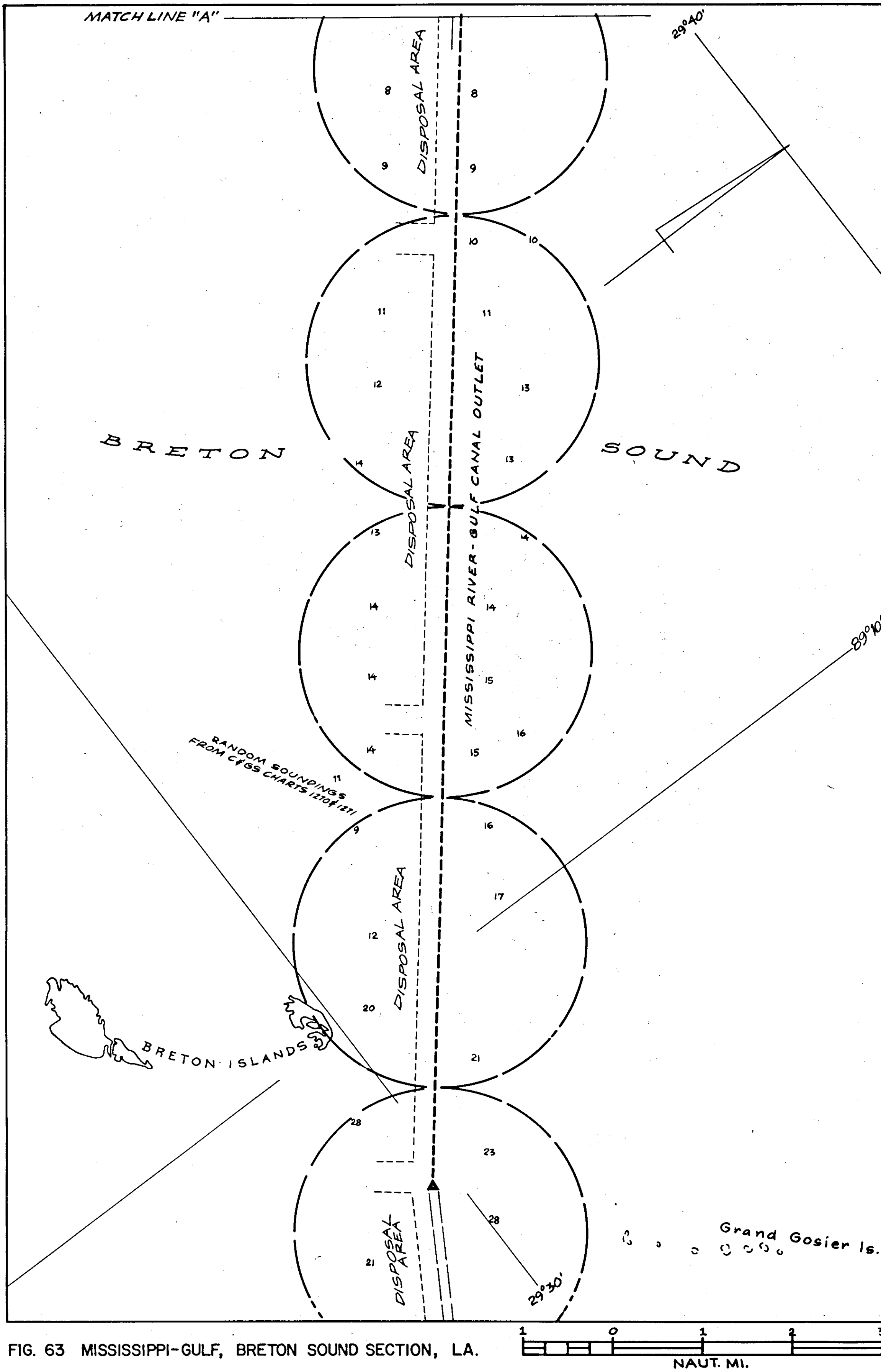

FIG. 63 MISSISSIPPI-GULF, BRETON SOUND SECTION, LA.

in scope and involves a channel 36 ft in depth and 500 ft in width from the Breton Islands in Breton Sound to a point approximately 10 miles northwest of Gardner Island.

The project area annually generates a total of approximately 8,158,000 cu yd of silt, clay, and sand (158,000 cu yd or approximately 3 percent of the Mississippi-Gulf Outlet total of 5,669,700 cu yd and all of the Breton Sound total of 8,000,000 cu yd). The frequency ranges from 18 months for the Mississippi-Gulf Outlet to 12 months for the Breton Sound section. Disposal is indicated as unconfined in the case of the Breton Sound section and confined in the case of the Mississippi-Gulf section.

The mean tidal range at the project area is 1.0 ft at the mouth of the channel. The datum plane is msl.

4.1.1 Dredged Material Receiving Site Description

4.1.1.1 Dredged Material Characteristics

According to the inventory, sediments within the Mississippi-Gulf Project Area are not polluted. The sediment consists of silty clay. Shoaling occurs at various rates in different segments of the project area (New Orleans District 1974a).

4.1.1.2 Marsh-Creation Situations

The following marsh-creation situations may occur within the project area: in open water paralleling lower portions of the channel in Breton Sound; scattered islands as in Lake Athanasio; and marsh extension at several locations in the northwestern portion of the project area.

There are existing dredged material disposal areas, both submerged and above msl, that parallel nearly the entire length of the channel within the project area.

Estuarine lakes and bayous of an accreting deltaic system make up the major portion of the project area. Salt marsh and black mangrove at the upper reaches of the project area are characteristic of Gulf coast estuarine systems. Estuarine waters support an abundance of shellfish and finfish which are harvested in commercial quantities (New Orleans District 1974a).

Mean diurnal tide range is 0.8 ft at the upper end of the channel (New Orleans) and 1.4 ft at the lower portion. Current patterns and velocities are governed largely by wind and tides. Hurricanes create considerable deviations in tides and currents. Water depths are not usually greater than -20 ft msl (New Orleans District 1974a).

No major urban centers are located within the project area.

4.1.2 Judgment of Desirability

4.1.2.1 Institutional Characteristics

Several Louisiana State agencies are concerned with estuarine areas:

State Department of Conservation
Wild Life and Fisheries Commission

Office of State Planning

Louisiana Coastal Commission

Louisiana Advisory Commission on Coastal and Marine Resources.

The Louisiana Coastal Commission serves as the overall policy-making body, while the Office of State Planning conducts an overall planning program.

Local cooperation is required for dredged material disposal in the Breton Sound portion of the project area. Dredged material from the upper portion must be deposited in disposal areas only.

4.1.2.2 Benefits and Costs

The total acreage of aquatic and marsh habitats within the project area has been considerably reduced. As such areas have already been used for disposal, it would seem that the long-term benefits of marsh creation could outweigh costs.

4.1.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following Louisiana citizens' groups:

Louisiana Wildlife Federation

Louisiana Association of Conservation Districts

Louisiana Audubon Society.

4.2 South and Southwest Pass, Louisiana; New Orleans District

The South and Southwest Pass area (Figure 64) is represented by two sections of the Mississippi River-

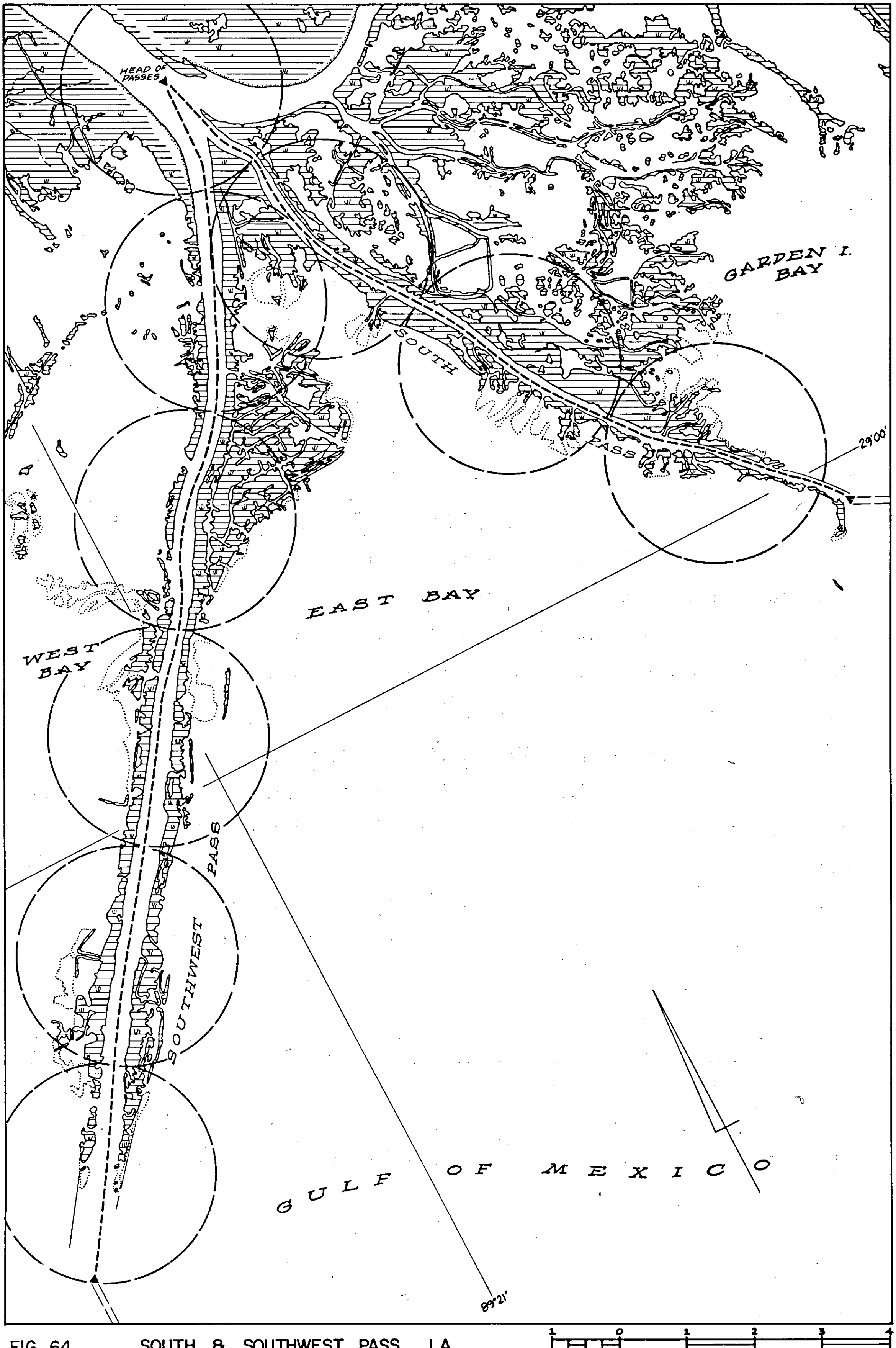

FIG. 64 SOUTH & SOUTHWEST PASS, LA.

Baton Rouge to the Gulf of Mexico project: South Pass and Southwest Pass. The location of the project area is southeast of New Orleans beginning at Head of Passes and ending at the -40 ft contour line in the Gulf of Mexico. The South Pass section is a channel 30 ft deep, 450 ft wide, and 13.5 miles long. The Southwest Pass section is a channel 40 ft deep, 800 ft wide, and 18 miles long.

The South and Southwest Pass Project Area annually generates 4,500,000 cu yd of sand and silt with a frequency of 12 months. Disposal is identified as confined with the site having a five-year life.

The mean tidal range at the project area is 1.0 ft. The datum plane is msl.

4.2.1 Dredged Material Receiving Site Description

4.2.1.1 Dredged Material Characteristics

The sediment requiring maintenance dredging is largely clay and fine silt with small amounts of very fine sand. These materials are dropped from suspension or deposited from the river bedload. The average suspended load is approximately 7 percent sand, 38 percent silt, and 55 percent clay. Bedload material samples indicate a wide variation in percentages of sand, silt, and clay. Like the suspended load, however, bedload grains coarser than fine sand are rare (New Orleans District 1973a).

The inventory indicates that sediments in the South and Southwest Pass Project Area are not polluted.

4.2.1.2 Marsh-Creation Situations

The following marsh-creation situations

may occur in the project area: marsh extension southward of the distributary bars, as in West Bay, East Bay, Garden Island Bay, etc.; within distributaries (deltaic estuarine creeks or rivers); and in open water of any number of bays along the passes. The placement of dredged material in these areas would contribute substantially to a natural process of delta formation already underway at the mouth of the Mississippi River.

Lunar tides are diurnal with a mean range of 1.0 ft msl and a mean spring tide range of 2.0 ft msl. Irregularities are predominant in this lunar pattern, however, and are controlled largely by interaction of Mississippi River discharges and wind-driven Gulf waters (New Orleans District 1973a).

Water depths vary proportionately with increased distance from the passes. Within two to three nautical miles, depths may exceed 20 ft msl. Beyond this distance, depths may be greater than 200 ft.

Depending on salinity regimes, combinations of salt and brackish marsh occur within the intertidal zones, while several upland or levee communities containing shrubs and trees occur above mhw. Swamp forest species are scattered. Marshes and open water in distributaries and in the bays contain abundant wildlife and commercial quantities of fin and shellfish (New Orleans District 1973a).

Many drilling platforms have been constructed in East Bay.

Dredged material disposal areas are located throughout the project area southward of the pass levees.

4.2.2 Judgment of Desirability

4.2.2.1 Institutional Characteristics

Several Louisiana State agencies are concerned with estuarine areas:

State Department of Conservation

Wild Life and Fisheries Commission

Office of State Planning

Louisiana Coastal Commission

Louisiana Advisory Commission on Coastal and Marine Resources.

The Louisiana Coastal Commission serves as the overall policy-making body, while the Office of State Planning conducts an overall planning program.

Local cooperation is not required for dredged material disposal.

4.2.2.2 Benefits and Costs

At present, methodologies for dredged material disposal and for marsh creation are probably very similar in this area, and there should be minimal additional costs involved. Benefits of a long-term impact could be reduced if marsh were created over benthos richer than the resultant marsh.

4.2.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following Louisiana citizens' groups:

Louisiana Wildlife Federation

Louisiana Association of Conservation Districts

Louisiana Audubon Society.

4.3 Atchafalaya River, Louisiana; New Orleans District

The Atchafalaya River Project Area (Figure 65) is represented by the Atchafalaya River-Morgan City to the Gulf of Mexico project. The location of the project area is southwest of Morgan City, Louisiana, beginning southwest of the mouth of the Lower Atchafalaya River and continuing southwest between Eugene Island and White Shell Key. The channel is 20 ft in depth, 200 ft in width, and is approximately 12 miles in length.

The project area annually generates 4,000,000 cu yd of silt with a frequency of 12 months. Disposal is indicated as overboard.

The mean tidal range is 0.8 ft. The datum plane is msl.

4.3.1 Dredged Material Receiving Site Description

4.3.1.1 Dredged Material Characteristics

Sediments are not polluted (New Orleans District 1974b). Sediment accumulations are from natural deltaic processes at the mouth of the Atchafalaya River.

4.3.1.2 Marsh-Creation Situations

Marsh-creation situations in the project area might be limited to open-water disposal along the lower Atchafalaya Channel. Existing overboard disposal has already generated islands of dredged material in the

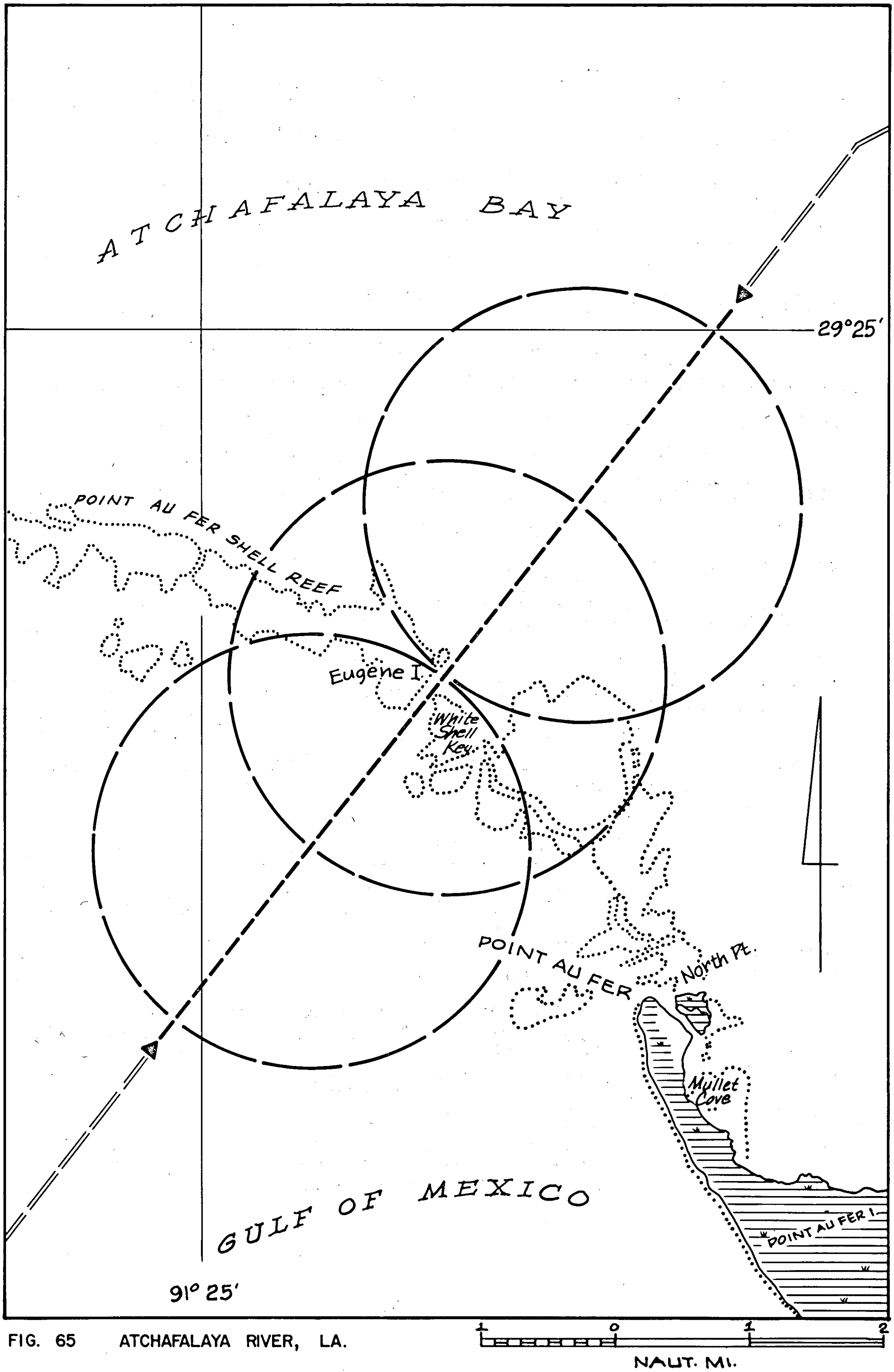

FIG. 65 ATCHAFALAYA RIVER, LA.

area. The dredged material is contributing to an overall delta formation process well underway in the bay.

The project area straddles the alternately exposed and inundated oyster shell reefs at Point au Fer. As this may be considered land, a further marsh creation situation could be land extension.

Minimum and maximum tides north of the project area, in the general area of Morgan City, have been recorded at -2.0 and +9.0 ft mlg (mean low Gulf), respectively. Lower minima and higher maxima have probably been experienced in the project area during major hurricanes. Tidal ebb is generally to the southwest by south nearly parallel to the lower Atchafalaya Channel (New Orleans District 1974b).

Average water depth within the project area is less than 10.0 ft, frequently not over 5.0 to 7.0 ft mhw, with many shallower areas along the oyster shell reefs and on the bay and Gulf of Mexico sides of Point au Fer.

4.3.2 Judgment of Desirability

4.3.2.1 Institutional Characteristics

Several Louisiana State agencies are concerned with estuarine areas:

State Department of Conservation
Wild Life and Fisheries Commission
Office of State Planning
Louisiana Coastal Commission
Louisiana Advisory Commission on Coastal and Marine Resources.

The Louisiana Coastal Commission serves as the overall policy-making body, while the Office of State Planning conducts an overall planning program.

Ownership of Louisiana estuarine areas by Federal, State, and private concerns is not well defined.

4.3.2.2 Benefits and Costs

Within the project area, marsh creation would contribute to a natural process of delta formation which is already well underway in Atchafalaya Bay. In addition, it would contribute to seminatural barrier island formation. Distribution of dredged material for marsh-creation purposes should be limited to areas of relatively low productivity. Parts of the Point au Fer shell reef are examples of the kinds of areas which might, if they are productive shellfishery areas, be avoided to reduce long-term costs.

4.3.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following Louisiana citizens' groups:

Louisiana Wildlife Federation

Louisiana Association of Conservation Districts

Louisiana Audubon Society.

4.4 Galveston Bay, Texas; Galveston District

The Galveston Bay Project Area (Figure 66) is represented by portions of several project sections. The project area is located in the vicinity of Galveston, Pelican Island, and Port Bolivar. The

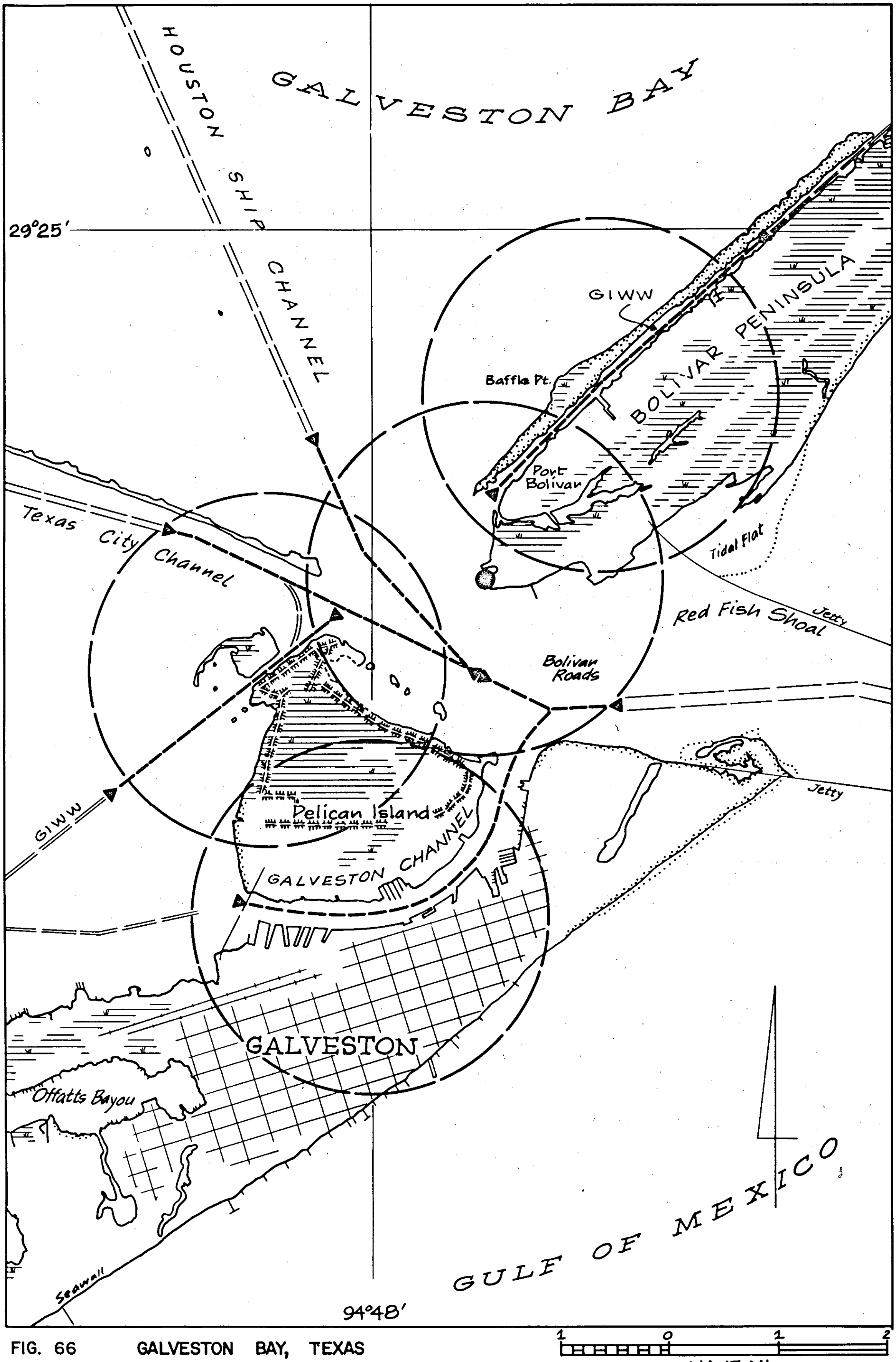

FIG. 66 GALVESTON BAY, TEXAS

channel dimensions of the project sections of the project area are as follows: Galveston Channel-Bolivar Roads channels are 36 ft deep and 1,200 ft wide for the former, and 40 ft deep and 800 ft wide for the latter; Gulf Intracoastal Waterway (GIWW) sections are 12 ft deep and 125 ft wide; channel to Port Bolivar is 30 ft deep and 200 ft wide; Houston Ship Channel to Redfish Shoal is 40 ft deep and 400 ft wide; and Texas City Channel is 40 ft deep and 400 ft wide.

The Galveston Bay Project annually generates a total of approximately 2,835,000 cu yd of sand, silt, and clay with frequencies ranging from 24 to 120 months. The project sections, their total cubic yardage, the percentage cubic yardage contributed to the project area, and frequency are as follows: Galveston Channel-Bolivar Roads Channel, 2,000,000 cu yd (100 percent), 24 months; GIWW from Port Arthur to Port Bolivar, 1,400,000 cu yd (10 percent), 24 to 60 months; GIWW from Texas City Channel to North Deer Island, 500,000 cu yd (100 percent), 24 months; Houston Ship Channel to Redfish Shoal, 100,000 cu yd (20 percent), 120 months; and Texas City Channel, 1,000,000 cu yd (50 percent), 24 months. Disposal is indicated as mainly overboard.

The mean tidal range of the project area is 1.4 ft. The datum plane is msl.

4.4.1 Dredged Material Receiving Site Description

4.4.1.1 Dredged Material Characteristics

Elutriate testing indicates volatile solids are 1.56 times above background levels in waters of the Bolivar Roads section of the project area. High volatile solids content of sediments are not thought to necessarily represent pollution status. Additional samples from numerous stations in the Galveston Channel section (Galveston District 1973) show pollutants in excess of all EPA standards except those for oil and grease.

Material to be dredged consists of sand in areas nearest the inlet, silty and sandy clay in the Entrance Channel, and probably clayey sand to sand in the remaining portions of Galveston Channel (Galveston District 1973).

4.4.1.2 Marsh-Creation Situations

The following marsh-creation situations may occur within the project area: land extension from protective barriers, as on the lee side of Bolivar Peninsula and Pelican Island; open water in Galveston Bay; land extension or island creation just within the inlet, as off the southwestern end of Bolivar Peninsula north of the ferry slip; open water paralleling channels; and several combinations of the above situations.

The tidal ranges are from 1.0 ft at the Texas City Channel to 1.4 ft at the Galveston Channel to Bolivar Roads. Tidal cycles are mostly semi-diurnal, but within Galveston Bay diurnal tides are recorded (Galveston District 1973).

Current velocities range from 4.0 fps on flood tides and 4.5 fps on ebb tide. Velocities are less in Galveston Bay proper (Galveston District 1973).

The Galveston Bay Project Area is a mixture of natural habitat and urban development. Galveston at the northeast end of Galveston Island is the largest urban center. All terrestrial features occur on barrier island or peninsula complex. Where development has not removed the natural habitats, typical Gulf coast dune-marsh biota (or ridge-slough) and topography persist. Waters of Galveston Bay are usually less than 20 ft msl in depth and contain scattered natural islands and islands of dredged material. Pelican Island is the largest dredged material disposal island in the project area.

Dredged material disposal has been largely upland in recent years; Pelican Island and Galveston have received the most volumes (Galveston District 1973). Seawolf Park, a municipal park, is located at the eastern tip off Pelican Island

4.4.2 Judgment of Desirability

4.4.2.1 Institutional Characteristics

The following Texas State agencies are concerned with estuarine areas:

Parks and Wildlife Department
General Land Office
Water Quality Board
Inter-agency Natural Resource Council.

A general coastal plan for Texas coastal areas is the responsibility of the Inter-agency Natural Resource Council. The Parks and Wildlife Department manages estuarine areas by use of a permit system. Water quality in estuarine areas is regulated by the Water Quality Board.

Texas owns estuarine areas below mhw, though such areas are not clearly defined.

Local cooperation is required for use of disposal areas in all segments except for the Port Bolivar ferry slip where there are no stated requirements.

4.4.2.2 Benefits and Costs

Considering the pollution status of much of the sediment in the project area, placement of dredged material in aquatic habitat could contribute to water-quality degradation. As it becomes necessary to expand Pelican Island, particularly to the west, marsh creation may be an extremely beneficial alternative for disposal if water quality improves in the future.

4.4.2.3 Public Attitudes

Biota, such as fin and shellfish, are dependent upon estuarine habitats and are harvested in commercial quantities. Sport fishing is also of economic importance. Galveston is one of the larger dry-cargo ports in the United States (Galveston District 1973).

The following Texas citizens' groups may represent public attitudes concerning estuarine land use:

Sportsmen's Clubs of Texas, Inc.
The Nature Conservancy
Texas Conservation Council
Texas Council for Wildlife Protection.

4.5 New Orleans Harbor, Louisiana; New Orleans District

The New Orleans Harbor Project Area (Figure 67) includes a section of the Mississippi River-Baton Rouge to the Gulf of Mexico project at New Orleans Harbor. The channel, immediately south of the city of New Orleans, is 36 ft in depth and 500 ft in width.

The New Orleans Harbor Project Area annually generates 2,200,000 cu yd of sand and silt with a frequency of 12 months. Disposal is indicated as overboard.

The mean tidal range at the project area is 0.8 ft. The datum plane is msl.

4.5.1 Dredged Material Receiving Site Description

4.5.1.1 Dredged Material Characteristics

Sediment in the New Orleans Harbor Project Area is not polluted according to the inventory. Sediment deposited from bedload and suspended load is largely silt and clay, although fine sand is common. Trash, roots, stumps, and logs are also present (New Orleans District 1973a).

4.5.1.2 Marsh-Creation Situations

Marsh-creation situations are limited to the Mississippi River channel.

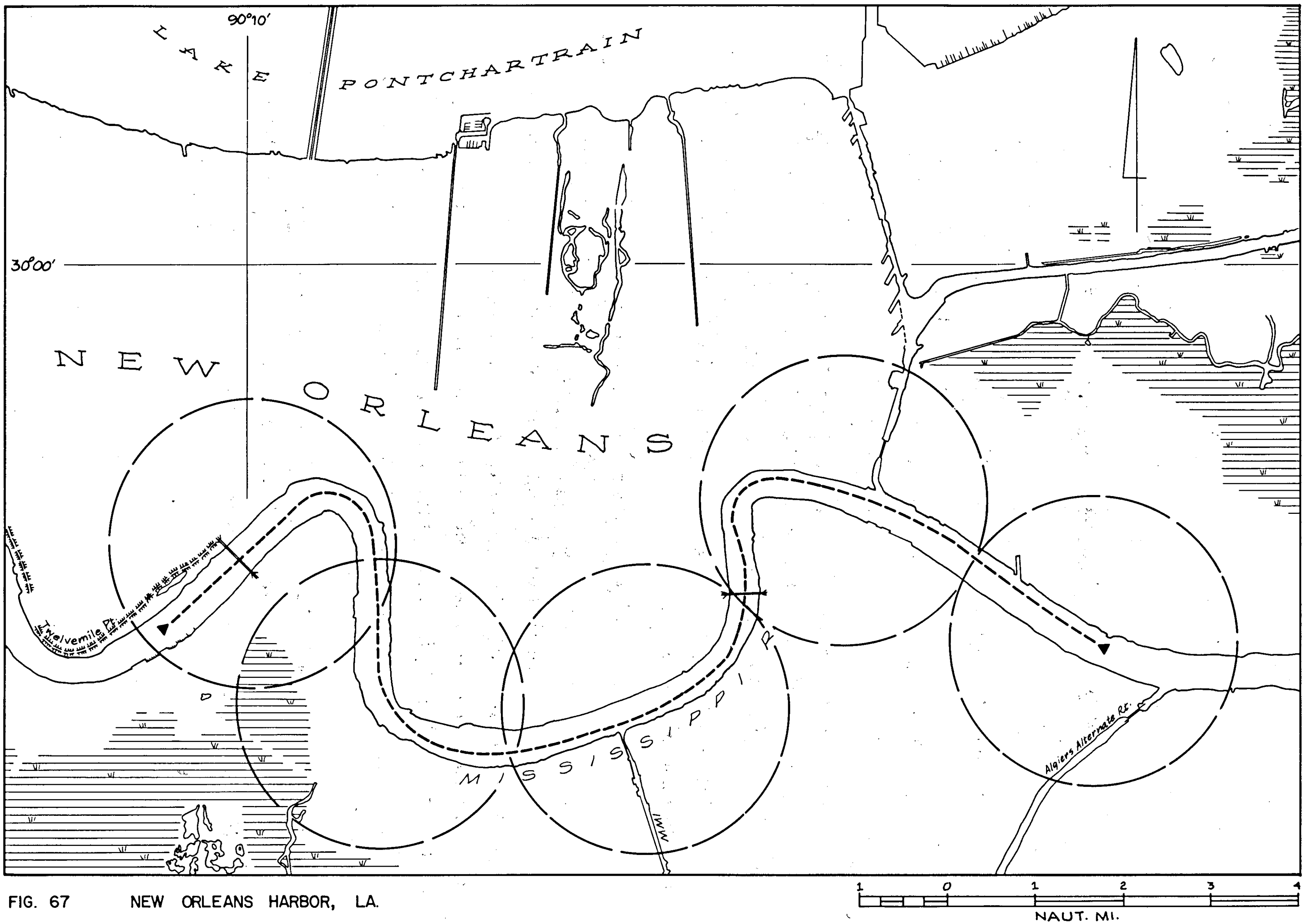

FIG. 67 NEW ORLEANS HARBOR, LA.

The river passes through an urban setting and through scattered marshlands that occur at the southwest and northeast sections of the project area.

The river itself is the major disposal area. Material is transported via floating pipeline and deposited below the -50-ft-mlg contour line downriver of the dredging. There is no buildup of material as a result of this method of disposal (New Orleans District 1973a).

Lunar tides and their deviations are similar to those in lower portions of the river (South and Southwest Pass Project Area, 4.2). Additional tide information shows a minimum recorded tide of -1.60 ft msl and a maximum of +21.27 ft msl (New Orleans District 1973a).

4.5.2 Judgment of Desirability

4.5.2.1 Institutional Characteristics

Several Louisiana State agencies are concerned with estuarine areas:

- State Department of Conservation
- Wild Life and Fisheries Commission
- Louisiana Coastal Commission
- Louisiana Advisory Commission on Coastal and Marine Resources.

The Louisiana Coastal Commission serves as the overall policy-making body, while the Office of State Planning conducts an overall planning program.

Ownership of estuarine areas by Federal, State, and private concerns is not well defined.

There are no requirements for local cooperation in disposal of dredged material.

4.5.2.2 Benefits and Costs

There would appear to be only marginal long-term benefits of marsh creation in the New Orleans Harbor Project Area.

