FOREWORD

This report, Analysis of the Role of the Gulf Intracoastal Waterway in Texas, contains six task reports on various facets of the Gulf Intracoastal Waterway in Texas. These six task reports describe the role of the Gulf Intracoastal Waterway as a transportation artery and the significance of this system to the economy of Texas.

The task reports provide baseline data on the Waterway on environmental implications, engineering aspects, sociological characteristics, economics impacts, funding alternatives, and legal considerations. A major thrust of the reports is an analysis of State sponsorship for maintenance and development of the Gulf Intracoastal Waterway in Texas. Funding alternatives are described for State sponsorship including estimated amortization and total costs for varying administrative and fiscal scenarios. Supplementing this approach is a thorough analysis of historical and existing laws bearing on State sponsorship of the Gulf Intracoastal Waterway.

The Industrial Economics Research Division extends grateful appreciation to the outstanding contributions to the total effort made by Mr. Dow Wynn of the Port of Port Arthur and Mr. Al Cisneros of the Port of Brownsville. Both played a vital role in drawing on the resources and expertise of representatives of Texas ports.

Particular thanks are given to Senator A. R. Schwartz and Joe M. Moseley of the Texas Coastal and Marine Council for their valuable assistance and support of the project.

Appreciation is extended to Col. Don S. McCoy and his staff, Department of the Army, Corps of Engineers, Galveston District, for their assistance and patience in responding to requests for information by the task force researchers.

This project received funding support from the Texas Port Association and the Texas Coastal and Marine Council. Additional funding support was derived from an institutional grant 04-3-158-18 made to Texas A&M University through the National Sea Grant Program, National Oceanic and Atmospheric Administration, United States Department of Commerce.

Perry J Shepard, Head
Industrial Economics Research Division
Texas Engineering Experiment Station
Texas A&M University
College Station, Texas

December, 1974

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Cont.)

Introduction

INTRODUCTION

John Miloy
Project Coordinator
Industrial Economics Research Division
Texas Engineering Experiment Station
Texas A&M University

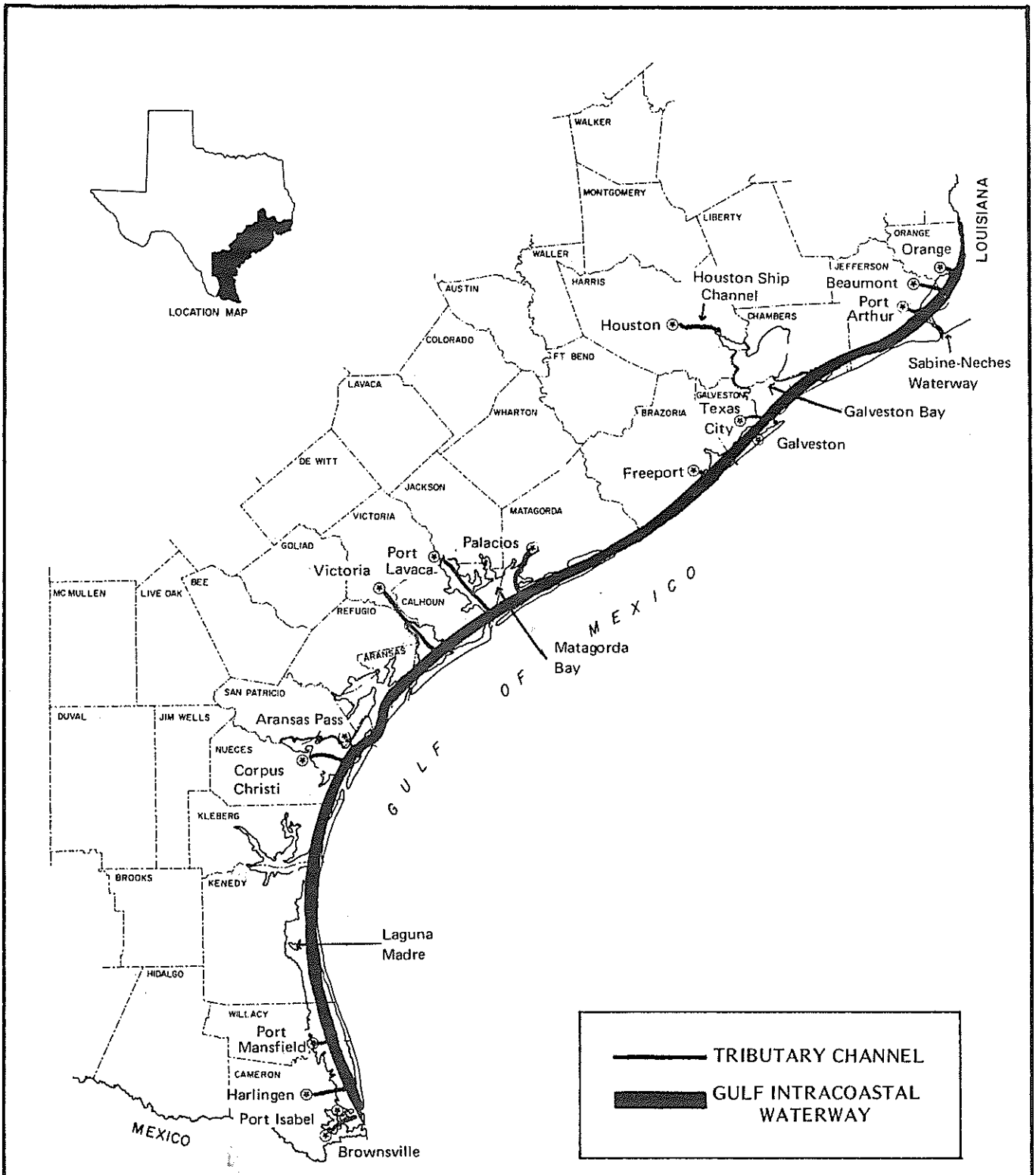
OVERVIEW

In Texas, the past five years have been marked by a rising level of interest in marine-related affairs and activities in the coastal zone. There is growing awareness that the land and water domains of the coastal zone comprise a valuable heritage for Texas and the nation.

The Gulf Intracoastal Waterway (GIWW), an integral artery in the water transportation system of Texas, extends 426 miles along the entire coast of Texas as shown in Figure 1. Reaching from Texas to Florida, this waterway system connects with other navigable rivers in the South and throughout middle America. The resulting transportation network allows industrial and commercial firms to receive and ship liquid and bulk commodities in large volumes at comparatively low rates. Relatively low water transportation costs stimulate industrial development and expansion at sites having access to inland waterways. For the past 25 years, an increasing number of industries have sought Waterway locations to benefit from low transportation costs.

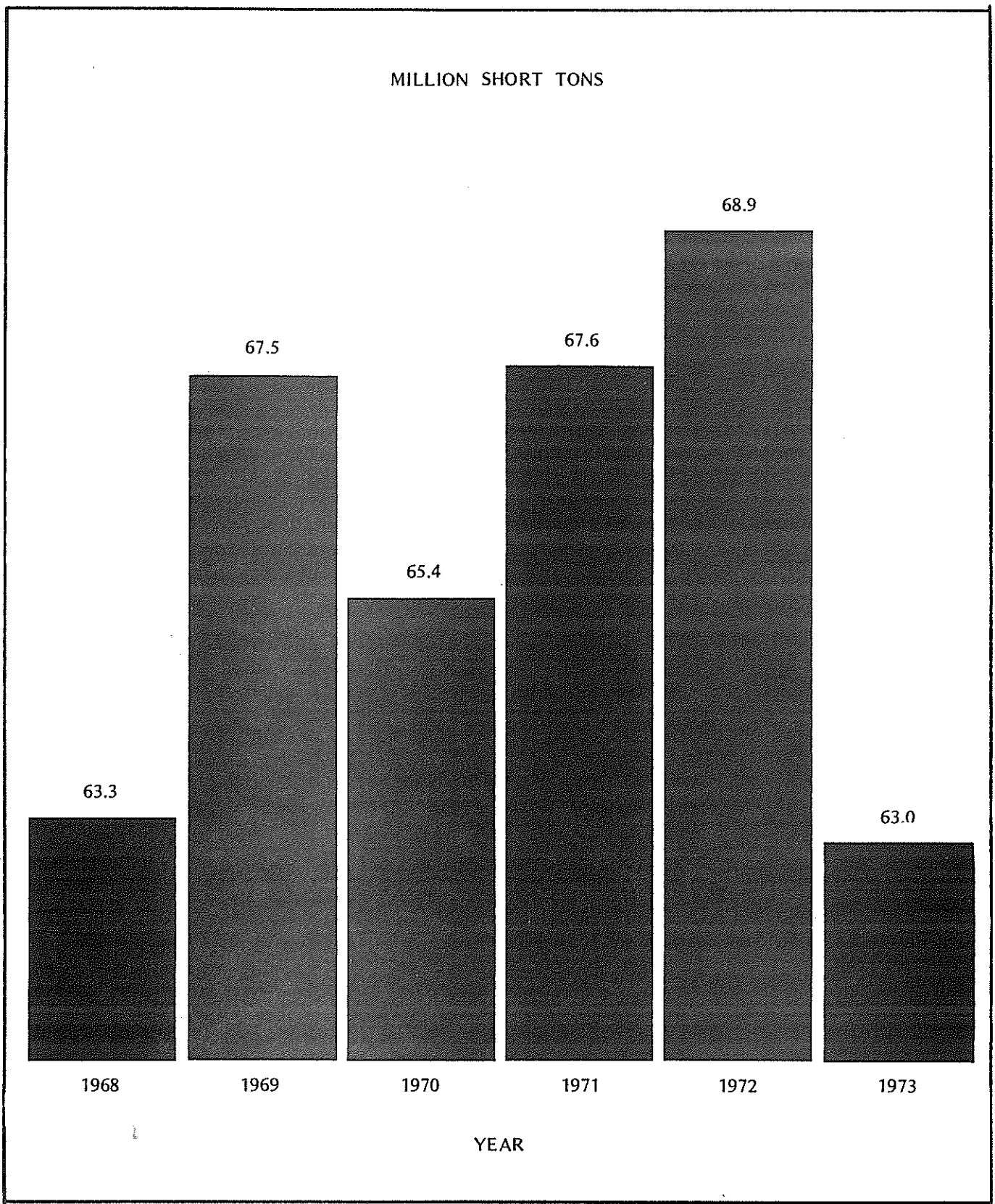
In 1937, while hearings were being held to obtain authorization for extension of the Gulf Intracoastal Waterway, the total annual volume of shipments in Texas was estimated at five million tons. Figure 2 illustrates the annual volume of commodities transported in Texas on the Waterway in recent years. The significant point is that, consistently, well over 60 million tons move on the Waterway annually. Such a consistent volume translates into a vital force in the economic life of all Texans. Some of the benefits related to activities dependent on the Waterway are employment, income, taxes, energy savings, and reduced prices on consumer products.

If future benefits are to be a certainty, maintenance and development of the Gulf Intracoastal Waterway in Texas are a necessity. In the past, the U.S. Army Corps of Engineers has borne the burden of maintaining and developing the Gulf Intracoastal Waterway. Once developed, segments of the Waterway are maintained by periodic dredging to remove accumulations of sediment and siltation. A continuing problem of the Corps of Engineers is disposal of dredged materials. Both upland disposal sites and deep ocean dumping are considered too costly; and securing diked dredge sites in the adjacent coastal area may be even more expensive due to ownership and environmental considerations. Regardless of where dredged materials are placed, the central issue is that additional monies are needed to secure sites for disposal of dredged materials. Rising land prices and inflation accentuate the difficulties which must be overcome to resolve the issue.



Gulf Intracoastal Waterway in Texas

FIGURE 1



Waterborne Commerce on the Gulf Intracoastal Waterway in Texas

FIGURE 2

Financial assistance and sponsorship by the State of Texas to maintain the Gulf Intracoastal Waterway merit serious consideration. Viewing present and anticipated economic benefits to Texas, assistance and support by the State of Texas to maintain the Waterway are priority items. Texas has never provided financial assistance to maintain or develop the Waterway.

BACKGROUND

While water transportation has long been recognized as a vital force in the economic affairs of Texas, a surprising lack of attention has been directed to the role played by the Gulf Intracoastal Waterway (GIWW) in maintaining a healthy economy in the state.

Several events combined to give a belated recognition to the important contribution of the GIWW to the economic well-being of all Texans. Publishment of the series of studies relating to deepwater terminals by Texas A&M University's Sea Grant Program led to an awareness that commodities brought ashore from deepwater terminals would need to be transshiped via pipeline or by the GIWW to processing plants.