4.5.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following Louisiana citizens' groups:

Louisiana Wildlife Federation

Louisiana Association of Conservation Districts

Louisiana Audubon Society.

4.6 Terrebonne Bay, Louisiana; New Orleans District

The Terrebonne Bay Project Area (Figure 68) is represented by two sections of the Houma Navigation Channel: Terrebonne Bay and Cat Island Pass. The project area location is south of Houma, Louisiana, with the channel beginning just southeast of Bayou Caillou and extending for approximately 15 miles into the Gulf of Mexico. The dimensions of the channel are 15 ft in depth and 150 ft in width.

The Terrebonne Bay Project Area annually generates 1,700,000 cu yd of silt and sand with a frequency of 12 months. Disposal is indicated as overboard.

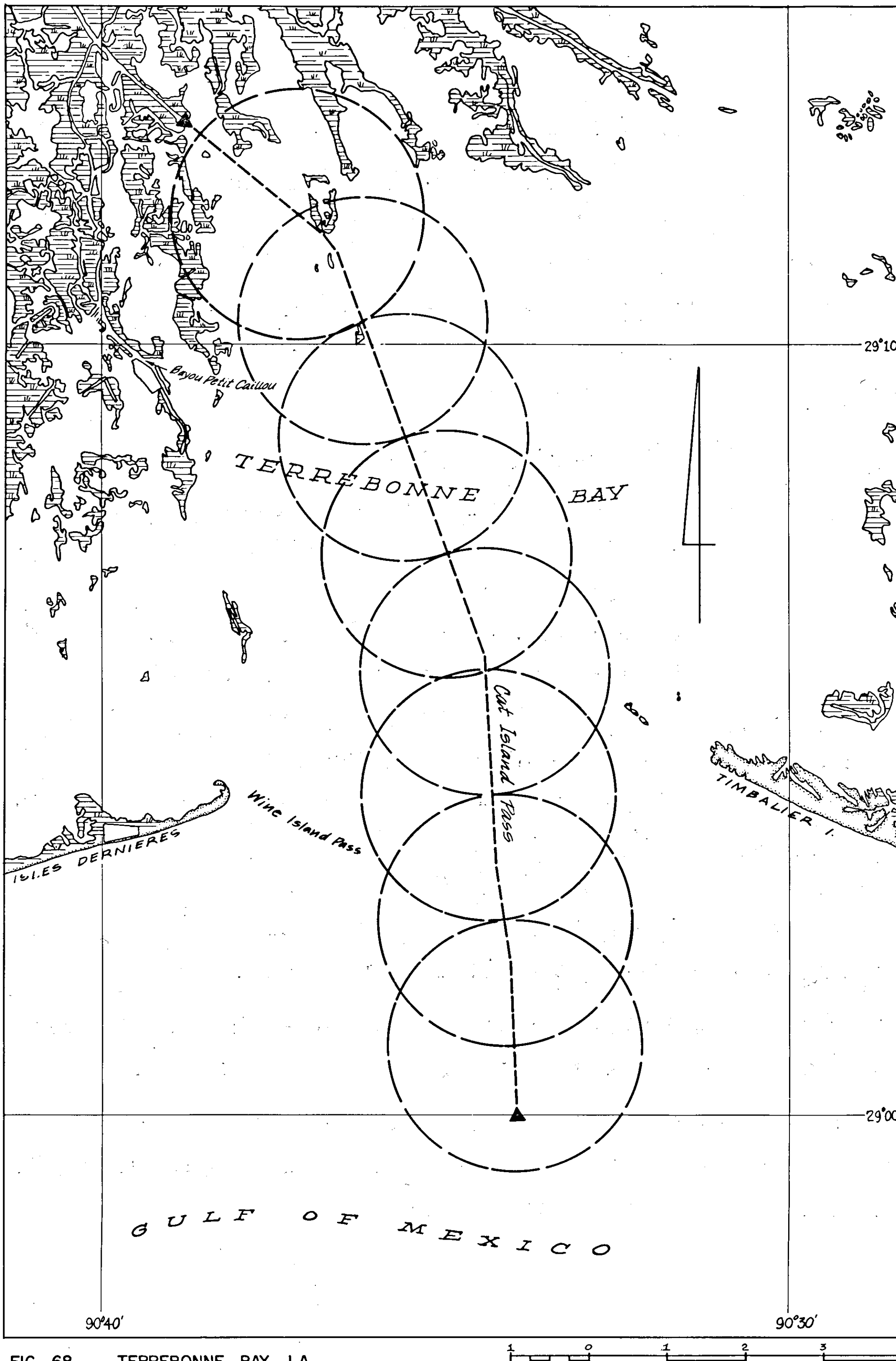

FIG. 68 TERREBONNE BAY, LA.

The mean tidal range for the project area is 0.8 ft. The datum plane is msl.

4.6.1 Dredged Material Receiving Site Description

4.6.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

4.6.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

4.6.2 Judgment of Desirability

4.6.2.1 Institutional Characteristics

The following Louisiana State agencies are concerned with estuarine areas:

State Department of Conservation
Wildlife and Fisheries Commission
Office of State Planning
Louisiana Coastal Commission
Louisiana Advisory Commission on Coastal and Marine Resources.

The Louisiana Coastal Commission serves as the overall policy-making body, while the Office of State Planning conducts an overall planning program.

Ownership of estuarine areas by Federal, State, and private concerns is not well defined.

4.6.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

4.6.2.3 Public Attitudes

Public attitudes concerning estuarine land use may be represented by the following Louisiana citizens groups:

Louisiana Wildlife Federation

Louisiana Association of Conservation Districts

Louisiana Audubon Society.

4.7 Sabine-Neches Canal, Texas; Galveston District

The Sabine-Neches Canal Project Area (Figure 69) includes sections of projects in the vicinity of Port Arthur, Texas, and Sabine Lake: Sabine-Neches Canal and Sabine-Neches Canal from Sabine River to Neches River. The canal dimensions of the former project are 40 ft deep and 400 ft wide and the canal dimensions of the latter project are 30 ft deep and 200 ft wide.

The project area annually generates a total of approximately 1,250,000 cu yd of sand and silt (250,000 cu yd or 25 percent is contributed from the Sabine-Neches Canal total of 1,000,000 cu yd). The frequency is 24 months and disposal is indicated as mainly confined.

The mean tidal range at the project area is 1.0 ft. The datum plane is msl.

4.7.1 Dredged Material Receiving Site Description

4.7.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

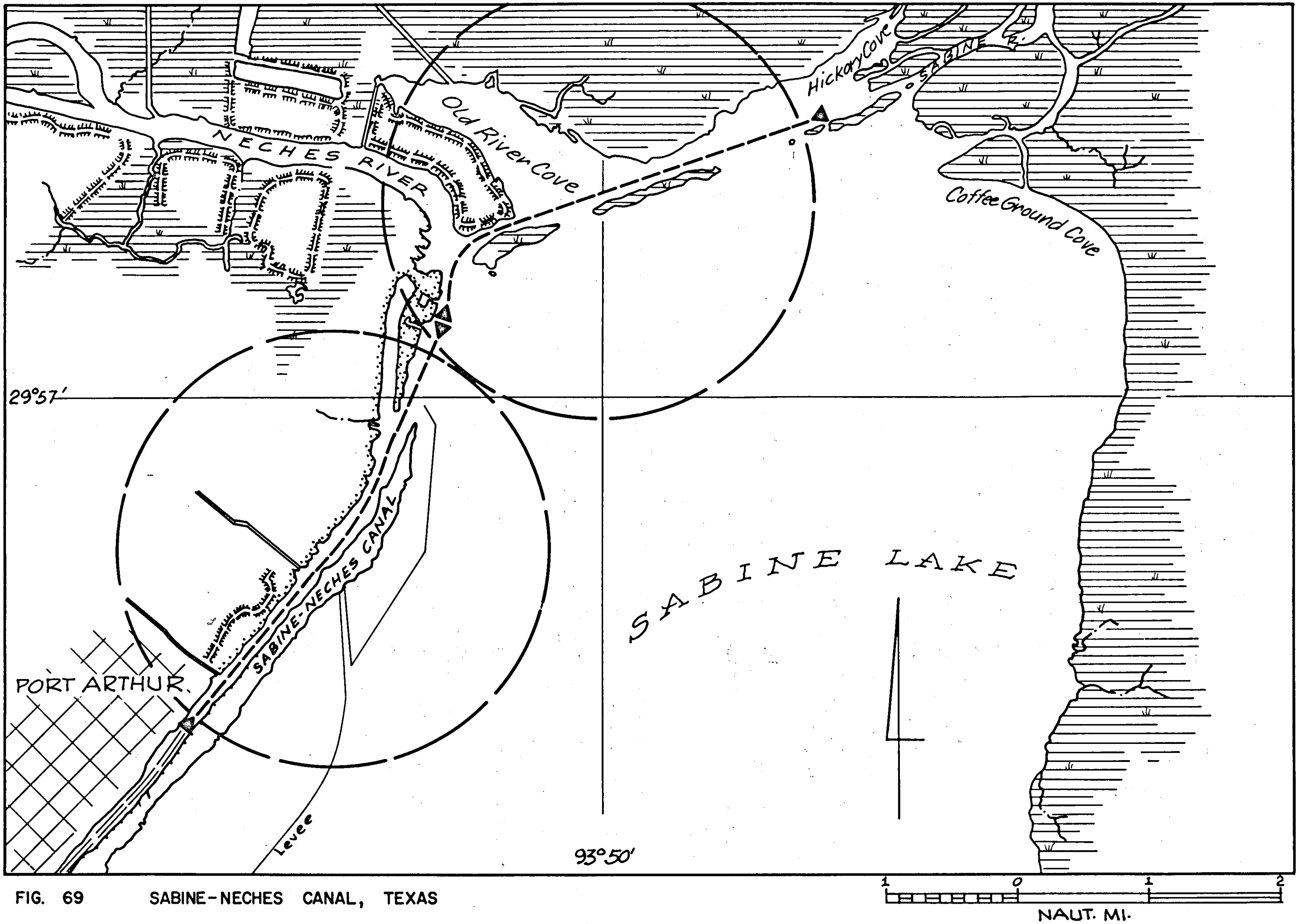

FIG. 69 SABINE-NECHES CANAL, TEXAS

4.7.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

4.7.2 Judgment of Desirability

4.7.2.1 Institutional Characteristics

The following Texas State agencies are concerned with estuarine areas:

Parks and Wildlife Department
General Land Office
Water Quality Board
Inter-agency Natural Resources Council.

A general coastal plan for Texas coastal areas is the responsibility of the Inter-agency Natural Resources Council. The Parks and Wildlife Department manages estuarine areas by use of a permit system. Water quality in estuarine areas is regulated by the Water Quality Board.

4.7.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

4.7.2.3 Public Attitudes

The following Texas citizens' groups may represent public attitudes concerning estuarine land use:

Sportsmen's Clubs of Texas, Inc.
The Nature Conservancy
Texas Conservation Council
Texas Council for Wildlife Protection.

4.8 Pascagoula Harbor, Mississippi; Mobile District

The Pascagoula Harbor Project Area (Figure 70) is represented by two sections of the Pascagoula Harbor project: a portion of the Mississippi Sound channel and the Pascagoula River channel. The project area is located to the west and south of Pascagoula, Mississippi. The sound channel is 38 ft deep and 350 ft wide and the river channel 22 ft deep and 150 ft wide.

The Pascagoula Harbor Project Area annually generates a total of approximately 1,152,000 cu yd of mud and silt (752,000 cu yd or approximately 20 percent is contributed from the sound channel total of 3,760,000 cu yd) with a frequency of 12 months.

The mean tidal range of the project area is 1.5 ft. The datum plane is msl.

4.8.1 Dredged Material Receiving Site Description

4.8.1.1 Dredged Material Characteristics

Sediment in the Pascagoula Harbor Project Area is polluted in excess of EPA standards. All parameters are exceeded except that for lead. The average annual rate of shoaling in the main ship channel, just north of the project area, is 3.0 ft (Mobile District 1973).

4.8.1.2 Marsh-Creation Situations

The following situations may exist for marsh creation: open water paralleling the channel and land extension from existing marsh and uplands, particularly the disposal area between the Pascagoula and the

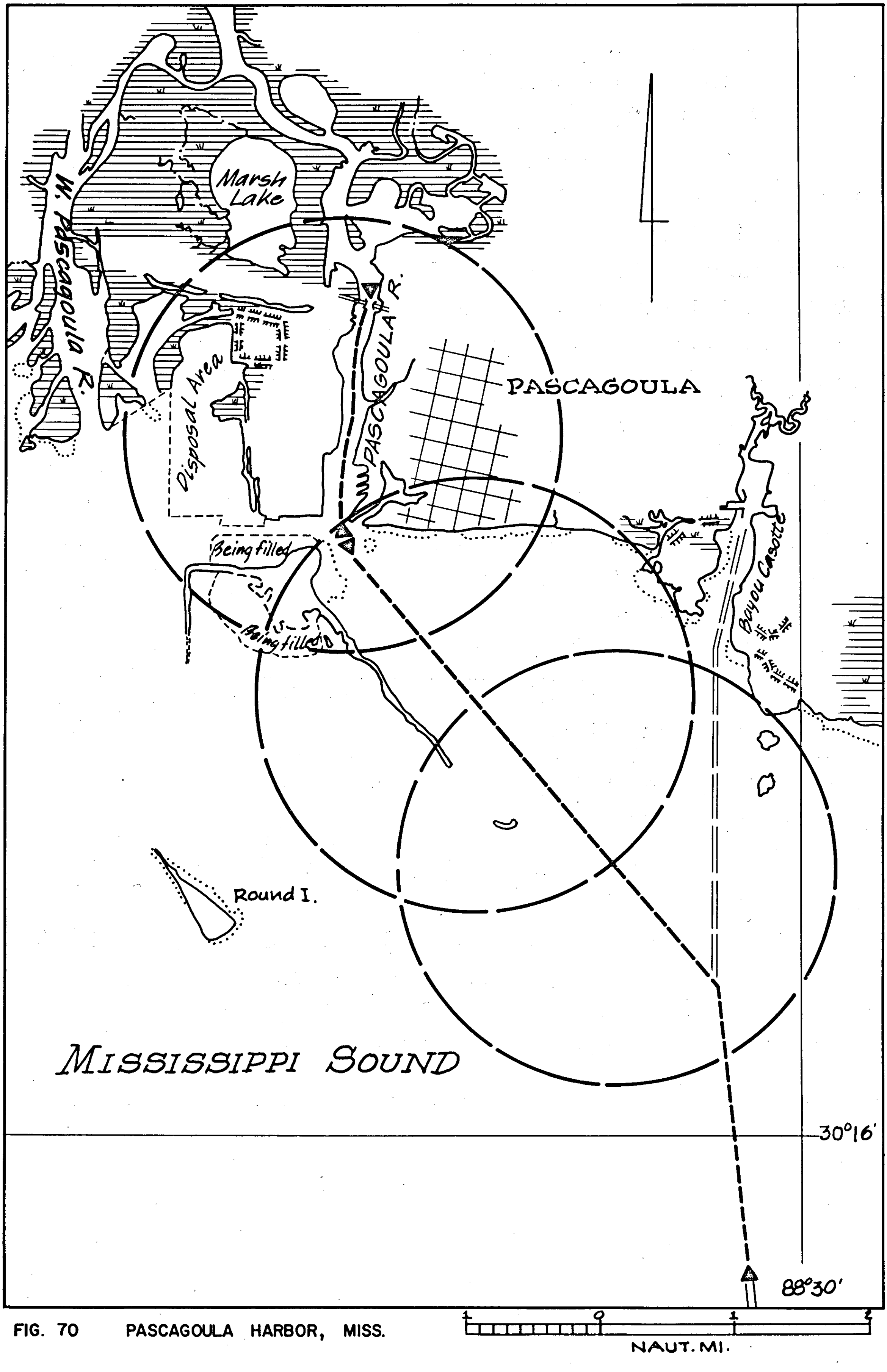

FIG. 70 PASCAGOULA HARBOR, MISS.

West Pascagoula Rivers, and the island southwest of the mouth of Pascagoula River.

Longshore currents in Mississippi Sound produce a westward littoral drift. Two islands just to the south of the general project area are migrating west at an annual rate of 42 ft. Water depths are less than 20 ft. At Pascagoula, mean tide level is 0.8 ft above mlw (1.6 ft); extreme low water is -2.5 ft mlw. Hurricane tides of 8.5 ft have been recorded. Water flow from the mouth of the Pascagoula River averages about 15,000 cu ft per second (Mobile District 1973).

Marshes composed largely of black rush occur in the project area, but these are not extensive. Other marsh and aquatic estuarine organisms are those typical of the Gulf coast. The major urban center is Pascagoula.

Disposal areas are located near the mouth of the Pascagoula River.

4.8.2 Judgment of Desirability

4.8.2.1 Institutional Characteristics

The following Mississippi State agencies are concerned with estuarine areas:

Air and Water Pollution Control Commission
Game and Fish Commission
Gulf Coast Research Laboratory
State Board of Water Commissioners.

Lands in estuarine areas, owned by State as well as private interests, are not well defined by tide mark.

Local cooperation is required for use of disposal areas.

4.8.2.2 Benefits and Costs

Long-term benefits may be gained from marsh creation, particularly in respect to shellfish harvesting if pollution levels are lowered in the future. There are existing dredged material disposal areas in open water, though some sections are diked.

4.8.2.3 Public Attitudes

Substantial commercial and sports fisheries occur, but shellfisheries are closed due to pollution (Mobile District 1973).

The Mississippi Wildlife Federation is the major citizens' group expressing concern in regards to estuarine land use.

4.9 Matagorda Channel, Texas; Galveston District

The Matagorda Channel Project Area (Figure 71) is represented by two projects in Matagorda Bay, Texas: a section of the Matagorda Ship Channel and a portion of the Gulf Intracoastal Waterway (GIWW) from Matagorda Bay to San Antonio Bay. The Matagorda Ship Channel is 36 ft deep and 200 to 300 ft wide and the GIWW section is 12 ft deep and 125 ft wide. The general location of the project area is between Port O'Connor and Matagorda Peninsula.

The project area annually generates a total of approximately 1,110,000 cu yd of silt and sand. The project sections, their total cubic yardage, the

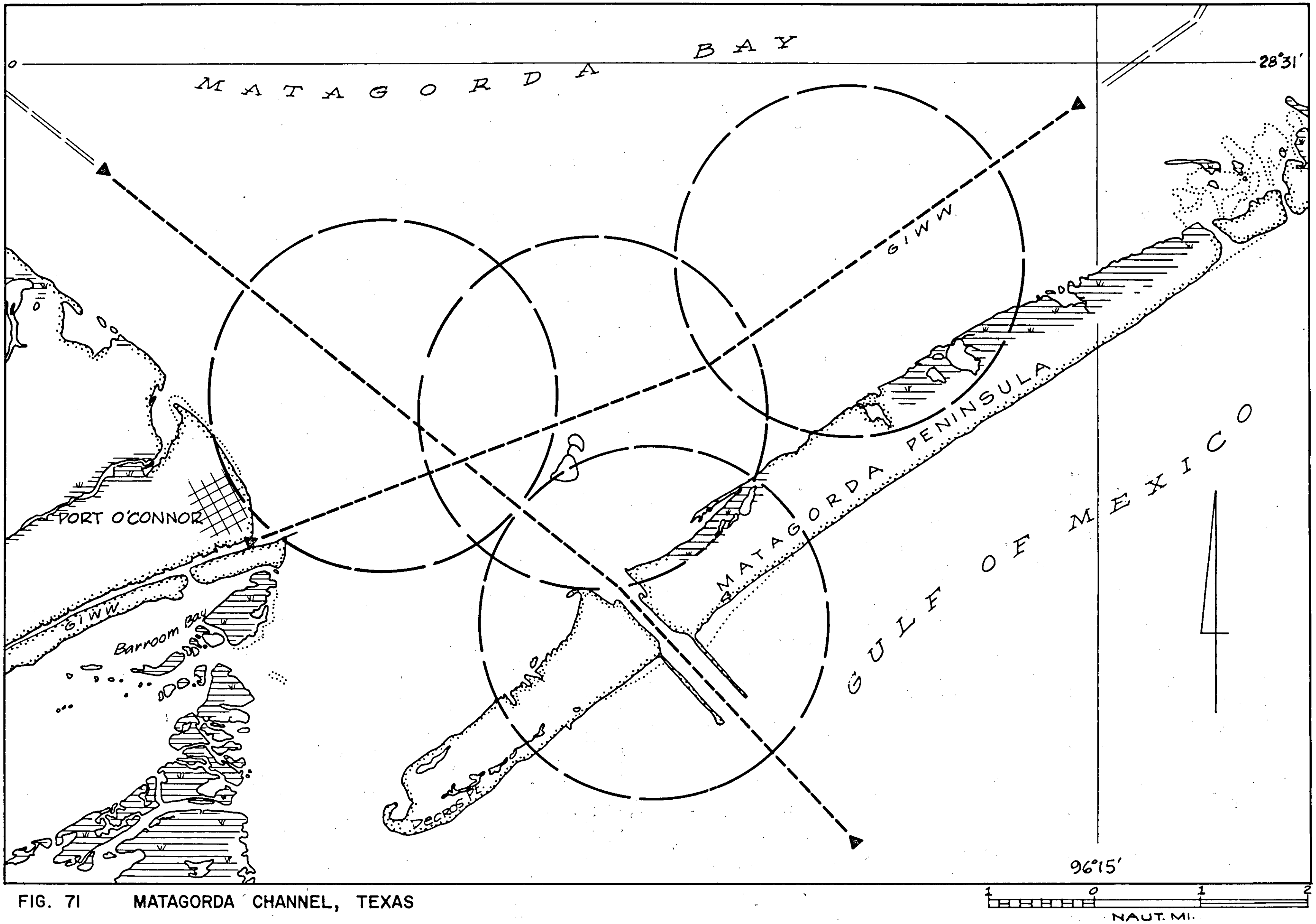

FIG. 71 MATAGORDA CHANNEL, TEXAS

percentage contributed to the project area, and their frequency are as follows: Matagorda Ship Channel, 3,600,000 cu yd (30 percent), and 12 to 120 months; and GIWW from Matagorda Bay to San Antonio Bay, 600,000 cu yd (5 percent), and 30 months. Disposal is indicated as mainly open-water disposal.

The mean tidal range at the project area is approximately 1.0 ft. The datum plane is msl.

4.9.1 Dredged Material Receiving Site Description

4.9.1.1 Dredged Material Characteristics

Sediment within the project area is not polluted beyond standards established by EPA (Galveston District 1971 and 1974). The most abundant sediment is sand.

4.9.1.2 Marsh-Creation Situations

The following situations may exist for marsh creation within the project area: open water behind Matagorda Peninsula in the Matagorda Bay; marsh extension behind Matagorda Peninsula; marsh extension off Matagorda Peninsula and north of Port O'Connor; open water paralleling channels; and in open water of the Gulf of Mexico.

Creation of marsh in open waters of the Gulf would probably require the additional construction of an artificial barrier island complex.

Sections of the Matagorda Ship Channel and the GIWW have tidal regimes ranging from mostly diurnal to almost diurnal. Tidal range is 0.7 ft in both areas

(Galveston District 1974). Water depths in undredged portions of the bay are usually less than 15 ft mlw; while those in the Gulf increase in depth to greater than 20 ft mlw.

The only urban center in the project area is Port O'Connor. The remainder of the land is largely uninhabited. Coastal dunes and marshes typical of the estuarine complex of the western Gulf coast dominate the landscape. Islands of dredged material or shoals paralleling the ship channel have been created by overboarded dredged material.

4.9.2 Judgment of Desirability

4.9.2.1 Institutional Characteristics

The following Texas State agencies are concerned with estuarine areas:

Inter-agency Natural Resource Council
Texas Parks and Wildlife Department
Texas General Land Office
Texas Water Quality Board.

A general coastal plan for Texas coastal areas is the responsibility of the Inter-agency Natural Resource Council. Texas Parks and Wildlife Department manages estuarine areas by use of a permit system. The water quality in estuarine areas is regulated by the Texas Water Quality Board.

The State owns estuarine areas to mhw, though such areas are not clearly defined.

Local cooperation is required for disposal areas only.

4.9.2.2 Benefits and Costs

Dredged material has already been placed along the Matagorda Ship Channel. This could provide an existing base for either marsh extension or marsh creation in open water. The low pollution status of the sediment and the predominance of sand would appear to support the long-term value of marsh creation in this project area.

4.9.2.3 Public Attitudes

Citizens' groups in Texas which may represent public attitudes regarding estuarine land use are:

Sportsmen's Clubs of Texas, Inc.
The Nature Conservancy
Texas Conservation Council
Texas Council for Wildlife Protection.

4.10 Mobile Harbor, Alabama; Mobile District

The Mobile Harbor Project Area (Figure 72) is represented by portions of several project sections which are in the vicinity of the southern area of Mobile Bay. The sections included in the project area are Mobile Harbor - southern reach of bay channel; two sections of the Gulf Intracoastal Water (GIWW); and Dauphin Island. The Mobile Harbor Bay Channel section consists of a channel 40 ft in depth and 400 ft in width. The GIWW sections, one continuing to the east and one continuing to the west, are 12 ft by 125 ft and 12 ft by 150 ft, respectively.

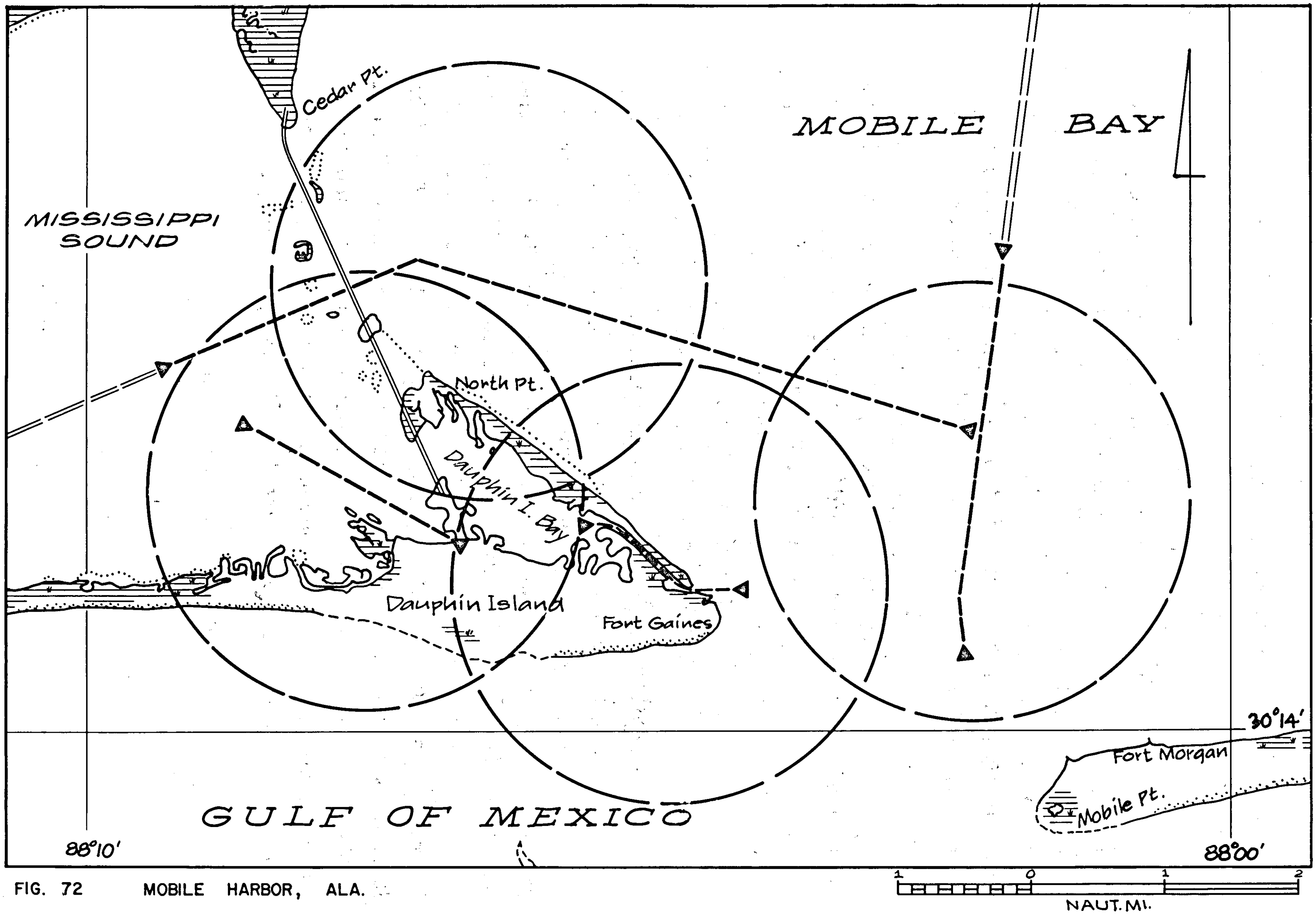

FIG. 72 MOBILE HARBOR, ALA.

The Mobile Harbor Project Area annually generates a total of approximately 914,300 cu yd of mud, sand, and silt with a frequency from 18 to 35 months. The project sections, their total cubic yardage, the percentage of cubic yardage they contribute to the project area, and their frequency are as follows: Mobile Harbor-Bay Channel, 5,700,000 cu yd (10 percent), and 18 months; GIWW from Pensacola Bay to Mobile Bay, 1,243,000 cu yd (10 percent), and 36 months; GIWW from Mobile Bay to Rigolets, 2,000,000 cu yd (10 percent), and 36 months; and Dauphin Island, 20,000 cu yd (100 percent), and 36 months. Disposal is indicated as mostly overboard.

The mean tidal range for the Mobile Harbor Project Area is 1.1 to 1.6 ft. The datum plane is msl.

4.10.1 Dredged Material Receiving Site Description

4.10.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

4.10.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

4.10.2 Judgment of Desirability

4.10.2.1 Institutional Characteristics

The following Alabama State agencies are concerned with estuarine areas:

Department of Conservation and Natural Resources

Division of Game and Fish

Division of Lands
Division of Marine Resources
Water Improvement Commission.

4.10.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

4.10.2.3 Public Attitudes

The following Alabama citizens' groups may represent public attitudes concerning estuarine land use:

Alabama Wildlife Federation
The Alabama Conservancy
Alabama Ornithological Society.

5.0 Pacific Geographical Region

The Pacific geographical region includes the Los Angeles, San Francisco, Sacramento, Portland, and Seattle Districts. The boundaries of the geographical region extend from the United States-Mexico border in the south to the United States-Canada border in the north. The coastal states included are California, Oregon, and Washington. Locations of the prime project areas are indicated in Figure 73.

No additional reconnaissance-scale information was made available in regards to the Suisun Channel Project Area (5.6) and the Quillayute River Project Area (5.10). For the remaining eight project areas, the values for average annual cubic yardage are reflective of information supplied by the respective Districts.

Due to the large scale of the project area maps for the Coos Bay Project Area (5.4) and the Quillayute River Project Area (5.10), the radii for effective dredged material disposal could not be placed on the respective figures. Therefore, all area within the figure can be considered for marsh-creation situations.

5.1 Grays Harbor, Washington; Seattle District

The Grays Harbor Project Area (Figure 74) is represented by two sections of the Grays Harbor project: Moon Island area and upstream of Moon Island to Cosmopolis. The project area is located approximately 14 miles north of Willapa Bay on the Pacific coast of Washington. The dimensions for the channel are 30 ft deep and 200 ft wide.

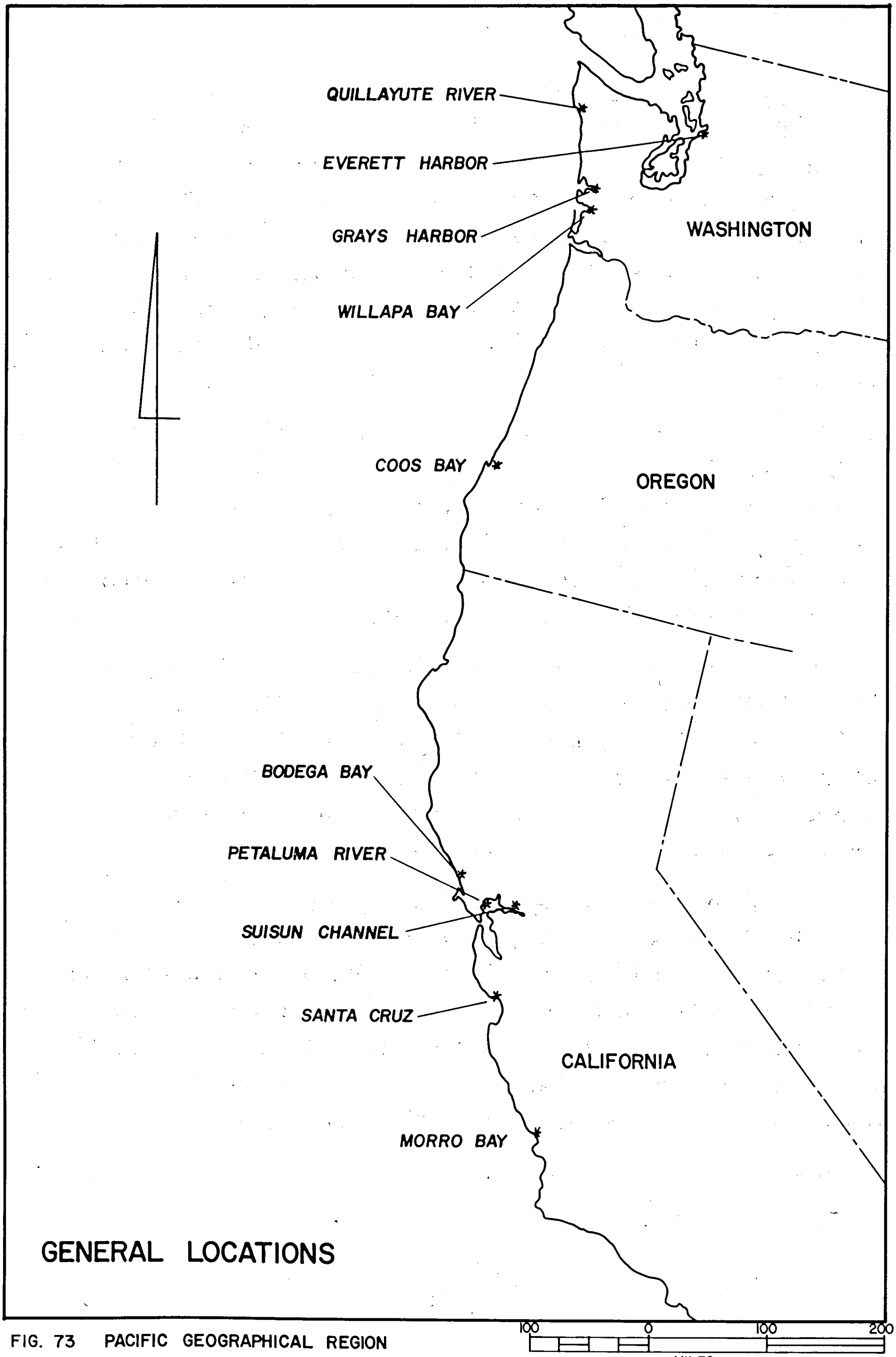

FIG. 73 PACIFIC GEOGRAPHICAL REGION

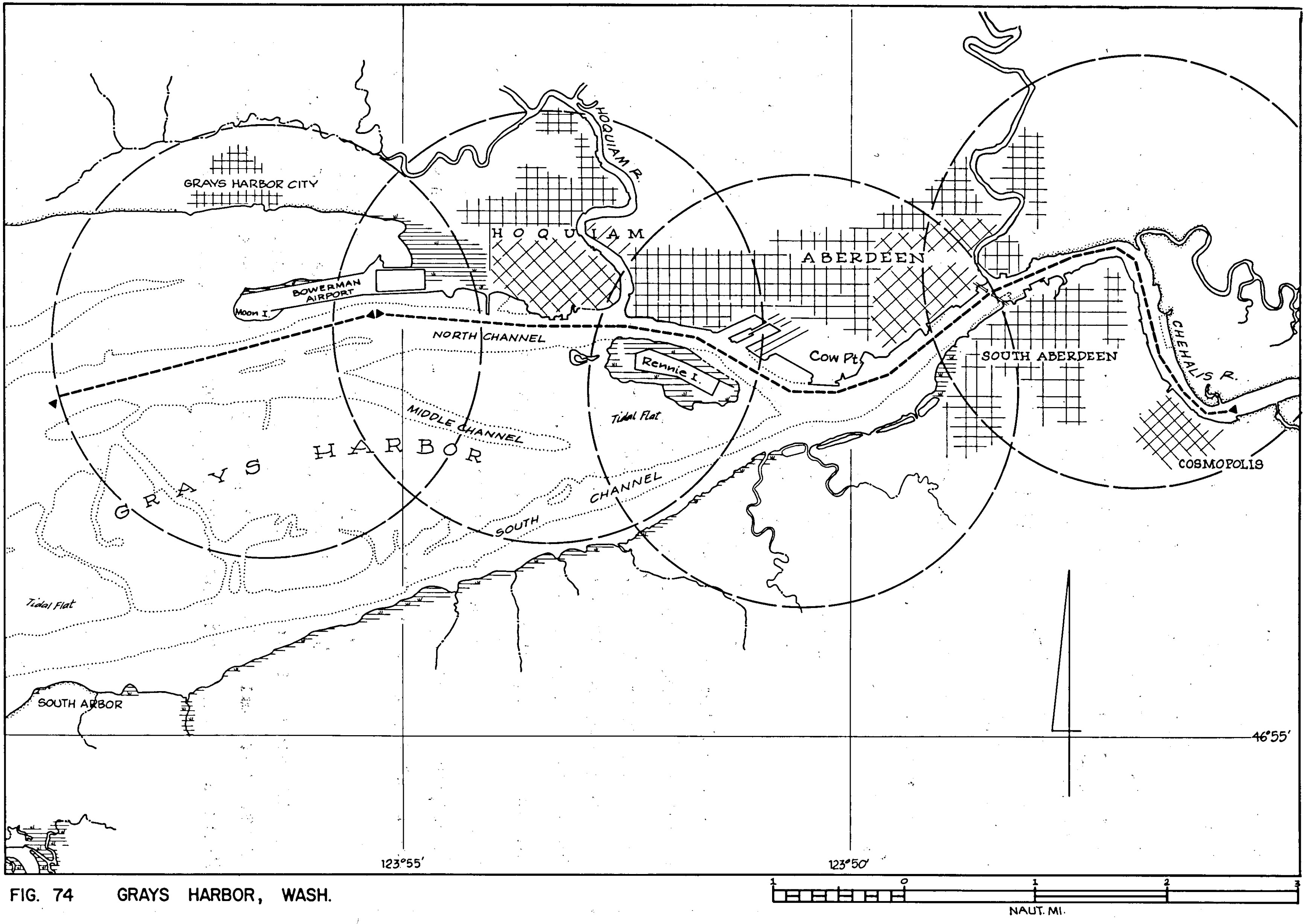

FIG. 74 GRAYS HARBOR, WASH.

The Grays Harbor Project Area annually generates a total of 800,000 cu yd of sand and silt with a frequency of 12 months. Annual cubic yardage and frequency for the sections are as follows: Moon Island area, 400,000 cu yd and 12 months; upstream of Moon Island to Cosmopolis, 400,000 cu yd and 12 months. Disposal is indicated as confined with the site having an undetermined life span.

The mean tidal range at the project area is 7.9 ft at Aberdeen. The datum plane is mean lower low water (mllw).

5.1.1 Dredged Material Receiving Site Description

5.1.1.1 Dredged Material Characteristics

The inventory has given a pollution status of not polluted (EPA standards) for sediment in the lower reaches of the Grays Harbor Project Area. The sediment of upper marshes (upstream of Moon Island to Cosmopolis) is polluted according to Seattle District (1972). Aquatic pollution is most strongly influenced by wood products industries located along Chehalis River.

Sand and silty sand sediment requiring dredging maintenance is generated from upstream as well as from oceanic sources.

5.1.1.2 Marsh-Creation Situations

The following situations may be available for marsh creation in the Grays Harbor Project Area: marsh extension from a large number of areas, such as Rennie Island and the small harbor area northeast of

Moon Island; open water paralleling existing channels (may be combined with marsh extension along the south shore of Chehalis River across from Cow Point); open water in shallow, nondredged portions of the harbor, as in the general area of the middle, north, and south channels; and land extension from any number of upland sites.

Tidal ranges in Grays Harbor at Aberdeen are as follows: mean range 7.9 ft mllw; diurnal range 10.1 ft mllw; extreme range 17.8 ft mllw.

Marsh areas support grasses, sedges, and other plant species typical of the middle Pacific coast. In addition, several mollusk and other invertebrate species are found in marshes as constituents of benthic communities in subaqueous habitats. Eelgrass is the common constituent of aquatic grass beds (Wolfe 1973).

Urban centers, such as Grays Harbor City, Hoquiam, and Aberdeen, are located along the north shore, while South Aberdeen and Cosmopolis are the major towns along the south shore.

The major disposal area within the project area is located north and west of Moon Island near Grays Harbor City. This area has been in use for 30 years (Seattle District 1972). Continued use of this area may be curtailed by recently expressed environmental concerns.

5.1.2 Judgment of Desirability

5.1.2.1 Institutional Characteristics

Washington State agencies concerned with estuarine areas are:

Department of Ecology
State Conservation Commission
Department of Fisheries
Department of Game
Department of Natural Resources
State Parks and Recreation Commission.

The Department of Natural Resources controls ownership and leasing of tidal areas. Estuarine lands below ordinary high tide are owned by State as well as private interests.

Public agency and private individual participation has been solicited in planning for future dredged material disposal methods in Grays Harbor (Seattle District 1972).

Local cooperation is required for disposal areas.

5.1.2.2 Benefits and Costs

There could be long-term benefits of marsh creation in the form of game and fishery resources and estuarine recreation. Should the pollution status of the sediments be reduced, much of the long-term cost of marsh creation could be defrayed. Costs could also be reduced by placement of dredged material in less productive areas of the harbor, so as to reduce damage to existing resources.

5.1.2.3 Public Attitudes

The following Washington citizens' groups may represent public attitudes concerning estuarine land use:

Washington State Sportsmen's Council
The Mountaineers
The Nature Conservancy
Washington Environmental Council, Inc.

5.2 Willapa Bay, Washington; Seattle District

The Willapa Bay Project Area (Figure 75) is represented by one section of the Willapa Harbor project and is located approximately 14 miles south of Grays Harbor. The section consists of a channel 24 ft deep and 200 to 300 ft wide and is approximately seven miles in length.

The Willapa Bay Project Area annually generates 400,000 cu yd of sand and silt with a frequency of 24 months.

The mean tidal range just west of the project area is 6.8 ft at Bay Center and Tokeland. The datum plane is mllw.

5.2.1 Dredged Material Receiving Site Description

5.2.1.1 Dredged Material Characteristics

The inventory indicates sediment in Willapa River is polluted, but the Seattle District (1971) indicates only one EPA standard is exceeded - volatile solids. Silty sand is the major material which is dredged.

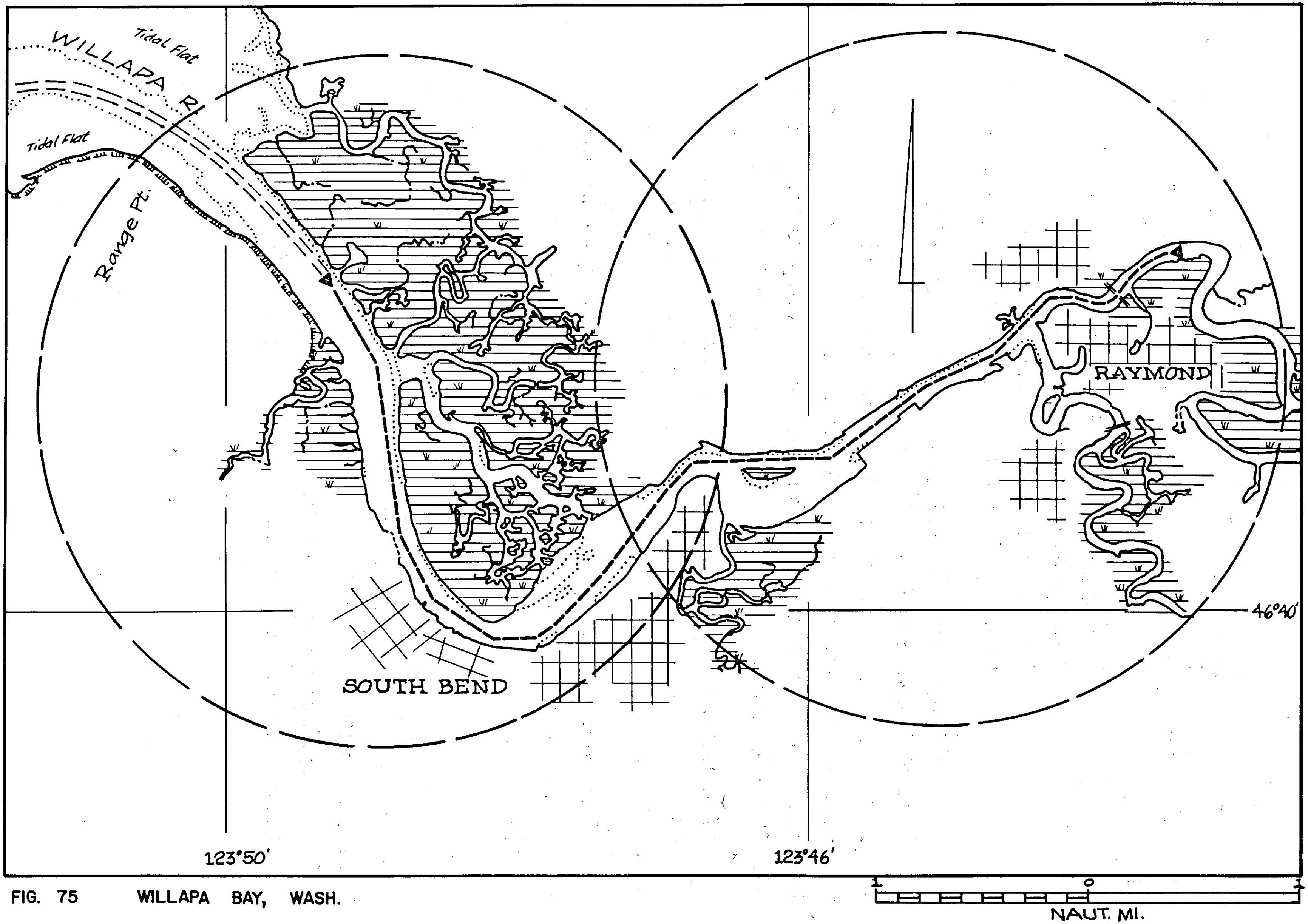

FIG. 75 WILLAPA BAY, WASH.

5.2.1.2 Marsh-Creation Situations

A few favorable marsh-creation situations may exist in the project area. Three situations are: paralleling the channel in Willapa River; estuarine creek tributary to Willapa River; and marsh extension, as in the widening of the river between Raymond and South Bend.

Brackish to fresh marsh conditions influence biota of the area, as clam and oyster distribution extends up the river only as far as the vicinity of Range Point (Seattle District 1971). Biota characteristic of brackish and fresh estuarine conditions in the northern Pacific coast are probably well exemplified. No major commercial fisheries are known to extend up the river as far as the project area. Waters passing through Willapa River are emptied into Willapa Bay, an area of prime fin and shellfish habitat (Seattle District 1971).

Six dredged material disposal areas are located within the project area. These areas vary from 15 to 150 acres and have useful lives of 10 to 40 years. They appear to be located in both upland and marshland areas. All are to be diked (Seattle District 1971).

Water depths within the project area are usually less than 10 ft mllw. Tides, if applicable, are unequal semi-diurnal.

Raymond and South Bend are the principal urban centers.

5.2.2 Judgment of Desirability

5.2.2.1 Institutional Characteristics

Washington State agencies concerned with estuarine areas are:

Department of Ecology
State Conservation Commission
Department of Fisheries
Department of Game
Department of Natural Resources
State Parks and Recreation Commission.

The Department of Natural Resources controls ownership and leasing of tidal areas. Estuarine lands below ordinary high tide are owned by state as well as private interests.

Local cooperation is required for use of disposal areas.

5.2.2.2 Benefits and Costs

Benefits which may be derived from marsh creation in brackish to freshwater situations are largely those of natural water purification and provision of wildlife habitat. Long-term costs of marsh creation could be reduced by emplacement of these communities.

5.2.2.3 Public Attitudes

The following Washington citizens' groups may represent public attitude concerning estuarine land use:

Washington State Sportsmen's Council
The Mountaineers
The Nature Conservancy
Washington Environmental Council, Inc.

5.3 Morro Bay, California; Los Angeles District

The Morro Bay Project Area (Figure 76) is represented by the Morro Bay project and is located midway between San Francisco and Los Angeles at Morro Rock. The channels range from 16 ft in depth and 350 ft in width, to 12 ft in depth and 150 ft in width.

The Morro Bay Project Area annually generates 350,000 cu yd of sand with a frequency of 36 months. Disposal is indicated as confined with the site having an indefinite life.

The mean diurnal tidal range at the project area is 5.4 ft while the extreme range is 8.5 ft mllw. The datum plane is mllw.

5.3.1 Dredged Material Receiving Site Description

5.3.1.1 Dredged Material Characteristics

Sediments requiring maintenance in the Morro Bay Project Area are not polluted, and no parameters exceed EPA standards (Los Angeles District 1973). Sediments consist largely of sand derived from eolian and eddy current erosion of unstabilized sands constituting submarine and subaerial portions of the spit west of Morro Bay.

5.3.1.2 Marsh-Creation Situations

Two situations for marsh creation may exist within the project area: marsh extension, as at the mouth of Chorro Creek over extensive tidal flats visible at mllw; and paralleling the channel on bottoms not exposed at mllw.

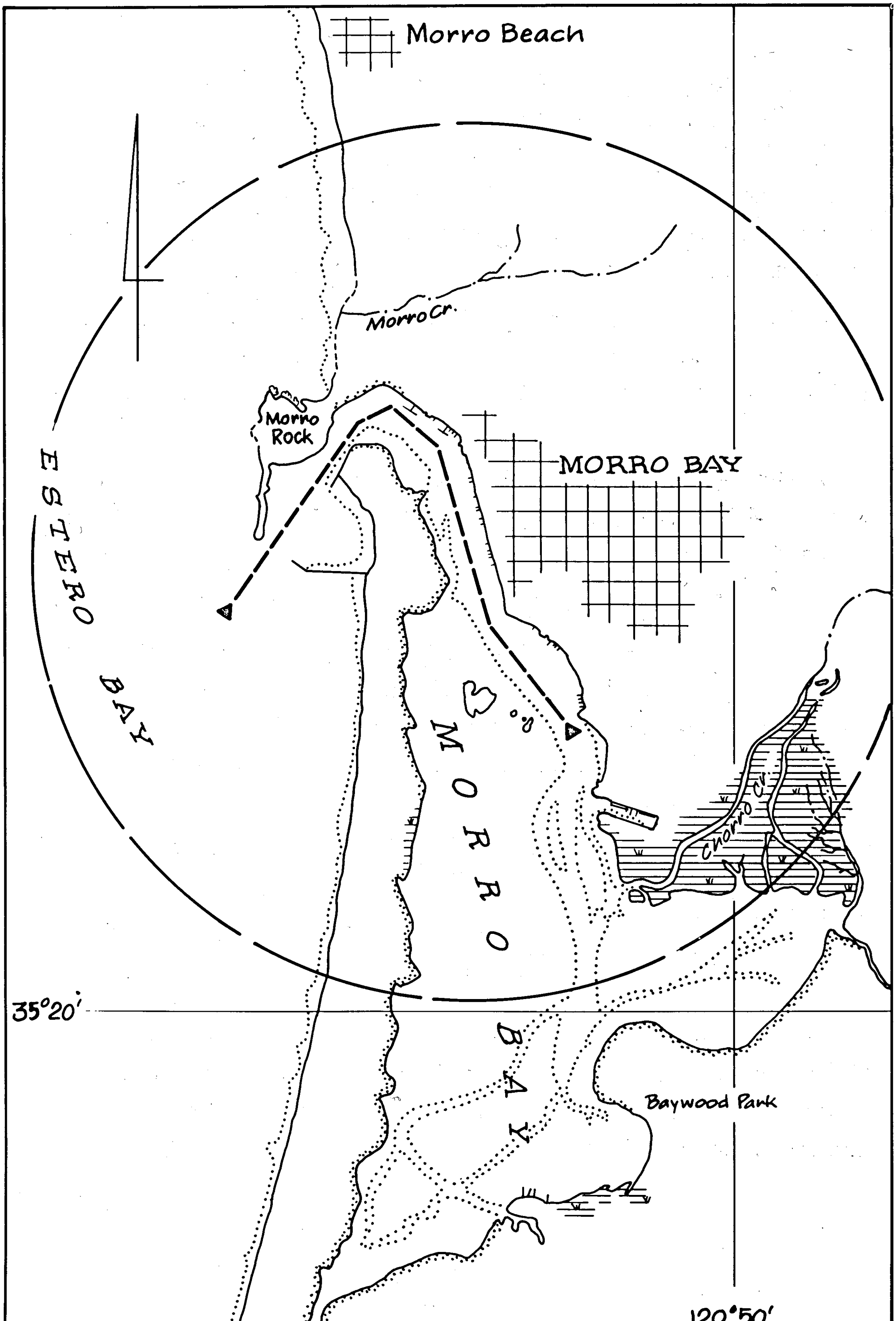

FIG. 76 MORRO BAY, CALIF.

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About three-fourths of Morro Bay is comprised of tidal flats at mllw. These exposed flats, along with adjacent marsh, support species characteristic of the southern Pacific coast. Six species of commercially important clams, as well as oysters, are harvested in the bay (958 acres leased by California State Department of Fish and Game). Salt marsh habitat also includes those species and is an important habitat for wildlife (Los Angeles District 1973). These areas afford important field education resources for regional colleges and universities (U. S. Department of the Interior 1971).

Morro Bay State Park is located just south of the terminus of the channel at the mouth of Chorro Creek in Morro Bay. The park includes much of the marsh around the mouth of Chorro Creek.

The town of Morro Bay is the major urban center. Most businesses other than those supplying general goods and services are heavily dependent upon the natural environment as it now exists (Los Angeles District 1973).

The major dredged material disposal area is about 0.5 miles southwest of the inlet in Estero Bay. Previously the sandspit separating Morro Bay from Estero Bay was used for disposal of dredged material, but it has become overloaded and is a significant contributor to sedimentation in the channel (Los Angeles District 1973).

5.3.2 Judgment of Desirability

5.3.2.1 Institutional Characteristics

California State agencies concerned with estuarine areas are:

The Resource Agency
- Department of Parks and Recreation
- Water Resources Control Board
- Wildlife Conservation Board
- Navigation and Ocean Development
- Fish and Game Commission
- Department of Fish and Game
- Department of Conservation
- Department of Water Resources

State Land Commission.

An Advisory Commission on Marine and Coastal Resources was created to develop a Comprehensive Ocean Area Plan. The State Land Commission controls state-owned land and has established a permit system for construction in tidelands.

Federal, State, local, and private concerns own land below the ordinary high tide mark. Ownership of Morro Bay is divided three ways: the city of Morro Bay owns the northern one-third of the bay; the State of California owns the middle third, including all of the sand spit south of the city-owned third; and the southern third is privately owned (Los Angeles District n.d.).

5.3.2.2 Benefits and Costs

The tidal flats and marshes within the project area are rich. It is doubtful that marsh creation would significantly enhance the net productivity of the presently desired natural goods and services supplied by the existing Morro Bay ecosystem.

5.3.2.3 Public Attitudes

Maritime recreation and tourism as well as commercial fishing supplied over $3,000,000 to local revenue in fiscal year 1970 (Los Angeles District 1973).

The following California citizens' groups may represent public attitudes concerning estuarine land use:

- California Wildlife Federation
- California Association of Resource Conservation Districts
- California Conservation Council
- California Tomorrow
- Council for Planning and Conservation
- California Division, Izaak Walton League of America, Inc.
- The Nature Conservancy
- Planning and Conservation League
- United New Conservationists.

5.4 Coos Bay, Oregon; Portland District

The Coos Bay Project Area (Figure 77) is represented by one section of the Coos Bay project: Mile 12-15. The project area is located in Coos Bay east of North Bend and the town of Coos Bay, Oregon. The channel is 30 ft deep, 650 ft wide, and approximately three miles long.

The Coos Bay Project Area annually generates 320,000 cu yd of silt with a frequency of 36 months. Disposal

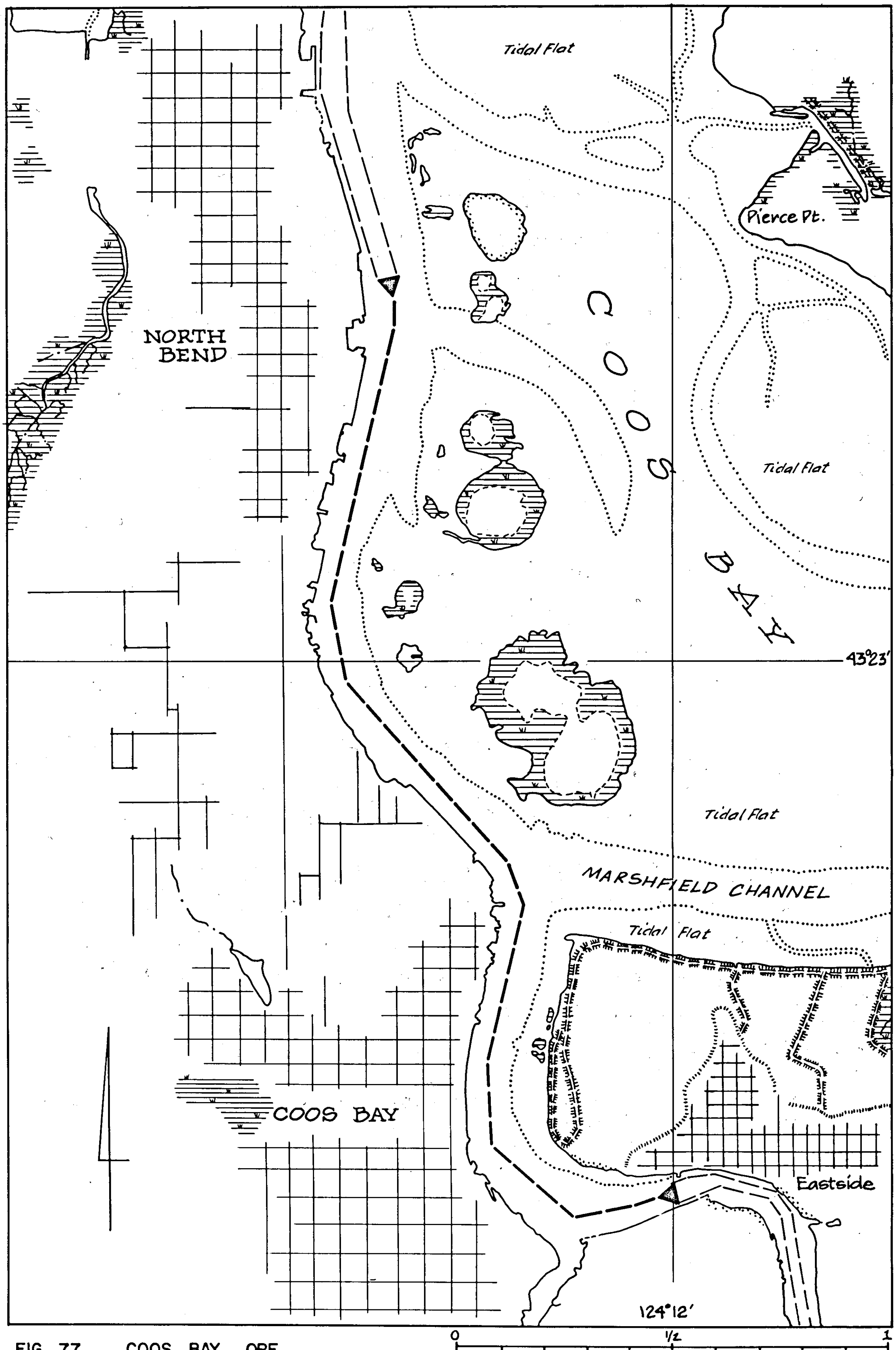

FIG. 77 COOS BAY, ORE.

is identified as confined with the site having a three-year life.

The mean of higher waters at the project area is 7.3 ft at Coos Bay. The datum plane is mllw.

5.4.1 Dredged Material Receiving Site Description

5.4.1.1 Dredged Material Characteristics

Sediment within the Coos Bay Project Area is polluted in excess of EPA standards as determined from samples taken by the Portland District (1972) during an experiment to determine the effects of hopper dredging on water quality and benthic fauna (Slotta et al. 1973).

Sediment from the above work was found to consist of about two-thirds silt-sized particles and one-third fine sand (Stevens, Thompson, and Runyan, Inc. 1972).

5.4.1.2 Marsh-Creation Situations

The following situations may be considered suitable for marsh creation: tidal flats presently consisting of mud and/or sand; marsh extension from existing marsh at the base of existing disposal areas; in open water away from channels, as in the bay east of the northern terminus of the project area channel; and in shallow estuarine creeks and rivers, such as Marshfield Channel.

The extreme tidal range experienced at Coos Bay is 7.3 ft. Water within the project area is shallow with depths usually less than 10 ft mllw.

Extensive tidal flats occur within the project area where habitat exists for shellfish and eelgrass. Below mllw, finfish nursery areas are fished for both commercial and recreational purposes, but shellfisheries are closed in most areas due to poor water quality (Gaumer et al. 1973). Marsh characteristic of the Pacific coast exists along the higher peripheries of the tidal flats.

The project area to the west of Coos Bay is urbanized.

Several dredged material disposal areas are located within Coos Bay on a major tidal flat. Certain areas between disposal sites are used for wet log storage.

5.4.2 Judgment of Desirability

5.4.2.1 Institutional Characteristics

The following Oregon State agencies are concerned about estuarine areas:

- Department of Environmental Quality
- Fish Commission
- State Wildlife Commission
- State Marine Board
- Water Resources Board.

The Office of Planning coordinates various aspects of marine environmental land use.

Federal, State, local, and private land ownership applies below the ordinary high tide mark.

Local cooperation is required for use of disposal areas only.

5.4.2.2 Benefits and Costs

The long-term benefits of conversion of presently rich tidal flats and creeks to marsh for disposal of polluted dredged material are probably outweighed by short-term costs. Even if dredged material were not polluted, there would probably be a net loss of estuarine resources.

5.4.2.3 Public Attitudes

Public attitudes regarding estuarine land use may be represented by the following Oregon citizens' groups:

Oregon Wildlife Federation

Oregon Environmental Council

Oregon Division, Izaak Walton League of America, Inc.

The Nature Conservancy

Oregon Student Public Interest Research Group.

5.5 Everett Harbor, Washington; Seattle District

The Everett Harbor Project Area (Figure 78) is represented by two sections of the Everett Harbor-Snohomish River project: deepwater to Station 331-50 and upstream of Station 331-50. The project area is located 12 miles north of Seattle, Washington, and east of Whidbey Island in Possession Sound. The channels range from 425 to 150 ft in width and 20 to 14 ft in depth.

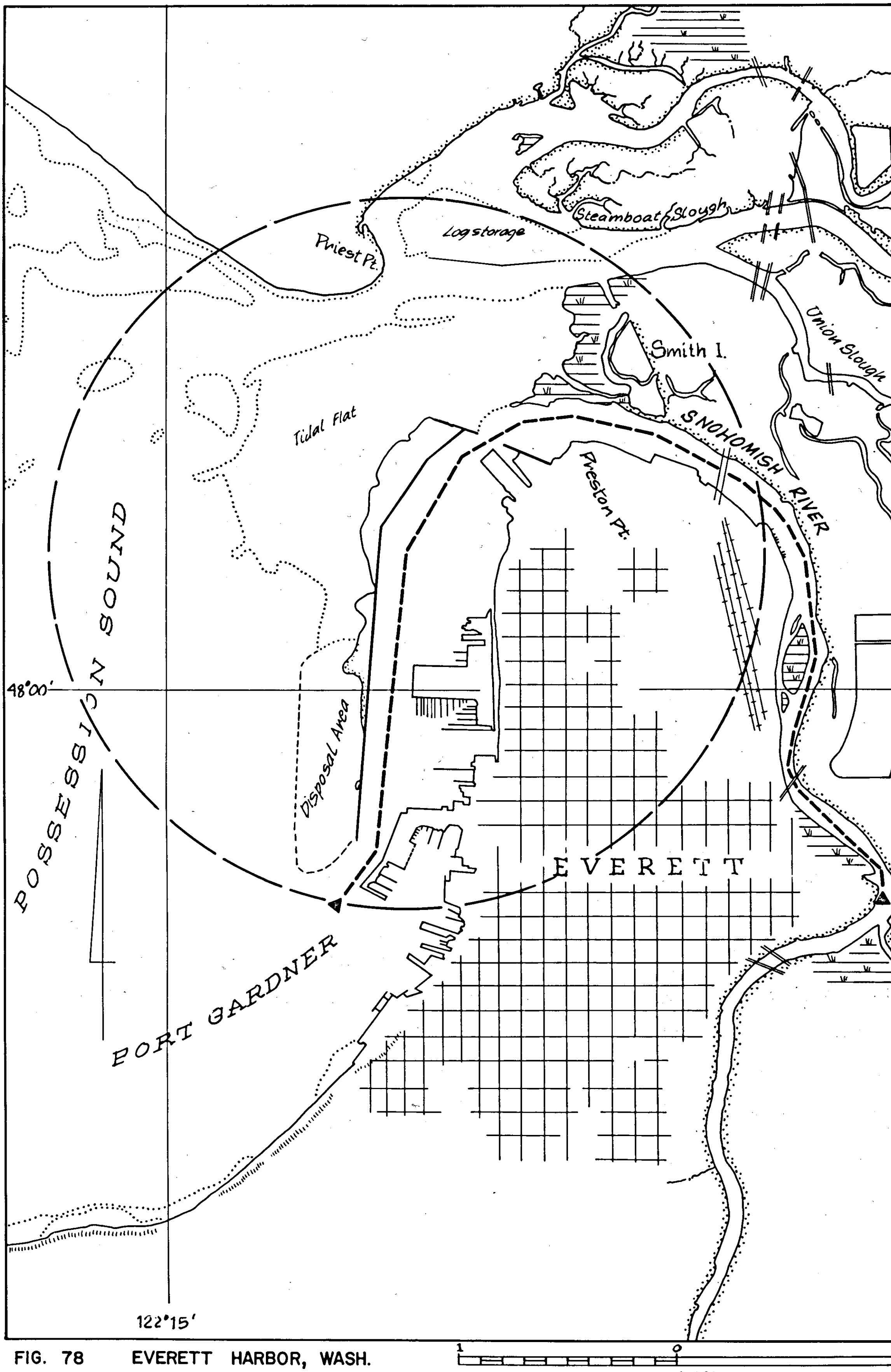

FIG. 78 EVERETT HARBOR, WASH.

The Everett Harbor Project Area annually generates 220,000 cu yd of silt and sand with a frequency of 24 to 36 months. Disposal is indicated as both confined and unconfined.

The mean tidal range for the project area is 7.5 ft. The datum plane is mllw.

5.5.1 Dredged Material Receiving Site Description

5.5.1.1 Dredged Material Characteristics

Sediment in the Everett Harbor Project Area consists of sand or silty sand. A larger portion of fine sand is found in sediments of the lower portion of the river. Pollution of sediment beyond EPA standards occurs in the river south of Preston Point. Portions of the river above this point are not as polluted (Seattle District 1973).

5.5.1.2 Marsh-Creation Situations

The following situations for marsh creation may occur within the project area: open water paralleling the channel, as along the lower portions of the river where open water is more ample; marsh extension, as from the marsh west of Smith Island; over existing tidal flat or into tidal creeks; over tidal flats, as on the extensive flat just northwest of the lower portion of Snohomish River; open water in tidal creeks; and extension of marsh from tidal flats into open water.

Tides within the project area are unequal semi-diurnal, which is typical for the Pacific coast. The diurnal range is 11.1 ft; the estimated extreme range is 19.0 ft. Water depths in undredged portions of the project area are consistently less than 30 ft.

Most of the marsh, creek, and tidal flat complex within the project area results from natural delta formation at the mouth of Snohomish River. Low-lying lands within the tidal range are populated by plant and animal species characteristic of the biota of the northern Pacific coast. Commercial fisheries resources consist of shellfish (certain areas may be closed due to high coliform bacteria counts) and 18 species of finfish. Migratory waterfowl are abundant at appropriate times of the year (Seattle District 1973).

Fifteen dredged material disposal areas have been designated near the project area. Dredged material removed from certain portions of the channel, where it is necessary to use clamshell and bottom dump barges, will be disposed of in the lower river channel. For the upper portions of the channel, a 15-acre state-owned, diked area is being managed for borrow material (Seattle District 1973).

5.5.2 Judgment of Desirability

5.5.2.1 Institutional Characteristics

Washington State agencies concerned with estuarine areas are:

Department of Ecology
State Conservation Commission
Department of Fisheries
Department of Game
Department of Natural Resources

State Parks and Recreation Commission.

The Department of Natural Resources controls ownership and leasing of tidal areas. Estuarine lands below ordinary high tide are owned by State as well as private interests.

Local cooperation is required for disposal areas.

5.5.2.2 Benefits and Costs

Everett is the major urban complex, and had a 1970 population of approximately 60,000. As the industry of the city is involved with processing forest wood products, rafted wet log storage areas are located in certain areas outside major channels (Seattle District 1973).

Extension of marsh into open water, particularly from existing tidal flats, could be the most feasible marsh creation method with the least reduction of existing productivity. In light of the marginally polluted status of sediment in the lower portions of the river, the long-term benefits of marsh creation are not certain.

5.5.2.3 Public Attitudes

The following Washington citizens' groups may represent public attitude concerning estuarine land use:

Washington State Sportsmen's Council
The Mountaineers
The Nature Conservancy
Washington Environmental Council, Inc.

5.6 Suisun Channel, California; Sacramento District

The Suisun Channel Project Area (Figure 79) is represented by the Suisun Channel project and is located on Suisun Slough off Grizzly Bay, 36 miles north of San Francisco. The channel is approximately 13 miles long from Grizzly Bay to Suisun City, California, with a depth of eight ft and width varying from 200 to 100 ft.

The Suisun Channel Project Area annually generates 120,000 cu yd of mud and sand with a frequency of 24 months. Disposal is indicated as confined.

The mean diurnal tidal range at the project area is approximately 5.0 ft. The datum plane is mllw.