Subsequently, with the emergence of the Coastal Zone Management Act in 1972, a general consensus evolved that water transportation, particularly the GIWW, would be a significant component of coastal planning for Texas.

Problems pertaining to the GIWW were discussed at several meetings of the Sea Grant College Advisory Council during 1973. Councilors Dow Wynn and Al Cisneros agreed to spearhead an effort to explore involvement and support from the Texas Ports Association. By August 10, 1973, the Texas Coastal and Marine Council sponsored a public meeting in Port Arthur to discuss the importance of the GIWW and problems associated with the waterway. At this meeting, the Texas Coastal and Marine Council moved to consider the introduction of legislation in 1975 to provide state sponsorship of the GIWW.

At a September, 1973, meeting of port directors, the mutual interests of the Texas Coastal and Marine Council and the Texas A&M University Sea Grant College Advisory Council in the GIWW were presented. The Texas Ports Association agreed to support a program to resolve the problems of the GIWW.

A final partner in the enterprise was enlisted by the interested parties at an October meeting in Galveston with representatives of the Corps of Engineers. Full cooperation was promised by the Corps of Engineers. This commitment was critical to the entire undertaking, due to the Corps' wealth of knowledge accumulated in their traditional responsibility in developing and maintaining the GIWW.

SCOPE OF THE STUDY

With funding support from the Texas Ports Association, the Texas Coastal and Marine Council, and Texas A&M University Sea Grant College Program, Dr. Robert C. Stephenson of Texas A&M University took the lead in developing a task force of researchers to conduct an objective analysis

of various aspects of the Gulf Intracoastal Waterway in Texas.

The task force prepared six separate reports on the problems and alternative solutions available to resolve the problems of the Waterway. These reports are included in this study covering the following aspects of the Gulf Intracoastal Waterway in Texas:

. environmental implications

. engineering aspects

. sociological characteristics

. economic impact

. funding alternatives

. legal aspects

A dominant theme of the effort was to document the importance of the Gulf Intracoastal Waterway to the people and economy of Texas. This report includes the findings and alternatives expressed by the researchers.

ACKNOWLEDGEMENTS

Grateful appreciation is directed to the many outstanding contributions of the total effort by Mr. Dow Wynn of the Port of Port Arthur and Mr. Al Cisneros of the Port of Brownsville. Both played a vital role in drawing on the resources and expertise of representatives of Texas ports.

Particular thanks are given to Senator A. R. Schwartz and Dr. Joe C. Moseley of the Texas Coastal and Marine Council for their valuable assistance and support of the project.

Appreciation is extended to Col. Don S. McCoy and his staff, Department of the Army, Corps of Engineers, Galveston District, for their assistance and patience in responding to requests for information by the task force researchers.

This report, "Analysis of the Role of the Gulf Intracoastal Waterway in Texas," received funding support from the Texas Ports Association and the Texas Coastal and Marine Council. Also, partial support was derived from an institutional grant 04-3-158-18 made to Texas A&M University through the National Sea Grant Program, National Oceanic and Atmospheric Administration, United States Department of Commerce.

Environmental Implications

ENVIRONMENTAL IMPLICATIONS OF MAINTENANCE AND IMPROVEMENT OF THE GULF INTRACOASTAL WATERWAY IN TEXAS

ROBERT B. DITTON and RONALD L. SCHMIED
Department of Recreation and Parks
College of Agriculture
Texas A&M University

INTRODUCTION

It is perhaps appropriate that the first public law to be signed in the 1970's was the National Environmental Policy Act (PL 91-190). Broadly, this Act established a national policy for the environment. Specifically, the Act requires all agencies of the Federal government to develop an environmental impact statement (EIS) for major Federal actions significantly affecting the quality of the human environment. Agencies are now required to consider the environmental impacts and adverse environmental effects, as well as project alternatives in the same way they have analyzed economic data in the past. Only in this way, it is reasoned, can the true costs of any resource development project be assessed. When PL 91-190 is coupled with state agency responsibilities under the U. S. Fish and Wildlife Coordination Act it becomes apparent that environmental considerations have taken on a new importance in natural resources decision making.

This report is not an environmental impact statement as required under PL 91-190 but rather a cursory review of some of the environmental considerations and impacts involved in maintenance and development of the Gulf Intracoastal Waterway. While no new primary data sources were generated, a vast amount of published material was reviewed in drafting this statement. Following a conceptual review of the environmental sub-systems contingent with the path of the GIWW, impacts associated with the maintenance and development of the Waterway are discussed and alternative means of materials disposal are analyzed.

THE TEXAS COASTAL ZONE: A VALUABLE RESOURCE

The Texas coastal zone is probably the most valuable and diverse grouping of natural resources in the state. Its bays, estuaries, marshes, and plains support a myriad of uses which have a major impact upon the socioeconomic well-being of the state as well as the entire nation.

The highly productive coastal waters and wetlands serve as the backbone of the Texas sport and commercial fishing industries by providing nursery and feeding ground for many economically important species of fish and crustaceans. These same areas provide critically important wintering, nesting, feeding, and resting habitats for numerous species of birds and waterfowl as well as diversities of other wildlife. In fact, approximately 60 percent of the Central Flyway waterfowl and a substantial percentage of the Mississippi Flyway waterfowl winter along the Texas coast.[1] Seventeen species protected under the Rare and Endangered Species Conservation Act (PL 93-205) inhabit the area. These include the American Alligator, Texas Red Wolf, Eastern Brown Pelican, the Southern Bald Eagle, and the Whooping Crane, to mention a few. (see Table 1)

In addition to wildlife, the coastal zone of Texas also supports a wide range of thriving industries. Among the most important are recreation and tourism, petroleum and natural gas drilling and refining, agriculture, forestry, manufacturing, shipbuilding, port activities, dairy and cattle ranches, sulphur mining, and sugar refining. During 1970, these industries created an income of about $10.8 billion.[2]

The Texas coastal zone is also one of the most popular residential areas in the state. According to the Bureau of the Census, in 1970, the 36 coastal counties increased in population 21.48 percent over the 1960 level of 2,885,026. By 1990, the area population is expected to be 5,060,700, a 75.41 percent increase over the 1960 figures.[3] It should be obvious that the coastal resources of Texas are extremely important to the state's welfare and that their utilization is an area for potential conflict. The solution of any problem requires an understanding of the problem. This requires a perspective of the Texas coastal zone and an introduction to some basic concepts of bay-estuarine systems.

---

[1] Letter from the U. S. Bureau of Sport Fisheries and Wildlife, (Albuquerque, New Mexico, July 19, 1960), p. 4.

[2] Billie I. Ingram, Economic Inventory of Recreation and Tourism within Texas Coastal Zone (Texas A&M University, 1973), p. 51

[3] Ibid., p. 50.

TABLE 1

DISTRIBUTIONS OF RARE AND ENDANGERED
VERTEBRATE SPECIES IN THE TEXAS COASTAL ZONE

SPECIES COMMON NAME	SABINE TO PT. O'CONNOR REACH 1	PT. O'CONNOR TO CORPUS CHRISTI REACH 2	CORPUS CHRISTI TO MEXICAN BORDER REACH 3
American Alligator	X	X	X
Houston Toad	X		
Texas Red Wolf	X		
Eastern Brown Pelican		X	X
Wood Ibis	X	X	X
White Faced Ibis	X	X	X
Whooping Crane		X	X
Eskimo Curlew	X		
Audubon's Caracara	X	X	X
Northern Aplomado Falcon			X
Ferruginous Hawk			X
American Osprey	X	X	X
Prairie Falcon			X
Attwater's Greater Prairie Chicken	X	X	
Southern Bald Eagle	X		
American Peregrine Falcon	X	X	X
Western Snowy Plover	X	X	X

SOURCE: "Environmental Impact Statement; Advanced Draft". Spring, 1974, U. S. Army Corps of Engineers. Galveston, Texas.

THE TEXAS COASTAL ZONE: AN ENVIRONMENTAL PERSPECTIVE

The Texas coastal zone, as defined by the Texas Coastal Management Program, extends southwest along the coast from the Sabine River to the Rio Grande, seaward into the Gulf of Mexico for a distance of 10.35 miles, and inland to include 36 counties. (see Figure 1) Of the 1,890 miles of coastal shoreline, 1,419 miles (74.6 percent) from bays and estuaries while 373 miles face the Gulf.[4] Parallel to this coastline there exists an almost continuous strip of barrier islands (80 percent of length of coastaline) consisting of Matagorda, St. Joseph, Mustang, and Padre Islands. Padre Island is the longest barrier island in the United States.[5]

The coastal zone has a total area of 33,223 square miles. Within this area there are fourteen bays, covering an area of 2,402 square miles, and 2,812 square miles of wetlands (fresh, brackish, and salt marshes). Also there are six designated wildlife refuges (five national, one state) with a total area of 213 square miles.[6]

Texas is drained by ten major river systems and many minor coastal drainage systems which enter the Gulf of Mexico either directly or through bays and estuaries. The ten major systems are (northeast to southwest) the Sabine, Neches, Trinity, San Jacinto, Brazos, Colorado, Guadalupe, San Antonio, Nueces, and Rio Grande. Of these ten, only the Brazos, Colorado, and Rio Grande enter the Gulf of Mexico directly. The other seven form estuaries and bays at their mouths before entering the Gulf.

The Texas coast is classified as Louisianian (see Table 2) and consists of an almost continuous series of bays, estuaries, and lagoons extending from Sabine Lake to Laguna Madre. The central depths of these embayments range from four to eighteen feet except in dredged channels or areas near inlets where local tides may scour out depths of 30-40 feet. These bays may extend 30 miles inland from the shoreline where they meet the "bay line," the area at which the gentle slope of the coastal plains limits the inland progress of the bays. At these bay heads, the river bay interface, are found alluvial plains and deltas that normally support marshes. The shores of many bays, the open coast, and both sides of the barrier islands and spits have miles of sandy beaches, tidal flats, and marsh areas.[8]

---

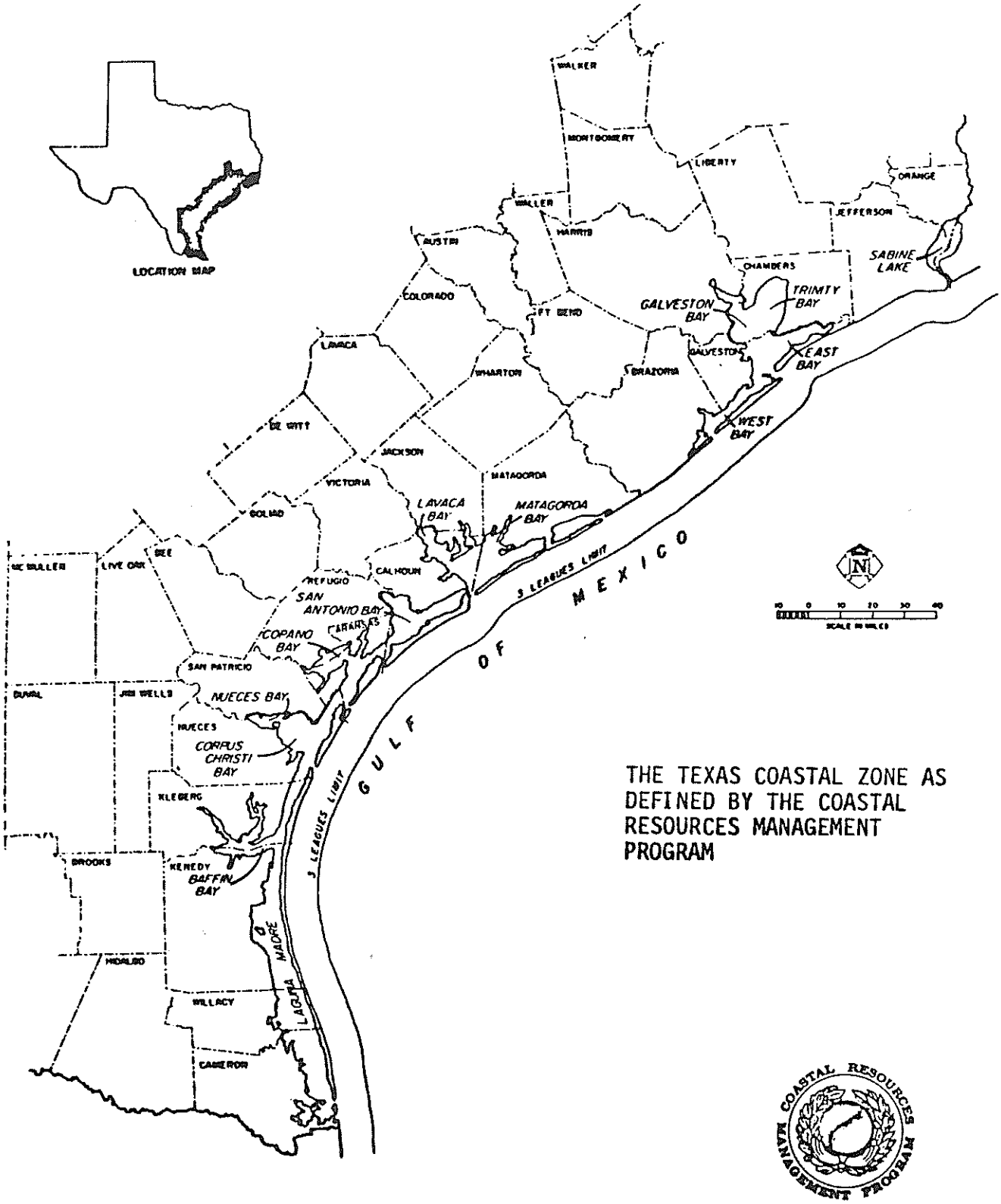
[4] Bill Fischer and P. T. Flawn, Minerals and Mining, Texas Coastal Zone, (Austin, 1970).