5.6.1 Dredged Material Receiving Site Description

5.6.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

5.6.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

5.6.2 Judgment of Desirability

5.6.2.1 Institutional Characteristics

California State agencies concerned with estuarine areas are:

The Resource Agency
- Department of Parks and Recreation
- Water Resources Control Board
- Wildlife Conservation Board

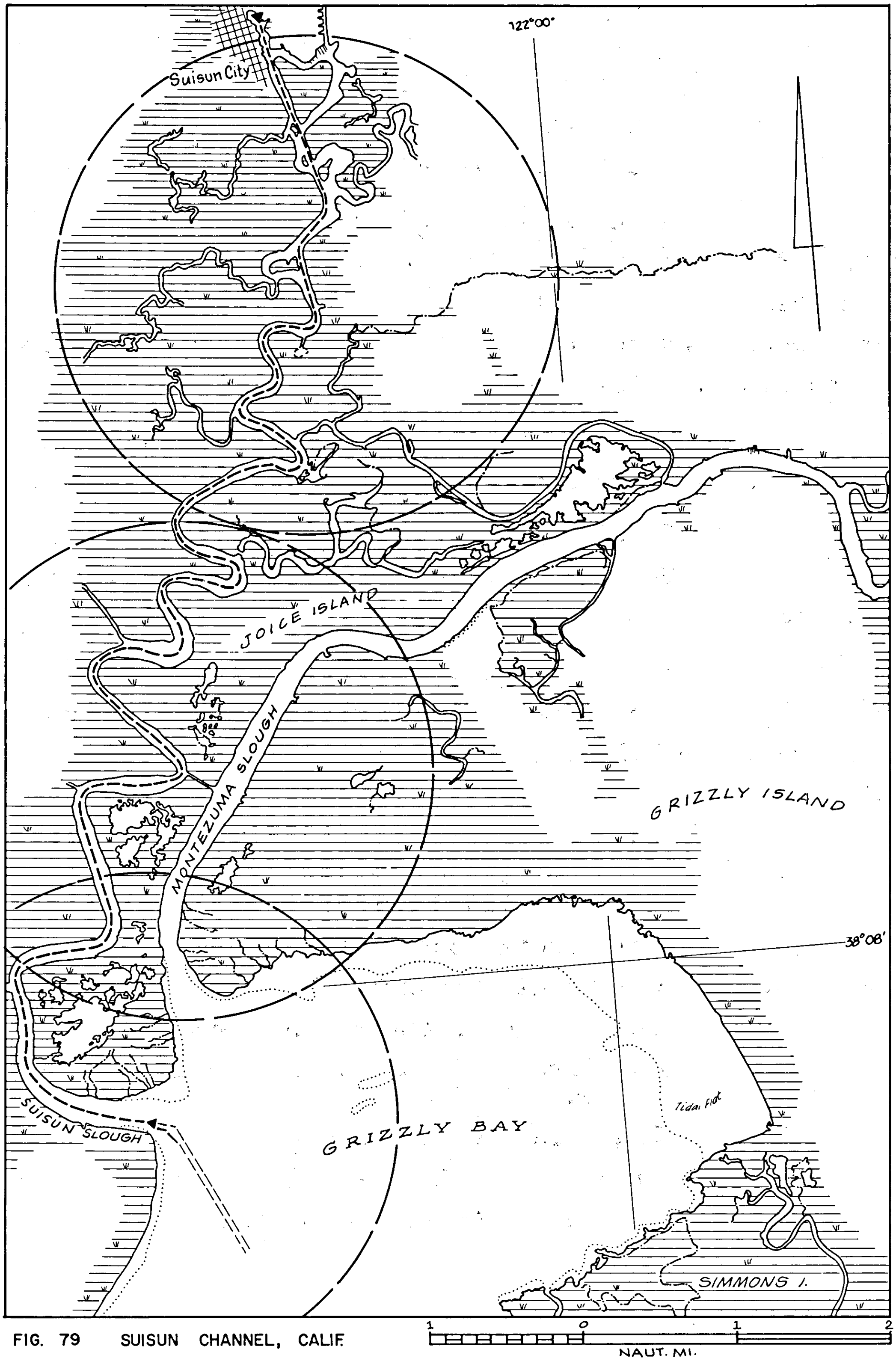

FIG. 79 SUISUN CHANNEL, CALIF.

Navigation and Ocean Development
Fish and Game Commission
Department of Conservation
Department of Water Resources
State Land Commission.

An Advisory Commission on Marine and Coastal Resources was created to develop a Comprehensive Ocean Area Plan. The State Land Commission controls state-owned land and has established a permit system for construction in tidelands.

Federal, State, local, and private concerns own land below the ordinary high water mark.

5.6.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

5.6.2.3 Public Attitudes

The following California citizens' groups may represent public attitudes concerning estuarine land use:

California Wildlife Federation
California Association of Resource Conservation Districts
California Conservation Council
California Tomorrow
Council for Planning and Conservation
California Division, Izaak Walton League of America, Inc.
The Nature Conservancy
Planning and Conservation League
United New Conservationists.

5.7 Bodega Bay, California; San Francisco District

The Bodega Bay Project Area (Figure 80) is represented by one section of the Bodega Bay project, the channel and turning basins. The project area is located 18 miles north of Point Reyes, east of Bodega Head, and into Bodega Harbor. The channel and turning basins are 12 ft deep, the channel is 100 ft wide, and the turning basins are 400 ft wide. The channel runs from Bodega Bay north, then southeasterly beginning at the town of Bodega Bay.

The Bodega Bay Project Area generates annually 90,000 cu yd of sand and silty sand with a frequency of 84 months. Disposal is indicated as confined in a diked area on shore.

The mean diurnal tidal range at the project area is 5.6 ft. The datum plane is mllw.

5.7.1 Dredged Material Receiving Site Description

5.7.1.1 Dredged Material Characteristics

Though data from recent sediment sampling are not available, pollution status is probably well below EPA standards. Fine to medium sand is found at the turning basin near the entrance channel, while very soft to black, clay and silty clay collect in the two turning basins (San Francisco District 1973a).

5.7.1.2 Marsh-Creation Situations

The only marsh-creation situations which may exist in the Bodega Bay Project Area are in open water, with or without connection to the existing land.

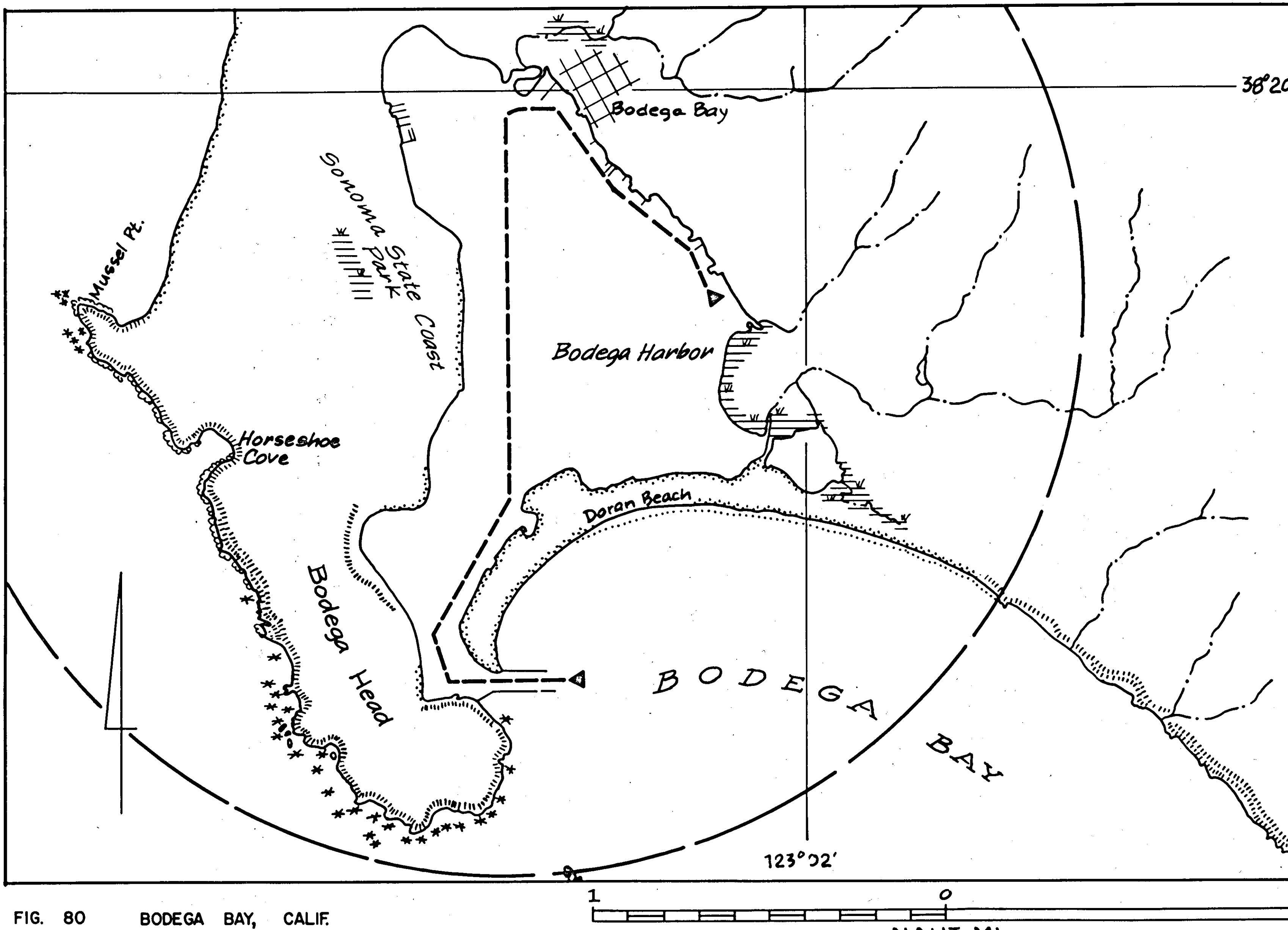

FIG. 80 BODEGA BAY, CALIF.

Water in undredged portions of Bodega Harbor is generally very shallow. Considerable differences in tidal means exist between the entrance channel and the north end of Bodega Harbor and indicate a severe tidal current regime (San Francisco District 1973a). The mean higher high varies from 5.7 ft at the entrance channel to 4.1 ft at the northern end of Bodega Harbor while the mean low water varies from 1.2 ft to 0.7 ft, respectively.

Existing marsh within the project area is minimal but fishery resources, including fin and shellfish, are abundant. Clam digging in Bodega is a major recreational pastime. Migratory waterfowl are abundant.

Sonoma State Coast Park extends from Bodega Head northward to the town of Jenner, and Westside County Park is located west of the town of Bodega Bay. Doran Beach is also a county recreation area (San Francisco District 1973a).

Five major dredged material disposal areas are scattered in both open water (land extensions) and upland sites. Some dredged material has been dumped in open water along the -30-foot contour (San Francisco District 1973a).

5.7.2 Judgment of Desirability

5.7.2.1 Institutional Characteristics

California State agencies concerned with estuarine areas are:

The Resource Agency

Department of Parks and Recreation
Water Resources Control Board
Wildlife Conservation Board
Navigation and Ocean Development
Fish and Game Commission
Department of Fish and Game
Department of Conservation
Department of Water Resources
State Land Commission.

An Advisory Commission on Marine and Coastal Resources was created to develop a Comprehensive Ocean Area Plan. The State Land Commission controls state-owned land and has established a permit system for construction in tidelands.

Federal, State, local, and private concerns own land below the ordinary high water mark.

Local cooperation is required for diked disposal areas.

5.7.2.2 Benefits and Costs

There would be few if any benefits associated with marsh creation in this area. In spite of some domestic sewage pollution, benthic infauna, such as clams, is very rich. Artificially created marsh could probably not surpass existing balances of natural productivity and human use.

5.7.2.3 Public Attitudes

The town of Bodega Bay is a small but important fishing village geared to a seasonal influx of nearly 1,000,000 people (San Francisco District 1973a).

The following California citizens' groups may represent public attitudes concerning estuarine land use:

- California Wildlife Federation
- California Association of Resource Conservation Districts
- California Conservation Council
- California Tomorrow
- Council for Planning and Conservation
- California Division of Izaak Walton League of America, Inc.
- The Nature Conservancy
- Planning and Conservation League
- United New Conservationists.

5.8 Santa Cruz, California; San Francisco District

The Santa Cruz Project Area (Figure 81) is represented by the Santa Cruz Harbor project. The project area is located on Monterey Bay south of San Francisco adjacent to the town of Santa Cruz, California. The dimensions of the entrance channel are 20 ft deep and 100 ft wide; the inner harbor channel 15 to 10 ft deep and 150 ft wide; and the turning basin 10 ft deep and 250 by 300 ft.

The project area annually generates 90,000 cu yd of sand with a frequency of 12 months. Disposal is indicated as overboard.

The mean diurnal tidal range is 5.3 ft. The datum plane is mllw.

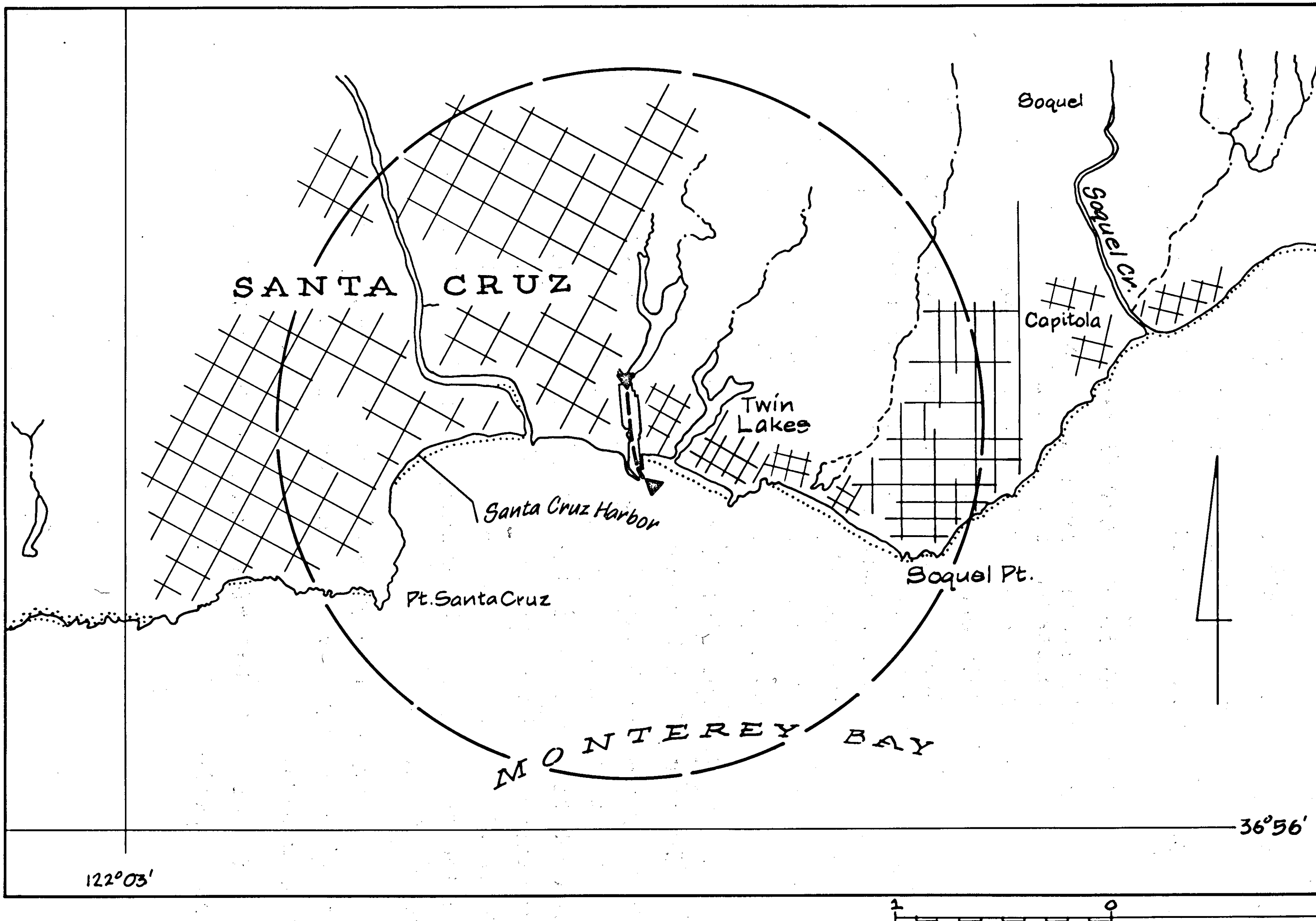

FIG. 81 SANTA CRUZ, CALIF.

5.8.1 Dredged Material Receiving Site Description

5.8.1.1 Dredged Material Characteristics

The inventory indicates the sandy sediments requiring dredging in Santa Cruz Harbor are not polluted in excess of EPA standards. These materials are derived from sea cliff erosion and fluvial riverine sources (San Francisco District 1973b).

5.8.1.2 Marsh-Creation Situations

There are essentially no marsh-creation situations available.

Dredged material has been, and probably will be, used to maintain beaches. Salt marsh vegetation does not exist within the project area, and none could exist along this segment of Pacific shore due to high-energy wave regime and lack of suitable substrate within the intertidal range (San Francisco District 1973b).

5.8.2 Judgment of Desirability

5.8.2.1 Institutional Characteristics

California State agencies concerned with estuarine areas are:

- The Resource Agency
  - Department of Parks and Recreation
  - Water Resources Control Board
  - Wildlife Conservation Board
  - Navigation and Ocean Development
  - Fish and Game Commission
  - Department of Fish and Game
  - Department of Water Resources
- State Land Commission.

An Advisory Commission on Marine and Coastal Resources was created to develop a Comprehensive Ocean Area Plan. The State Land Commission controls state-owned land and has established a permit system for construction in tidelands.

Federal, State, local, and private concerns own land below the ordinary high water mark.

Local cooperation is required for use of disposal areas.

5.8.2.2 Benefits and Costs

There could be no great benefits associated with marsh creation in the Santa Cruz Project Area.

5.8.2.3 Public Attitudes

The following California citizens' groups may represent public attitudes concerning estuarine land use:

California Wildlife Federation
California Association of Resource Conservation Districts
California Conservation Council
California Tomorrow
Council for Planning and Conservation
California Division, Izaak Walton League of America, Inc.
The Nature Conservancy
Planning and Conservation League
United New Conservationists.

5.9 Petaluma River, California; San Francisco District

The Petaluma River Project Area (Figure 82) is represented by two sections of the Petaluma River project: the channel in San Pablo Bay and the river channel. The project area is located in San Pablo Bay north of San Francisco and extends northward for approximately four miles up the Petaluma River. The San Pablo Bay channel is eight ft deep and 200 ft wide, while the river channel is eight ft deep and 100 ft wide for a length of approximately four miles.

The Petaluma River Project Area annually generates 54,000 cu yd of clay (24,000 cu yd from the 70,000 cu yd of the entire river channel) with frequencies of 48 months for the river channel and 144 months for the San Pablo Bay channel. Disposal is indicated as confined in the case of the river channel and unconfined in the case of the San Pablo Bay channel.

The mean tidal range at the project area is 6.1 ft. The datum plane is mllw.

5.9.1 Dredged Material Receiving Site Description

5.9.1.1 Dredged Material Characteristics

Sediments accumulating in the lower Petaluma River and upper San Pablo Bay channels are polluted beyond tentative EPA standards. Pollutants originate from agricultural, domestic, and industrial sources upstream (San Francisco District 1974).

Visual classification of sediment has defined two major clay sediment types: those with a

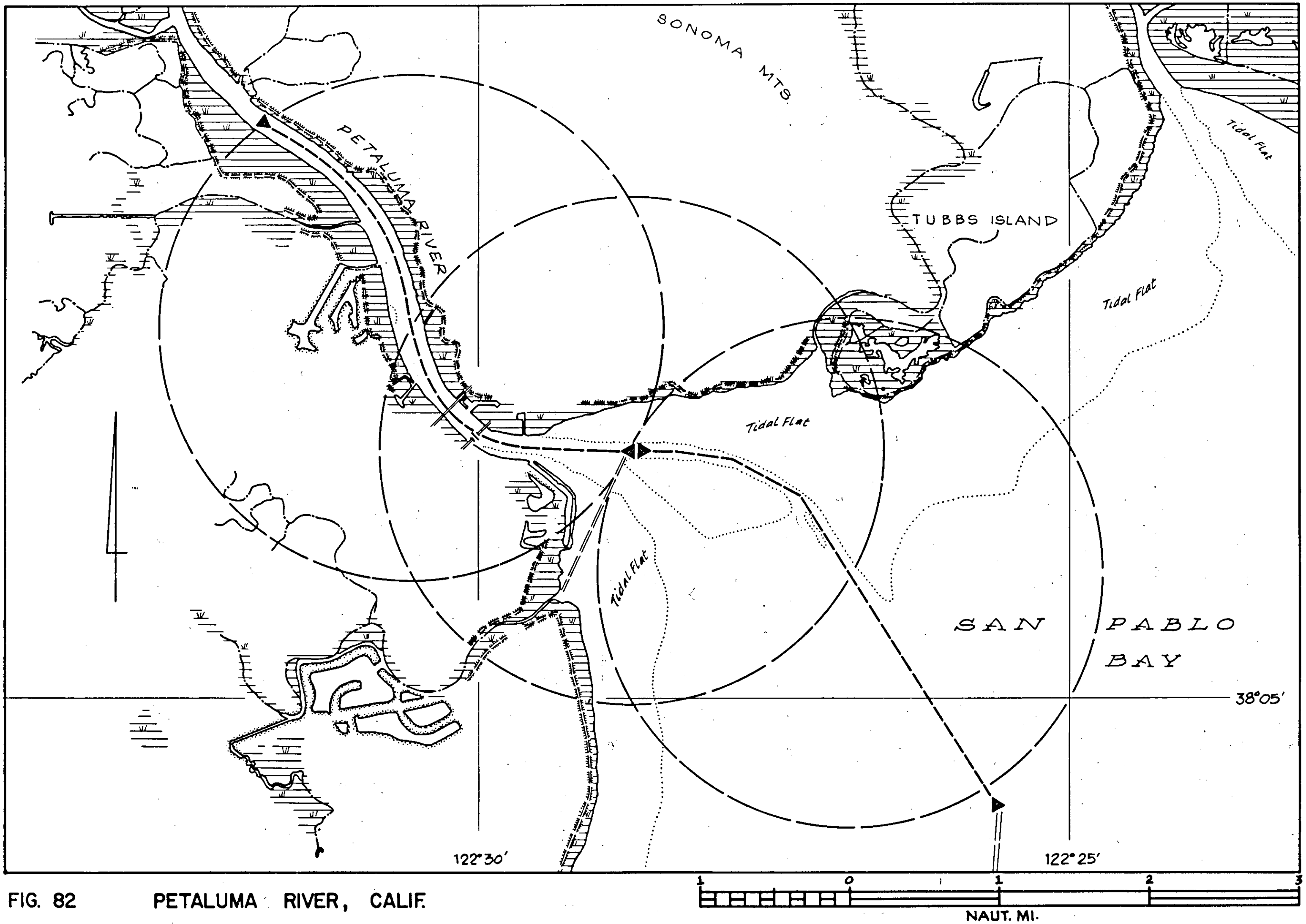

FIG. 82 PETALUMA RIVER, CALIF.

trace of silt-size particles and those without. The sediment bears a trace of organic material, has an odor, and is dark gray (South Pacific Division Laboratory 1974).

5.9.1.2 Marsh-Creation Situations

The following situations may be available for marsh creation within the project area: tidal (mud) flats adjacent to existing marsh, as the area just southwest of Tubbs Island; marsh extension over tidal (mud) flats; open, shallow water paralleling the channels; and tidal (mud) flats paralleling the channels.

At San Pablo Bay, the tide ranges from 4.35 ft at mhhw to -1.85 at mllw. The maximum tidal range is 8.80 ft (San Francisco District 1974).

Ebb and flood tide currents vary from 1.0 to 2.0 fps, respectively, in the approach and entrance to Petaluma River (U. S. Department of Commerce 1974). These velocities are probably considerably reduced over mud flats where continued deposition of sediments occurs. Water depths in undredged areas seldom exceed 5.0 ft mllw.

Fringes of marsh occur landward of the mud flats. These marshes are subject to the semi-diurnal inequal tides. They support several species of plants occurring in rather distinct zones which are governed by flooding frequency. Salt marshes serve as ultimate sources for several kinds of commercially important shell and finfish, as well as feeding and/or breeding areas for resident or migratory bird species and terrestrial vertebrates. Salt marsh occurs in the lower portions of the project area, while some brackish marsh may occur in the upper reaches of Petaluma River.

San Pablo Bay National Wildlife Refuge is located within the northern portion of the project area west of Tubbs Island. This refuge consists of 11,790 acres of open water and tidelands and about 50 acres of terrestrial communities.

Some shellfish bed areas in the project area have been closed due to pollution levels.

The disposal area for current maintenance dredging in the Petaluma River area is to be located further south, toward San Francisco Bay (San Francisco District 1974).

5.9.2 Judgment of Desirability

5.9.2.1 Institutional Characteristics

California State agencies concerned with activities in California estuarine areas are:

- The Resource Agency
  - Department of Parks and Recreation
  - Water Resources Control Board
  - Wildlife Conservation Board
  - Navigation and Ocean Development
  - Fish and Game Commission
  - Department of Fish and Game
  - Department of Conservation
  - Department of Water Resources
- State Land Commission.

The Advisory Commission on Marine and Coastal Resources has been responsible for development of a Comprehensive Ocean Area Plan. The State Lands Commission controls state-owned land and has established a permit system for construction in tidelands.

Federal, State, local, and private concerns own lands below the ordinary high tide mark.

Local cooperation is required for use of diked disposal areas.

5.9.2.2 Benefits and Costs

With a local public reaction against use of land disposal areas for dredged material, the benefits of marsh creation increase substantially, even in the case of polluted sediments. Such is the case in the San Pablo Bay area. With decreases in water pollution, shellfish beds could be re-opened. Artificially created marsh could add acreage for shellfish, finfish nursery grounds, and wildlife habitat.

5.9.2.3 Public Attitudes

Citizens' groups representing public attitudes concerning estuarine land use in California are:

California Wildlife Federation

California Association of Resource Conservation Districts

California Conservation Council

California Tomorrow

Council for Planning and Conservation

California Division, Izaak Walton League of America, Inc.

The Nature Conservancy

Planning and Conservation League

United New Conservationists.

5.10 Quillayute River, Washington; Seattle District

The Quillayute River Project Area (Figure 83) is represented by the Quillayute River Project at La Push, Washington. The project area is located where the Quillayute River meets the Pacific Ocean at James Island and La Push. The channel, beginning at James Island, is 10 ft deep and 100 ft wide to the boat basin (10 ft deep and 1,070 by 420 ft), thence at the same depth and a width of 75 ft to the mouth of Smith Slough.

The Quillayute River Project Area annually generates 50,000 cu yd of sand and gravel with a frequency of 12 months. Disposal is indicated as both confined and unconfined.

The mean tidal range for the project area is 6.5 ft. The datum plane is mllw.

5.10.1 Dredged Material Receiving Site Description

5.10.1.1 Dredged Material Characteristics

No further reconnaissance-scale data were available.

5.10.1.2 Marsh-Creation Situations

No further reconnaissance-scale data were available.

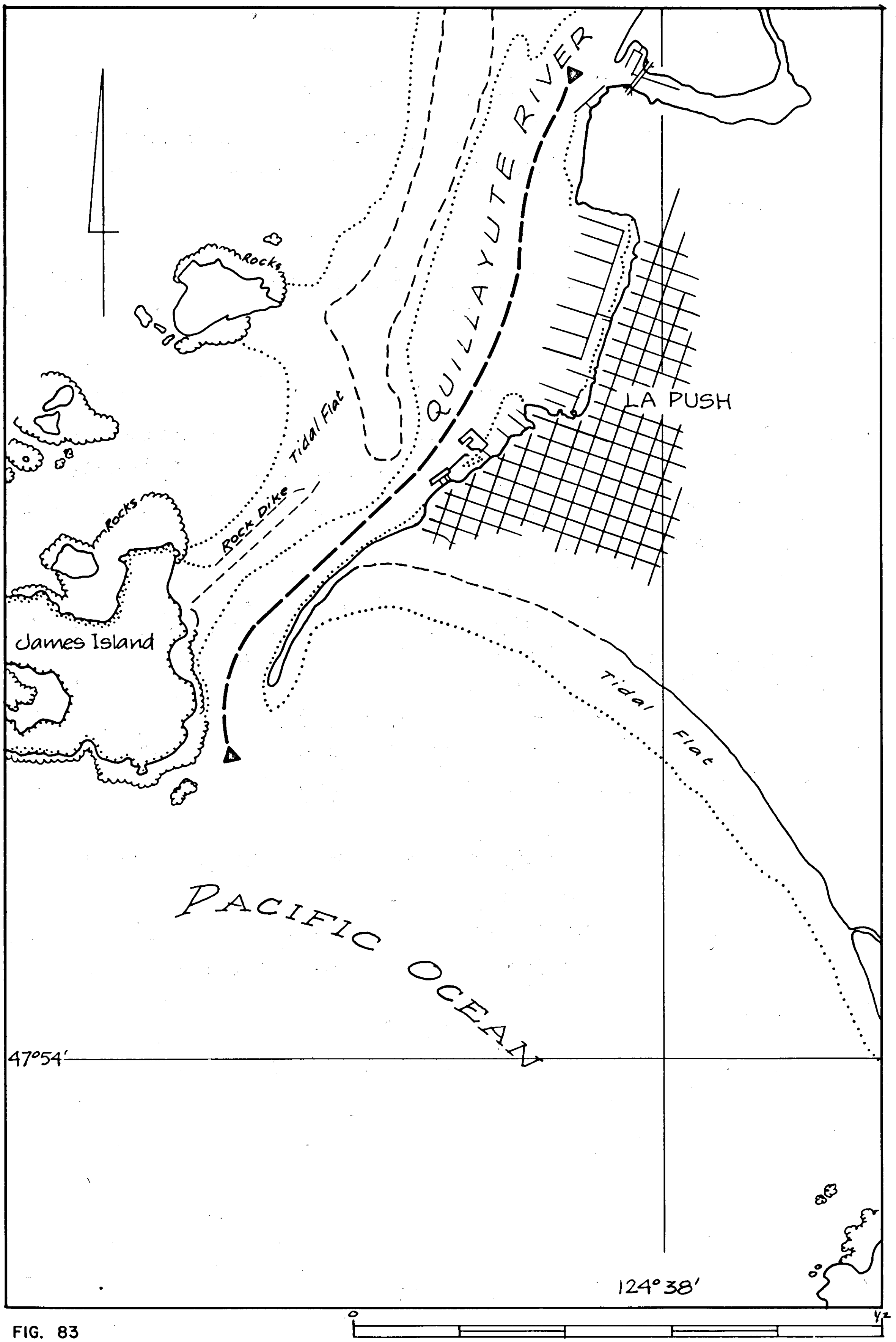

FIG. 83
QUILLAYUTE RIVER, WASH.

5.10.2 Judgment of Desirability

5.10.2.1 Institutional Characteristics

Washington State agencies concerned with estuarine areas are:

Department of Ecology
Department of Fisheries
Department of Game
Department of Natural Resources
State Parks and Recreation Commission.

The Department of Natural Resources controls ownership and leasing of tidal areas. Estuarine lands below ordinary high tide are owned by State as well as private interests.

5.10.2.2 Benefits and Costs

No further reconnaissance-scale data were available.

5.10.2.3 Public Attitudes

The following Washington citizens' groups may represent public attitude concerning estuarine land use:

Washington State Sportsmen's Council
The Mountaineers
The Nature Conservancy
Washington Environmental Council, Inc.

SECTION C

SELECTION OF OPTIMUM PROJECT AREAS

1.0 Selection Methodology

The mail request to Engineer Districts (Appendix A) was designed to elicit sufficient information to complete description of the 50 prime project areas and to allow selection of 10 optimum project areas. Information received is summarized in Section D of Volume II. Thus, as all available information was received, the 10 prime project areas within each geographical region were compared as to their relative suitability for marsh creation.

As described in Sections A and B of Volume II, materials provided from the mail requests varied from the most cursory to very detailed compilations of data for certain aspects of information requested. Only a few specific kinds of reconnaissance-scale data were available for all of the prime project areas surveyed. From Scarboro River, Maine, to Everett Harbor, Washington, the information common to all project areas included tidal ranges as an indication of water-energy regime, particle size or general textural class, and data on the pollution status of the sediment dredged.

The information on the pollution status of the dredged material was compared with EPA pollution standards for open-water disposal of sediments, but the fact that the old standards are used inconsistently and are often not locally applicable and the new guidelines are currently in the process of being developed, rendered the relevance of the EPA standards to the evaluation of marsh-creation sites questionable. Where the positions and desires of regulatory agencies, political, and/or economic interests were available, they were considered; however, such information was usually very limited.

In several cases, the information used to select the 50 prime project areas was revised and corrected by the Engineer Districts. Project areas that upon revision no longer met the criteria used in initial screening were eliminated from further evaluation as potential optimum project areas. Discontinuing projects, changes in annual volume, or a shift of dredging mode could each cause the deletion of a given project area from further evaluation.

In the case of a number of project areas, no additional reconnaissance-scale information was available and, therefore, these were not considered beyond the prime candidate level. Of the 50 prime project areas for which reconnaissance and detailed information was requested, Engineer Districts responded with materials on 38. By geographical region, those project areas not covered were: New England Geographical Region-Wells Harbor, Maine; Middle Atlantic Geographical Region-Corson Inlet, Absecon Creek, and Broad Thorofare, New Jersey; South Atlantic Geographical Region-Georgetown Harbor and Charleston Harbor, South Carolina; Gulf Geographical Region-Mobile Harbor, Alabama, Terrebonne Bay, Louisiana, and Sabine-Neches Canal, Texas; and Pacific Geographical Region-Suisan Channel, California, and Quillayute River, Washington.

Unavailability of information served as an important criterion in the selection process. It should be noted, however, that until such data are collected, District Engineers will be faced with the same inadequacy of information for making decisions concerning marsh development in their areas.

The Engineer Districts might well select areas other than the locations chosen by CZRC on the basis of the same reconnaissance-scale information used here. This variance would depend upon Engineer District priorities and immediate needs. The great majority of the prime project areas probably have a number of ecological situations acceptable for marsh creation and, thus, could be considered optimal under given sets of socio political, economic, and operational conditions.

For the purpose of this study, CZRC, in accordance with ODMR, has emphasized the selection of project areas which provide a broad spectrum of ecological diversity among project areas within and between geographic regions, as well as a broad representation of ecological situations within the project areas selected. The existence of ecological situations suitable for marsh creation was determined from the information base of data, maps, and diagrams supplied by the Engineer Districts and supplemented by the study of U. S. Geological Survey quadrangles, NOS charts, and other reference materials available to CZRC.

The bias toward ecological variety is reflected in the 10 optimum project areas ultimately selected. Although appropriate for marsh creation, each site should be viewed within the overall context of this study, and may not necessarily be the best project area from the aspect of individual District Engineers. The inherent diversity of project areas selected will, however, mesh well with the multiformity of the ODMR research program.

2.0 Reconnaissance-Scale Criteria Selections

2.1 New England Geographical Region

The two project areas selected for further evaluation under the detailed scale were Long Island IWW, New York, and Raritan River, New Jersey. Selection of project areas in this geographic region was difficult because of the small annual volumes of dredged material produced (with the exception of Raritan River), the relatively long periods between maintenance dredgings, and the high levels of pollutants in the sediments. In addition to those project areas mentioned previously, two other project areas (Lake Mauntauk Harbor and Shoal Harbor, New York) were eliminated because reconnaissance-scale information provided was very scant.