[5] Ingram, p. 50.

[6] Fisher and Flawn.

[7] Division of Natural Resources and the Environment, The Management of Bay and Estuarine Systems, (Austin, 1971), p. II-2.

[8] Ibid.



THE TEXAS COASTAL ZONE AS DEFINED BY THE COASTAL RESOURCES MANAGEMENT PROGRAM

COASTAL RESOURCES MANAGEMENT PROGRAM

THE TEXAS COASTAL ZONE

FIGURE 1

TABLE 2

REGIONAL CLASSIFICATION OF COASTAL ZONES OF NORTH AMERICA*

I. ARCADIAN - Northeast coast of North America (from the Artic to Cape Cod)

Characteristics - Rocky, glaciated shoreland and submarine topography; shoreline subject to winter icing; large attached algal species important producers; biota essentially boreal.

II. VIRGINIAN - Coast of middle Atlantic states (from Cape Cod to Cape Hatteras)

Characteristics - Climate, topography, and biota transitional between Regions I and III; lowland streams, coastal marshes, and muddy bottoms becoming prominent; biota primarily temperate with some boreal species.

III. CAROLINIAN - Coast of south Atlantic states (from Cape Hatteras to Cape Kennedy)

Characteristics - Estensive marshes and (cypress) swamps; muddy bottoms very important; waters turbid and highly productive; biota temperate with some subtropical elements.

IV. LOUISIANIAN - Northern coast of Gulf of Mexico (from central Florida to Tuxpan, Mexico)

Characteristics - Quite similar to Region III, but more tropical in environmental conditions and in biotic composition; bottoms mostly terrigenous.

V. VERA CRUZIAN - Eastern coast of Mexico (from Tuxpan to the base of the Yucatan Peninsula)

Characteristics - Diverse shoreland (hills and volcanic mountains grading southward to extensive low plains, marsh, and swampland); bottoms mostly terrigenous; biota distinctly tropical, but with some temperate elements.

VI. WEST INDIAN - Eastern coast of tropical America (southern tip of Florida, Yucatan Peninsula, Caribbean coast of Central America, West Indian islands)

Characteristics - Shoreland low-lying (karst) limestone varying to mountainous, but distinctly calcareous; foreshore and seabed with calcareous marls, sands, and coral reefs; biota tropical.

TABLE 2 (Continued)

VII. COLUMBIAN - Northwestern coast of North America (from Artic to southern California)

Characteristics - Shoreland predominantly mountainous; rocky foreshores prevalent; extensive algal communities, especially offshore kelp beds; biota boreal to temperate.

VIII. CALIFORNIAN - Western coast of North and middle America (from southern California through Mexico and Central America)

Characteristics - Shoreland generally mountainous (often volcanic); rocky coasts with volcanic sand; general absence of marshes, swamps, and calcareous bottoms; biota tropical.

IX. GREAT LAKES - Great Lakes of North America.

Characteristics - Rocky, glaciated topography; cold-temperate climate; freshwater only; biota a mixture of boreal and temperate species together with anadromous and marine invaders.

*Only the outstanding descriptive characteristics of each are given.

SOURCE: From Rezneat Darnell, "Critical Problems of the Coastal Zone: Ecological Effects of Man's Activities," 1972.

With this specific overview of the Texas coastal zone in mind, a discussion of the basic concepts of bay-estuarine systems is useful.

An estuary, according to Donald W. Pritchard of the Chesapeake Bay Institute, is "a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage." From a geomorphological standpoint estuaries can be sub-classified into those which are (1) drowned river valleys, (2) fjord-type estuaries, (3) bar-built estuaries, and (4) estuaries produced by tectonic processes.[9] Texas estuaries are generally classified as a hybrid of the drowned river valley and bar-built types.

All bay-estuarine systems, and indeed all of the world's ecosystems, have similar functional parts;

1) They have chemical nutrients and energy sources (solar).
2) They have producers: photosynthetic plants which capture solar energy and use it to produce organic compounds and bind these compounds with chemical nutrients in order to create living protoplasm.
3) They have consumers: animal species (herbivores, carnivores, or multivores) which feed upon plants and each other in order to construct a chain transfer of nutrients and energy.
4) They have decomposers: microorganisms, the majority of which are bacteria, which break down dead protoplasm and release the nutrients so that they can be reused by the photosynthetic plants.[10]

Thus, in cyclical manner a balanced ecosystem regenerates and perpetuates itself. When one or several functional units are destroyed or impaired by either man's activities or natural disasters, the system's balance is affected or destroyed. It is important to realize that while the impairment of consumer or decomposer units affects the quality of the system, the stoppage of nutrient influxes or the destruction of producer units will destroy the system or greatly reduce its productivity.

In addition to these functional characteristics, coastal ecosystems have some special characteristics which make them, in many respects, unique and more complex than other systems.

First, the functional processes of coastal ecosystems are spread out geographically. Coastal ecosystems are composed of three major interdependent zones: upland, bay-estuary, and marine. These zones are separated geographically in a "downhill interzone series" running from upland areas, seaward. For example, many of the nutrients

---

[9] George H. Lauff, "What is an Estuary: Physical Viewpoint," Estuaries, (Baltimore, 1967), pp. 3-4.

[10] Dr. Rezneat Darnell, "Critical Problems of the Coastal Zone: Ecological Effects of Man's Activities," (Unpublished working paper for The Water's Edge, 1972), p. 3.

utilized by the estuarine and marine zones originate in upland areas and are distributed to the lower areas by way of rivers and streams in the form of bark, leaves, dead animals, and dissolved chemicals. Also, there exists a geographical separation of the different habitats within each zone. For instance, marsh habitats (biotopes) may be predominately located at the head of the bay or estuary while oyster reefs or grass-flat habitats exists at various locations within the water portion of the bay. Figure 2 illustrates these geographical separations. [11]

Second, there is a marked redundancy of functions within coastal ecosystems. Coastal ecosystems are composed of numerous habitats (biotopes), each of which make some net contributions to the total system by fulfilling one or several functional capacities (nutrient source, producer, consumer, etc.). In addition, each biotope has its own endemic species of plants and animals which perform and duplicate the functional activities of the system. Further duplication occurs, especially in the producer and consumer functions, with the introduction of transient species which can occupy the same functional "niche" in a variety of habitats. This phenomena is exemplified by certain species of fish or crustaceans that live the majority of their lives in marine habitats, but live in estuarine habitats during adolescent stages.

Third, and probably most important, is the characteristically high productivity of coastal ecosystems, especially in bay and estuarine zones. Figure 3 graphically illustrates the comparative productivities of various terrestrial and aquatic systems. Productivity is defined as the rate at which nutrients are synthesized into living protoplasm, or tissue. The unit of measure is biomass (biological mass). It is easily seen that estuaries producing at their minimum rate per acre equal the most productive agricultural rate. At its upper limit, an estuary can out-produce moist land agriculture by a factor of two. When the productiviti of U. S. agriculture is taken into consideration, the significance of this fact becomes obvious.[12]

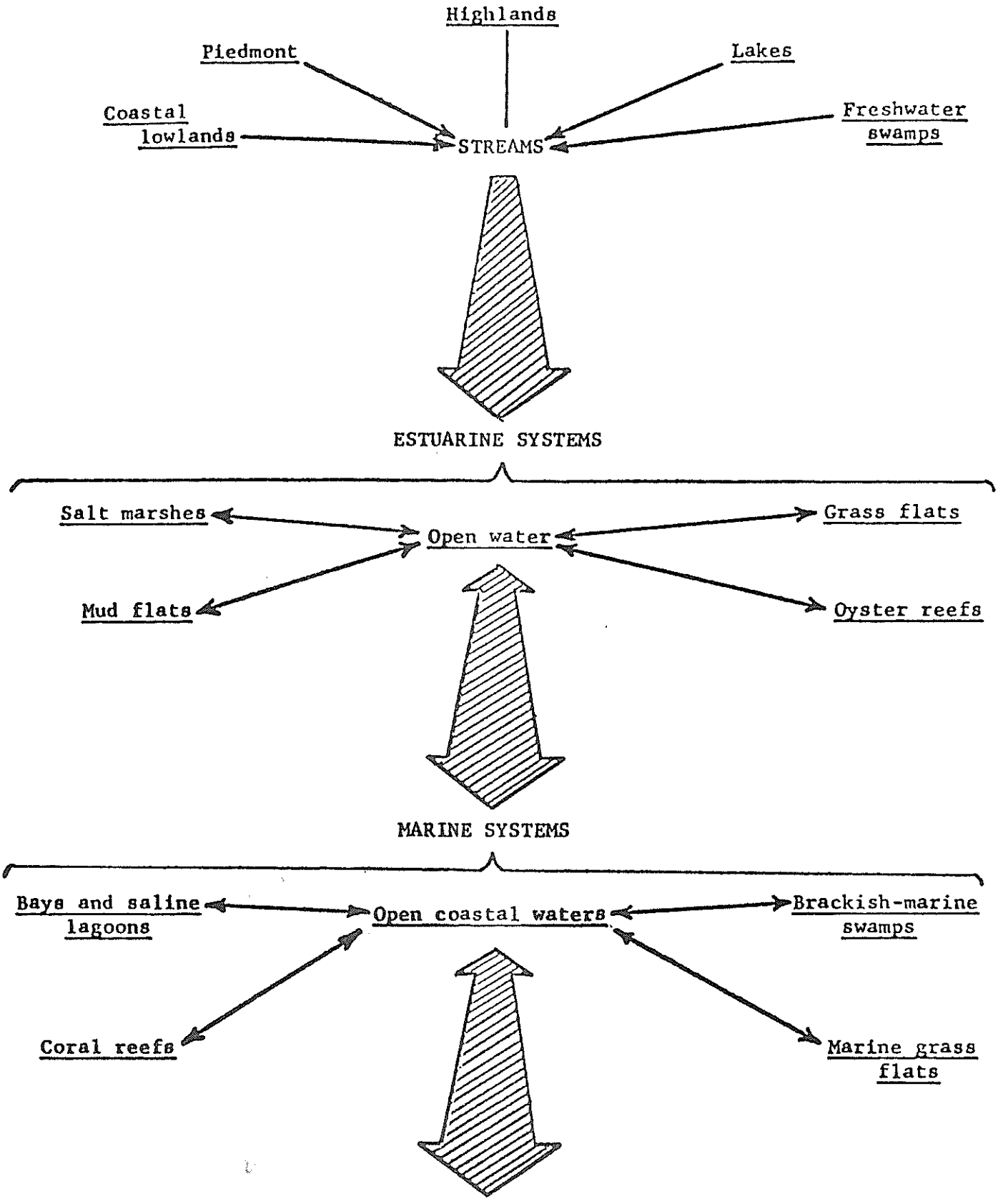
Last, in close relation with "downhill interzone series," the general economy of coastal ecosystems is biased on an import - local use - export phenomena. The overall net movement of nutrients and energy is seaward, even though some smaller backflows into the estuaries from the continental shelf occur due to tidal action. Each organism or habitat (biotype) imports and uses nutrients and energy in its turn and eventually passes them on (exports) to the next user or zone. This idea is conceptualized in Figure 4.[13]

---

[11] Ibid.

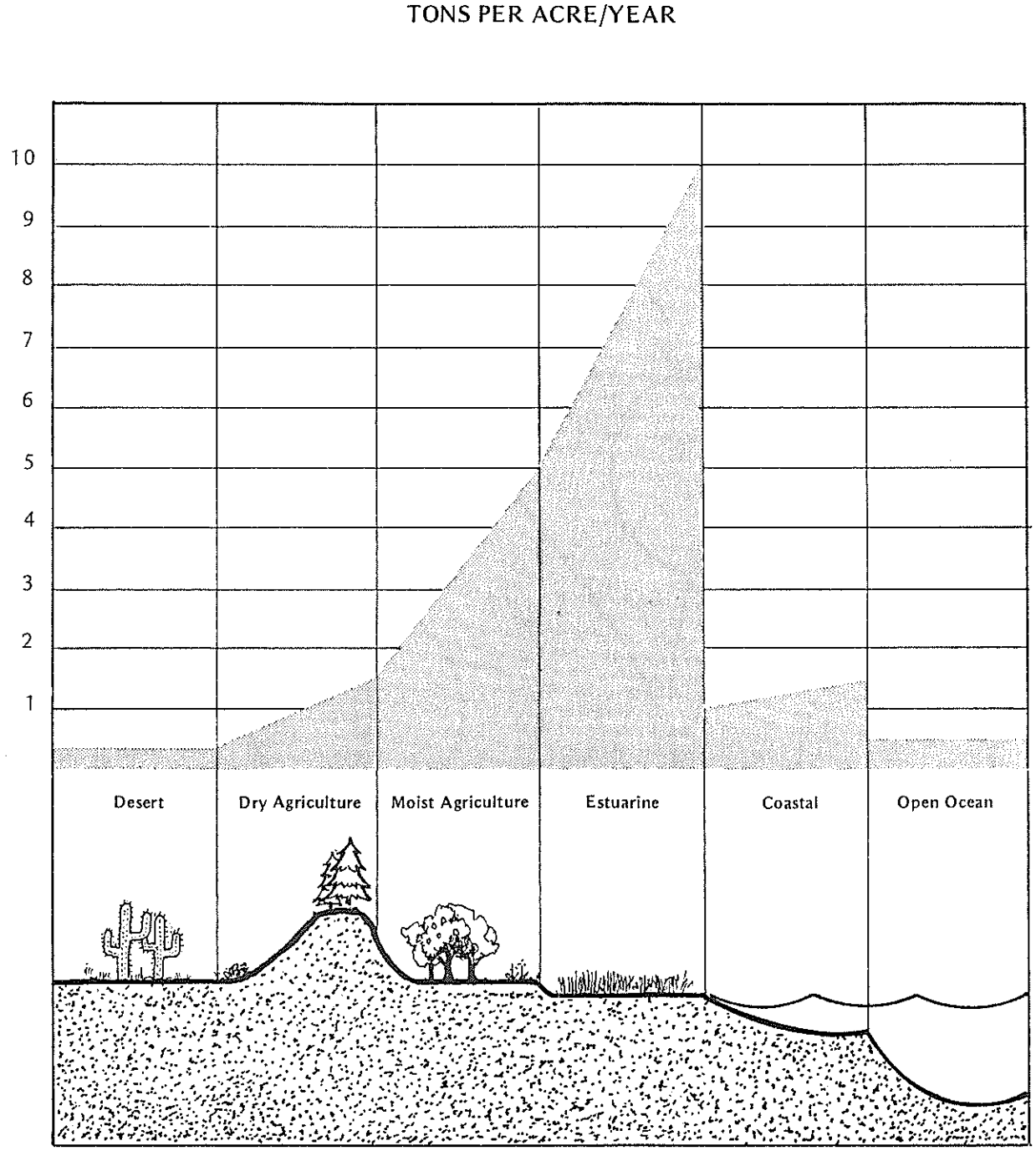
[12] Institute of Ecology, Man in the Living Environment, (1971), p. 267.

[13] Darnell, p. 5.



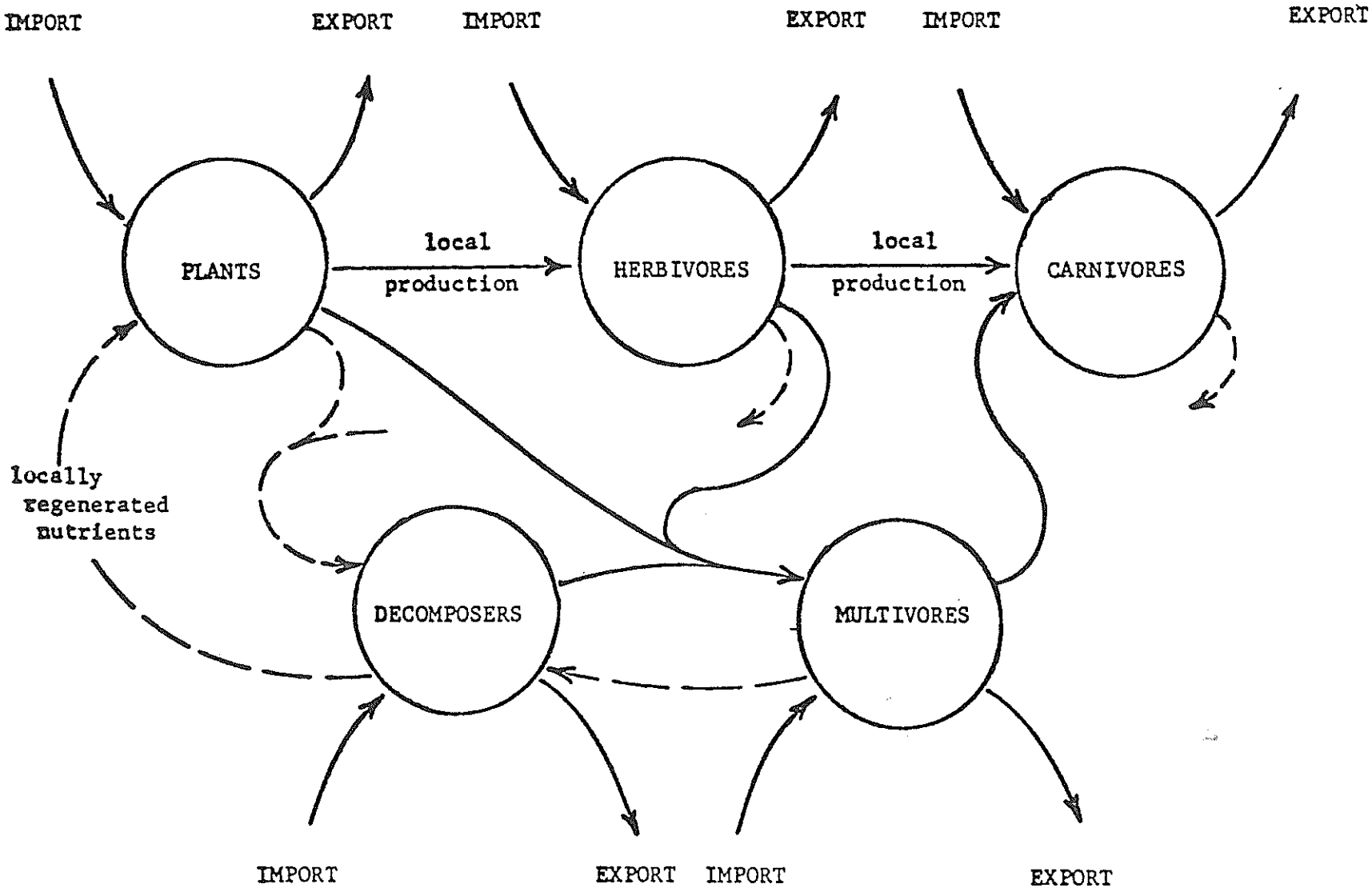
INTERRELATIONSHIPS OF ECOLOGICAL SUBCOMMUNITIES AFFECTING OR MAKING UP THE COASTAL ZONE SYSTEM OF A GIVEN REGION (From Rezneat Darnell, "Critical Problems of the Coastal Zone: Ecological Effects of Man's Activities," 1972)

FIGURE 2



Comparative Production Rates Among Terrestrial and Aquatic Systems

FIGURE 3



FUNCTIONAL PATHWAYS WITHIN AND BETWEEN SUBCOMMUNITY TYPES OF THE COASTAL ZONE OF A GIVEN REGION (from Darnell)

FIGURE 4

From this discussion several significant conclusions may be made. First, coastal ecosystems are complex and interrelated and consequently any interference or destruction of any single sub-system is likely to produce ecological effects locally as well as in other parts of the system. This is especially true when the effect is produced in the uphill portion of the interzone series. Secondly, whenever these interferences occur, damages accrue not only to the endemic species but also to those which utilize the habitat temporarily during different stages in their lives.

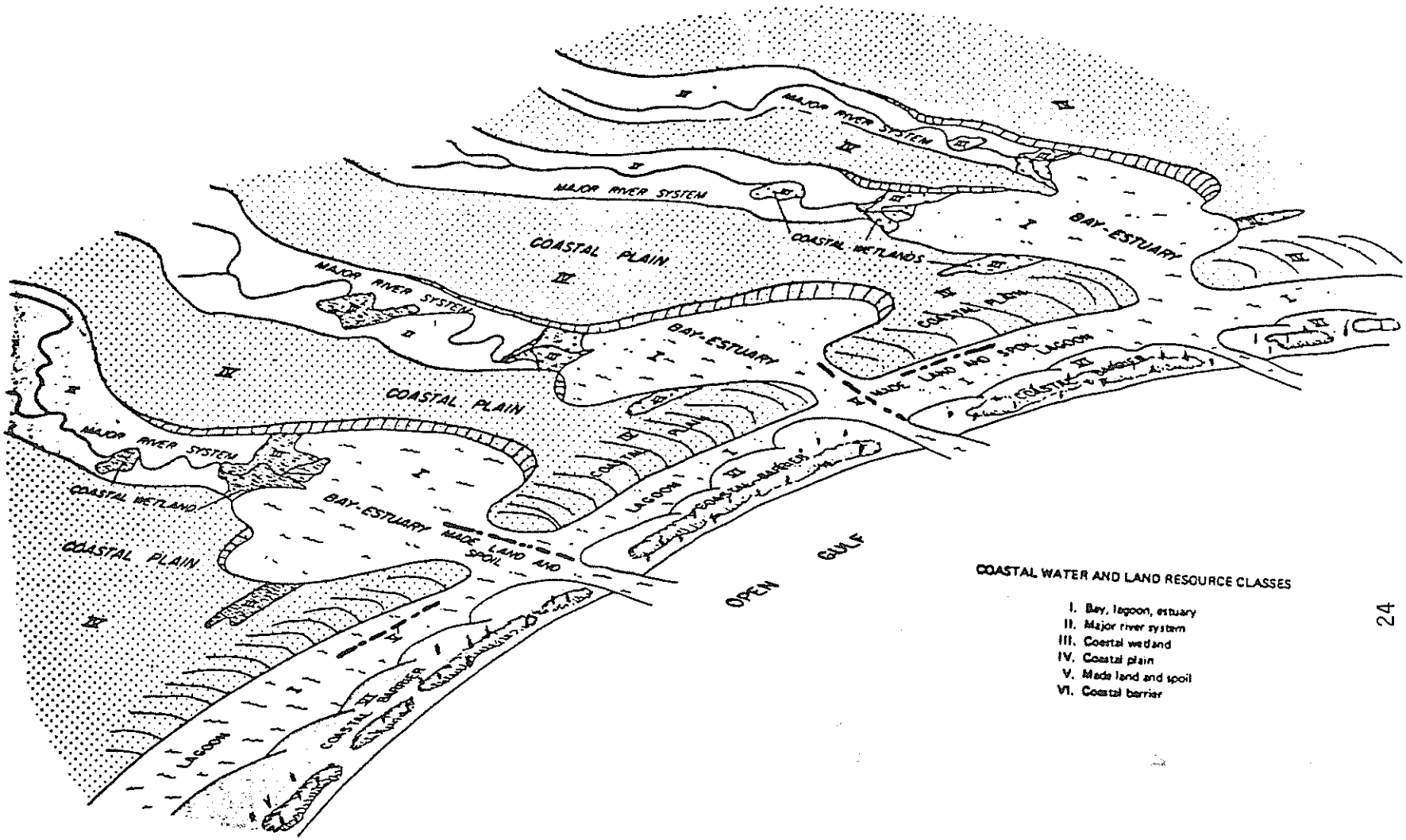
The third and final conclusion to be made is that due to functional redundance in coastal ecosystems, sizable amounts of human use can be sustained without destroying the system, as long as man understands his effects on the system and limits his use accordingly.[14]

Before this discussion of an environmental perspective in the Texas coastal zone is complete one further topic needs consideration. To discuss the environmental impacts of the Gulf Intracoastal Waterway in terms of plant or animal species affected would be too complex, while a discussion in terms of effects to the entire coastal ecosystem would be too general. Therefore, this study will focus on the environmental impacts to biotopes (habitats), the net effect of which implies impact to the entire ecosystem. A biotope is defined as a region, uniform in environmental conditions and in populations of animals and plants for which it is the habitat. Some biotopes may cover wide areas, such as extensive turtle grass flats, or may be discrete small units, like an oyster reef. Thus, the concept of biotopes is used to describe common recognizable Texas Gulf coast communities. Eighteen biotopes (habitats) have been identified and described (Table 3) for later use.[15] Figure 5 conceptualizes the possible spatial distribution of these biotopes in a bay-estuarine system.