Long Island IWW was chosen because it appeared to offer a variety of opportunities for marsh creation associated with the physiography attendant the bay and barrier island system dominating the project area. Raritan River offered apparent land extension sites along the periphery of islands and the southern shore. Possible sites in Mattituck Harbor, New York, were limited primarily by the narrowness of Mattituck Creek. A developing recreational boating trade would militate against any decrease in navigable waters or space for marinas, and sediment in parts of the upper creek is becoming increasingly polluted (New

York Conservation Dept. 1969). These same constraints, including severe pollution of sediment from residential sources and duck farms and relatively small annual volumes, also applied generally to the Peconic River, New York (New York District 1972).

2.2 Middle Atlantic Geographical Region

Optimum project areas selected were Indian River Inlet, Delaware, and Smith Island, Maryland. Indian River Inlet was not among the original 50 prime candidate project areas because the dredged material volume data used in the initial screening were not accurate and the length of the channel being dredged was not known. Philadelphia District suggested this project area by supplying CZRC with the draft environmental impact statement for the project and an up-to-date estimate of annual dredging volume. This new CE project data, combined with the apparent variety of ecological situations in which marsh could be created, the protected nature of the Indian River Bay and Rehoboth Bay, and the relatively low pollutant status of water and sediments and the broad spectrum of particle sizes to be dredged (shell, sand, silt, and clay) reported by Philadelphia District (1973) were the primary factors supporting the selection of this project area.

Smith Island, Maryland, largely a marsh island, was selected principally because its offshore location in the Chesapeake Bay presents an opportunity to research the possibilities of replenishing marshlands lost to erosional processes and enhancing wildlife habitat adjacent to a national wildlife refuge. This marsh-island complex seemed to offer possible open water, estuarine creek, and land extension sites for marsh creation. Also in its favor was the low pollution status of water and sediment.

Reasons for eliminating the other prime project areas, all in the Norfolk District, were varied. Tangier Channels, Virginia, was very similar to Smith Island, Maryland; in fact, the two are semi-connected by mud flats. The Tangier Channels did not have the same degree of protected sites, however, or the location of a wildlife sanctuary whose resources might possibly be supplemented by marsh creation. Fisherman's Island, Virginia, was similar to Smith Island except that it was more subject to high-energy tidal fluctuations and had higher average salinities. Thus, it contained characteristics of both Smith Island and Indian River Inlet, and its inclusion would not add significant variety to the 10 optimum project areas. This, too, was the case for Swash Bay, Virginia. Even though relatively well protected, this estuarine area nonetheless was comparable to the Indian River Inlet and had a smaller annual production of dredged material, which unlike the latter was moderately polluted, according to Norfolk District (1974). The great volume of recreational, commercial, and governmental waterborne traffic, as well as the high degree of shoreline development, were sufficient to eliminate Lynnhaven Inlet, Virginia, from further consideration.

2.3 South Atlantic Geographical Region

St. Lucie Inlet, Florida, and Roanoke Sound, North Carolina, were the project areas selected in the South

Atlantic geographical region. Rationale for selecting these project areas as optimum rests almost entirely on the desire to lend biogeographic and ecological diversity to the 10 project areas finally selected.

Four of the project areas not chosen were Savannah Harbor, Brunswick Harbor, Jacksonville, and Tampa Harbor. All these were in heavily urbanized areas and contained polluted sediment. Even though each offered marsh-creation possibilities, none were sufficiently different from the Raritan River Project Area to justify their selection. With the exception of the more open bays of the Tampa Harbor Project Area, the others were also limited by the areal extent of places appropriate for marsh creation. New River Inlet and Beaufort-Morehead City, North Carolina, also not chosen, were unpolluted and nonurban in character, but were ecologically similar to Indian River Inlet, Delaware (Wilmington District 1974).

Thus, the opportunity for artificial marsh creation in a relatively clean, unurbanized area centered in predominantly mangrove estuarine conditions recommended the selection of St. Lucie Inlet (Jacksonville District 1973a). In contrast, the position of the Roanoke Sound Project Area behind the Outer Banks in a primarily wind tide-controlled estuarine environment and apparent opportunities for artificial marsh creation in all five ecological situations were the keys to its selection.

2.4 Gulf Geographical Region

Selection of the optimum project areas in the Gulf geographic region was also influenced by a desire to infuse the final 10 optimum project areas with variety.

The annual volumes available from the 10 prime candidate project areas in this geographical region were very large, the lowest being the Mobile Harbor Project Area (914,300 cu yd). Again, the location of project areas in highly urbanized areas and the attendant problems of pollution and/or large waterborne commerce caused the deletion of the Mississippi River gulf outlet, South Pass and Southwest Pass, and New Orleans Harbor, Louisiana; Pascagoula Harbor, Mississippi; and Galveston Bay, Texas.

The inclusion of an area consisting principally of open water was considered desirable in that such an area was not represented elsewhere. The Atchafalaya Bay Project Area meets that requirement; it is the delta region of the largest distributary of the Mississippi River and is expected to fill with silt at a dramatic rate within the next two decades or less (New Orleans District 1973b). Thus, this project area represents an opportunity to construct an extensive marshland, much of which could be subsequently extended into the Gulf of Mexico, while at the same time creating stable upland wildlife habitat on landward portions. The chance to operate in such a rapidly changing area with such large quantities of silty sediments is compelling from the research viewpoint.

The Matagorda Channel Project Area offered an ecologically different condition not encountered in other geographical regions. Climatically, it is located on a semi-arid reach of the Gulf coast. This area provided open-water and land-extension marsh-creation sites, and the silty sandfill available is relatively unpolluted.

2.5 Pacific Geographical Region

The very radical differences in the ecological conditions of the northern and southern Pacific coast dictate that one of the optimum project areas be selected from each.

Within the northern Pacific area, the selection of the Grays Harbor Project Area rather than Coos Bay, Willapa Bay, or Everett Harbor hinged on the fact that Grays Harbor sediments were unpolluted and about 25 percent greater on an annual volume basis than those of the other project areas. Grays Harbor is geographically the northernmost project area and adds ecological diversity to the optimal project areas selected.

In the southern Pacific area, the Petaluma River Project Area was selected because it had the most acceptable conditions for artificial marsh creation. For instance, there is little or no salt marsh present within the Santa Cruz or Bodega Bay Project Area, both being subject to very high water-energy conditions (San Francisco District 1973a, 1973b). The presence of Chorro Creek State Park, many archeological sites, and commercially important shellfish areas, militate against the Morro Bay Project Area (Los Angeles District 1973). In addition, all three areas lack adequate planting stock of California cordgrass. Institutional constraints at Petaluma River are minimal (San Francisco District 1974). Planting stock is abundant and large areas appropriate for marsh creation are available.

SECTION D

DESCRIPTION OF OPTIMUM PROJECT AREAS

The final step in the evaluation of project areas was based on detailed-scale information obtained through the mail request sent to Engineer Districts. This source was supplemented by visits to the Engineer District Offices to obtain added detailed-scale information on the characteristics of dredged material; environmental description; institutional considerations, benefits and costs, and public attitudes related to marsh creation; and to verify possible marsh-creation sites. The detailed-scale evaluation represented an enlargement upon the reconnaissance scale. Thus, the interviews held with Engineer District personnel, Federal, State, local, and public agencies and organizations were the source of amplification of information relative to the project area.

As part of the review and analysis of mail request information, the optimum project areas were described and evaluated. The preliminary results of detailed-scale evaluation consisted of rough draft, detailed project area descriptions, and, based on the knowledge of sediment particle size, water-energy regime, and the general hydrography and physiography of the project area, and tentative specific sites for marsh creation. These preliminary selections were then surveyed by aerial reconnaissance from low-flying, fixed-wing aircraft and, in some cases, brief on-ground inspections, and the suitability of the sites was evaluated visually. In the Petaluma River Project Area, excellent aerial photographic coverage was substituted for a site visit. In the St. Lucie Project Area, comparable photography plus extensive field experience obviated the need for on-site inspection. In several instances, the observations brought about the rejection of preliminary sites and the selection of more appropriate ones. Upon talking with Engineer District personnel and discussing specific sites, further deletions and additions were occasionally made. Each Engineer District was also given the opportunity to read and comment on rough draft materials relating to project areas under their jurisdiction. A final step in evaluating specific marsh-creation sites involved the study and interpretation of black-and-white aerial photographs (scale 1 in.=1000 ft) of all 10 optimum project areas. The photo missions were flown during the spring of 1974 and thus are the most up-to-date coverage possible for the present study.

In many instances, information beyond the level of reconnaissance scale was not available. While this was true for all the kinds of information desired, it was especially so for considerations of institutional constraints, costs and benefits, and public attitudes.

Several references were used extensively in describing the climatology and hydrological aspects of the optimum project areas. Weather descriptions came from Chief of Naval Operations 1956 and 1958; Lull 1968; and Nelson and Zillgitt 1969. United States Department of Commerce publications, including Coast Pilot 1967, 1968, 1972, 1973, 1974, Tide Tables 1973, and Tidal Current Tables 1973 were the sources of hydrologic information. Other references are cited specifically as necessary and proper.

1.0 New England Geographical Region

1.1 Long Island Intracoastal Waterway Project Area and Marsh-Creation Sites

The project area is a segment of the Long Island Intracoastal Waterway (LIWW) extending from near Moriches Inlet westward into Bellport Bay. The entire project is located leeward of Great South Beach (Fire Island), a barrier island. Material dredged from this segment of LIWW could be used to construct marsh in several locations.

The four sites selected for possible marsh creation are marsh-extension situations protected to various degrees by a barrier-island complex. Three of the sites are land extensions of existing islands, two of which have been dredged material disposal sites in the past, and the other site is an extension of marshes on the barrier island.

1.1.1 Characteristics of Dredged Material

1.1.1.1 Physical Properties

Sediment to be dredged is composed mostly of sand, although New York District (1974b) indicates that material ranging from hard sand to sticky mud constitute the general bottom type of the project area.

1.1.1.2 Chemical Nutrient Status

Chemical nutrient status of sediment to be dredged from the channel has not been determined. Relative to sediments in surrounding areas, O'Connor and Terry (1972) found considerable reduction of benthic macrofauna associated with channel sediments, but this may have been due largely to summertime anaerobic conditions.

Nutrient-rich organic material that has accumulated from duck farms still contributes substantially to the total nutrient load in the sediments, as well as the waters.

The following description of water chemical nutrient parameters may be used as an indirect evaluation of sediment chemical nutrient status of Great South Bay and tributaries (New York District, 1974b). Dissolved oxygen concentrations are often near or above the 100-percent saturation value, which is to be expected, at least on the surface, in a shallow wind-driven system. Oxygen levels in deeper waters are likely to be much lower.

Mean dissolved inorganic phosphorus (DIP) value in the bay was 0.69 microgram-atoms of phosphorus per liter (μg-at. P/l) of bay water. River values had a mean of 1.01 μg-at. P/l. DIP often indicates the inputs of specific sources, such as duck farms, which explain the higher values in the rivers. Duck farms are located adjacent to rivers and streams which flow into the bays.

Particulate phosphorus is an indicator of planktonic biomass and amounts of detritus. The bay waters had a mean value of 1.05 μg-at. P/l. The mean value of river was 1.58 μg-at. P/l.

Nitrogen, like phosphorus, is an indicator of eutrophic status. Nitrate values for the bay had a mean value of 4.08 μg-at. NO_3-N/l. River water entering Great South Bay averaged about three times the value for the bay (12.09 μg-at. NO_3-N/l). Nitrite values had a mean of 0.17 μg-at. NO_2-N/l for the bay. The rivers averaged twice as high as the bay, with 0.51 μg-at. NO_2-N/l.

Ammonia levels in the bay averaged 2.44 μg-at. NH_4-N/l and the rivers had a mean of 2.07. The highest values were found along the north shore and western portions of the bay.

Chlorophyll a values are an index of phytoplankton abundance and primary productivity. The bay had a mean value of 6.4 μg of chlorophyll a per liter, while the rivers flowing into the bay had a mean value of 22.3 μg/l. The highest measurements of chlorophyll a were made in areas of highest nutrient concentrations, thus indicating cultural eutrophication. Pheophytin, a natural degradation product of chlorophyll a, as an indicator of algal decomposition ranged from 0.7 in May to 11.8 in October with a mean value of 4.1 μg/l for the bay. The rivers had a mean of 4.5 μg/l.

The ratio of nitrogen to phosphorus (N/P ratio) represents their relative availability in the water column, relative to each other. The N/P ratio was 9.7:1 for the bay and 14.5:1 for the rivers. The highest values were measured along the north shore. Several rivers supply nitrogen and phosphorus at ratios greater than required for inshore plankton and are, therefore, potential sources of eutrophication for the bay. These eutrophic conditions have led to extensive phytoplanktonic blooms from March through August and again in October, particularly in shallow bays. In general, there are diatom blooms in the spring followed by secondary dinoflagellate blooms. During the summer, growth is normally conspicuous but not usually excessive to the point of being noxious. In the fall, there is a second diatom bloom. During the rest of the year, algal activity is low. Of significance are the blooms of Nannochloris, a small green algae, dinoflagellates, and red algae, which occur in quiet warm waters where nutrient substances are abundant.

Another indirect indication of chemical nutrient status is bacterial growth (New York District 1974b). High coliform counts have caused Great South Bay on the north shore from Blue Point to Bellport, Bellport Bay from Bellport to Mastic Beach, and the entire northern half of Moriches Bay to be closed to shellfishing.

1.1.1.3 Pollution Status

Sediment occurring in Moriches Bay and Great South Bay was analyzed by the New York District (1974b). Three parameters, Kjeldahl nitrogen, oil and grease, and chemical oxygen demand, were found to exceed EPA standards.

Information in the preceding section (1.1.2) is, of course, quite relevant to the assessment of the pollution status of sediment. In addition, O'Connor and Terry (1972) reported that accumulations of organic sludge, "duck sludge," released from duck farms were widespread. These deposits were several feet in depth and contained more than 10 percent organic matter (dry weight). It is probable that some of these types of pollutants are contained in sediment within the LIWW Project Area channel.

1.1.2 Environmental Description

1.1.2.1 Climatology

Mean annual precipitation in the project area is approximately 44 in. Monthly distribution of rain shows highest accumulations for a three-month period, during July, August, and September (17.2 in. or nearly 40 percent of annual total). December, January, and February are the months of least precipitation (9.4 in., or about 21 percent). January temperatures range from 23 to approximately 40°F and in July from 63 to 78°F. The length of freeze-free periods varies between 180 and 210 days.

Mean monthly wind speeds in the project area range from 9.2 to 15.5 knots, with a mean annual speed of 14.3. Highest speeds occur in the winter months, when the prevailing winds are from the northwest. Summer winds are mostly southerly in direction.

Gale force winds (34-47 knots) occur with a percentage frequency of up to 3.7 days for each month. Hurricanes, although relatively uncommon, have been responsible for the opening of inlets along the entire length of Fire Island.

1.1.2.2 Hydrology

1.1.2.2.1 Water-Energy Regime

The tidal ranges at Smith Point Bridge as measured by Norman Porter Associates (1967) vary from 0.7 ft for normal to 1.5 ft for spring tides. Normal tides have a high of 0.9 ft and a low of 0.2 ft (msl); spring high is 1.9 ft and spring low is 0.4 ft. Normal ebb and flood tide currents were measured at 1.0 fps, while spring tide flood and ebb were 2.5 and 2.0 fps, respectively.

No wave data were available, but wave heights probably do not become great except under extreme storm conditions in the sound of the project area. Fetch over water for the predominant westerly to northwesterly winds is short. Fetch for northeasterly, southeasterly, and southwesterly winds is considerably greater.

Though not specifically applicable, the following information quoted from the New York District (1974b), may set a frame of reference for circulation in the project area:

"At Fire Island Inlet, the ocean waters enter Great South Bay and spread out with the rising tide toward Oyster Bay. Great South Bay is characterized by a small inflow of tidal waters and poor circulation. Wind direction often governs circulation. Tidal circulation is sufficient to prevent stratification in the open bay but not near the inlets and rivers... Foehrenbach (1969) suggests a 48-day flushing rate for Great South Bay. This length flushing period is attributable to the small amount of water entering the bay and confinement of the water to the deeper channels."

"Ground-water flow is estimated at 28 million cubic feet per day. Creek flows are estimated at 24 million cubic feet per day during a year of high rainfall."

"Communication with adjacent waters is extremely limited for Moriches Bay, Quantuck Bay and Shinnecock Bay."

1.1.2.2.2 Hydrography

Roughly two-thirds of the project area is above -3.0 ft mlw. Such areas are fairly level to gently sloping sand and mud bottoms. Depths in the remaining portions of the bays are usually less than seven ft. Shoaling along the channel probably occurs most heavily near the western terminus of the project area.

A significant portion of the islands and shoals near the channel are constructed of dredged material. John Boyle Island near the western terminus of the project area channel is a lump of dredged material. Pattersquash Island was once several islands that now have been united by dredged material disposal.

1.1.2.2.3 Prevailing Sedimentation Regime

The general isolation of the project area from oceanic sediment sources accounts for the large percentage of fine-grained material from adjacent land sources.

1.1.2.3 Biotic Communities

Biotic features for the project area have been taken from New York District (1974b) and O'Connor and Terry (1972).

LIWW Project Area is within a biologic and geologic transitional zone between New England and Middle Atlantic estuarine habitats. Long Island itself is an unusual combination of marine and glacially influenced physiography. The barrier island-bay physiography of the project area dominates the biophysical setting.

1.1.2.3.1 Terrestrial Ecosystem

Terrestrial portions of the landscape surrounding the immediate project area may be divided into two separate entities: the mainland of Long Island and the barrier island (Fire Island or Great South Beach).

Long Island is heavily disturbed due to long-term human habitation. Previously natural biota have been displaced in upland and, to some extent, lowland communities paralleling major streams. Pine forests of upland areas give way to forests dominated by service berry (*Amelanchier* sp.), black gum (*Nyssa* sp.), and holly (*Ilex opaca*).

Upland portions of Fire Island bear the same tree species, but they are strongly influenced by salt spray and are therefore gnarled. Pine and cedar grow with a low, scrubby aspect in the barrier island sands. Beach grass (*Ammophila breviligulata*), beach plum (*Prunus* sp.), poison ivy (*Rhus* sp.), and wild rose (*Rosa* sp.) occur in dune areas, while pine and hardwood low forests grow in the more protected leeward sides of the island.

1.1.2.3.2 Estuarine Ecosystem

Estuarine biotic communities dominated by salt-marsh species are characteristic of shorelines within the project area. These border aquatic communities are dominated by various species of benthic macrofauna.

Marsh plant communities are dominated by smooth cordgrass, saltmeadow cordgrass, and salt grass, depending upon flooding frequency and factors of human disturbance. Disposal of dredged material on marshes has, in many areas, converted original marsh biota to stands of common reed. Salt marshes are important habitat for waterfowl, and extensive use is made of this habitat as well as the more aquatic sections by various species of shorebirds, marshbirds, and migratory waterfowl. More than 80 bird species frequent such areas.

Aquatic estuarine communities below mlw support abundant growths of eelgrass, which becomes broken and uprooted during storms and is washed ashore and into adjacent marshes. Eelgrass is a major food for several species of waterfowl, especially brants. It forms important habitat for hard and soft clams. Several species of macroscopic algae are common throughout.

Other wildlife species, such as raccoons, opossums, foxes, and several other kinds of predatory species depend on estuarine habitats for the majority of their food.

The northern diamondback terrapin is the most characteristic reptile of the estuarine communities.

1.1.3 Institutional Considerations

Representatives of the U. S. Department of the Interior, Fish and Wildlife Service, Division of River Basin Study, and Fire Island National Seashore; the Environmental Protection Agency; and the New York State Division of Environmental Conservation were contacted in order to inform them of the project and solicit their views and comments.

Although conceptually in agreement with the project objectives, agency representatives expressed a number of concerns. Much of Fire Island is under the jurisdiction of the National Park Service, which would prefer marsh creation in the narrow portion of the island west of Davis Park. The Park Service has applied for a CE permit to conduct such work on a small scale near Barrett Beach. The island sites selected and their adjacent bottoms are under the jurisdiction of the town of Brookhaven. The possibility of contaminating nearby shellfish beds through use of polluted material in the marsh-creation project could result in strong opposition from both the town and the 1500 fishermen utilizing these waters. Furthermore, the New York Department of Environmental Conservation is concerned that more resource value would be lost in covering productive shellfish flats than might be realized through the addition of salt-marsh biota.

1.1.4 Benefits and Costs

As will be seen subsequently in the description of the other optimum project areas, detailed-scale information on the benefits and costs associated with marsh creation is practically nonexistent. Thus, until quantification of the kinds of value that were discussed in Volume I as attached to marshes, particularly artificial ones, are available, a reasonable analysis of benefits and costs will remain impossible. Of great importance to such an analysis would be the ability to evaluate the trade-offs of converting one habitat to another.

No information beyond theoretical concepts and reconnaissance-scale information were available for this project area.

1.1.5 Description of Specific Marsh-Creation Sites

The following sites were selected for possible marsh development (Figure 84).

Site 1. Ridge Island

This island may be extended westward over shallow flats permitting marsh development in the lee to the west. This site is exposed to westerly winds blowing the full length of Great South Bay. Material placed on it would therefore be subject to some erosion and redeposition over productive shellfish bottoms nearby.

Site 2. John Boyle Island

This lump of dredged material in the open waters of Bellport Bay was once a tern nesting colony prior to the establishment of vegetation on its upland areas. It could be extended both to the north and south, permitting marsh development along its protected southeastern shoreline. Constraints are similar to those of Site 1.

Site 3. Marsh Cove

This protected area in the extreme eastern end of Bellport Bay presents an opportunity to extend the existing marsh northward. Its use is constrained primarily by the nature of the benthic resources that would be covered, as well as the polluted nature and physical properties of dredged material available.

FIG. 84 LONG ISLAND I.W.W., N.Y.

Site 4. Pattersquash Island

Once a complex of marsh islands, past deposition of dredged material has raised the elevation of much of this area above the marsh level. It represents an opportunity to extend the existing complex to the eastward, parallel to the navigation channel, using material already in place and to expand the spit so-created to the south with additional dredged material. The site is well protected from all but easterly winds, but would be subject to some wake wash from vessels traversing the channel. The use of this site is constrained primarily by the nature of the benthic resources which would be covered.

1.2 Raritan River Project Area and Marsh-Creation Sites

This project area begins at the Washington Canal in New Jersey and extends to Raritan Bay south of Staten Island, a distance of approximately six miles.

Three marsh-creation sites were selected from within the Raritan River Project Area. Two were land extensions of islands and the other a shoreline land extension site.

1.2.1 Characteristics of Dredged Material

The dredged material is soft mud.

1.2.1.1 Physical Properties

The fine-grained mud in the South Channel ranges from silty sand to clayey silt. Near the mouth of the river, the particle size increases through silt to sand-silt-clay or silty sand.

1.2.1.2 Chemical Nutrient Status

No specific nutrient status data were available to this study.

The river bottom at present sustains several fish and crab species. Dredged material will undergo a slight change during the dredging/disposal phases when some leaching of nutrients is to be expected. A return to previous nutrient values is anticipated after cessation of operations.

1.2.1.3 Pollutant Status

Sewage disposal into the Raritan River by some 140 waste-treatment facilities of various degrees of efficiency has, according to the inventory of dredging projects, resulted in waters that are polluted. Sewage waste content is to be expected in the sediment portion of the dredged material.

Analyses of dredged material reveal that volatile solids, Kjeldahl nitrogen, oil and grease, lead, and zinc levels exceed EPA standards (New York District 1973). Despite these levels of pollution, several species of fish and blue crabs are still present, indicating that the waters continue to support aquatic life.

1.2.2 Environmental Description

1.2.2.1 Climatology

The Raritan River Project Area has a mean annual precipitation of 44 in. The annual snowfall of 28 in. covers the ground 30 days out of the average year. The mean length of freeze-free periods is 210 days. Mean winter minimum and maximum temperatures are 24 and

41°F, respectively; while in summer, these temperatures are 64 and 84°F, respectively.

During the winter, south through west-northwest winds of about 20 knots are predominant. Wind speeds of about 15 knots prevail out of the south through the west. Gales are frequent in winter and occur on nearly 10 percent of all days.

1.2.2.2 Hydrology

1.2.2.2.1 Water-Energy Regime

The Raritan River flows at an average of 2.5 fps. In the area of the South Channel, the average velocity is expected to be slower. This is surmised from sedimentation rate comparisons and inferred by the contour of the river through the stretch where the South Channel is located.

The mean tidal range is 5.1 ft at Perth Amboy and 5.2 ft at Sayreville. Mean low water is 2.5 ft below msl. There are two high and two low tides per day.

At Perth Amboy Highway Bridge, the current floods at an average velocity of 2.0 fps and ebbs at 3.0 fps. At the Washington Canal, the flood and ebb tide currents both average 2.5 fps.

That portion of the area to the east of the NY and LB Railroad Bridge is subject to significant wave activity when the wind is blowing from the east to east-southeast. Normal wind regimes do not include easterly winds which blow over long fetches of water and thus build up heavy seas. When easterly winds are experienced, they result from migratory systems where easterlies persist for short periods (four to six hr). The winds, waves, and tides produced when hurricanes sweep up the coast comprise the most severe weather to be expected in the area.

1.2.2.2.2 Hydrography

Depths flanking the dredged channels are shallow, running one to three ft in the southern portions of the river to west of the Edison Bridge. Depths in the northern portions are deeper, running six to 14 ft in this section of the river. East of the Edison Bridge and extending to the NY and LB Railroad Bridge, the depths range from six to 19 ft north of the channel and one to 12 ft south of the channel. The Main Channel is 25 ft deep and 300 ft wide in that section which extends from the NY and LB Railroad Bridge to the wharf at the Raritan Arsenal. The South Channel joins the Main Channel opposite Keasby; from this point to the property line of the Titanium Pigment Company, the channel is 25 ft deep and 300 ft wide, thence it is 15 ft deep and 150 ft wide until it rejoins the Main Channel near Crab Island. Between the two channels is a long spit covered with marsh.

1.2.2.2.3 Prevailing Sedimentation Regime

Sedimentation is uniformly mud. The river deposits most of its load along that section extending the length of the segmented spit abreast the Raritan Arsenal. The rate of sedimentation in the South Channel amounts to 237,900 cu yd per year as compared to 73,900 cu yd per year for the Main Channel.

1.2.2.3 Biotic Communities

The lower portion of the Raritan River is subject to tidal influences originating from the adjacent bays and ocean. Brackish conditions extend approximately 12 miles upstream from the river mouth (Dean and Haskin 1964). Maximum salinities in the project area range from approximately 24 ppt at the river mouth to nine ppt near the entrance of the Washington Canal (Dean and Haskin 1964).

1.2.2.3.1 Terrestrial Ecosystem

The most extensive terrestrial communities within the project boundaries are located between Sayreville and South Amboy. The area is heavily industrialized and contains little vestige of its original biota. Oldfield communities, upland forest associations, and intermediate seral stages are found here.

1.2.2.3.2 Estuarine Ecosystem

Tidal marshes are the most prominent vegetative feature found along the riverine borders of the project area. Extensive marsh acreage occurs north of Sayreville, while smaller marsh communities exist along tributary creeks and on the south side of the river mouth.

Smooth cordgrass dominates the lower marsh areas that are regularly flooded. This grass generally occurs in relatively pure stands and attains its greatest height where tidal inundation is most frequent. Slightly higher, irregularly flooded marsh areas are usually dominated by salmeadow cordgrass and salt grass.

Often associated with these species are sea lavender, plantain, aster, saltbush, goldenrod, and glasswort. Beyond this zone and in less saline waters, common reed, cattail, salt marsh bulrush, and big cordgrass are frequently present.

A variety of wildlife species inhabit the Raritan marshlands. Characteristic mammals found in these communities include raccoons, meadow voles, least shrews, Norway rats, muskrats, long-tailed weasels, minks, and river otters (Connor 1953). Typical avian residents are great blue herons, marsh hawks, soras, clapper rails, Virginia rails, black rails, red-winged blackbirds, and sharp-tailed sparrows. Reptiles found in these communities include eastern mud turtles, eastern painted turtles, and northern diamondback terrapins. Conspicuous invertebrate constituents are fiddler crabs, common periwinkles, mussels, and grass shrimp.

Estuarine open-water communities occur adjacent to the tidal marshlands. The polluted nature of these waters influences the abundance and diversity of wildlife inhabiting these regions. Carps, catfishes, killifishes, and other tolerant fish species currently inhabit the lower river basin. The anadromous striped bass, alewife, blueback herring, and Atlantic shad occur in the adjacent bay region but are not characteristic components of the Raritan watershed at the present time (New York District 1973). Benthic invertebrate populations in these aquatic communities are dynamic and species dominance varies depending on salinity, temperature, dissolved oxygen, predator life cycles, turbidity, and environmental stress. Year-round invertebrate residents of the Raritan River are Balanus improvisus, Mya arenaria, Macoma spp., Spia filicornis, Bowerbanhia gracilis, Mogula manhattensis, Edotea triloba, Cyathura polita, Rithropanopeus harrisii, and Callinectes sapidus (Dean and Haskin 1964). Common avian residents in these communities are mallards, canvas-backs, greater scaups, buffleheads, oldsquaws, great black-backed gulls, ring-billed gulls, herring gulls, and Canada geese. Most of these are primarily wintering species. Mammals and reptiles are not significant components of the open-water communities.

1.2.3 Institutional Considerations

Representatives of the U. S. Department of the Interior, Fish and Wildlife Service, Division of River Basins Study; Environmental Protection Agency; and the New Jersey Department of Environmental Protection were contacted in order to inform them of the project and solicit their views and comments. All agency representatives endorsed the basic concept of the project and wished to be involved in future stages.

1.2.4 Benefits and Costs

The data required to present a meaningful summary of an analysis of benefits and costs associated with the creation of marsh were not available to this study.

1.2.5 Description of Specific Marsh-Creation Sites

The following sites were selected for possible marsh development (Figure 85).

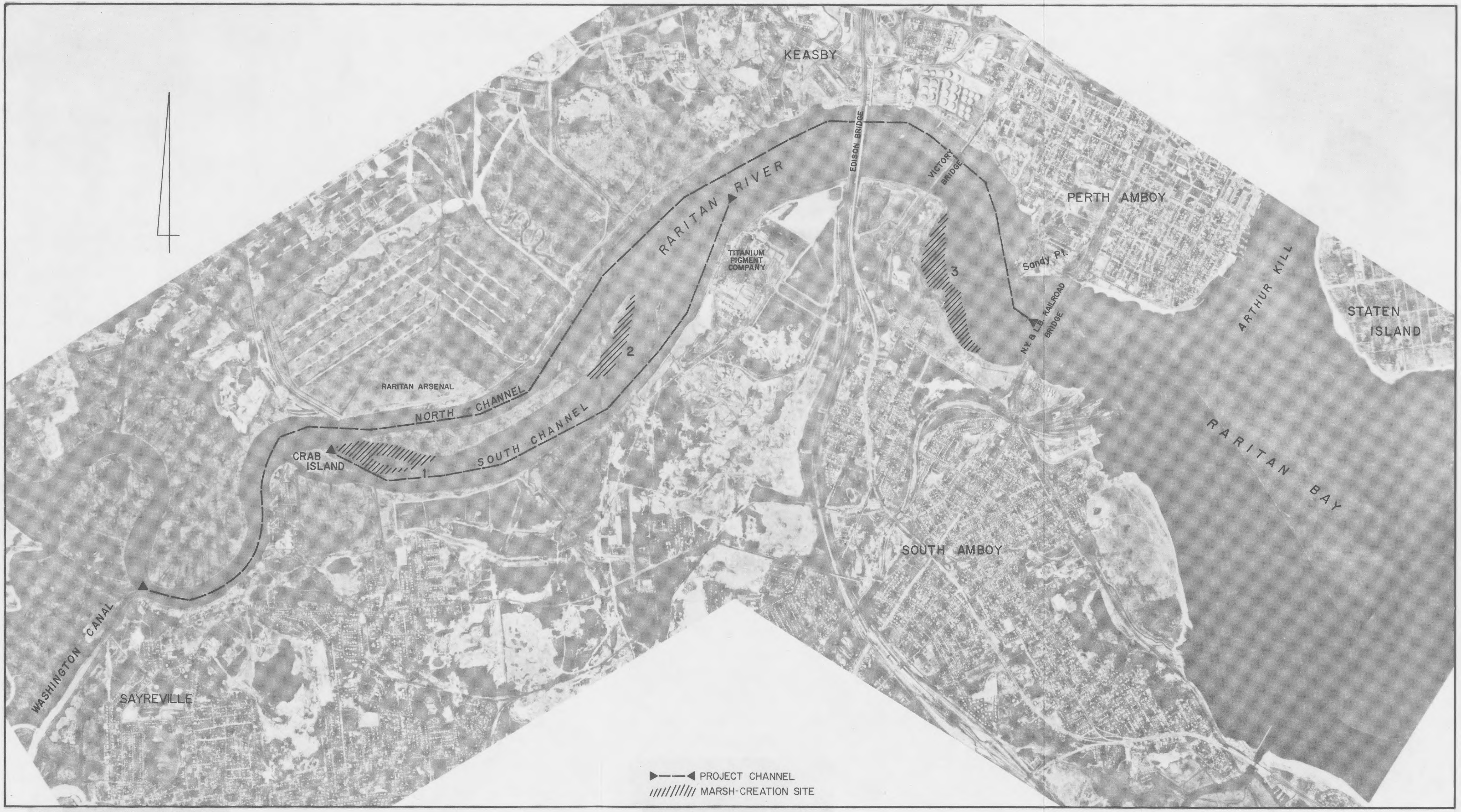

FIG. 85 RARITAN RIVER, N. J.

Site 1. Marsh Island-West

The western tip of the marsh island at the upstream terminus of the South Channel presents an opportunity to extend existing smooth cordgrass marsh over shallow mudflats. This site is extremely well protected from wave action by the narrowness of the Raritan River, the short fetch to which it is exposed, and an existing bulkhead along its northern side. The flats which would be covered consist of soft, fine material. The use of this site is constrained by its close proximity to the Main Channel and South Channel, the small area available, the fine-textured nature of the dredged material, and the availability of an upland disposal site.

Site 2. Marsh Island-North

The northernmost island lying between Raritan Arsenal and Sayreville could likewise be extended northward, between the Main Channel and South Channel. The same characteristics and constraints applicable to Site 1 likewise apply here.

Site 3. Southern Shore

A shallow cove along the southern shore of Raritan River between Victory Bridge and the NY and LB Railroad Bridge presents an opportunity to extend the existing marsh fringe across shallow sand and mud flats. Although somewhat exposed to easterly winds blowing across Raritan Bay, this site is protected from winds in all other quadrants. It is also larger and more removed from the navigation channel than Sites 1 and 2, and could receive dredged material from the lower reaches of the Arthur Kill. The use of this site is constrained primarily by the fine-textured polluted nature of the material available.

2.0 Middle Atlantic Geographical Region

2.1 Indian River Inlet Project Area and Marsh-Creation Sites

The project area is inland from Indian River Inlet and includes portions of Rehoboth Bay and Indian River Bay. A channel running from the inlet westward to Millsboro extends through the area and will furnish the dredged material from which the new marsh can be created. Water-energy values are light to moderate and soil characteristics are excellent for the purpose of marsh creation.

Three marsh-creation sites were selected from within this project area. Two are extensions of exising marsh areas and one is the extension of an island of dredged material.