---

[14] Ibid.

[15] Carl H. Oppenheimer and Kennith G. Gorden, Texas Coastal Zone Biotopes: An Ecography, (University of Texas Marine Science Institute, 1972).



CONCEPTUAL SCHEME OF A TYPICAL TEXAS COASTAL AREA
(From Division of Natural Resources and the Environment,
The Management of Bay-Estuarine Systems-Phase I, 1972, p. IV-2)

FIGURE 5

TABLE 3

A DESCRIPTIVE INDEX OF TEXAS COASTAL ZONE BIOTOPES

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
1. Open Beach and Shelf	Biotope including the water column and seabed extending from high tidemark of exposed coast to edge of Continental Shelf. Inshore areas have variable wave action, along shoal currents and sandy bottom. Offshore, less wave action and stronger, directional currents.	All along Texas Gulf Coast	Sport and commercial fishing, recreation, spawning and habitat grounds for many Gulf fish. Oil, gas, and mineral deposits.
2. Jetty and Bulkhead	Man-made structures of variable materials, constructed to restrict channel sedimentation, or provide Docking Areas. Acts as substrate and protection for marine flora and fauna. Adapted to salinity $\geq$ 15 ppt.	At mouths of channels, harbor works or wherever else man decides to build them.	Protects channels and harbor from expensive sedimentation, stabilizes beaches, and provides habitat for certain marine ecosystems.
3. Dune and Barrier	Dune and Barrier Islands created by depositional and aeolian processes.	All along Texas Gulf Coast, especially	They cause the impoundment of coastal lagoon systems,

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
3. (continued)	Dunes vary in height to 40 feet on open shore. They are usually vegetated flats, swales, potholes, and lagoons existing on barrier islands behind dunes. A limited diversity of flora and fauna exist.	along southwest portion.	provide a protection barrier to storm surges, vegetation retards sand migrations from covering roads and dwellings. Dunes help stabilize beach.
4. Channel	The bed of a natural or man-made stream of water; or deeper part of a river, bay, harbor, etc. They have low primary biological productivity due to turbidity, high current flow, and sedimentation. Flora and fauna of this biotope related to habitat through which it passes.	Throughout the Texas Coastal Zone.	Provide arteries through which organisms move to spawn, feed and grow, and nutrients travel in and out of coastal bays and estuaries. Serve as links between biotopes, can allow salt water intrusion.
5. Blue-Green Algal Flat	Leathery mats of blue-green algae grow in sand or silt, extending over miles of shoreland or restricted to		

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
5. (continued)	shallow depressions just inland of shoreland tidal ranges. They are productive and contain large varieties of microorganisms.		
6. Mud Flat	Extensive regions in highest backwaters of estuarine system made of mobile, drained fine silt with some ponding. They grade into algal mats in areas subject to wind tides, and are often bounded by salt grass and glassworts. They have high productivity in terms of bacteria, protozoans, and other infaunal organisms. There are also other organisms which inhabit the mud flat surfaces.	Backwater regions of estuaries along Gulf Coast.	Highly productive areas that produce many organisms comprising lower echelons of food chain. Provide excellent feeding grounds for birds.
7. Spartina Saltwater Marsh	A grassy area comprised mainly of smooth cordgrass that is subject to inundation due to tidal action. The underlying	Found on backsides of barrier islands and along shores of bays and estuaries	Plant material produced in this biotope makes a large and critical contribution to the estuarine food chain. Grassblades

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
7. (continued)	sediment ranges from fine anaerobic silt to sand and shell. Fluctuations in temperature, salinity, water depth and sediment limit the numbers of organisms found there, but their production is very high. The cordgrass offers protection and food for many birds, animals and microorganisms.	that are subject to tidal action.	offer food and production anchorage directly to birds, mammals, crustaceans, etc. The decay and decomposition of the grass into detritus indirectly supplies food to the rest of the ecosystem and is especially important to the support of marine nursery grounds.
8. Materials Bank	Man-made emergent-submergent mounds of mud, sand, and shell dredged off bottom sediments in in bays, estuaries, rivers, and Gulf to create channels. They vary in shape and size and may extend vertically up to 20 feet. Upon stabilization they offer good substrate for the growth and occupation of plants and animals endemic to	Found either on land or in water bodies usually adjacent to channels being maintained by man.	Materials banks often develop into good bird nesting and resting areas, as well as new food sources and homes for other plants and animals. They have possibilities as retreats for fishermen, boaters, picnickers, and campers.

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
8. (continued)	the local habitat. This biotope is a relatively low producer.		
9. Sand Flat	Flat area consisting of unstable sand, often bounded by saltgrass and inundated by wind tides. Attached plants or animals are generally precluded but area has high microflora - fauna production. Some crabs, oysters, worms, and other animals also found. Area is good bird feeding ground.	Found along bays and estuaries especially in areas exposed to frequent winds.	Large micro-flora biomass produced is important link in lower echelons of food chain.
10. Bay Planktonic	This biotope consists of upper layers of the bay, estuarine, or Gulf waters that is penetrated by sufficient amounts of sunlight and has the chemical composition needed to support phytoplanktonic growth. These areas may encompass miles	Found in water columns in coastal areas where proper chemical and physical conditions exist.	This biotope is critically important as it forms the backbone of the entire food chain.

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
10. (continued)	or just small patches. The plankton use sunlight to fix carbon. An example is a phytoplankton "bloom".		
11. Oyster Reef	An area where solid bottom substrate and sufficient nutrient carrying tides exist to support bottom sedentary filter feeders like American oyster and associated animals. These animals secrete hard exoskeletons that form bottom ridges and mounds called reefs. They require low salinities and fairly shallow water. Many sessile and swimming animals may be associated with the reef.	Found in all major Texas bays except Baffin Bay and Laguna Madre. (These two have too high a salinity.)	This biotope is commercially important to oyster, fish, shellfish, and construction industry. When reefs are emergent they provide good resting places for birds.
12. Fresh Water Marsh	A highly productive grassy marsh area consisting primarily of reeds and rushes, that develops in areas of fresh water ponds or	Found in permanent fresh water ponds or river areas maintained by high water level	Important source of food for estuary; used both directly by feeding animals or indirectly in form of detritus. Important food

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
12. (continued)	rivers. The sediments are usually anaerobic muds with high organic contents and fertility. Much detritus is produced and diverse and abundant wildlife inhabits the marsh.	or rainfalls. In the Gulf area they are found at junctions of a river and bay, or estuary.	Source for lower echelons of food chain, fish, shellfish, and birds. Especially good nesting area for birds.
13. River Floodplain Forest	A forested area existing on the damp alluvial clay loam that is found in the floodplains of a river. It has a broad-leafed deciduous upper canopy, a middle canopy of the same, and a ground cover of shrubby tangled thickets. A very diverse flora and fauna inhabit the area.	Found along most river floodplains in the Texas Coastal Zone.	An important source for bay-estuary systems of solar energy fixed as plant material. Many of the leaves and plant material is decomposed to detritus, an important nutrient for downstream flora and fauna.
14. River Mouth	This is a low salinity area at interface between rivers and bays. Bottom sediment is sandy muds and water is usually turbid 3-7 feet deep with low pH.	Found at mouths of rivers where they enter Texas coastal bays.	Important as nursery grounds for shrimp, crab, and clams.

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
14. (continued)	During low river flows water becomes brackish. Plants include freshwater and widgeongrass; animals include clams, snails, shrimp, and crabs.		
15. Thalassia Grass Flat	Subaqueous grass stands which grow along margins and throughout bays and lagoons in 1-5 feet of water. These areas are extensive, have large biomasses and are highly productive. Predominate plants include turtle, shoal and widgeongrass. High diversities of fauna inhabit the flats.	Found in and along margins of coastal bays and lagoons, where water depth and turbidity allow sunlight penetration.	One of major nursery areas for many fish and crustaceans. It provides protection and anchorage for many fish invertebrates and microalgae. In fall, stems and leaves break off and become an important link in food chain of other biotopes.
16. Hypersaline	A lagoon area into which seawater flows and evaporation is greater than runoff. High salinities develop (some 50%) and low diversity of flora and fauna exist. Primary producers and blue-grass algae.	Found mainly in Baffin Bay and Laguna Madre.	Baffin Bay and Laguna Madre are the most extensive hypersaline biotopes in the U. S. They have great value to Texas as commercial fisheries and waterfowl wintering grounds.

TABLE 3 (continued)

BIOTOPE (COASTAL ZONE SUB-SYSTEM)	DESCRIPTION	WHERE PRIMARILY FOUND	IMPORTANCE
17. Prairie Grasslands	A region of grasses, trees and herbs. Often called one of the most complex ecosystems. Great diversities of habitats, flora and fauna exist in the grasslands.	Found in a 30-40 mile strip along Texas coast southward to Kenedy County where it meets the coastal dune region.	It supports large, diverse populations of animal and plant life which are commercially, recreationally, and aesthetically important to Texas.
18. Upland Deciduous Forest	Upland forest is the normal climax for well drained upland areas like Brazos County. The upper canopy consists of small-leafed deciduous trees like post oaks, with a varied lower canopy of evergreens and shrubs. Flora and fauna much less diverse than floodplain forests.	Found in upper limits of Texas Coastal Zone.	Important as domestic land, agriculture, industry, and recreation.

SOURCE: Texas Coastal Zone Biotopes: An Ecography, Carl H. Oppenheimer and Kennith G. Gordon, University of Texas Marine Institute, 1972. Port Aransas, Texas.

THE GIWW AND THE COASTAL ENVIRONMENT

The development of the Gulf Intracoastal Waterway (GIWW) was formally authorized in 1828 when Congress appropriated $18,000 for construction of a channel extending from Mobile Bay to Mississippi Sound. Until 1942, the GIWW developed in scattered sections as local needs arose. Justifications for its development were the provision of access between the Gulf and numerous growing ports, industries and private holdings, and the development of a low cost inland transportation system. Gradually the number and use of interconnecting waterways became more extensive, and more heavily used sections had to be widened and deepened. In July 1942, Congress authorized the enlargement of the Gulf section of the Intracoastal Waterway from Apalachee Bay, Florida to Corpus Christi, Texas with an added extension to the Mexican border. The authorized bottom width and depth was 125 feet by 12 feet, respectively. Since 1942 there have been many improvement projects authorized for specific sections of the Waterway. To date, the U. S. Army Corps of Engineers has standing authorization to implement deepening, widening, alignments, and maintenance activities.[16]

In the earlier stages of the GIWW development, little thought was given to environmental considerations. The deciding factors for location and design principally revolved around economic, political and engineering criteria. If they existed at all, environmental concerns were confined to private protests against the destruction of personal property. However, concurrent with the passage of the Fish and Wildlife Act in 1956 and the Fish and Wildlife Coordination Act in 1958, an environmental imperative was evolving. After a decade of maturation and intensification during the 1960's, this imperative was formally institutionalized in the National Environmental Policy Act of 1970. Accordingly, in addition to the usual cost-benefit analyses, political and engineering criteria, the Corps of Engineers must now consider and evaluate the environmental impacts of their GIWW projects before implementation.

Before an evaluation of the environmental impacts can be made, it is necessary to know the path that the GIWW takes across the Texas coastal zone, and more importantly, the habitats which are traversed.[17] It is therefore necessary to trace the route of the GIWW to fully understand its interface with the coastal ecosystem.

---

[16] U. S. Army Corps of Engineers, An Environmental Statement for Maintenance Dredging Gulf Intracoastal Waterway -- Texas Section (Advanced Draft), (Galveston, 1974.

[17] Information concerning the location of biotopes along the GIWW taken from Environmental and Biological Assemblages Maps prepared by the Bureau of Economic Geology, (University of Texas, Austin).