2.1.1 Characteristics of Dredged Material

2.1.1.1 Physical Properties

The bottom near the mouth of the Indian River Bay between Indian River Neck and White Neck is a mixture of silt and clay while that inland from the entrance is sand with some mixture of shell and pebbles. The range of size in sand grains, pebbles, and shell as well as the silt and clay make a sediment mixture that would be substantial and cohesive when used to build a marsh.

2.1.1.2 Chemical Nutrient Status

No specific nutrient status data were available to this study.

Sediment conditions are such that shellfish are grown and taken in both Rehoboth and Indian River Bays.

Flounder use the area as a nursery ground. Photosynthesis occurs on a year-round basis; the by-products in decay add to the nutritional content of the sediment. There is a large input of nutrients into the bays from the tidal marshlands which surround them.

2.1.1.3 Pollutant Status

The creeks entering the bays are polluted; fish kills in creeks have occurred (Philadelphia District 1973). There has been an increased rate of sedimentation; however, there is a low level of pesticide in the water. The polluting agents come from increased residential and marine activity. Overflowing septic tanks are sufficient to threaten potable water sources. The above factors have not yet reduced the sediment to a polluted status as described in the inventory of dredging projects. The industry in the area consists of a clamshucking factory and a plant to extract magnesium chloride from the water.

2.1.2 Environmental Description

2.1.2.1 Climatology

The humid mesothermal climate of the area is best described as moderate. Summers are generally comfortable with only a few hot, humid periods and winters are relatively mild with occasional intrusions of cold air from the north. Northeasters which last two or three days occur when migratory lows, with their attendant rain and snow, pass along the coast.

Mean annual temperature is approximately 57°F with winter maximum and minimum temperatures of 48 and 30°F, respectively. Summer mean maximum is 83°F, while 68°F is the mean minimum. The average length of freeze-free periods is 210 days. The mean annual precipitation in the project area is 45 in. This total includes 10 in. of snowfall which covers the ground for 18 days.

Winds with speeds of 15-25 knots, depending on direction, predominate from the south through northwest. During the summer, winds of 15-20 knots from the south through west prevail. In the winter time, gale-force winds occur on about 12 percent of all days. The area is influenced by a hurricane about once every two years.

2.1.2.2 Hydrology

2.1.2.2.1 Water-Energy Regime

The mean range of tide at the ocean inlet is 3.8 ft and is 2.4 ft at the highway bridge.

The current at the entrance channel is about 3.4 fps. Values along the shores of the inland bays are lower, and very little, if any, erosion has occurred in the selected site areas except that caused by wind-generated waves and currents.

The site selected north of Burton Island is protected from the northeasterly winds of the storms which pass up the coast by the barrier beach section east of Rehoboth Bay. Largest fetch into the site is from the northwest, but a wind blowing from that direction would have a relatively short duration. Wave-height values will be in the 2- to 4-ft range in such eventuality. The site should be able to withstand wave action of this type if, as expected, the duration is less than six to eight hours. The site selected for increasing the marsh on the northside of Long Neck is likewise well protected against the direct effects of wind-produced waves. Littoral currents generated by prolonged duration of winds would be more erosive to the second site than the island site proposed; however, littoral current values in the bay have been found to be low.

2.1.2.2.2 Hydrography

The project area is traversed from east to west by a channel extending from the inlet to Millsboro, a distance of 14 miles. The channel dimensions vary along its length; through the inlet, the depth is dredged to 15 ft and the width is 200 ft. From the western end of Burton Island, the channel width narrows to 100 ft and the depth is maintained at nine ft. Material from the channel maintenance program are disposed south of the channel in an area near Sand Island. This area extends from the beach barrier westward about 2.5 miles. Soundings in the areas selected for marsh development are not available. On-site soundings will determine best locations for marsh construction within the proposed areas.

2.1.2.2.3 Prevailing Sedimentation Regime

Sediment enters the bay through discharge from the Indian River and the various creeks which feed into the two bays. Direct runoff from the marshlands which surround the bays carries some sediment of a silty type with some clay content.

Sediment also enters the area through the inlet via tidal currents, storm tides, and wind waves.

This sediment is a combination of various grades of sand, pebbles, and shell fragments (Philadelphia District 1973).

2.1.2.3 Biotic Communities

Estuarine bays, lagoons, and baymouth barrier islands occur in the project area. Tidal marshes are the principal vegetative feature. The summary presented by Philadelphia District (1973) is used extensively in the following discussion of biotic communities.

2.1.2.3.1 Terrestrial Ecosystem

Beach dune communities occur on the barrier islands to the east of Indian River and Rehoboth Bays, while coastal shrub thicket communities exist on Long Neck Island and Burton Island. More extensive and diverse terrestrial communities characteristic of the Middle Atlantic geographical region are present on surrounding upland areas.

2.1.2.3.2 Estuarine Ecosystem

Tidal marshes occupy the littoral zones of Indian River Bay, Rehoboth Bay, and their tributaries. Smooth cordgrass dominates the wetter marsh areas from approximately msl to mhw. This grass generally occurs in monospecific stands, and its height and density are influenced by the frequency of tidal inundation. The succeeding community above mhw is usually dominated by saltmeadow cordgrass and salt grass. This marsh zone is frequently bordered on its lower edge by glasswort and sea lavender, and on the upper edges by a shrub community composed principally of marsh elder and silverling. In less brackish areas, the marsh communities above mhw are usually dominated by big cordgrass, blackgrass, and cattails. Throughout the marshlands on topographically elevated hillocks and in man-disturbed areas, common reed is frequently present, often in relatively dense stands. This species is quick to establish and often attains heights of 10 ft.

Wildlife in these salt marshes is varied. Marsh hawks, American bitterns, clapper rails, black rails, soras, red-winged blackbirds, and great blue herons are characteristic avian residents; while fiddler crabs, mud crabs, grass shrimp, mussels, and common periwinkles are typical invertebrate inhabitants. Mammals present in these communities include least shrews, Norway rats, raccoons, river otters, and muskrats. Reptiles are represented by the northern diamondback terrapin.

Open-water communities comprised of bays, lagoons, and creeks lie adjacent to the marshlands. Reportedly, these waters do not contain any eelgrass beds in their subtidal zones. Other submergent aquatics, such as widgeongrass are probably dominant. These seagrasses provide food, shelter, and attachment substrate for a variety of animals. Typical fish species attracted to these communities include striped killifishes, mummichogs, winter flounders, Atlantic silversides, bay anchovies, and sheepshead minnows. All but the bay anchovy are known to spawn in the bay waters. Typical benthic invertebrates found in these aquatic communities are Tellina agilis, Mulinia lateralis, Glycera dibranchiata, Pectinarice gouldi, Anachis translerata, A. awara, Clymenella torquata, Ampelisea abdita, A. vadorum, *Neomysis americana*, *Mysidopsis bigelowi*, *Metamysidopsis munda*, *Gastrosaccus dissimilis*, *Mercenaria mercenaria*, and *Callinectes sapidus*. Birds, and especially waterfowl, are abundant in these communities. Horned grebes, great blue herons, Canada geese, brants, snow geese, pintails, canvas-backs, common goldeneyes, buffleheads, oldsquaws, white-winged scoters, surf scoters, and several species of gulls and sandpipers are common winter residents. Mallards and black ducks are abundant the year-round.

2.1.3 Institutional Considerations

Representatives of the U. S. Department of the Interior Fish and Wildlife Service, Division of River Basin Study; the Environmental Protection Agency; the National Oceanic and Atmospheric Agency, National Marine Fisheries Service; and the Delaware Department of Natural Resources and Environmental Control were contacted in order to inform them of the project and solicit their views and comments. All agency representatives endorsed the basic concept of creating additional marshes through the use of dredged material and wished to be involved in future stages of the project as it progresses. They likewise were reluctant to comment on the desirability of using any specific site until site-specific information became available. In commenting on the Draft Environmental Impact Statement for the Indian River Inlet Project, both the Department of the Interior and EPA had suggested marsh creation as an alternative to past open-water or contained fast land disposal.

2.1.4 Benefits and Costs

Analysis of benefits and costs beyond the reconnaissance-scale associated with marsh creation was not possible because of a lack of data directly related to the project area.

2.1.5 Description of Specific Marsh-Creation Sites

The following sites were selected for possible marsh development (Figure 86).

Site 1. Little Cedar Island

The area from Little Cedar Island extending southward into Head of the Gut represents an opportunity to extend the existing marsh system westward or to create additional marsh island. The site is within pumping distance of both maintained channels, but would more appropriately serve the channel to Indian River Inlet. Use of this area is constrained primarily by the dangers of erosion from strong northwest winds, productivity of bottoms which would be covered, and interference with osprey nesting on nearby duck blinds.

Site 2. Nats Cove

This marsh-fringed area is protected from all but northerly winds. Bluff Point, at its eastern extremity, was used for dredged material disposal in 1968 and could be extended westward to afford even more protection to the waters behind. Similar spits at the Pullover and Raccoon Point indicate that the dominant current direction is northwestward and would facilitate spit development at Bluff Point. Use of this site is constrained primarily by the benthic resources that would be covered in the marsh-creation process.

FIG. 86 INDIAN RIVER, DEL.

Site 3. Sand Island

Sand Island is a designated disposal area for material removed from the Indian River Inlet project. Although exposed to westerly and southerly winds, and to a lesser degree northerly winds, the benthic resources in this area have been periodically disrupted by past dredging activities and, thus, would probably be less valuable than those in sites 1 and 2. Existing Sand Island could be expanded to the east and south, providing a protected area to the southeast in which new marsh could be developed. Shorebirds and gulls were using emergent portions of Sand Island as a resting area on April 16, 1974, but no sign of a nesting colony was apparent. This site would appear to be ideal for a tern colony, however, and these birds would probably utilize freshly dredged material if it were deposited on the island. Use of this site is constrained primarily by physical factors; the long westerly and southerly fetch could produce excessive erosion, necessitating some form of control structures.

2.2 Smith Island Project Area and Marsh-Creation Sites

The project area encompasses two existing channels: one which links Rhodes Point and the town of Tylerton and the other which provides passage from Chesapeake Bay to the town of Ewell and thence to Twitch Cove in Tangier Sound through the Big Thorofare River. A side channel connects Tyler Ditch with the Big Thorofare channel at Easter Point. The water energy, which is land-erosive, is primarily due to wind-driven waves; sites selected have been determined by features which offer best protection against those offending wind regimes which are most constant. The selected sites are within the effective range of hydraulic pumping from project channels.

The five sites selected for marsh creation within the Smith Island Project Area are all land- or marsh-extension opportunities. Three are associated with islands and two within estuarine creek situations.

2.2.1 Characteristics of Dredged Material

2.2.1.1 Physical Properties

The material dredged from the Twitch Cove section of the Big Thorofare channel is sand and silt; the material from the Tangier Sound and of the channel is sand. The sediment from the Tyler Creek Channel is predominantly sand with some sandy clay admixture.

2.2.1.2 Chemical Nutrient Status

No specific nutrient status data were available to this study.

This set of properties can only be qualified through inference. The Smith Island area abounds in fish, oysters, and clams and is a refuge for migratory, semi-migratory, and year-round resident birds. This condition indicates that the nutritional value of the sediment is high since it supports the biota upon which finfish, shellfish, and bird populations subsist. Sediment from previous operations has been used as marsh fill and became vegetated shortly after placement.

2.2.1.3 Pollutant Status

The CE inventory of dredging projects noted that the sediment of the Smith Island area was not polluted.

There are no industrial plants on the island and the population totals about 700 people. There is both commerical- and sport-boating in the area; however, pollution has remained relatively light.

2.2.2 Environmental Description

2.2.2.1 Climatology

The project area has a mean annual precipitation of 48 in., including 12 in. of snow which covers the ground for 18 days; therefore, climate is classed humid mesothermal. The winter temperature ranges have mean maximums and minimums of 46 and 29°F, respectively, and the summer maximum and minimum temperatures are 86 and 68°F, respectively. Length of freeze-free periods averages 230 days.

The winds vary southwesterly to northwesterly both during the summer (mean of 7.5 knots) and winter (mean of 11 knots). While these mean wind values are relatively light, each month of the year contains record of one or more days during which the wind blew at speeds of 34 knots or greater. January, with the highest frequency, averages 45 hr of gale winds; while the month of July is the lightest month in this respect with a two-hr average. Within the innocuous two-hr average, however, are hidden several hurricanes. The hurricane season extends from June through October, and it is an infrequent year that does not see one or more of these destructive storms sweep up along the Atlantic Coast and disrupt activity in the Smith Island area.

2.2.2.2 Hydrology

2.2.2.2.1 Water-Energy Regime

The tidal range at Smith Island averages 1.7 ft. There are two high and two low tides per day.

Tidal currents are rather light, averaging 1.7 fps or less. Kedge Straights has 1.5 fps at ebb. The current at Smith Island Shoal is 0.7 fps at ebb. The very shallow waters at both selected sites attest to low-energy levels at these places.

Wave exposure is significant on Smith Island shores. The erosion that has occurred has been due primarily to this factor. Proposed marsh-creation sites on Long Creek and Tyler Creek are best protected from wind-generated waves and littoral currents. Although not a problem at these sites, winds from the south and from the west-northwest offer greatest fetches over which winds can generate significant wave heights, thus special protective structures for marsh establishment might be necessary for any marsh-creation sites exposed to these fetches. The other proposed sites are more exposed to westerly winds and would require protection of some kind. January is the stormiest month, but greatest destruction can occur during the summer and autumn when hurricane activity is possible in the area.

2.2.2.2.2 Hydrography

Smith Island consists of a large number of marshy islands separated by narrow thoroughfares. Channel width averages about 40 ft and the depths vary from four to six ft. A side channel off the Big Thorofare at Tyler Ditch is six ft deep and 40 ft wide. The other channel of interest extends from Rhodes Point to Tylerton and has a controlling depth of six ft.

From time to time sediments have choked sections in the southern end of the Rhodes Point to Tylerton Channel requiring local boatmen to use their knowledge of the area to exit the south end. Elsewhere in the Smith Island area, the water is very shallow and appears as mud flats at low tide.

2.2.2.2.3 Prevailing Sedimentation Regime

The sediment, primarily sand, results from tidal wash brought into the area by tidal currents and from erosion of the wetland banks caused by wind-produced waves.

2.2.2.3 Biotic Communities

Estuarine tidal marshes, lagoons, and creeks dominate the Smith Island Project Area. Extensive upland terrestrial communities do not occur on the island due to its low topography. Much of the description of the biotic communities comes from Baltimore District (1974).

2.2.2.3.1 Terrestrial Ecosystem

Most of the higher elevations on Smith Island were created during periods of channel dredging and are the result of deposition of dredged material. Some of these disposal sites are virtually bare sand while others are covered with various forbs, grasses, shrubs, and occasionally trees. One disposal area located northeast of

Tylerton is occupied by a woodland community approximately 15-20 acres in size. Other trees and shrubs are present in the three villages located on the island. A few narrow sand beaches are also present on the island and occur primarily along its western shores (Baltimore District 1968). The higher tree and shrub vegetated areas provide nesting cover for herons, black ducks, and song birds; a more sparsely revegetated area at the confluence of Tyler Ditch and Big Thorofare is utilized by a breeding colony of herring gulls. In addition to their value as bird-nesting areas, these systems serve as essential refuges for marsh animals during periods of flooding. As such, they contribute greatly to the overall productivity of the Smith Island area.

2.2.2.3.2 Estuarine Ecosystem

Tidal marshes occupy the greater portion of Smith Island. Black needlerush vegetates more than 80 percent of the area, with saltmeadow cordgrass, smooth cordgrass, and salt grass making up the remainder of the irregularly flooded marshes. Common threesquare, spike rush, and marsh elder are frequently present on slightly higher elevations or in waters of lower salinity.

Widgeongrass, an important waterfowl food, occurs on the bottoms of the shallow pools and creeks found within the tidal marshes. This seagrass is also present in the shallow subtidal zones of the lagoons and open waters adjacent to the marshlands. The abundance of widgeongrass depends upon prevailing water depth, salinity, substrate, and turbidity. Densest growth generally occurs in areas where water depths are two to three ft, where salinities are moderately low, and where substrates consist of soft sand and mud.

The estuarine communities of Smith Island are important resting and feeding habitat for migratory waterfowl, especially during unusually cold winters when better habitats to the north are frozen over. The shallow pools within the salt marshes are utilized extensively by these avian species and the surrounding marsh grasses provide efficient protective cover. Canada geese, pintails, and redheads comprise the greatest percentage of the wintering avifauna. Marsh hawks, clapper rails, and numerous black ducks are present year-round and are known to nest on the island (Scott and Cutler 1973; Baltimore District 1974). Nesting ospreys have utilized 20 of the 22 nesting platforms erected on the refuge. Other species which are present during the various months of the year are common terns, Forster's terns, least terns, black skimmers, ring-billed gulls, great blue herons, soras, Virginia rails, black rails, and sharp-tailed sparrows. Reptiles and mammals are poorly represented in these estuarine communities with only the northern diamondback terrapin, minks, nutria, and muskrats known to be present. Species of fish present include the striped bass, spot, weakfish, white perch, bay anchovy, American eel, sheepshead minnow, striped blenny, Atlantic silverside, mummichog, striped killifish, and menhaden (Metzgar 1973; Baltimore District 1974). Characteristic invertebrates found in these areas are blue crabs, American oysters, soft-shell clams, fiddler crabs, mud crabs, periwinkles, barnacles, limpets, mussels, segmented worms, and others.

The population of Smith Island is entirely dependent upon the estuarine ecosystem for its existence. During 1972-73, approximately 8,500 bushels of oysters, valued at dockside at nearly $42,500, were harvested in that vicinity. Crabbing is also important. Commercial fishermen landed approximately 565,000 lb of finfish in the vicinity of Smith Island in 1971 (Baltimore District 1974).

2.2.3 <u>Institutional Considerations</u>

Representatives of the U. S. Department of the Interior, Fish and Wildlife Service, Division of River Basins Study, and Martin National Wildlife Refuge; the Environmental Protection Agency; the National Oceanic and Atmospheric Administration; National Marine Fisheries Service; the Maryland Department of Natural Resources; and the Virginia Marine Resources Commission were contacted in order to inform them of the project and solicit their views and comments. Without exception, all agency representatives endorsed the basic concept of creating additional marsh through the use of dredged material and wished to be involved in the future stages of the project as it progresses. Agency representatives were also unanimous in their reluctance to comment on the desirability of using any specific sites until additional site-specific environmental data and design information were available. The greatest reservations were expressed by a representative of Martin National Wildlife Refuge, who was opposed to any open-water disposal within the refuge boundary but would consider filling some of the existing black needlerush marsh to create a salt meadow or shrub system. Such areas, he felt, would be more valuable to the refuge than simply creating more needlerush marsh.

2.2.4 Benefits and Costs

The study was unable to obtain any existing data that would permit a rational analysis of the relative benefits and costs to be incurred by this proposed project. This task, important as it is, must therefore await an in-depth study of the Smith Island area and the generation of new economic data.

2.2.5 Description of Specific Marsh-Creation Sites

The following five sites were selected for marsh creation (Figure 87).

Site 1. Long Creek

The eastern side of Long Creek, along Bare Marsh, is sheltered from all but westerly winds and presents an opportunity to extend the marsh westwardly or to create a new marsh island. The site is within pumping distance of most of the channel maintenance work on the island and could serve as a central repository for dredged material.

Use of this site is constrained by the possibility of material moving back into the maintained channel, the necessity to maintain free tidal interchange in Long Creek, the erosive effect of westerly winds, and considerations of Martin National Wildlife Refuge.

Site 2. Fishing Creek Marsh

A small cove on the eastern side of Fishing Creek Marsh, along the western shore of Tyler Creek just north of the Maryland-Virginia line, could be filled in, extending

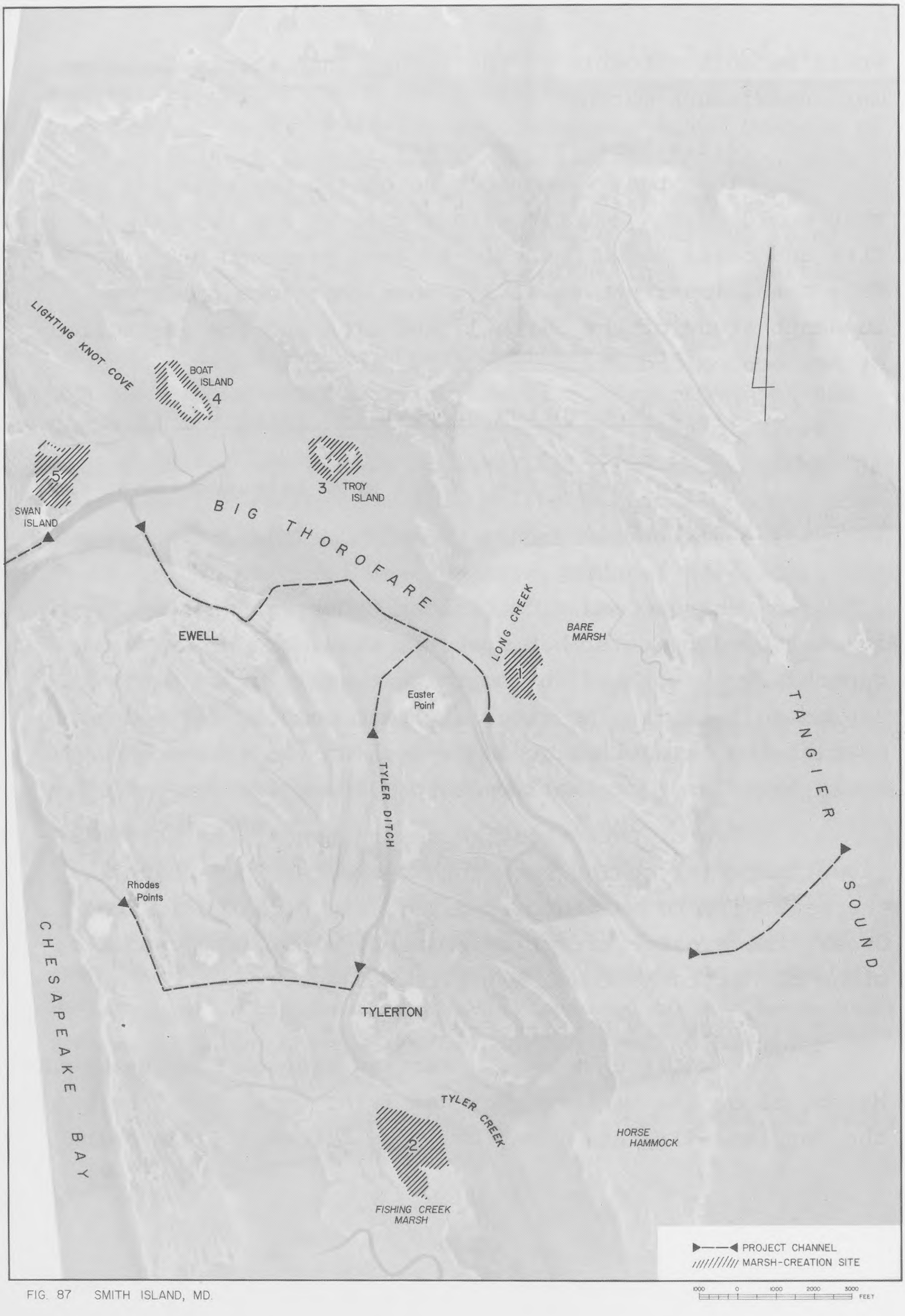

FIG. 87 SMITH ISLAND, MD.

the existing marsh northward. This site could serve the Rhodes Point to Tyler channel, but would be too remote for use in maintaining the Big Thorofare. Well protected from westerly winds, the site is exposed to an easterly fetch of about one mile. The use of this site is constrained primarily by the dangers of erosion from easterly winds.

Site 3. Troy Island

This small island in the embayment portion of Big Thorofare could be considerably enlarged, or a new island created nearby, by the use of dredged material. Water depths in this area are generally less than one ft at mlw. A net addition of only about two ft of fill would be required to create a suitable marsh surface, thus minimizing the area of peripheral bottom that would be covered. Although this site is well protected from northerly winds, it is exposed to westerlies and lies within the wildlife refuge. Use of this site is constrained by the amounts of productive bottom that would be covered in marsh creation and the danger of erosion from westerly winds.

Site 4. Boat Island

This site lies about one-half mile west of Troy Island, in the Big Thorofare embayment. The discussion of Troy Island is also relevant to Boat Island.

Site 5. Swan Island

The northern jetty protecting the Big Thorofare channel from the open waters of Chesapeake Bay is anchored to Swan Island. This area has previously been used for dredged material disposal, with 10,000 cu yd being deposited there as recently as the fall of 1973. The western margin of Swan Island has been severely eroded, and the tie between the island and the jetty has been broken. The use of Swan Island provides an opportunity to reinforce the shoreward end of the jetty, to provide a feeder beach north of the jetty, and to extend the marsh area north and east from Swan Island. Swan Island is exposed to the full erosive force of Chesapeake Bay waters and to a two-mile fetch in the easterly direction, but is reasonably well protected in the north and south quadrants. Use of this area is constrained by the probability that much of the material placed along the western beach would be washed away, the possibility that material would be refluxed into the existing channel, and the considerations of Martin National Wildlife Refuge.

3.0 South Atlantic Geographical Region

3.1 Roanoke Sound Project Area and Marsh-Creation Sites

This project area is located in the sound between Roanoke and Bodie Islands. A dredged channel extends from Nags Head Light to Duck Island with two side channels branching from the main channel: one through Shallowbag Bay to the town of Manteo and the other into Wanchese.

The entire sound is shallow and tidal currents are slight; therefore, site selection emphasized convenience considerations, such as ease of deposition of dredged material and facility with which the developing marsh can be periodically monitored. The four marsh-creation sites selected in this project area include three land extensions of existing marsh and the fourth is a series of islands of dredged material.

3.1.1 Characteristics of Dredged Material

3.1.1.1 Physical Properties

The bottom in the section from the northern end of the project area to Broad Creek is of medium-fine sand. From Broad Creek to Duck Island, the sand is more coarse. The coarse sands are often covered with a fine veneer of silt. There is some shell content in the dredged material, especially in the Shallowbag area.

3.1.1.2 Chemical Nutrient Status

No specific nutrient status data were available to this study.

An organic carbon analysis, reported by Schwartz (1973), indicated low percentages of carbon content throughout Roanoke Sound. Percentages at the northern end of the sound are slightly higher than those near Duck Island at the southern end. The finfish population estimated in that study indicates larger numbers of fish in Roanoke Sound than in Croatan Sound, Stumpy Point Bay, or Ocracoke Channel. This infers that the chemical nutrient status in the project area is sufficient to sustain basic trophic levels supporting fish species common to regional estuaries.

3.1.1.3 Pollutant Status

Only total volatile solids and chemical oxygen demand data, recorded in 1971, were provided in Wilmington District (1974) information. The volatile solid data outside the harbor range from 0.3 to 6.0 percent; while Manteo Harbor and Wanchese Harbor had 17 and 21 percent, respectively. The harbor levels exceed EPA standards. Chemical oxygen demand values of sediment in Manteo Harbor (21 percent) and Wanchese Harbor (27 percent) also far exceeded those of Roanoke Sound, which ranged from 0.4 to 6.2 percent. Thus, EPA chemical oxygen demand criterion was exceeded only slightly in sediment at one station in the sound; but the chemical oxygen demand was significantly higher than the criterion in both harbors.

3.1.2 Environmental Description

3.1.2.1 Climatology

The climate of the project area is humid mesothermal with a mean annual precipitation of 48 in. Temperatures are relatively mild in that winter mean maximum and minimum temperatures are 55 and 40°F, respectively, and maximum and minimum readings in summer are 85 and 70°F, respectively. Average number of frost-free days is about 270.

Two general wind regimes dominate the project area. From September through February, winds average 10 knots from north-northeast. This changes to the southwest at nine knots, on the average, during March through August. Itinerant storms cause winds which well exceed the general averages. The stormiest month is January when winds of gale force (34 knots or greater) can be expected for 65.5 hr.

During a span of 55 years, more than 21 tropical storms have passed close to the area. The tides these storms push ahead of them are sufficient to inundate the flat islands of the Outer Banks and cause abnormally high water levels in Roanoke Sound. Such storms alter the hydrography, as well as natural formation of marshes, of the area by transport of sand from the ocean to the sound and from one section within the sound to another.

3.1.2.2 Hydrology

3.1.2.2.1 Water-Energy Regime

The tidal range is slight in the area. At Oregon Inlet the mean is 1.8 ft. This can be amplified by the wind, however, which can collect the water into sections of the sound depending upon its direction, force, and duration. There are two high and two low tides per day at the Oregon Inlet end of the sound; however, the tidal effect in the channel area abreast Wanchese and Manteo is small and is generally masked by wind-driven components. Since winds are normally strongest in the afternoon and weakest at night, the wind-produced tides are diurnal.

Tidal currents are minimal in Roanoke Sound; however, the current at Oregon Inlet often reaches 10.1 fps. Currents which exist within the sound are primarily wind driven and are on the order of one to 3.4 fps generally from the south along the axis of the channel; they are strongest in midafternoon. Currents should not be a deterrent to new marsh construction.

The sites chosen are well protected against the waves generated by normal weather regimes. Should a hurricane cross the area, large-scale waves might either destroy or build up any newly constructed marsh. The sites selected are in the lee of existing land with respect to those wind directions and fetches which generate large waves. The land, however, is flat and large waves riding on heavy swells have swept over Bodie Island into the sound. There is no sure shelter against such an eventuality.

3.1.2.2.2 Hydrography

Water depths in the sound are one to nine ft (shallowest on the Bodie Island side). A section south of Duck Island in Old House Channel has depths to 18 ft. The contours near Roanoke Island range from three to six ft. The channel, which traverses the deeper water near Roanoke Island, is dredged to 12 ft. The width of the channel is 100 ft.

3.1.2.2.3 Prevailing Sedimentation Regime

The study by Schwartz (1973) indicated that some fine material is carried into the sound by runoff from the adjacent streams and swamps; however, the bottom is composed primarily of sand. Some fine sand of oceanic origin is swept into the sound through Oregon and other inlets and distributed south of Duck Island by currents. Sediment in the northern end of the sound is medium-fine sand, and the sediment in the middle part of the sound to Duck Island is coarse sand. The basic sand sediment is periodically covered by a thin veneer of silt, which moves in response to the wind-controlled currents of the project area. The sand is later exposed when the silt is removed by the currents.

3.1.2.3 Biotic Communities

The major ecosystem in the Roanoke Sound Project Area is estuarine, made up of sloughs, bays, creeks, channels, and shoals bordered by an intertidal marsh community. Protecting the sound on the east is Bodie Island, a barrier island which bears the major terrestrial ecosystem, and the west side also has considerable marshland. The western portion of the project area includes Roanoke Island with the largest areal extent of marsh.

3.1.2.3.1 Terrestrial Ecosystem

The terrestrial community of Bodie Island is typical of a stabilized barrier island as described by Dolan et al. (1973). The terrestrial ecosystem and its associated communities on Bodie Island are described below, proceeding from the ocean side across the barrier island to the upland community on the sound side.

The surf and beach community is typified by the paucity of vegetation and is influenced by wave and tidal action. Above this it is the foredune habitat dominated by sea oats (Uniola paniculata), beach grass, and other herbaceous species. Characteristic animals of this habitat include ghost crabs, sand fleas, and savannah sparrows. Vegetation behind the dunes is composed of a shrub and grass habitat, characterized by wax myrtle, silverling, and marsh elder. Following the grass and shrub community, a maritime shrub thicket often occurs. It is composed of yaupon, scrub live oak, and wax myrtle. Animals typical of this community include green anoles and the southern black racer. Leeward of the shrub thicket, the maritime forest, composed mainly of live oak and red cedar, dominates. Typical animal life includes the eastern cottontail, opossums, Carolina wrens, cardinals, and the rough green snake (Engels 1952). Terrestrial communities on Roanoke Island are highly disturbed but consist largely of maritime live oak and pine forest species.

3.1.2.3.2 Estuarine Ecosystem

The marsh community, both low and high salt marshes, are flooded on a regular and irregular basis, respectively. Smooth cordgrass is the dominant plant in the low salt marsh. Proceeding to slightly higher elevations, black needlerush becomes dominant, frequently occurring with or above saltmeadow cordgrass and salt grass.

The high marsh constitutes 90 percent or more of the marsh communities in the project area. Within this community, mammals, such as muskrats, otters, raccoons, minks, and nutria, are typical (Wilson 1962). Birds are the most obvious animal life observed in the marshes. A variety of rails, herons, and egrets are present throughout the year either as summer or permanent residents.

The estuarine waters of Roanoke Sound have been studied by Schwartz (1973) and his findings were used extensively in this description.

The salinity of Roanoke Sound varies greatly both seasonally and geographically. These variations fluctuate under the seasonal influence of freshwater discharge from the large coastal drainage areas. Schwartz found that waters in the northern portion of Roanoke Sound were often fresh, while those south of Manteo are subject to higher salinities emanating from Oregon Inlet. During the winter and spring months, the sound salinities drop because of surface rain waters from Currituck and Albermarle Sounds which are passed south to Oregon Inlet. Annual salinities at Oregon Inlet ranged from 7.1 to 31.8 ppt while salinities in the upper portions of Roanoke Sound ranged from approximately fresh to 18 ppt. These wide fluctuations and the presence of a land barrier significantly influence sessile organisms.

During periods of low salinities, marine fish do not enter the sound, and high salinities of summer and fall restrict freshwater fishes to the upper portions of the sounds. Thus, the largemouth bass and other freshwater fish are caught in the upper portions of the sound. Fish characteristic of salt water occur in the lower portion of the sound and include spots, red drums, black drums, mullets, and spotted sea trouts. Invertebrates of economic importance that occur are American oysters, quahog clams, blue crabs, and shrimp. Throughout the estuarine system, large, diverse avian populations utilize all portions of the estuarine ecosystem, especially during the migratory periods, when large numbers of waterfowl and shorebirds are present as winter residents and transients. Typical permanent residents include black skimmers, black ducks, and double-crested cormorants. Sea turtles are found on the seaward side of Bodie Island inshore and on the sandy beaches during the summer reproductive season.

3.1.3 Institutional Considerations

In addition to contacts with Wilmington District, the U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife; and the North Carolina Department of Natural and Economic Resources, Division of Commercial and Sports Fisheries, were interviewed. No major constraints or opposition to the concept of marsh creation were voiced. In general, representatives felt that significant coordination and site-specific planning would be necessary before actual marsh creation could proceed.

The North Carolina Department of Natural and Economic Resources, Division of Commercial and Sport Fisheries, is strongly in favor of marsh conservation to the point of opposing any project that proposes to remove either high or low marsh, regardless of the merits of the work. Where estuarine projects are approved, the State favors mitigation in the form of "replacing similar habitat". For instance, the State opposes the covering of productive bottoms in favor of placing newly dredged material in an area and attempting to vegetate the deposits - the Division of Commercial and Sport Fisheries prefers the use of enclosed (diked) upland (above mhw) disposal sites. The possibility was suggested of marsh planting in suitable natural areas such as adjacent to the existing lumps of dredged material and the possibility of introducing more smooth cordgrass into the Albermarle Sound area.

The Wilmington District is currently paying from $0.81 to $1.50 per cu yd of dredged material from their various projects in the project area. They voiced some concern that extending the hydraulic pipeline to areas beyond current disposal sites, although within effective range of one booster, might be prohibitive in terms of cost.

3.1.4 Benefits and Costs

Beyond the reservations Wilmington District expressed regarding dredging costs (3.1.3), no additional information was available for analysis of benefits and costs specifically related to marsh creation.

3.1.5 Description of Specific Marsh-Creation Sites

The locations of the sites selected are shown on Figure 88.

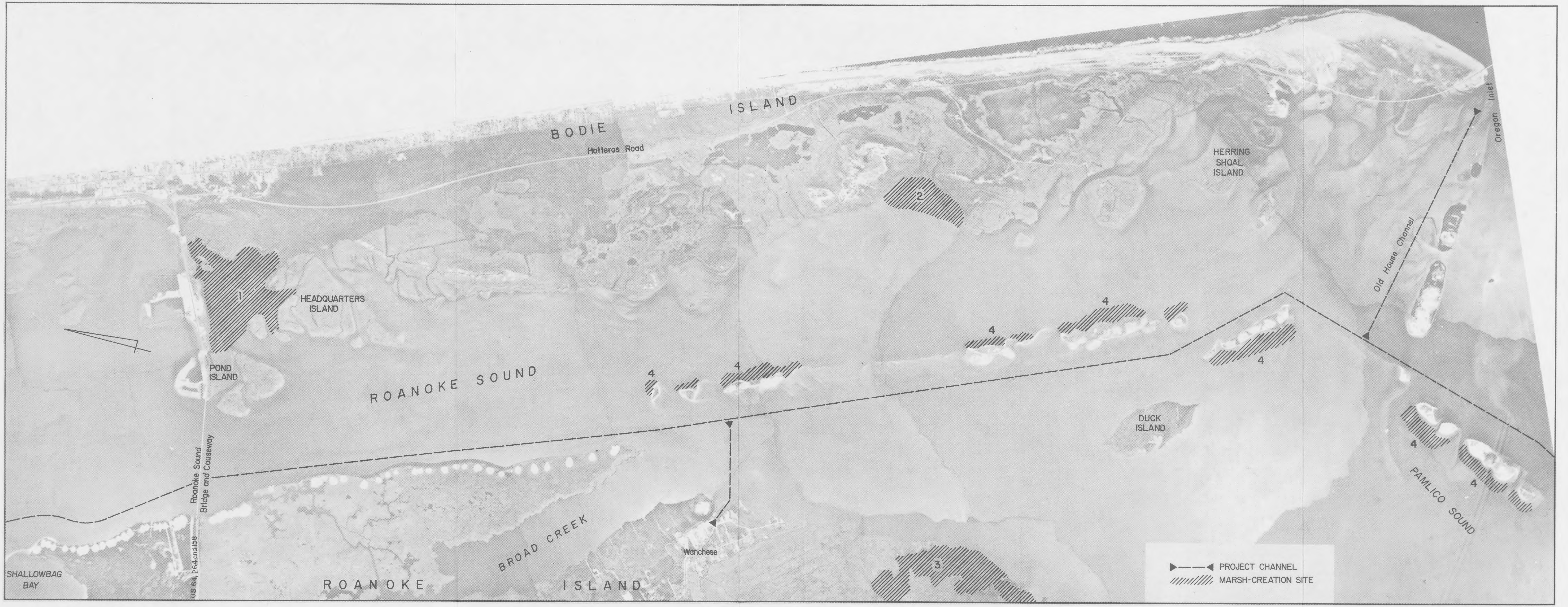

FIG. 88 ROANOKE SOUND, N. C.

Site 1. Bodie Island-North

This site is well protected from a long northward fetch by the bridge and island associated with the causeway from Roanoke Island to Bodie Island, as well as islands to the south which cut off a long fetch from that direction. The water depths in the embayment are shallow (0.5 to +2.0 ft) and the shore is vegetated by black needlerush. Smooth cordgrass could be used to extend the existing marsh toward the surrounding island; however, care would have to be taken to prevent waterfowl from eating the seedlings.

Site 2. Bodie Island-South

Essentially the same as site 1, this site is somewhat less protected. The generally low water-energy regime of the project area and site location will allow marsh creation, and the higher salinities here would be more conducive to smooth cordgrass establishment than those of site 1.

Site 3. Roanoke Island

The conditions controlling sites 1 and 2 are applicable to this site. It is the most exposed of the three and more subject to fall and winter northeasters and to southwesterly winds and waves during the spring and summer. Even under these more exposed conditions, the sandy nature of the material dredged will probably allow marsh creation on this site. Artificial marshes developed could be extended to Duck Island; however, such a plan would require detailed predictions of impacts on estuary circulation.

Site 4. Dredged Material Islands

Several islands of dredged material along the main channel offer excellent opportunities for marsh creation by extending them toward Bodie Island. Care would be necessary to ensure adequate circulation patterns between potential island-marsh complexes and the barrier island. The islands are sparsely vegetated, but appear to be fairly stable. Creating marsh would likely decrease the amount of sediment re-entering the main channel, particularly during northeasters; and because the islands are close to the present dredging operations, marsh creation would not involve additional expense. Other similar island situations exist west of the main channel and Old House Channel. While they may experience a higher water-energy regime throughout the year, these conditions are not viewed as severe constraints.

Although not specifically discussed or represented by a selected site in the present study, several sites suitable for marsh creation in open-water situations are probable. A detailed hydrologic survey would, however, be needed to locate such areas.

3.2 St. Lucie Inlet Project Area and Marsh-Mangrove Creation Sites

The project area is located between Hutchinson Island and Jupiter Island and includes the convergence of the Indian and St. Lucie Rivers near Stuart, Florida. Currents in the inlet are strong. The normal currents in the inlet itself have been altered by the construction of a jetty which extends seaward from North Point (the northern shore of the inlet). This jetty, now in ruins, extends about 0.2 miles offshore and forms a barrier such that erosion of the beach south of the inlet has been aggravated to a degree requiring implementation of a beach enrichment program. The projected extension of this jetty and the construction of a new one from South Point will further alter current patterns in the seaward section of the inlet. Because of this and the high water energy outside the inlet, marsh-creation site selection was restricted to the inland section of the inlet where depths and current velocities are lower.

The three sites selected from within this project area are land-extension opportunities of existing islands and build up of shoal areas.

3.2.1 Characteristics of Dredged Material

The bottom sediments are sand and shell.

3.2.1.1 Physical Properties

The sand in the inlet is generally tannish gray of medium grade and mixed with poorly graded shell fragments. Seaward of the inlet, the sediment is fine sand and shell and is subject to shifting by wave and tidal action. The grain sizes of samples taken in the borrow area vary in size from 0.1 to 2.0 mm, with 65 percent being about 0.5 mm (Jacksonville District 1973a).

3.2.1.2 Chemical Nutrient Status

No specific nutrient status data were available to this study.

3.2.1.3 Pollutant Status

Chemical analysis of sediment in the project area performed by the Corps of Engineers in 1972 indicated that, by EPA standards, the sediment was not polluted (Jacksonville District 1973a).

3.2.2 Environmental Description

3.2.2.1 Climatology

The project area has humid subtropical climate with a mean annual precipitation of approximately 53 in., most of which occurs from June through November. Average daily winter maximum and minimum temperatures are 75 and 58°F, respectively, and the corresponding means for summer are 92 and 75°F. Days during which temperatures go below freezing occur in less than half the years of record.

In summer, east through south winds predominate with speed varying from 10 to 20 knots; while winter winds are highly variable in speed and direction. Hurricanes seldom cross the project area. They tend to follow the Gulf Stream north, however, and it does swing close to the coast near the inlet and peripheral hurricane winds are felt there. Approximately 30 percent of the years of record show the influence of these destructive storms.

3.2.2.2 Hydrology

3.2.2.2.1 Water-Energy Regime

The mean tidal range is 2.6 ft above mlw on the ocean side of the inlet and about one ft on the landside. There are two high and two low tides per day. The offshore littoral drift current is from north to south. In the inlet, the current is a combination of tidal currents, wind-produced components, and the floodwater discharge from Lake Okeechobee. A combination of ebb after a spring tide and a heavy discharge from the lake can produce a current in excess of 12 fps at the inlet, where cross currents at the entrance complicate navigation (Jacksonville District 1973a).

Wind-waves are dependent on wind velocity, fetch, and duration. On the average, the wind has an easterly component 283 days out of the year. On windy days, wave heights arriving at the inlet are on the order of five to eight ft. As the waves reach the shoal water, heights can build up to 10-12 ft. Hurricanes generally skirt the area to seaward, but their tidal effects can still be felt at the inlet (Jacksonville District 1973a).

3.2.2.2.2 Hydrography

Soundings across the inlet range from less than one ft on the south side to 14 ft on the north side of the channel. The channel through the inlet is oriented along an east-to-west line and joins the channels of the AIWW and the Okeechobee Waterway. A 1969 hydrographic survey indicated channel depths of seven to 12 ft over the bar at the entrance and through the inlet to buoy 7A where it meets Indian River; thence, the depths increase to 14 ft at its junction with the AIWW and the Okeechobee Waterway (Jacksonville District 1974).

Aerial photos show considerable shoaling on the east side of Indian River down to North Point and across to Sewall Point.

3.2.2.2.3 Prevailing Sedimentation Regime

Sediment (medium sand and shell),

transported by littoral currents which predominate from the north, is derived primarily from the ocean; however, there are minor seasonal variances. Some tidal current transport of sand occurs from the Indian River to seaward. The discharge from the Okeechobee Waterway does not materially alter the character of sedimentation in the inlet (Jacksonville District 1973a).

3.2.2.3 Biotic Communities

The principal ecosystems in the project area are terrestrial and estuarine, the latter consisting of marsh, mangrove, and open-water communities located in parts of the St. Lucie River, Indian River, Willoughby Creek, Manatee Creek, the Great Pocket, AIWW, and numerous small coves.

3.2.2.3.1 Terrestrial Ecosystem

Several distinct biotic communities occupy the upland regions surrounding the project area. Beach dune communities and saw palmetto-scrub thickets are present on the outer barrier islands. Slash pine flatwoods, sand pine scrub, tropical hardwood forests, and associated seral stages, such as old fields, occur on the mainland.

3.2.2.3.2 Estuarine Ecosystem

The littoral zones of the estuarine waters in the project area are occupied by salt marshes and mangrove communities. The former occur only in scattered clumps. The intertidal zones having salt marsh are regularly flooded and contain, almost monotypically, smooth cordgrass. On higher elevations within this zone, black needlerush may be present along with saltmeadow cordgrass, often one or the other are in relatively pure stands. Beyond mhw the marsh is subject to infrequent inundation and rapid evaporation thereby influencing an accumulation of salts. Highly salt-tolerant, succulent plants, such as glasswort, saltwort, and sea oxeye, are prevalent in these areas. Salt marshes appear to pioneer the establishment of mangrove.

Wildlife in the St. Lucie salt marshes is diverse. Characteristic year-round avian residents are clapper rails, white ibises, wood storks, American bitterns, great egrets, and several species of herons. During winter, these communities provide habitat for willets, greater yellowlegs, lesser yellowlegs, marsh hawks, sharp-tailed sparrows, Virginia rails, soras, and long-billed marsh wrens. Typical mammals include raccoons, rice rats, marsh rabbits, and river otters. Reptiles include the American alligator, Florida east coast terrapin, and eastern cottonmouth. Macro-invertebrates are important components of these salt marshes and characteristic species include grass shrimp, fiddler crabs, oysters, mussels, and common periwinkles.

The mangrove communities are the tropical ecological equivalent of temperate salt marsh communities. The project area is in the lower part of the transition zone between predominantly salt marsh and mangrove regions. The latter is dominant here. Both communities have very similar water, soil, and tidal requirements and both are detritus-based communities (Davis 1940). Mangrove communities are typically composed of red, black, and white mangrove. These species may occur mixed or in distinct zones. Red mangrove often grows in pure stands on shores and low islands where the soil is covered by tidal waters even at low tide. Black mangrove generally occurs in loose soils from just below mhw to more landward locations. The lower portions of this region are flooded daily, while the higher portions may be inundated only during spring tides or high wind-driven tides. Glasswort, saltwort, and, occasionally, smooth cordgrass may be present with black mangrove. White mangrove seldom forms distinct zones and usually occurs as a subdominant in the other mangrove associations (Davis 1940). Where white mangrove zones do occur, they are usually located on topographically elevated areas that are relatively free of regular flooding.

The biota inhabiting mangrove communities include marine forms, inshore and littoral organisms, and more terrestrially oriented animals. Characteristic macro-invertebrates are coon oysters, squareback crabs, hermit crabs, mud crabs, snapping shrimp, and members from the genera *Melampus*, *Cerithium*, *Littorina*, *Arenicola*, and *Capitella* (Teal and Teal 1969, Miner 1950, State University System of Florida 1973). The killifish and other fish species often inhabit shallow pools found around black mangroves (Teal and Teal 1969). Common avian species are snowy egrets, Louisiana herons, little blue herons, green herons, and red-winged blackbirds. Mammals and reptiles inhabiting mangrove communities include bobcats, black rats, and mud turtles. Other faunal species present include many of those listed for salt marsh communities.

Open-water estuarine communities exist adjacent to the mangroves and tidal marshes. Submerged seagrass beds are present in these communities where adequate substrate, salinity, and light penetration occur. Widgeongrass grows in waters having soft sand substrates and salinities less than 25 ppt (Phillips 1960). This species may be distributed from intertidal areas to depths of seven ft, although densest growths are usually found in waters two to four ft deep mhw (Phillips 1960). In waters having higher salinities, *Diplantheria wrightii*, *Syringodium filiforme*, Caribbean halophila (*Halophila baillonis*), and occasionally turtlegrass may be present (Phillips 1960). These nutrient-rich seagrasses provide food, shelter, and substrate for a variety of faunal species. Typical fish species attracted to these communities include spotted seatrouts, sheepsheads, snooks, sea basses, flounders, and mullets. Characteristic macroinvertebrates are blue crabs, grass shrimp, pink shrimp, white shrimp, brown shrimp, and spiny lobsters. Principal avian constituents of these areas are red-breasted mergansers, lesser scaups, black skimmers, and American coots. Mammals are represented by the manatee and bottlenosed dolphin.

3.2.3 Institutional Considerations

The U. S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, and the Florida Audubon Society were contacted. General concurrence with the concept of marsh and mangrove establishment was given, but reservations were voiced. The Vero Beach representative of Sport Fisheries and Wildlife favored use of open-water disposal sites in general and objected to the filling in of small lagoons. He would not judge the proposed planting at the sites selected, but said that he would be opposed to converting any presently "productive area" to a continuous mangrove canopy, even though the productivity and importance of mangrove is widely accepted.

3.2.4 Benefits and Costs

Analysis of benefits and costs was not possible beyond the reconnaissance scale. This project area provides a useful example of problems expected in such an analysis. Jacksonville District (1973b) has estimated the benefits to be derived from a proposed jetty-weir plan at the inlet. They predict that the project would mean an average annual equivalent benefit of $97,000 to recreation. The question of how marsh-mangrove creation would benefit recreation is open and requires more specific research even to make a general prediction, much less an estimate in the site-specific cases considered in this study.

3.2.5 Description of Specific Marsh-Mangrove Creation Sites

The marsh-mangrove complex described in 3.2.2.3 offers the opportunity of using two or more different physiognomically and taxonomically different species of plants to create wetland habitat-smooth cordgrass and species of mangrove. The seral stage prior to mangrove development appears to be smooth cordgrass marsh. Eventually, mangrove species invade the marsh and assume dominance. Initial planting of smooth cordgrass followed by plantings of red mangrove would, therefore, seemingly speed the establishment of mangrove habitat.

Figure 89 shows the location of the three sites selected for the creation of marsh-mangrove.

Site 1. Hole-in-the-Wall

This site is completely protected from all but the most severe storm surges. The creation of marsh-mangrove on the islets toward the middle of the embayment would provide mangrove not easily accessible by foot and could, therefore, be effectively managed for bird habitat. The principal constraint attendant this site would be the covering of productive benthic communities. This factor must be carefully evaluated, particularly in light of the site's location in St. Lucie State Park.

Site 2. Sewall Point

The small islands forming in the shoal areas immediately southeast of Sewall Point can be joined and extended. The natural accretion apparently occurring around this site recommends it as a marsh-mangrove creation site. Further, creation would likely stabilize sediments and prevent their movement into the channels. In time the marsh-mangrove complex could be extended to Sewall Point, but circulation patterns and natural sedimentation patterns developing in response to that action would require study.

Site 3. Dredged Material Islands

The five islands of dredged material selected as marsh-mangrove creation sites are discussed together. Four of them occur immediately along the Indian River channel and are subject to similar water energy regimes. Site 3a, forming a spit toward St. Lucie Inlet, could be extended

FIG. 89 ST. LUCIE INLET, FLA.

toward site 3b. This complex could serve to prevent some of the littoral sediments moving from the inlet from entering the Indian River channel. The diked disposal area, site 3c, is also a land-extension opportunity toward Hutchinson Island, as is site 3d. Site 3e is an island of dredged material more protected from the influence of the Indian River. Even though it is surrounded by shoal areas, it may be subject to considerable wave action of boat traffic from Seminole Shores as that development continues to grow.

Should marsh-mangrove creation be deemed useful on each of these islands, careful consideration of circulation and sedimentation will again be necessary, particularly at Bessie Cove.

4.0 Gulf Geographical Region

4.1 Atchafalaya River Project Area and Marsh-Creation Sites

This project area is located at the southern extremity of the Lower Atchafalaya River channel which connects Morgan City, Louisiana, and the Gulf of Mexico. The Gulf entrance to the channel lies between Eugene Island and White Shell Key.

Because of potential damage from storm surges associated with hurricanes in the western Gulf of Mexico, the three sites selected are in the protected area behind Point au Fer Reef. The sites are a land extension of the reef, an open-water area along the project channel, and land extension on existing dredged material islands on the west of the project channel.

4.1.1 Characteristics of Dredged Material

4.1.1.1 Physical Properties

The dredged material in this area is classified as 10 percent sand, 65 percent silt, and 25 percent clay. Subsurface sediment consists of about 80 ft of Holocene deposits over a Pleistocene base. The Holocene is composed of very soft marsh clay with various amounts of organic material. The marsh deposits themselves are overlain by soft to medium bay and gulf silty clay with a maximum depth of about 15 ft beneath the proposed sites. The Point au Fer Reef Zone consists of a top layer of irregularly cemented oyster shells lying on blue clay. Particle-size distributions were not available.

4.1.1.2 Chemical Nutrient Status

No specific nutrient status data were available to this study.

The bottom areas including those selected as possible marsh-creation sites are constantly covered by nutrient-rich natural sediment from the Atchafalaya River. Since extensive marshes already exist in the Point au Fer area, newly created marsh islands can probably be expected to become vegetated after placement, but the dredged material placed for marsh creation should be sprigged with smooth cordgrass. Existing islands of dredged material do not appear to be vegetating rapidly; however, plantings should be successful and establish marsh which will stabilize the dredged material and provide new habitat.

4.1.1.3 Pollutant Status

The inventory of dredging projects for this area indicated that the sediment was not polluted. Privately leased oyster beds near Point au Fer, but well outside the project area, are not harvested because of high bacterial counts and turbid waters. Adult oysters are normally transferred to other areas for seven days prior to harvesting. A detailed pollutant analysis is not available (New Orleans District 1973b).

4.1.2 Environmental Description

The project area is in the humid subtropical climate, having a mean annual precipitation of 63 in.; the heaviest rains occur in July and August. The mean length of freeze-free periods is 310 days. Summer temperatures range between 75 and 90°F (summer mean 82°F) and mean winter temperatures vary between 48 and 66°F, with the overall winter average 57°F.

Prevailing winds in the winter are northerly to easterly from 11-21 knots; while easterly winds of less than 11 knots are typical in the summer. Gales are rare in this area; however, a damaging tropical storm can be expected along the Louisiana coast about every third year. The hurricane season extends from June through October with a maximum probability of occurrence in September.

4.1.2.2 Hydrology

4.1.2.2.1 Water-Energy Regime

Tides in this area are chiefly diurnal with a mean range of 1.1 ft. Typical tidal elevations at Morgan City are: extreme spring tide, 3.9 ft; mean tide, 1.34 ft; mean high tide, 1.89 ft; and mean low tide, 0.75 ft.

A cold northerly outbreak over the area can cause a -2.3 ft tidal elevation, while southerly storm surges associated with hurricanes have been known to yield a maximum tidal elevation of 8.5 ft.

Currents on the Atchafalaya Bay side of Eugene Island range from 1.0 to 2.0 fps depending upon the phase of the tidal cycle and the amount and direction of winds. Currents gulfward of Eugene Island range from 0.5 to 1.7 fps with intensity and direction also governed by tidal and wind-stress components.

The selected marsh-island creation sites are only moderately protected from wind-driven waves in winter. The project area has a fetch of nearly 20 miles to the north; however, water depths are so shallow that wave heights over three to five ft should be rare. During the summer, when the predominant air flow is from the east, local wind waves should not exceed one to two ft. Wave erosion of new marsh islands should not be significant except during occasional hurricanes.

4.1.2.2.2 Hydrography

Atchafalaya Bay is extremely shallow with depths in undredged areas mostly ranging from one to six ft. The potential site immediately north of Point au Fer Reef is only one to two ft deep; while the site northeast of Eugene Island and east of the main channel averages five to six ft in depth. Beyond the shallow waters induced by the placement of dredged material, the waters around the island sites are comparable to the latter site with several more shallow areas present also.

4.1.2.2.3 Prevailing Sedimentation Regime

Sedimentation is almost exclusively from the Atchalafaya River basin with the Red and Mississippi Rivers the major sources. The rate of fill in the lower basin is now estimated at 0.27 ft per year. Garrett et al. (1969) indicate that increased sedimentation from upstream projects should develop natural channel banks to the area adjacent to Point au Fer Reef by 1980 and fill past the reef by 1990. The proposed disposal sites appear to offer excellent potential for acceleration of marsh growth and planned management of an already dynamically and rapidly changing situation.

4.1.2.3 Biotic Communities

The biotic communities of the project area are primarily estuarine waters, consisting of marshes, large oyster reefs of Point au Fer Shell Reef, and shallow waters with the major tributary being the Atchafalaya River. Much of the biophysical information cited here came from Volume 2, Appendix F, of the CE Report on Gulf Coast Deep Water Port Facilities (1973).

4.1.2.3.1 Terrestrial Ecosystem

Terrestrial communities are far removed from the project area. Their occurrence begins approximately 10 miles north of the project area on the mainland. The major communities include the cypress-tupelo swamp and cottonwood-willow-sycamore bottomland hardwood forest. Other species present in these forests include water oak, American elm (*Ulmus americana*), live oak, white ash (*Fraxinus americana*), and hackberry (*Celtis laevigata*).

4.1.2.3.2 Estuarine Ecosystem

Salinity gradients in Atchafalaya Bay are major factors in determining the distribution of plant associations and related animal life zones. Salinity in the bay ranges from 10 ppt at North Point to 0.5 ppt for the greatest portion of the bay up to the mouth of the Atchafalaya River. Thus, the marsh located around the shoreline of the bay is fresh marsh, dominated by maiden-cane, bull tongue, spike rush, and alligator weed. An intermediate marsh habitat dominated by saltmeadow cordgrass and bull tongue is present on the north side of Point au Fer Island; bull tongue is transitional between the fresh and brackish marsh. The brackish marsh covers most of Point au Fer Island and is dominated by saltmeadow cordgrass and salt grass. Typical invertebrate organisms of these marsh communities include periwinkles, clams, fiddler crabs, and the red swamp crawfish, which is valued as a delicacy by the local human residents.

Intermittent patches of salt marsh along the beach extend from North Point southward along the shoreline. Plants typical of this community include smooth cordgrass and associated species. Thus, suitable smooth cordgrass and saltmeadow cordgrass planting stock is available for initial stabilization of the marsh-creation sites. These two species will likely be replaced by fresh marsh species. After a period of time artificial introduction of the latter may be advisable.

Avian species utilizing the various marsh systems and associated tidal flats throughout the year for feeding and nesting purposes include ibises, herons, egrets, and rails. During the winter months a variety of waterfowl, such as geese, mallards, and canvasbacks, among others, can be found feeding and resting in these marsh habitats. Typical mammals of the marshland include otters, minks, nutria, raccoons, and muskrats. All are economically important and sought-after fur bearers. The American alligator is also abundant in these marsh habitats.

The bottoms of estuarine waters adjacent to the marsh communities typically support beds of green algae (Caulerpa prolifera), brown algae (Dictyota dichotoma), and red algae (Gracilaris caudata). Invertebrates associated with this community are similar to those occurring in the marsh communities. Benthic communities in Atchafalaya Bay are probably inhibited greatly by natural turbidity. Freshwater fish which live in the upper portion of the bay include sport and commercial fish, such as large-mouth bass, blue gills, crappies, freshwater drums, and bigmouth buffaloes. Species that occur in the more brackish and saline environments at the lower end of the bay and into the Gulf of Mexico include tarpons, spots, menhadens, mullets, red snappers, and others which are of economic importance to the area. Gulls, terns, and brown pelicans are commonly observed feeding on fish over the open water, and pelagic birds, such as the blue-faced booby, can be seen sporadically throughout the year, while the magnificent frigatebird is an occasional visitor. Few marine mammal species appear near shore. Bottle-nosed dolphins, frequent inhabitants of the estuarine and nearshore waters, are the most common marine mammal.

4.1.3 Institutional Considerations

Several State and Federal agencies were interviewed to ascertain their views and comments regarding marsh creation and to inform them of the project and its status. Officials in the U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife (BSFW), Division of River Basins Study; Region VI of the EPA; and the Louisiana Wildlife and Fisheries Commission were contacted. All agency representatives were in accord with the basic concept of marsh creation utilizing dredged material and desired to be a part of the project as it evolves in the future. None of the agencies were willing to go on record as agreeing to any of the sites selected, preferring to withhold judgement until site-specific data and project design are developed.

The greatest single constraint arising against marsh creation in this project area was outlined by Bureau of Sport Fisheries and Wildlife personnel. Presently, the New Orleans District is proposing to widen the existing channel from 200 to 400 ft while maintaining the depth at 20 ft. A group of several organizations collectively known as the South Louisiana Environmental Council, Inc., has brought suit to prevent project enlargement. They contend that saltwater intrusion is possible and that the destruction of 8,000 acres of marsh is unnecessary. BSFW supports the suit against the Corps and would be seriously opposed to any program within the proposed dredging project that could be construed as mitigation for marshlands lost while enlarging the channel upstream. Therefore, until the court case is settled, BSFW would oppose marsh creation even though the project area is far separated from the marshes that would be destroyed. After the conclusion of the court case, BSFW has no general objections to the concept of marsh creation using dredged material.

4.1.4 Benefits and Costs

The study did not uncover data that would allow a reasonable analysis of the benefits or costs that might derive from marsh creation in the project area. CZRC recognizes the importance of the various activities conceivably enhanced or curtailed by marsh creation; however, a benefit and cost analysis of effects within the

Atchafalaya Bay requires more data than were available for the present study.

In interviews with both State and Federal agencies, the concensus was that no commercial or sport fishing activity nor productive shellfish leases exist in the study area. Officials felt that benefits usually associated with marsh ecosystems would override any constraints or costs not evident at present.

4.1.5 Description of Specific Marsh-Creation Sites

Figure 90 indicates the location of the following sites selected for marsh creation.

Site 1. Northern edge of Point au Fer Reef

The north edge of Point au Fer Reef northeast of Eugene Island is a shoal area possibly appropriate for extension of occasionally emergent mud flat. Long northward fetch in the winter could present some problems; however, the overall relatively low water-energy regime should not militate severely against the creation of marsh habitat.

While this site is well within pumping distance of dredging areas, monitoring of this marsh-creation site should be designed to determine whether or not the dredged material is moving back into the channel.

Site 2. Open water east of channel

An open-water marsh-creation situation exists at this site. Field observation revealed shoal water and shallow depths at a time of very high flood stage, April 16, 1974. Thus, from the standpoint of overall water-energy

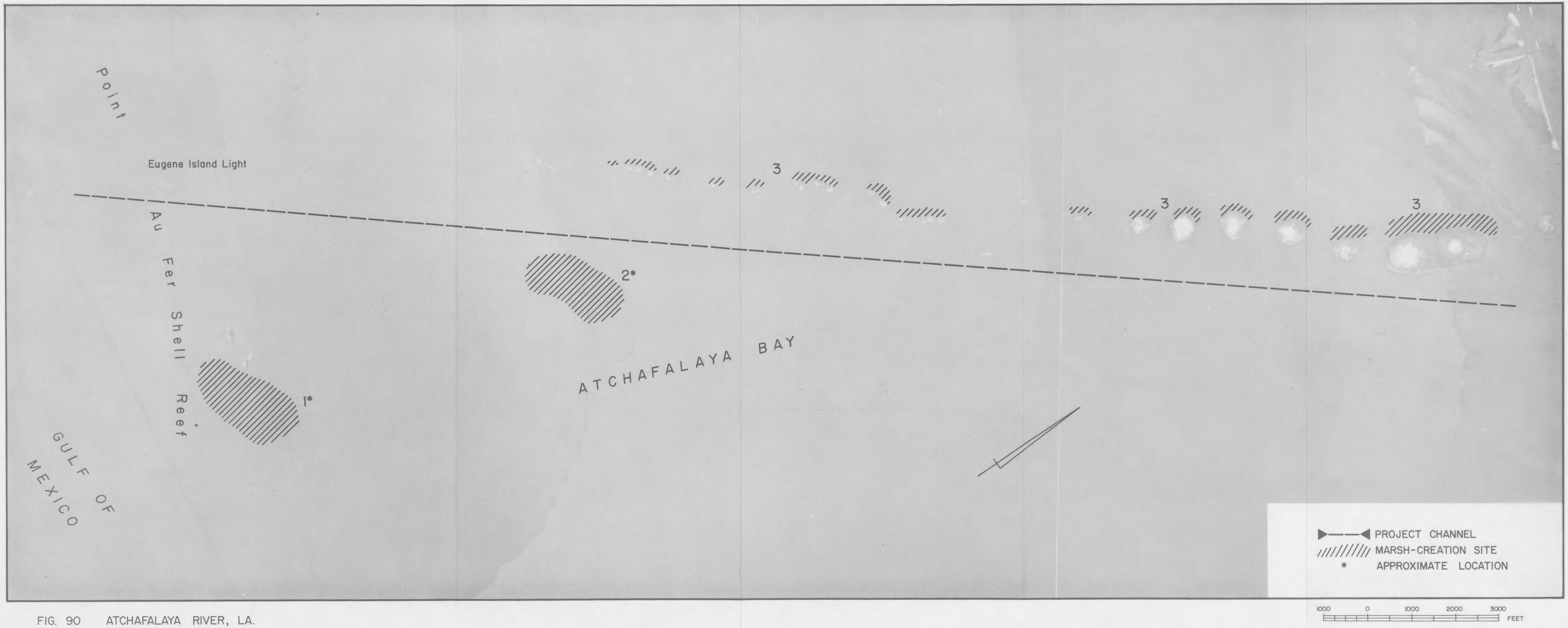

FIG. 90 ATCHAFALAYA RIVER, LA.

regime, this site presents an opportunity essentially the same as site 1. The possible constraint of sediments re-entering the channel is probably more likely here. Dredged material is currently placed west of the channel, and a shift to disposal on the east side of the channel should not present significant if any change in dredging costs.

The particular utility of this site resides in the research value to be gained from attempting open-water marsh creation in a rapidly filling bay. Such information would be extremely valuable in devising an orderly development of diverse wildlife habitat, rather than risking conditions not as easily managed for particular purposes, such as access to sport fishing.

In both sites 1 and 2, no well-established seagrass benthic communities will be destroyed that would not be more than compensated for by marsh creation. To reinforce this notion and to provide evidence that water-energy regime is not a severe constraint, the sediment load of fine material is being deposited at such a great rate that recreational boating is nonexistent in the bay because navigation is so difficult. Obviously, benthic communities are in a constant state of transition under such a sedimentation regime.

Site 3. Dredged material islands

Starting approximately two miles northeast of Eugene Island Light and immediately west of the channel, a string of emergent dredged material islands extends to the 20-ft bottom contour in the upper portion of Atchafalaya Bay. These islands offer the opportunity of creating marsh on emergent shoreline, thus each of the islands in the project area, as well as those to the northeast, are considered viable potential marsh habitat and very comparable.

The dredged material islands offer a protective lee against erosive forces that might derive from long northeasterly fetch across the bay. Each of these islands could be considerably enlarged to the west without deploying an additional booster pump. The channel sides of the islands do not appear to be eroding; however, stabilization provided by marsh plant species would ensure a minimal amount of sediment return to the channel. As marsh is extended to the west, upland habitat could be constructed adjacent to the channel. The only other readily apparent biophysical constraint of note is the need to maintain open water between some of the islands for water exchange between the east and west halves of the bay. With careful placement of dredged material and suitable plantings, circulation can be facilitated at least until natural sedimentation regimes completely alter the current patterns of the entire Atchafalaya Bay.

4.2 Matagorda Channel Project Area and Marsh-Creation Sites

The project area is centered near the intersection of the Matagorda Ship Channel and the GIWW. The intersection is to the east of Port O'Connor and north of the Matagorda Peninsula. Dredged material from channel maintenance operations will be used to create marsh.

The four marsh-creation sites chosen are all land-extension situations. Three of the sites are extensions of marsh on the bay side of Matagorda Peninsula, and the fourth is a land extension of portions of an existing dredged material island.

4.2.1 Characteristics of Dredged Materials

4.2.1.1 Physical Properties

The dredged material is sandy silt (from the GIWW) and silty sand (from the Matagorda Ship Channel).

4.2.1.2 Chemical Nutrient Status

No specific nutrient status data were available to the study.

4.2.1.3 Pollutant Status

Sediment taken from that portion of GIWW which extends from Freeport to Matagorda Bay has been determined by CE analysis to be polluted. But sediment from that portion of the waterway extending across Matagorda Bay and through San Antonio Bay has been determined to be unpolluted. The sediment taken from the Matagorda Ship Channel and tested by CE show EPA criteria exceeded for zinc, total nitrogen, and volatile solids contents (Galveston District 1971). Sediment to be dredged within the project area are relatively unpolluted.

4.2.2 Environmental Description

4.2.2.1 Climatology

The project area climate is technically designated as humid subtropical; however, based on the annual rainfall of 38-40 in. per year, it comes close to the upper limits of the more arid steppe-like climate. Mean temperature ranges between 49 and 67°F in the winter;

the summer maximum and minimum range is between 75 and 93°F. Growing seasons are long with the mean length of frost-free periods at 330 days.

Predominant wind patterns over the general area are quite variable from the north through southeast in the winter. Average wind speeds vary, as well, between 10 and 15 knots. In the summer, winds predominate out of the southeast at speeds near 10 knots.

Gales are relatively rare, but tropical storms directly affect this area on the order of once every three years. Tidal effects and swells generated by hurricanes which swing towards the east after entering the Gulf of Mexico (and thus do not cross over the Texas coast) can still damage beach areas.

4.2.2.2 Hydrology

4.2.2.2.1 Water-Energy Regime

The tidal range along the northern coast of the Matagorda Peninsula is 0.7 ft above msl. The range increases off the western tip of the peninsula to 1.4 ft in Pass Cavallo. Tidal currents are, therefore, relatively light. Wave height buildup is restricted by the length of fetch available. Fetches from the west, east, and south are too short for the buildup of more than a chop, but the fetches to the northeast and northwest can produce waves up to five ft in height if winds are of sufficient strength and duration.

4.2.2.2.2 Hydrography

The Matagorda Ship Channel is dredged to a 36-ft depth and a 200-ft width. The Gulf Intracoastal

Waterway, which intersects it at a point three miles up the channel from the entrance, is dredged to a depth of 12 ft and a width of 125 ft. Soundings between the GIWW and Matagorda Peninsula show 14-ft depths near the channel which shoal abruptly about 500 yd from the peninsula beach to two- to 4-ft depths.