This interface description will proceed by areas (seven) of the Texas coastal zone as they are delineated by the Bureau of Economic Geology. (see Figure 6)

Beaumont-Port Arthur Area

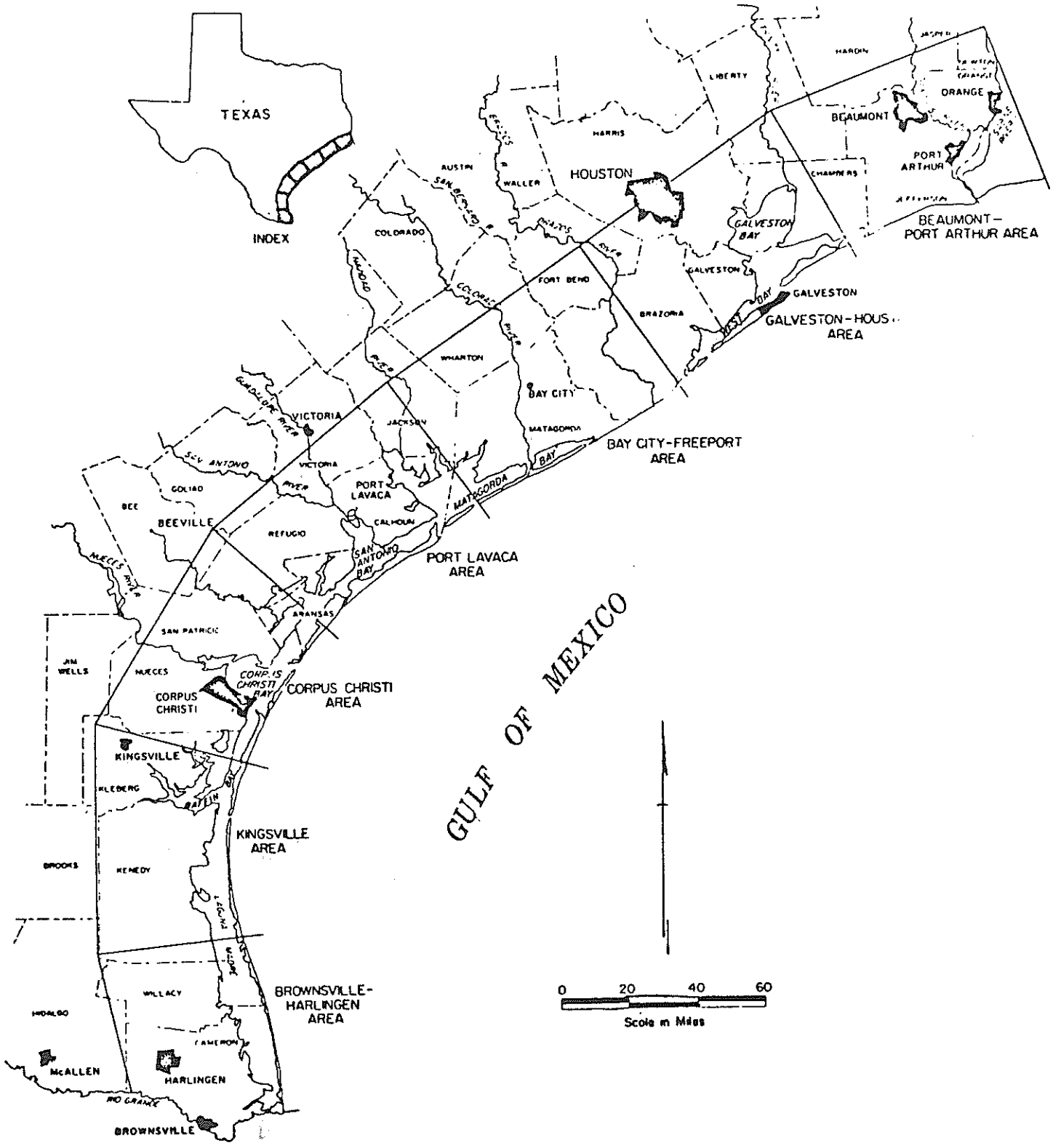
Upon entering Texas, the Gulf Intracoastal Waterway passes through the Sabine River floodplain where it traverses patches of fluvial fresh water swamp and floodplain forest.[18] It then passes through the Sabine River channel until it enters Sabine Lake, a low salinity river mouth area (Sabine and Neches Rivers). After crossing the lake it enters the Sabine-Neches canal (channel) which extends along the west margin of Sabine Lake heading southwest, until it meets the Port Arthur channel. Along this section there are large subaqueous spoil banks and salt marsh and prairie grasslands, which lie landward of the canal. The GIWW from Port Arthur to East Bay consists of a land-cut through alternating salt and brackish water marshes. This area is the best American Alligator and muskrat habitat in Texas as well as an excellent waterfowl wintering ground. In addition, immediately west of Port Arthur the GIWW passes through the southern end of the J. D. Marfee State Wildlife Management Area, which is located south of the Big Hill Reservoir (fresh-brackish water lake).

Galveston-Houston Area

Here the GIWW crosses the far-east end of East Bay (high salinity bay) directly south of the Anahuac National Wildlife Refuge. It then follows a land-cut through a section of salt marsh, crosses Rollover Bay and enters another land-cut which extends the length of Bolivar Peninsula on the bay side. Along this cut there exists expanses of saltwater marsh and vegetated dune and barrier flat as well as large deposits of spoil on the banks of the canal. Next, the GIWW enters Galveston Bay, where it intersects the Galveston entrance, Houston and Texas City channels, and crosses the north end of Pelican Island through a salt marsh area. The GIWW then traverses Galveston Bay behind Galveston Island, an area containing many oyster reefs, and then crosses over West Bay and enters a land-cut canal on the back side of West Bay. The canal extends to Chocolate Bay and passes over grassflats and saltwater marshes. After crossing Chocolate Bay it enters another land-cut that continues to the end of this section along this last land-cut, the GIWW passes through salt and brackish water marshes, several fresh water lakes, and the Brazoria National Wildlife Refuge. Spoil sites are located along the canal on alternating sides.

---

[18] Underlining used to indicate and highlight biotopes. If desired, refer to Table 2 for a description of a particular biotope.



INDEX OF THE ENVIRONMENTAL STUDY AREAS OF THE TEXAS COASTAL ZONE
(As Defined by the Bureau of Economic Geology)

FIGURE 6

Bay City-Freeport Area

In the Bay City-Freeport area, the GIWW is primarily a land-cut that starts at Oyster Creek and continues to Matagorda Bay. In this section river mouth biotopes are crossed at Oyster Creek and at the Brazos River channel near Freeport. Between Freeport and the east end of Matagorda Bay the GIWW passes primarily through areas of salt to brackish water marsh. Also in this section it crosses the San Bernard River (river mouth biotope) and the southern portion of the San Bernard National Wildlife Refuge at Cedar Lakes, an important waterfowl and wildlife refuge. All along this land-cut there are subaqueous and subaerial spoil deposits.

At the east end of Matagorda Bay the GIWW crosses Caney Creek, a fluvial area containing both floodplain forests and river mouth biotopes. From Caney Creek to Oyster Lake, the GIWW makes a land-cut on the north side of Matagorda Bay. This land-cut section passes through salt and brackish water marshes, prairie grasslands, river mouth (Colorado River crossing), and spoil bank biotopes. The GIWW then crosses Oyster Lake, named for its highly productive oyster reefs, and then makes a short land-cut, southwest, and enters Matagorda Bay.

Port Lavaca Area

There are five main divisions of the GIWW in this section. The first consists of a channel cut through Matagorda Bay. The bay is an open bay, 6-10 feet deep, with its lower end under tidal influence. It has live oyster reefs, grassflats, and a high species diversity.

The second is a land-cut section running from Port O'Connor to San Antonio Bay. This section of the GIWW cuts through prairie grassland, salt to brackish water marsh, and grassflat biotopes and also crosses parts of Espiritu Santo and Shoalwater Bays. These bays have shallow water and dense submerged to emergent vegetation which are valuable nursery areas for fish and crustaceans.

The third section is a channel cut across San Antonio Bay; a bay which is typical of those located between this area and the Corpus Christi Waterway. These extremely productive bays have large beds of shoal, widgeon, and turtlegrass that support large populations of fish and crustaceans. These populations are the backbone of local sport and commercial fishing industries.[19]

The fourth section is a land-cut across Blackjack Peninsula. The area through which the canal is cut consists of bay margin-grassflat,

---

[19] Letter from U. S. Bureau of Sport Fisheries and Wildlife, (July, 1960), pp. 2-3.

mixed marsh, and prairie grassland biotopes. Moreover, the Aransas National Wildlife Refuge borders (to the north) on the entire length of this land-cut. This refuge is a wetland area that is used as a nesting and wintering ground by geese, ducks, and the famous whooping crane and also provides valuable nursery areas for many species of crustaceans and fish.

The fifth and final section of the GIWW in the Port Lavaca area is a channel cut across Aransas Bay. This bay is very similar to San Antonio Bay.

Corpus Christi Area

In the Corpus Christi area the GIWW continues through Aransas Bay and the northern part of Redfish Bay where it crosses numerous grassflat-bay margin and spoil bank biotopes. Redfish Bay has a great importance as a waterfowl nesting, feeding, and resting ground. Landward of Redfish Bay are fresh water marsh, prairie grassland, and patches of upland forest biotopes. The GIWW then passes over open water in Corpus Christi Bay (biologically similar to San Antonio and Aransas Bays) and enters the Laguna Madre via a channel cut through shallow bay grassflats.

Kingsville and Brownsville-Harlingen Areas

In these last two areas the GIWW is a continuous cut channel through the Laguna Madre. The water body formed by Buffin Bay and the Laguna Madre is the most extensive hypersaline biotope in the U. S. It has an average depth of 3-4 feet but is sometimes deep as 12 feet in places like "The Hole." The salinity of the Laguna ranges from 5 to 80 parts per hundred with the higher salinity areas occurring in the lower portions. The bay botton consists generally of submergent to emergent grassflat, reef, and spoil bank biotopes. These areas are used extensively as breeding, nursery, and feeding grounds by fish and crustaceans as well as resting grounds for waterfowl. In 1971, the lower reaches supported a 275,000 man-day/year and the upper a 400,000 man-day/year sport fishing industry.[20] In addition, extensive commercial fish, shellfish, and shrimping industries use the waters in and adjacent (coastal) to Laguna Madre.

MAJOR ENVIRONMENTAL IMPACTS ASSOCIATED WITH DREDGING AND DREDGE MATERIAL DISPOSAL

As a consequence of the current emphasis on maintenance of the Gulf Intracoastal Waterway in Texas, the major environmental impacts

---

[20] Letters from the Bureau of Sport Fisheries and Wildlife, (Albuquerque, New Mexico, July 13, 1971 and August 20, 1971).

result from either dredging operations or the disposal of dredge material. However, before discussing these impacts, it must be made clear that for the purposes of this study, environmental impacts include only those which deal strictly with the physical, chemical, and biological components of the "natural" ecosystem.

Environmental Impacts of Dredging

There are two basic classes of dredges; mechanical (dipper, ladder, and bucket) and hydraulic (hopper, pipeline, and side-casting). The U. S. Army Corps of Engineers uses hydraulic dredges almost exclusively along the Gulf Intracoastal Waterway due to their greater utility in maintenance operations. In addition, hydraulic dredges are more economically and technologically efficient and produce less environmental damage than mechanical dredges. However, the use of hydraulic dredges on the GIWW is not completely free of environmental impact. These impacts that do result are beneficial or adverse.

Beneficial impacts of dredging operations accrue over both short and long time periods. Channels cut through bay systems or into previously enclosed coastal bays serve to stimulate water circulation greatly in those areas. This is a significant short-term benefit to those areas. Coastal bays and estuaries and the many habitats within these areas have optimum ranges of salinity that are crucial to their existence and productivity. Also, in order to function, a downhill series type of ecosystem needs to move larger amounts of nutrients from one area to another. Both of these critically important factors are maintained by water circulation and flow patterns. By keeping circulation routes open, dreding provides the long-term environmental benefit of maintaining or improving the productivity of coastal bay-estuarine systems through circulation augmentation.

Also associated with dredging operations are adverse environmental effects. The major short-term adverse effects include: (1) the removal or destruction of 70 percent of the benthic organisms and much of the vegetation that is directly encountered by the dredge; (2) a short-term increase in turbidity, which may or may not harm fish and crustaceans in the area, and; (3) a resuspension of pollutants.[21] This resuspension of pollutants from the sediment may or may not produce long-term adverse effects depending on the nature of the pollutants, how rapidly they resettle, and whether or not they become concentrated in local fish and crustaceans instead of back in bottom sediments.

---

[21] U. S. Army Corps of Engineers.

The major long-term adverse environmental effect of dredging is a reduction in both productivity of the area being dredged and the overall productivity of the bay-estuarine system. The U. S. Army Corps of Engineers estimates the average annual area of the GIWW and tributaries dredged each year for maintenance to be only 23/100 of one percent of the total bay bottom area along the Texas Gulf coast.[22] Since this is only an estimate, documentation of the extent of bay bottom affected is needed.

Environmental Impacts of Dredge Material Disposal

The operation of dredges in maintenance or development activities naturally produces large amounts of dredge material, that is, dislodged sediment removed from channel or bay bottoms. The material is then deposited in nearby designated sites which are generally located either in open waters, in marsh areas, or on land. Various environmental impacts result from the several methods of material disposal.

The process of dredge material disposal can result in an assortment of beneficial environmental effects. When dredge material is dumped in open water the nutrients that had settled into the sediments are resuspended in the water column. This creates a short-term stimulation of local productivity. Another short-term benefit results when the material contains shell or rocky substances. Upon deposits in open waters, the fine sediments settle out of the harder material creating a good substrate for oysters and other crustaceans to grow on.

A long-term benefit of material disposal is the creation of habitats. The shallowing effect of open water material disposal creates new areas in which grassflats may grow. These can become highly productive areas depending on how often new material deposits disrupt its growth. If these areas become emergent and are left alone for substantial periods, they may support vegetation and eventually animal life. In fact, many of these islands frequently become bird rookeries. When dredged material deposited along bay margins become emergent, the area becomes useful for the support of marsh biotopes, an extremely productive and important component of bay-estuarine systems.

Most of the more serious adverse environmental impacts of the GIWW result from present material disposal methods. The extent of these impacts depends greatly upon the area affected.

---

22 Ibid.

Various studies have been made on the effects of material disposal in open or semi-enclosed waters. It is agreed that the material settles fairly rapidly but is carried along the bottom as a flocculated column for distances as great as 1,600 feet. The extent of spreading depends upon local current and tide magnitudes. Initially, many of the benthic plants and animals are buried, turbidity increases, pollutants are resuspended, and an area of the bay bottom is either lost or its configuration changed. The increased turbidity suffocates many fish and crustaceans and reduces photosynthesis as a result of decreased sunlight penetration. These are only the major short-term adverse effects that have been documented.

In addition, some long-term effects are generated. Initial destruction of vegetation and animals results in a long-term reduction or suppression of local productivity. Repopulation can usually occur in six months, but whether or not productivity is restored depends upon the time intervals between the redeposition of material. Further effects on productivity result from the resuspension of pollutants in the area. Creation of lethal concentrations are immediately destructive to endemic flora and fauna while sub-lethal concentrations may or may not be harmful due to accumulated concentrations occurring in local organisms over time.

The eventual buildup of dredged material mounds following sequential material depositions, and the alteration of bottom contours may have adverse effects on water circulation patterns, especially when proper spacing techniques are not practiced. The eventual long-term adverse effects of poor circulation are reduced productivity or the destruction of bay-estuarine systems.

Material disposal in marshes creates adverse environmental impacts which undergo multiplier effects because of the critical importance of marshes to bay-estuarine productivity. Short range adverse effects include the destruction of vegetation and wildlife, the disturbance of water circulation within the marshes, the reduction in total marsh area, and the reduction in air quality due to odors. In the long run, the various short-term impacts reduce or destroy a highly productive habitat which support diverse populations of organisms. These highly productive marshes constitute the major part of the bay-estuarine producer function. It is critically important to realize that once substantial amounts of material are dumped in a marsh and tidal influence is lost, the marsh biotope is irreversibly converted to a less productive upland type.

When upland land areas are used for material disposal, the adverse environmental effects are not nearly as pronounced or far reaching. The short-term effects are the same as those for a marsh area but the impact of long-term effects is more localized. Land disposal sites undergo a suppression of productivity until the area is repopulated. The long-term productivity level is dependent upon the frequency of material disposal in the area.

ENVIRONMENTAL CONCERNS AND PERSPECTIVES OF INTERESTS INVOLVED WITH THE GIWW

This paper would be incomplete without a discussion of the environmental charges and perspectives of agencies, groups, and individuals involved with the Gulf Intracoastal Waterway. Conflicts between these charges and perspectives need to be uncovered and commented upon.

First, the U. S. Army Corps of Engineers' GIWW construction and maintenance projects "are governed by considerations of impacts on the environment, cost, available rights-of-way, and engineering feasibility" in disposal of dredge materials, "including location, dimensions of areas used and containment levees required."[23] The Corps is required by statute to comply with PL 90-190 but is similarly required to consider other aspects in its decision-making procedure of weighing costs against benefits. Environmental protection is but one of several multiple objectives. If environmental considerations were weighed too heavily, it is probable that costs would increase disproportionately. It is also likely that the project would not be authorized because of an unfavorable ratio of benefits to costs.

The Texas Parks and Wildlife Department, on the other hand, has opposed deposition of dredge spoil under PL 85-624 as well as PL 90-190. According to the Parks and Wildlife Commission's Wetlands Policy, "ecological need will be a major determining factor of consideration."[24] Not only has the Department weighed the environment heavily, it is its major concern. Its objectives and operations framework is singular when compared with that of the Corps of Engineers.

In recognizing that wetlands are of indispensable value, the Commission is most concerned with the location of dredge material areas and encourages material disposal techniques that are most benign. They support upland and deep water disposal (particularly in areas already in use), over controlled disposal in shallow water habitats.

While its policy is clear in its language and intent, it fails to recognize the costs associated with implementing such a policy. This is especially important when the costs are borne

---

[23] Ibid.

[24] Texas Parks and Wildlife Commission, Dredge Spoil Policy #3000-9, (Austin, February 8, 1974) p. 1.

by the Corps of Engineers.

It is also necessary to examine the dredging and habitat protection concerns of local, regional, state, and national environmental groups. Studying national groups is difficult to do in a reliable and unobtrusive manner. One route to the necessary information would be to examine environmental positions relative to the GIWW as expressed in public hearing testimony presented to the Corps of Engineers. Unfortunately, all construction projects on the GIWW were authorized prior to the passage of the National Environmental Policy Act and therefore public hearings have not been held. The public hearing held in December 1973 to consider a permit for the development of a multi-purpose deep-draft inshore port in Corpus Christi Bay does provide considerable insights into the environmental concerns of groups and the public that may be applicable to the GIWW. Digestion of this testimony is difficult because "everyone is for ecology and the environment" and "no one would support a project detrimental to the environment." Environment is important, but how important. This is the critical determination.

It is impossible to identify a single "environmentalist" position relative to the GIWW, dredge material disposal and habitat destruction. There are "environmentalists" and there are "environmentalists." It is useful to examine and understand a number of environmental viewpoints held toward Waterway construction and maintenance:

1) The Total Destruction Argument

   a) the coastal ecology will be destroyed permanently by dredging activity

   b) environmental destruction is regarded as a dichotomous variable, i.e., the environment is either pure or destroyed

   c) technological solutions such as artificial transplantation of marsh grasses are unacceptable.

2) The Develop with Nature Argument

   a) we can have our cake and eat it too because organisms adapt to modifications in the environment

      1. birds use dredge material bank as rookery

      2. marine organisms repopulate after development

   b) there is a super-abundance of habitat and we won't miss the small percentage associated with material disposal

c) while preventing as much environmental destruction as we can, we will make every attempt to restore affected areas through technological applications

3) The Protection by Location Argument

a) less opposed to development proposals if estuarine areas are classified (with protection for more productive areas such as mangrove swamps) as marine organism management areas as proposed by National Estuary Study

b) if more productive habitat areas can remain inviolate, they are willing to consider development proposals and alternatives

4) The Out-of-Sight, Out-of-Mind Argument

a) concerned with environmental implications of project adjacent to their community

b) their solution is to move project somewhere else

c) while the GIWW can't be moved, it is conceivable that this group might favor disposal and habitat destruction as long as it takes place elsewhere

5) The User Group-Oriented Argument

a) while one national environmental group has broad concerns, they are particularly interested in the impacts on the areas they presently have under lease as bird sanctuaries. Perhaps their concern is over-specialized

b) the "hooks and bullets" environmental philosophy is best expressed by the observation that if fishing is better (better in numbers, presumably), then obviously, the environment is being protected.

Some additional observations are in order. The National Audubon Society was the only national organization to provide testimony on the environmental aspects of the Corpus Christi project. Most of the groups testifying or providing letters for the record were local or regional groups, many of an unincorporated nature. Either the national or state groups are not interested in dredge material disposal in the coastal zone, or the rare opportunity to be heard at a coastal development permit hearing caught them by surprise. The "Develop with Nature" argument was espoused by most local officials, legislators, and interest groups appearing at the hearing. The most responsible environmental argument seems to be the protection by locational argument. This argument, as might be expected, has been articulated by scientists, planners, and officials from the National

Marine Fisheries Service, the U. S. Bureau of Sport Fisheries and Wildlife, and the Texas Parks and Wildlife Department. While many of the other "environmental" arguments offer little hope of being overcome, they do provide the greatest litigation threat to projects contemplated. It would appear that many environmental arguments can be neutralized through careful analysis and classification. Subsequently, coastal areas may be protected from dredge disposal on the basis of productivity.

There are a number of other state and federal agencies involved in GIWW decisions as they affect the coastal zone, such as the U. S. Army Corps of Engineers. Because their environmental concerns are more global, they are able to meet their environmental responsibilities under statute (where they exist). The Governor and Legislature, it might be reasoned, are dedicated to the economic development of the state's resources while taking environmental safeguards. In his Corpus Christi testimony, the Governor pointed out he will do "all /he/ possibly can to insure that all aspects of the environment are protected and, naturally, the development will be subject to all state and federal environmental laws." Such a statement passes the responsibility to agencies who are already in statutory conflict.

Caught in the middle of the web of inter-agency conflict is the private landowner who has previously granted easements to the U. S. Army Corps of Engineers to place material on his lands. Now disposal must be done in compliance with Parks and Wildlife Commission policy, resulting in levees on his property to contain the material. Not only do such levees restrict what use the landowner can make of his land, but the added costs must be borne by the U. S. Army Corps of Engineers, and/or others in the future.[25] Without taking issue with the environmentally sensitive policies of the Parks and Wildlife Commission, it would appear that greater funding flexibility is in order as a backup to their policy. Further, in our judgment, the private landowner's contention that he gave permission only to place materials, not to construct levees to contain the materials, is not in keeping with the public interest. This remains to be tested in the courts, however.

ALTERNATIVES TO MINIMIZE ENVIRONMENTAL DEGRADATION

Maintenance and development of the Gulf Intracoastal Waterway during an age of growing public and governmental environmental concern is a difficult task. With many actively seeking to minimize environmental degradation and/or destruction, it is imperative that all alternatives be seriously considered and weighed.

---

25 Ed Holder and Betty Poland, "Landowner Blocks Dredging by Corp," The Beaumont Enterprise, (Beaumont, February 15, 1973).

Cessation of Maintenance

Probably the first logical alternative to the maintenance and development of the Gulf Intracoastal Waterway is cessation of those activities. It is obvious to most that this alternative is not realistic or feasible due to the impact of the GIWW upon the economy of the state and the nation. Failure to maintain the channels would result ultimately in their closure. As a result, port activities would be hindered, if not eliminated, and products would have to be transported by truck or rail--means which are twenty and five times more expensive, respectively, than barge or ship transport. In addition, many areas like Port Mansfield, whose economy is based on commercial and sport fishing, would be economically paralyzed without channel access to bay and Gulf fishing areas. In terms of environment damage, areas like Laguna Madre would suffer increases in salinity, fish and vegetation kills, and marsh destruction due to impairment of water circulation. There are many other reasons which negate the cessation of the maintenance and development of the GIWW as a viable alternative.

Maintenance at Lower Depth

The second possible alternative is to maintain the GIWW at a lower operating depth. Several arguments tend to rule out the feasibility of this alternative. First, although the choice to maintain the GIWW at a ten foot depth, for example, would suspend the need for maintenance temporarily, maintenance would have to be resumed to maintain the new depth.

Second, the majority of the barges and ships presently using the GIWW have been designed and built to operate in 12 feet of water. In fact, authorization already has been obtained to deepen some reaches of the GIWW to better accommodate both growing commercial traffic and deeper draft barges and vessels. Even more important, present widths and depths are inadequate to handle present sizes and numbers of vessels/tows in the GIWW.