The Matagorda Ship Channel within the project area is flanked to the east by small islands and shoals of deposited dredged material. These islets are not emergent above water in most cases. Water depths, aside from the line of islets and shoals which parallel the channel to the east, are 10 ft or greater to a distance within 200 yd of the shore.

4.2.2.2.3 <u>Prevailing Sedimentation Regime</u>

Sedimentation composition is a combination of sand and silt. The silt is most probably discharged from the Lavaca and Navidad Rivers and other estuarine creeks of the area. The sand is swept into the area by tidal currents having been scoured from the bottom of the Gulf or eroded by wave action from beaches. Blanton et al. (1971) depicted the project area sediment adjacent to the Matagorda Peninsula and tidal marsh substrates as a mixture of sand, silt, and clay; the general sedimentology of the bay side of Matagorda Ship Channel consists of clayey silt to silty clay with silty sand on the Port O'Connor side of the channel.

4.1.2.3 <u>Biotic Communities</u>

The biotic communities of this area have been described in Volume 3, Appendix F, of the CE Report on Gulf Coast Deep Water Port Facilities, (1973) and that information has been used extensively in the description of this project area.

Matagorda Bay is an estuarine bay; its major tributaries consist of the Colorado, Navidad, and Lavaca Rivers. The bay is surrounded by narrow bands of mud flats and marshes which border the terrestrial communities. The southern portion of the bay is dominated by the Matagorda Peninsula, which extends across the bay nearly isolating the bay from the Gulf of Mexico.

4.1.2.3.1 Terrestrial Ecosystem

Major terrestrial communities present in the project area are classified as a coastal prairie community, lower coastal range community, and a vegetated barrier flat community, the latter located on Matagorda Peninsula.

The coastal prairie community is located north and east of Matagorda Bay and is considered to be a highly productive range characterized by big bluestem (*Andropogon gerardi*), panic grasses (*Panicum* spp.), and numerous species of annual and perennial forbs. Typical animals of this community include ground squirrels, badgers, bobcats, scaled quails, Harlan's hawks, western coachwhips, bullsnakes, and others. The lower coastal range community is located on the west side of the bay with the characteristic species adapted to long, hot, and dry summers and mild winters typified by switchgrass, bluestem, salt grass, saltmeadow cordgrass, vine mesquite (*Panicum* *obtusum*), brush live oak, mesquite (*Prosopis juliflora*), and prickly pear (*Opuntia* spp.). Characteristic animals include spotted skunks, desert cottontails, burrowing owls, lesser nighthawks, white-tailed kites, Texas tortoises, and western diamondback rattlesnakes.

Matagorda Peninsula is regarded as a barrier island which is occupied by the vegetated barrier flat community typified by salt-tolerant grasses and forbes, such as saltmeadow cordgrass, sea oats, seacoast bluestem (*Schizochyrium scoparium* var. *littoralis*), and morning glory (*Ipomoea* sp.). In addition, mesquite and live oak occur as scattered specimens on the higher elevations. Animals typical of this association include keeled-earless lizards, eastern yellow-bellied racers, fulvous harvest mice, and field sparrows.

4.2.2.3.2 Estuarine Ecosystem

The marshlands of the project area are all salt marshes typified by salt-tolerant plants; salinities of the waters range from 30-32 ppt. The salt marsh is not extensive in the bay and forms a relatively narrow band between the uplands and open water. Species observed in the field included smooth cordgrass, glasswort, saltwort, salt flat grass, black needlerush, sea purslane, and sea oxeye. Invertebrates typical of the salt marsh include periwinkles and fiddler crabs. Reptiles include Texas diamondback terrapins and Gulf salt marsh snakes. Resident birds typical of the marsh community are numerous, with the most obvious including herons, ibises, and egrets. The project area is located within a major migratory route and, during the winter months, various waterfowl and shorebirds are observed utilizing the marsh community and associated tidal flats for food, cover, and rest. Mammals typical of this community include raccoons, swamp rabbits, and rice rats.

The open-water community of the estuaries is characterized along the Texas coast by manateegrass, widgeongrass, shoalgrass, and turtlegrass. Submerged vegetation is located on the bay side of the Matagorda Peninsula and north of the project area in Lavaca Bay. There are, however, few areas of extensive seagrass beds in the project area, and these beds are very sparse within the specific sites selected. Texas estuaries are characterized by relatively low benthic diversity and high numbers of organisms. According to Parker (1959, 1960), the following five benthic communities are recognized within the bay: river influenced, inlets, open bay, enclosed bay, and grass flats. The open-bay community is the predominant community in the bay and characteristically supports large populations of shrimp and crabs. Oyster reefs located in the bay comprise 42,010 acres. No commercially productive oyster reefs occur in the project area; however, the organism is present throughout (Galveston District 1974). A variety of fish inhabit this community, with the most popular species including sea trouts and drums. All are prized for their sport and commercial value.

Sea turtles occur on the Gulf side of the peninsula during the breeding season, at which time they may be observed close offshore and on the beaches.

Double-crested cormorants and laughing gulls are typical avian residents. During the winter months, common loons and herring gulls are observed. All of these species feed on fish. During the migratory season, large rafts of waterfowl are observed on the open waters and diving and dabbling for fish, crustaceans, or plants. The most common mammal observed in the open water is the bottle-nosed dolphin; few other marine mammals enter into these confined and shallow waters.

4.2.3 Institutional Considerations

The following State and Federal agencies were contacted regarding this marsh creation project: the U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife, Division of River Basins Study, and the U. S. Geological Survey; U. S. Department of Commerce, National Oceanic and Atmospheric Administration, and the National Marine Fisheries Service; Region VI of the EPA; and the Texas Division of Planning Coordination, which surveyed other State agencies with interest and authority in coastal area matters. As in other geographic regions, marsh creation was acceptable conceptually to all agencies interviewed, and they each desired to participate in future site-specific planning and development. None wished to commit themselves to sites without further data and study. No significant constraints of any type beyond normal coordination and legalities were expressed.

4.2.4 Benefits and Costs

Data sufficient to allow a reasonable and meaningful analysis of the benefits and costs related to this project were not available. The gathering of new data will be necessary before an adequate study of the Matagorda Channel Project Area can be attempted.

4.2.5 Description of Specific Marsh-Creation Sites

The sites selected for marsh creation shown in Figure 91 are discussed below.

Site 1. Matagorda Peninsula, East of Jetty

The jetty near the old airfield site on the Matagorda Peninsula provides an excellent protected area along the shoreline upon which extension of existing marsh is possible. The waters just off shore are very shallow with no seagrass beds that would be destroyed by extending the marsh. The long northward fetch is apparently not prohibitive for marsh creation as attested to by existent marshes along the inside of Matagorda Peninsula. Sediment may be naturally accreting along the jetty; however, this would appear to enhance creation of marsh. There is more than sufficient planting stock available from marshes adjacent to this site. Source of dredged material for development of this site is primarily sandy silt from the GIWW.

Site 2. Matagorda Peninsula, East of Channel Cut

The discussion for the site east of the channel cut is similar to that of site 1 with the differences being that dredged material, silty sand, would be supplied from the Matagorda Ship Channel cut. This material would be deposited inside the naturally forming bar off the shoreline.

FIG. 91 MATAGORDA CHANNEL, TEXAS

Site 3. Matagorda Peninsula, West of the Channel Cut

Again, the same general conditions applicable to sites 1 and 2 are active at the site west of the channel cut. A spit has formed off the western point of the channel cut to the inside of the peninsula. This site is immediately adjacent to an existing upland disposal site and offers an excellent opportunity for marsh creation. In terms of availability of dredged material, distance and ease of pumping, and protection, this site may be the most justifiable of the three.

Site 4. Dredged Material Island

The dredged material island, just to the northwest of the channel cut and located on the east side of the Matagorda Ship Channel, offers opportunities for land extension and creation of marsh. This island, under the protective influence of the Matagorda Peninsula and outside erosive force from the apparently strong currents through Pass Cavallo, has a protective spit forming off the northeast and southwest tips of the island. The shallow waters and naturally accreting sediments in the lee of these spits would allow marsh creation and, thus, the development of additional valuable habitat in Matagorda Bay. Dredged material used to enhance this island could be derived from both the GIWW and the Matagorda Ship Channel.

5.0 Pacific Geographical Region

5.1 Petaluma River Project Area and Marsh-Creation Sites

This project area is located in San Pablo Bay and extends up the Petaluma River to Hog Island. The San Pablo Bay channel is eight ft deep and 200 ft wide, while the river channel is eight ft deep and 100 ft wide.

Three marsh creation sites were chosen in this project area. Each is located behind dikes, two on the southern shore of the Petaluma River and the other west of Tolay Creek near Tubbs Island.

5.1.1 Characteristics of Dredged Material

5.1.1.1 Physical Properties

Dredged material in this project area is described as silt and sand. The silt in this area is really a silty clay containing various substances, such as shells, organic matter, and peat. Most of the bay mud is made up of very fine-grained particles ranging from clay size to silt and fine sand. San Pablo Bay mud, which is exposed at low tide, is unconsolidated -- that is, semi-fluid -- and is very impermeable. It normally consists of 1/3 solid particles and 2/3 water or air. No detailed information is available on the composition of the silt and sand in the Petaluma River, but much of the material is deposited by tidal action from the bay.

5.1.1.2 Chemical Nutrient Status

No specific nutrient status data were available to the study.

5.1.1.3 Pollutant Status

Analysis of sediments reveals that the Petaluma River Channel is lightly polluted, while the San Pablo Bay Channel is nonpolluted (San Francisco District 1974). Oil and grease content and heavy metal constituents in the Petaluma River exceed EPA standards for open-ocean disposal.

5.1.2 Environmental Description

5.1.2.1 Climatology

The Petaluma River Project Area is typified by a marine (noncoastal) west coast climate with cool wet winters and warmer, drier summers. Eighty percent of the 24-inch mean annual precipitation falls between November and April and snow is extremely rare. The mean annual temperature is a mild 59°F; the winter averages 47°F and the summer 66°F. Extreme temperatures for the summer have reached 109°F, while the winter low was 17°F.

Winds in the project area range from eight to 12 knots out of the north through northeast and summer velocities range between 10-15 knots, prevailing from the south through the west. Seabreezes have a strong effect in summer causing considerable diurnal variation from day to night in both direction and speed. In winter, gale winds occur on about two to three percent of all days.

5.1.2.2 Hydrology

5.1.2.2.1 Water-Energy Regime

The mean tidal range for the project area is 6.1 feet with two high and two low tides per day.

The North Bay area experiences considerable variation in tidal range. Tidal elevations and ranges (in feet) across the flats (based on msl and mllw tidal datum) are:

	msl	mllw
Mean Higher High Water	4.27	6.10
Mean Lower Low Water	-1.83	0.00
Mean Tidal Range	6.10	6.1
Maximum High Water	5.77	8.5
Minimum Low Water	-4.83	-2.0
Maximum Range	10.5	10.5

Average flood-tide direction at the Petaluma River approach is toward 020° with an average speed of 1.0 fps. Ebb direction at the approach is 185° at 1.2 fps. At the river entrance, flood direction is 295° at 2.0 fps; while ebb is toward 090° at 1.7 fps.

Wind waves are not expected to be a factor in the river portion of the project area and will very rarely exceed two to three ft in San Pablo Bay.

5.1.2.2.2 Hydrography

San Pablo Bay is very shallow in the project area. Depths in water-covered areas are only one to three ft at mean low water (the average of all low tides). The San Pablo Bay and Petaluma River channels are normally dredged to depths of eight ft.

5.1.2.2.3 Prevailing Sedimentation Regime

Sediments are a combination of silt and sand. The sources are the Petaluma River Basin and

San Francisco Harbor, and deposition is caused by tidal forces. It is estimated that the channel through the mud flats in San Pablo Bay would, without dredging, fill to a depth of less than two ft in four years (San Francisco District 1974).

5.1.2.3 Biotic Communities

The dominant biotic communities of the project area are estuarine with the major tributary being the Petaluma River. The estuarine ecosystem is composed of marsh, tidal flat, salt pond, and open-water communities. The salinity of waters in the project area ranges from salt water in San Pablo Bay to fresh water several miles up the Petaluma River. The San Pablo Bay National Wildlife Refuge is located north of the channel and portions of this refuge occur within the project area. The Refuge is estuarine in nature composed of marshlands, tidal flats, and open water. It is a major resting area for migratory waterfowl supporting 50 percent of California's canvasbacks during the winter months (San Francisco District 1974).

5.1.2.3.1 Terrestrial Ecosystem

Terrestrial communities prevalent in the project area are dominated by man and consist primarily of marginal farmlands and waste areas. The river valley is bordered on the north and south by low mountains.

5.1.2.3.2 Estuarine Ecosystem

The salt marsh is a narrow belt paralleling the shoreline of San Pablo Bay and the banks of the Petaluma River, reaching up the Petaluma River for approximately two miles. The salt marsh varies in width from 2000 ft to less than 100 ft and is typified by a California cordgrass zone between mean sea level and mean high tide. Growing above the California cordgrass, salt grass may occasionally be present; however, pickleweed is usually the dominant plant. Both species occur to the limits of extreme high tide. Other vegetation occurring scattered throughout the salt marsh includes salt bush, jaumea, marsh dodder (Cuscuta salina), and alkali heath (San Francisco District 1974). The brackish marsh extends above the salt marsh zone for approximately seven miles up the river. The brackish marsh is dominated by southern bulrush, with hardstem bulrush, cattail, bog burreed, sea spurreys, and brass buttons as lesser members of the community (Mason 1972). Besides the important nutrient mechanisms that function in the marsh and its subsequent influence on the bay waters, another major function of the marsh is its natural attraction to the avifauna. With the marshes located on the Pacific flyway, a multitude of waterfowl, shorebirds, gulls, terns, rails, herons, egrets, and other species, are present during the winter months utilizing this habitat for food, rest, and cover. These marshes are also considered habitat for the California clapper rail, California least tern, and the salt marsh song sparrow, all listed as endangered bird species. Also considered as endangered is the salt marsh harvest mouse. Other common and permanent inhabitants of the marsh include raccoons, river otters, avocets, willets, sanderlings, western sandpipers, and redback sandpipers.

The tidal flats at the mouth of the Petaluma River are quite extensive into San Pablo Bay. Numerous algal species replace vascular plants as dominant species in this community. Mason (1972) reports that well over one hundred invertebrate species, typified by polychaetes and mollusks, inhabit the tidal flats. Some of the mollusks include bent-nose clams, gaper clams, common bay mussels, Japanese littleneck clams, mud clams, ribbed mussels, eastern softshell clams, and oysters. The avian populations which utilize this community include most of the species previously discussed.

The open-water community in San Pablo Bay is shallow, except for the maintained channel, with the substrate typically supporting beds of eelgrass. Within the bay characteristic fish include Pacific herrings, anchovies, green sturgeons, white sturgeons, and starry flounders; the last two are also found in brackish waters. Fish, such as the western roach, threespine sticklebacks, and mosquitofishes occur from brackish waters to the freshwater habitat of the river. Anadromous fishes typical of the area include salmon and striped bass, both important to commercial and sport fisheries. Gulls and terns are observed feeding on fish, while wintering waterfowl can be seen diving for fish, crustaceans, and benthic invertebrates, and dabbling for plant foods.

5.1.3 Institutional Considerations

The conceptual basis of this marsh-creation program was explained to several State, Federal, and local agencies including: U. S. Department of Interior, Bureau of Sport Fisheries and Wildlife, Division of River Basin Study; U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service; the Environmental Protection Agency; the California Department of Fish and Game, Department of General Services, State Office of Planning and Research; and the San Francisco Conservation and Development Commission (SFCDC). All agencies contacted expressed general agreement that the goals and benefits of the marsh creation were desirable, and each wished to be kept informed of program progress. Each was interested in participating in the collection of data and information necessary to completely evaluate and design the actual development of marsh. The only constraint, not related to technical procedures raised, was the question of actual land ownership within the project area; however, the SFCDC, which grants permits and has complete jurisdiction over activities in the wetlands of San Francisco Bay area, was not aware of obvious ownership problems or conflicting land-use plans. All agencies were unanimous in their disapproval of disposal on existing wetlands.

5.1.4 Benefits and Costs

This study was unable to garner sufficient data to effectively analyze benefits and costs of marsh creation in the project area. However, as an indication of the current worth of the San Francisco Bay estuary, Delisle (1966) estimated that net recreational benefits derived would reach $15,575,500 by 1980 from $9,122,800 estimated for 1966. Given the history of burgeoning urbanization within the bay area, it is at least safe to say that the relationship of marsh creation to increasing pressures and needs of the populace is well worth additional investigation.

5.1.5 Description of Specific Marsh-Creation Sites

Marsh creation within the wetland area of the San Francisco Engineer District is a popular and an actively sought-after alternative to other forms of dredged material disposal. Three sites within the Petaluma River Project Area represent unique opportunities to reclaim lowlands which are believed to have been marshland at one time. Figure 92 shows the locations of the selected sites: site 1, Hog Island, is on the east bank of the Petaluma River; site 2 is northeast of the State Road 37 bridge; and site 3 borders the marsh along Tolay Creek west of Tubbs Island. Because of the essential similarity of the sites, they are discussed collectively. Creating or extending marsh landward of existing marsh is a specific ecological situation not considered previously in this study. However, the notion of marsh rejuvenation is particularly attractive in the San Francisco Bay region, while deposition on existing wetlands is not likely to be approved under any circumstance.

All three sites are presently completely diked and separated from the fringe of existing marsh by levees. Elevations within the sites range from 0.0 ft msl to -3.0 ft msl; therefore, because California cordgrass grows up to approximately +4.0 ft msl, between four to seven ft of dredged material can be placed on certain portions of these sites. The parcels in question are presently

FIG. 92 PETALUMA RIVER, CALIF.

marginally productive grazing lands, as well as generally nonproductive areas, vegetated with several grass species, forbs, and scrub perennials. Marsh creation in the project area would involve opening the levees to allow tidal inundation of the disposal sites. After marsh is established on these sites, it can be extended farther inland by the subsequent breaching of additional levees.

The fringe of established marsh consisting primarily of California cordgrass on the shoreline and pickleweed up to the levees indicates that water-energy regime within the project area is consistent with marsh establishment. The natural marshes would provide a valuable buffer during stabilization and a source of natural re-vegetation stock to supplement the San Francisco District's program for establishing California cordgrass nursery.

5.2 Grays Harbor Project Area and Marsh-Island Creation Sites

This project area is located approximately 14 miles north of Willapa Bay on the Pacific coast of Washington. The area extends from the town of Cosmopolis down the Chehalis River for about 10 miles to the vicinity of Moon Island on the north shore of Grays Harbor. Various sections of the North Channel (30 ft deep and 200 ft wide) are the source of dredged material.

Three marsh-island sites were selected from within the Grays Harbor Project Area. Two sites chosen are extensions of existing land, and one is a site on open tidal flat.

5.2.1 Characteristics of Dredged Material

Dredged material is broadly classed as a mixture of silt and sand.

5.2.1.1 Physical Properties

No detailed information on physical properties was available to CZRC. The dredged material in the Moon Island area is listed only as "sand", while upstream from Moon Island to Cosmopolis, it is listed as "silty sand". Sampling on the south shore of Grays Harbor revealed substrate varying from watery mud to gravel and small rock.

5.2.1.2 Chemical Nutrient Status

No specific nutrient status data were available to the study.

5.2.1.3 Pollutant Status

The inventory of dredging projects indicates that the deep-water portions of Grays Harbor and the North Channel in the vicinity of Moon Island are not polluted according to EPA standards. The area upstream of Moon Island to the town of Cosmopolis is classified as moderately polluted. No specific values for concentrations of solids, oil and grease, or heavy metals were available.

5.2.2 Environmental Description

5.2.2.1 Climatology

This area is typical of a Pacific northwest coastal climate with cool, dry summers and stormy, wet winters. Mean annual precipitation is 90 in., including five in. of snow annually. The latter occurs from

November through March. Summer temperatures vary between 51 to 68°F, the mean being 60°F; winter temperatures range between 36 and 50°F, with an average of 42°F.

In the winter, gales are common with winds over 35 knots reported on 6 percent of all days. During the winter, wind directions and speeds are extremely variable, ranging between eight and 12 knots, and normally have an easterly component. Wind speeds in the summer are the same as winter; however, they are steady out of the north through northwest.

5.2.2.2 Hydrology

5.2.2.2.1 Water-Energy Regime

Tides in this area are unequal semidiurnal with two high tides and two low tides per day. The mean tidal range in the North Channel of Grays Harbor is 7.6 ft with a mean diurnal range of 7.9 ft. A range of 14 ft may occur at time of maximum tides and strong southwest winds. Mean tide level at the same location is 5.2 ft above mlw.

Current measurements in the North Channel are not available; however, from values listed at the harbor entrance and from dredge masters comments, it is deduced that both ebb and flood currents in North Channel rarely exceed 5.1 fps, with 3.4 fps being most common.

The harbor area is well protected from oceanic storm surges and swells generated by distant storms. Since the local winds have a predominant direction from the east in winter, wind-driven waves inside the harbor cause little erosion in proposed marsh-creation sites.

Fortunately, the strongest winds are from the north, also a protected direction. Parts of the project area have local waves of two to three ft, but these are ground swells that are not particularly erosive in nature.

Flooding due to heavy rains has occurred on both the Hoquiam and Chehalis Rivers.

5.2.2.2.2 Hydrography

Grays Harbor tidelands are extensive, varying from 32 to 96 square miles depending on tides, river flow, and wind stress. At least part of all three marsh-island creation sites, for instance, are exposed mud flats at low water. Middle Channel (south of the proposed tidal flat and marsh-island site) has depths varying from four to 11 ft at low water and could provide alternate access to this site.

5.2.2.2.3 Prevailing Sedimentation Regime

The dredged material in the North Channel area is unpolluted sand and silt amounting to 400,000 cu yd per year. Virtually all of this is believed to be from river sources with the major flow occurring during the late winter and spring months.

Sedimentation can curtail deep-draft shipping in one year if dredging ceases, and major harbor traffic would completely stop in several years (Seattle District 1974).

5.2.2.3 Biotic Communities

The major biotic community of Grays Harbor is an estuarine community typified by immense tidal flats with considerable variability in the frequency and extent of exposure. Major tributaries entering the project area include the Chehalis, Hoquiam, and Wishkah Rivers. The estuary is bordered by rocks, steep bluffs, and hills with the terrestrial communities occupying the uplands.

5.2.2.3.1 Terrestrial Ecosystem

The major terrestrial community of the project area is the Pacific douglas fir community, which is typical of extremely moist, humid conditions of the Pacific northwest. Predominant trees of this community include douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), sitka spruce (*Picea stichensis*), western hemlock (*Tsuga heterophylla*), western arborvitae (*Thuja plicata*), and red alder (*Alnus rubra*). Typical mammals associated with this community include mountain beavers, masked shrews, deer mice, tree phenacomys, and, increasingly, coyotes. Avian species that are peculiar to this association include Stellar's jays, western flycatchers, chestnut-backed chicadees, brown creepers, and red crossbills.

5.2.2.3.2 Estuarine Ecosystem

The estuarine community of Grays Harbor has been studied by Wolfe (1973) and his findings were used extensively in the following description.

The marshlands within the project area are minimal, occurring in limited areas usually as a thin shoreline fringe. The marshes are characterized by seaside arrowgrass and glasswort, which are found in circular clumps. These clumps or tussocks eventually accrete to the point where substantial salt marsh bulrush invades and occupies the outer rim with the higher center being occupied by lyngbye sedge; as accretion continues, the latter assumes dominance. Above the low-marsh margin, baltic rush and tufted hairgrass occur. In general, this sequence also follows an elevational gradient from the open water toward upland fringe communities of redtop (Agrostis alba), salt grass, baltic rush, and, where fresh water accumulates, cattail, wild ryegrass (Elymus mollis), and various arborescent species mentioned previously. The rocky shorelines along the intertidal zone have encrusting micro-algae providing a food source for a number of invertebrates typical of the marsh and rocky intertidal zone including periwinkles, limpets, barnacles, and various isopods and amphipods. Shorebirds typical of this shoreline during the winter months include black turnstones, rock sandpipers, and surf birds. Tidal flats account for a large area of Grays Harbor and are devoid of vegetation except for small areas vegetated by eelgrass and patches of fucoid and red algae. Within this habitat a number of burrowing invertebrates are typical residents, such as eastern softshell clams, polychaetes, oligochaetes, mud shrimp, and others. The estuarine open-water community is typified in the shallows by the presence of eelgrass. This important aquatic plant serves as a food source and substrate for a variety of aquatic animals, such as waterfowl, shiner perches, and three-spine sticklebacks and the commercially important dungeness crab, both as adults and immature stages, eastern softshell clams, and abalones. A number of invertebrates already discussed also occur in deeper open waters of the estuary. Commercially important anadromous fishes, such as chum salmons, coho salmons, and chinook salmons, utilize this community as a zone of passage during their spawning runs, as do steelhead trouts, searun cuthroats, sturgeons, and shads. Other fish present in the estuarine community include English soles, sand soles, starry flounders, snake blennys, Pacific herrings, surf smelts, northern anchovies, and others.

Characteristic avifauna of the estuary include permanent residents, such as great blue herons, American bitterns, mallards, Virginia rails, and least grebes.

Typical avifauna of the open waters in the estuary includes common loons, arctic loons, red-throated loons, pintails, harlequin ducks, mergansers, and a variety of gulls.

5.2.3 Institutional Considerations

The most compelling aspect of the conditions attendant to the prospect of creating marshes or marsh-islands in Grays Harbor is the lack of basic biophysical data necessary to effectively carry out their construction. Appropriately, the major concerns of agencies contacted relative to the present study included a desire to accumulate the body of knowledge needed to determine, for instance, whether trading a parcel of tidal flat for marsh-island habitat is justifiable from the standpoint of overall ecosystem function, particularly such features as salmon migration. There was some disagreement among representatives of various agencies on the value and overall general productivity of the Grays Harbor estuary...

again, pointing up the need for more study.

Federal agencies queried included the National Marine Fisheries Services of the U. S. Department of Commerce, the Environmental Protection Agency, and the Bureau of Sport Fisheries and Wildlife of the U. S. Department of the Interior. State agencies contacted were the Department of Ecology, the Department of Fisheries, and the Department of Game; one non-governmental organization, the Washington Environmental Council, was contacted. From all the conversations held, the only issues raised were: first, a strong desire to avoid creating fast land for private concerns; and, second, the feeling that the implications of marsh-island creation on the commercial finfish and shellfish economy of Grays Harbor, as well as sport fishing, were not well enough understood. On this point, opinions voiced seemed to indicate the impacts might range all the way from very favorable to perhaps harmful.

5.2.4 Benefits and Costs

Little or no data acceptable for a meaningful analysis of the likely impacts of marsh-island creation are available. The foregoing sections pinpoint the reasons for this and, of course, the general difficulties encountered in other project areas were at work here as well. An effective description of benefits and costs normally associated with marsh-island creation was more difficult in Grays Harbor than in the other geographical regions of the current study. For instance, there seems to be no general concensus or even remotely confident feeling that certain animal organisms are dependent on marshes of the Pacific northwest nor that commercial and sport fishing or even waterfowl hunting are directly tied to the maintenance of a well-balanced, if relatively small, marsh ecosystem. Until answers to questions as basic as these are answered with some certainty, analysis of benefits and costs to be evolved as a result of marsh-island construction is impossible.

5.2.5 Description of Specific Marsh-Island Creation Sites

The estuarine ecosystems of the Pacific northwest are ecologically quite different from those of the southern Pacific, Gulf, and Atlantic coasts. The upper Grays Harbor estuary, although highly disturbed by urban-industrial encroachments, has the general characteristics common to marshes of the general region. Coastal marshes here are tolerant to inundation by saline to brackish waters and typically have a depauperate, but distinct flora. Even though the uniqueness of these marshes is readily evident, the basic understanding of ecological relationships is not nearly as well understood as those of other marsh ecosystems in North America. Because of this, a cooperative study has recently been started by the Washington State Departments of Ecology, Game, and Fisheries to study the effects of maintenance dredging on Grays Harbor. This two-year effort should provide information including a detailed model of hydrological and sedimentological characteristics, the life histories of marsh species (plants in particular), and the identification of animal species dependent on the marshes, as well as the extent of that reliance and the importance of the marsh ecosystem to the estuary as a whole.

Today, such a body of information is nonexistent in the Pacific northwest; therefore, an opportunity for new research in marsh-island creation exists, along with a real chance to have a significant impact on the development of a program of dredging projects in basic harmony with nature.

Figure 93 shows the location of the three sites selected.

Site 1. Rennie Island

A relatively large portion of Rennie Island is dredged material, and the center of the island is used as a settling pond for paper-mill effluents. Sediments have accumulated on the western tip of the island and adding to this area would be an extension of the island and development of marsh fringe. It is conceivable that this complex might be eventually extended to the proposed site 2, discussed below.

Site 2. Tidal Flat

The tidal flat at the confluence of North Channel and Middle Channel is an area of shoal water at high tide. With sediments accreting naturally in this area, it seems an excellent opportunity to construct a marsh-island complex.

Site 3. Moon Island

Like site 2, there is shoal water at this site during high water. The marsh fringe on the north and south side of the island could be joined with artificial marshes created on the tip of the airport peninsula and be extended increasingly to the pilings off the end of Moon Island.

Generally speaking, the conditions that would

FIG. 93 GRAYS HARBOR, WASH.

dictate the basic format of a marsh-island construction project are similar at each of the three sites. Because of the relatively high water-energy regime in the upper Grays Harbor and the apparent limited, naturally occurring marshes, the creation of large expanses of marsh is probably not a viable proposition. However, the creation of islands with a marsh fringe would provide a complex of interrelated habitats, generally like those found on Rennie Island, but without its pollution and aesthetically poor quality. It could prove necessary, because of long fetch to the west, to sink pilings along any erosive sides of all three of these marsh-island sites. These piles should not, however, need to be maintained. Data accruing from the Grays Harbor study should determine the need for such design and engineering features, as well as marsh-island configurations most conducive to current regimes needed for the biophysical and socioeconomic well-being of the estuary.

Because of the fortuitous timing of the Grays Harbor study, the overall relative newness of marsh and marsh-island concepts to the Pacific northwest, and the need for research into the basic biophysical requirements for such projects, Grays Harbor must be considered among the top priority project areas reviewed in this study.

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APPENDIX A

MAIL SURVEY

January 29, 1974

Dear

This letter is a request for your help toward the completion of a study which we feel will be of great interest and aid to you in the operation and planning of future dredging activity.

Coastal Zone Resources Corporation (CZRC) is performing a study of artificial habitat creation under contract (DACW39-73-C-0116) from the Office of Dredged Material Research (ODMR) at the Waterways Experiment Station (WES). The investigation is entitled "Study of the Identification of Relevant Criteria and Survey of Potential Application Sites, Including Test Sites for Artificial Habitat Creation". The study is concerned with the factors that affect the hypothetical selection of dredged material disposal sites intended for development of artificial habitat in ecological situations which include: open water, open water behind barrier islands, inlets, land extensions, and estuarine creeks and rivers.

To date CZRC has developed selection criteria based on various kinds of considerations and has completed the screening of 1,013 potential project areas listed in the Inventory of Dredging Projects compiled by ODMR. The result of the screening process was the selection of 50 prime candidate Project Areas, 10 within each of the 5 major geographic regions shown on the enclosed map. Both the selection criteria and the 50 prime candidate Project Areas have been approved by ODMR. The Project Area in some instances may encompass two or more sources of dredged material and thus offer opportunities for artificial habitat creation in one or more ecological situation.

The next step in our work is the selection of Project Areas which are optimum for artificial habitat creation. To accomplish this, we require more detailed data and a greater variety of information and data than we now have. Through the coordination of ODMR, we are requesting that the Districts, in which the prime candidate Project Areas are located, supply us with the information they have pertaining to those Project Areas. In order to maintain our work schedule for completion of this investigation, we are asking that the information requested be returned to us by 18 February 1974. We are enclosing a description and the location of the Project Areas occurring in your jurisdiction as modified from the District Project Books to which we had access. The following outline lists the specific items of required information which will allow us to employ the selection criteria we have identified and to make the final choice of optimum Project Areas. The progress and ultimate success of this program depends on our receiving all the relevant qualitative as well as quantitative information available. We will, of course, return any items that you wish. Any and all corrections or additions to our Project Area descriptions, summarized in A below, will be greatly appreciated.

A. Description of Dredging Projects in Each Project Area

1. Project function
2. Dimensions
3. Maintenance Schedule
4. Spoil Engineering Data
    a. Physical Characteristics

b. Chemical Characteristics

B. Environmental Setting of Current Disposal Areas

1. Hydrology (Water-Energy Regime)
   a. Tidal Ranges and Cycles
   b. Currents and Other Water Movements*
   c. Wave Exposure and Fetch
2. Hydrography of Estuarine Bottoms
3. Physiography of Terrestrial Ecosystems
4. Water Quality (Including Pollution Status)
5. Sediment Characteristics
   a. Dredged Materials
      (1) Pollutant Levels
      (2) Particle Size Distribution and Other Fundamental Physical Properties**
      (3) Chemical Soil Nutrient Status
   b. Receiving Site
      (1), (2), and (3) in 5.a.
6. Biotic Description
   a. Intertidal Organisms (Marsh Plants and Animals)
   b. Benthos
   c. Plankton
   d. Nekton

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* Wind driven currents and orbital motion.

** Sorting, skewness, sphericity (shape), compaction characteristics, plasticity, hygroscopicity, and surface adsorption and particle change.

e. Neuston

f. Unique Biota and/or Communities

7. Ecosystem Maps, Aerial Photographs, and/or Environmental Impact Statements

C. Socio-Political Setting

1. Recreational Uses (Including Esthetics)

2. Public Attitudes

3. Legal and Institutional Constraints

D. Economic Setting

1. Costs of Dredging Operation

a. Current

b. Projected

E. Post-project Setting or On-going Project Changes

1. Changes in Ecosystems

2. Changes in Socio-political Status

3. Changes in Economics

CZRC recognizes that the amount and variety of information requested is great. We also understand that in some cases the information we seek may not exist. Verification of this latter case is a valuable input toward the development of realistic criteria applicable to the process of artificial habitat creation. At any time that we can be of help in explaining further the character of the information and materials we desire, please call Dr. John C. Nemeth (919/799-4470).

Thank you for your help in this important project. We look forward to hearing from you in the near future.

Sincerely,

John C. Nemeth
Ecologist

In accordance with ER 70-2-3, paragraph 6c(1)(b), dated 15 February 1973, a facsimile catalog card in Library of Congress format is reproduced below.

Coastal Zone Resources Corporation.
Identification of relevant criteria and survey of potential application sites for artificial habitat creation, by Coastal Zone Resources Corporation, Wilmington, N. C. Vicksburg, U. S. Army Engineer Waterways Experiment Station, 1976.
2 v. illus. 27 cm. (U. S. Waterways Experiment Station. Contract report D-76-2)
Prepared for U. S. Army Engineer Waterways Experiment Station, Environmental Effects Laboratory, Vicksburg, Miss., under Contract No. DACW39-73-C-0116 (Neg.) (DMRP Work Unit No. 4A01)
Includes bibliographies.
Contents.-v.1. Relevant criteria for marsh-island site selection and their application.-v.2. Survey of potential application situations and selection and description of optimum project areas.
1. Artificial marsh construction. 2. Dredged material. 3. Dredged spoil. 4. Habitats. 5. Marshes. (Series: U. S. Waterways Experiment Station, Vicksburg, Miss. Contract report D-76-2)
TA7.W34c no.D-76-2