Different Dredging Methods

A third alternative involves the use of different dredging methods. This alternative has been recognized and implemented in the past. As a result, the U. S. Army Corps of Engineers presently is using hydraulic dredges (hopper, pipeline, and side-casting) for practically all maintenance projects. These dredges "vacuum" the sediments off bay or channel bottoms and either retain the material in large shipboard hoppers, cast it to the side of the dredging area, or pump it through pipelines to inland disposal sites. Compared with mechanical types of dredges, the dydraulic dredges are both the most technologically advanced and the least environmentally destructive. Thus this alternative already has been used to the maximum extent presently possible.

Coordination of Material Disposal Site Selection

The fourth alternative for reducing environmental impact is to intensify efforts to coordinate the interests of the Corps of Engineers, state and local governments, and private sectors in the selection and use of material disposal sites. Various sections of the GIWW have local characteristics which make them problem areas deserving of more intensive coordination in the selection of material disposal sites. Three basic factors make such sections problem areas.

The first factor is shoaling rate. Shoaling is the process by which sediments are deposited along the bottoms of water bodies such that with time, effective water depth is lessened. Shoaling rates depend upon many factors, a few of which are the configuration of the sides and bottom of the channel, bank and bottom sediment characteristics, flow rates and resistance to flow in the water body, and the amount of sediment typically suspended in the water column. Channels with high shoaling rates have to be dredged more frequently in order to maintain an established depth. Frequent dredging requires more, or larger disposal sites to accommodate the larger volumes of material, and thus increases the possibility of environmental disturbbance. According to the U. S. Army Corps of Engineers there are (in order of shoaling rates from greatest to least) three general types of canal sections along the GIWW in Texas: land-cut, shallow bay, and deep bay or channel. With rapid shoaling, the maintenance of land-cut or shallow bay areas requires considerably more intensive coordination between interested parties if environmental damamge is to be minimized.

The second factor is, that in some sections, the GIWW interface with biologically fragile and valuable biotopes. Although bay-estuarine systems are composed of many sub-systems (biotopes), some are more critical to the survival of the system than others. These are producer areas, typically marshes or shallow bay-grassflat biotopes, which convert incoming nutrients into food forms which are eventually cycled through and utilized by the entire system. Destruction of these areas would eventually result in disturbance and/or destruction of the entire system. These interfaces usually occur along land-cut or shallow bay sections of the GIWW, areas which also, due to their high shoaling rates, require frequent maintenance dredging. Obviously, if alternate sites are not available, material must be disposed of on these valuable lands, with adverse environmental consequences. In order to minimize this impact, dredging operations and disposal site selection must be intensively coordinated.

Concerning availability of material disposal sites, the third factor, it should be clear that the availability, acquisition, and use of material disposal sites along land-cut sections of the GIWW present more serious potential problems than either shallow or deep bay channel sections. The state owned submerged lands under the bays are more readily accessible and usable than the lands adjacent to land-cut sections which generally are privately owned.

In light of this information on shoaling rates, biological values of biotopes, and availability of material disposal sites, several points should be clear. First, land-cut sections, due to their high shoaling rates, proximity to biologically fragile and valuable biotopes, and problems of disposal site availability require first priority in coordination of material disposal site selection. In order of decreasing priority, shallow bays and deep bay channels should be considered next. Second, once coordination priorities are established, attention should focus on the use of alternate material disposal methods to further minimize adverse environmental impacts of the Gulf Intracoastal Waterway.

Material Disposal Alternatives to Reduce Environmental Damage

Various improvements over present day material disposal techniques could be made. Initially, previously obtained easements and material disposal sites should be used to the greatest degree possible to reduce the number of new sites subjected to disposal damage. Once material disposal sites are obtained and used all other conflicting uses of these sites should be prohibited. Presently, many of the dredge material islands which are built in bays by repeated disposal are taken over by squatters or become bird rookeries, uses which preclude or delay the use of the island for disposal. Action should be taken to reserve the entire site for material disposal.

Secondly, much can be accomplished through regulation of timing of dredging and disposal activities. Different sections of the coastal ecosystem reach their peak of biological activity and productivity at varying periods of the year. For example, shallow bay grassflats are most productive during spring, summer, and fall months. Any dredging in these areas should be scheduled for winter months when these grass beds die back or become dormant. Likewise, the banks of the GIWW in the Aransas Wildlife Refuge section are used as nesting and wintering grounds by the near-extinct whooping crane. Dredging and disposal in this area should be performed during the months when the whooping crane does not inhabit the area so that minimal disturbance to these endangered birds will occur. Basic research is needed to develop an environmentally-sensitive maintenance schedule for the entire GIWW.

Thirdly, the use of levees and dikes can substantially reduce adverse environmental effects of material disposal. Levees and dikes, when used effectively, restrict the encroachment of disposal upon adjacent areas and localize the damage.[26] However, procedures for their use

---

[26]Skidaway Institute of Oceanography, in Savannah, Georgia, is doing research to determine the effects of spoil deposition in marsh areas. It is also experimenting with replanting of marsh grasses in low spoil areas (marshes) in conjunction with diked and undiked spoiling methods.

should be clarified and coordinated between the Corps of Engineers, state agencies, and private interests. It should be remembered that although the Corps constructs levees on land, it does not have Congressional authorization or appropriations to do so in open water.[27]

Fourthly, deep water material disposal can be utilized, a process which involves minimal environmental impact. Practically all deep water disposal is performed by hopper dredges. Their use along the GIWW is restricted by operational requirements of 22 feet of water and economies of distance (greater distances to disposal sites increase costs). Due to these restrictions, deep water disposal is a limited but useful alternative method and should be used where and whenever possible.

The fifth and final disposal alternative involves disposal site selection procedures. Next to deep water disposal, upland material disposal creates the least adverse environmental impacts. Therefore, every effort should be made to gain additional upland easements, in preference to fee simple acquisition, for future material disposal use. Increased costs are involved both in the purchase of upland easements and their use, especially when material must be pumped large distances to reach these sites. Whether or not the value of our coastal resources is great enough to warrant the added costs involved in their protection is yet to be resolved in the political arena.

In cases where upland disposal sites are not available or are entirely too expensive to acquire and use, productivity mapping could be utilized to select new non-upland disposal sites. Some sections of the GIWW traverse large expanses of marshes, shallow bays, or other biologically valuable areas where the absence of upland sites makes disposal in these valuable areas necessary. Given that some marshes or shallow bay areas are more productive than others, the less productive ones should be determined in advance and used accordingly. Applied on a microscale this method helps to minimize adverse effects locally. Productivity mapping can also be used as a macromethod to provide a coast-wide plan to guide GIWW development and maintenance activities with minimal adverse environmental impacts to the valuable coastal ecosystems.

DISCUSSION

It is not foreseen that state sponsorship of the GIWW will overcome the wide spectrum of environmental concerns described in this paper. Many of the principal agencies involved are at "loggerheads" because of conflicting statutory responsibilities. Texas Parks and Wildlife and its sister federal agencies are responsible for protecting habitat above all else under the Fish and Wildlife Coordination

---

[27] U. S. Army Corps of Engineers.

Act and NEPA. The U. S. Army Corps of Engineers is responsible for considering environmental consequences, but must consider many other facets involved if it is to generate a favorable benefits-to-costs ratio and proceed with the project. While the public and many other agencies are involved, the Corps and Parks and Wildlife Department are the principal players. The private landowner who has granted disposal easements to the Corps also has a stake in any environmental solutions because use of his land is involved.

State sponsorship of the GIWW will, in the long run, open up a wider array of alternatives for coordinating the statutory responsibilities of the two major interests involved. State sponsorship will back state statutory responsibility to enable the execution of the environmental recommendations of the State Parks and Wildlife Department. The litigation threat posed by the private landowner who has previously granted disposal easements remains, but state sponsorship might allow for a more coordinated and sensitive response to litigation and its threat. The litigation threats posed by environmental groups remain, but may be overcome more easily by better coordination and more flexible funding arrangements between agencies.

If agencies believe that state sponsorship will lead to the development of a single position on dredge disposal in the coastal zone, they are mistaken. To arrive at a singular state position would probably ignore many present state and federal statutory responsibilities--many of which are either accidently or intentionally in conflict. We prefer to believe that many statutes are intentionally in conflict, and as such, serve as checks and balances in the environmental planning process. Therefore, the real meaning of state sponsorship is not to streamline a bulky planning process but to achieve financial flexibility in meeting environmental responsibilities and to foster more meaningful coordination.

BIBLIOGRAPHY

Darnell, Dr. Rezneat. "Critical Problems of the Coastal Zone: Ecological Effects of Man's Activities." (Unpublished working paper for The Water's Edge, 1972).

Division of Natural Resources and the Environment. The Management of Bay and Estuarine Systems--Phase I. Austin: University of Texas, 1972.

Fischer, Bill and P. T. Flawn. Minerals and Mining, Texas Coastal Zone. Austin: Division of Planning Coordination, 1970.

Fisher, W. L., J. H. McGowen, L. F. Brown, Jr., and C. G. Groat. Environmental Geologic Atlas of the Texas Coastal Zone--Beaumont-Port Arthur Area. Austin: Bureau of Economic Geology, 1972.

Fisher, W. L., J. H. McGowen, L. F. Brown, Jr., and C. G. Groat. Environmental Geologic Atlas of the Texas Coastal Zone--Galveston-Houston Area. Austin: Bureau of Economic Geology, 1972.

Holder, Ed and Betty Poland. "Landowner Blocks Dredging by Corps," The Beaumont Enterprise, February 15, 1973.

Ingram, Billie I., Ph.D. An Economic Inventory of Recreation and Tourism with Texas Coastal Zone. Texas A&M University: Industrial Economic Research Division, 1973.

Institute of Ecology. Man in the Living Environment. Report of the Workshop on Global Ecological Problems, 1971.

Lauff, George H., Ed. Estuaries. Baltimore: Horn-Shater Company, 1967.

Lauff, George H. "What is an Estuary: Physical Viewpoint," Estuaries. Baltimore: Horn-Shater Company, 1967.

Letters from the U. S. Bureau of Sport Fisheries and Wildlife. Albuquerque, New Mexico: July 19, 1960; July 13, 1971; and August 20, 1971.

May, Edwin B. Environmental Effects of Hydraulic Dredging in Estuaries. Montgomery: Skinner Printing Company, 1973.

Natural Resources Institute. Gross Physical and Biological Effects of Overboard Spoil Disposal in Upper Chesapeake Bay. University of Maryland: Natural Resources Institute, 1970.

Odum, Eugene P. Fundamentals of Ecology. Second and Third Editions. Philadelphia: W. B. Saunders Company, 1971.

Oppenheimer, Carl H., Ph.D., and Kennith G. Gorden, Ph.D. Texas Coastal Zone Biotopes: An Ecography. Port Aransas: University of Texas Marine Science Institute, 1972.

Sherk, J. A., J. M. O'Connor and D. A. Neumann. Effects of Suspended and Deposited Sediments on Estuarine Organisms--Phase II. University of Maryland: Natural Institute, 1972.

Skidaway Institute of Oceanography. Research to Determine the Environmental Response to the Deposition of Spoil on Salt Marshes using Diked and Undiked Techniques--Final Project Report. Savannah: Skidaway Institute, 1974.

Texas Parks and Wildlife Commission. Dredge Spoil Policy #3000-9. Austin: Texas Parks and Wildlife Commission, February 8, 1974.

Texas Water Quality Board. Texas Water Quality Standards. Austin: Texas Water Quality Board, 1973.

U. S. Army Corps of Engineers. Record of Public Meeting on Nueces Navigation District. Volumes I and II. Galveston: Corps of Engineers, Devember, 1973.

U. S. Army Corps of Engineers. An Environmental Statement for Maintenance Dredging, Gulf Intracoastal--Texas Section (Advanced Draft). Galveston: U. S. Army Corps of Engineers, April, 1974.

Engineering Aspects

ENGINEERING ASPECTS OF OPERATION AND MAINTENANCE OF THE GULF INTRACOASTAL WATERWAY IN TEXAS

JOHN B. HERBICH
Ocean Engineering Program
College of Engineering
Texas A&M University

SILTATION OF THE WATERWAY

INTRODUCTION

Stretching along the Gulf of Mexico coast of the United States from northern Florida to the southern tip of Texas is one of the principal arteries of the vast inland waterways systems of the United States - the Gulf Intracoastal Waterway (GIWW).

GIWW is the counterpart of the Atlantic Intracoastal Waterway, which similarily skirts the Atlantic Ocean from Trenton, N.J., to the Eastern Coast of Florida. A connection linking both waterways through Florida is under construction.

The many bays and sounds that indent and parellel the Gulf Coast have been used as vital transportation routes since the days of the first settlers. Since passage between the various bays could be made only through the open Gulf, the need for a sheltered inland connecting route was recognized by the early settlers and by the U.S. Congress as early as the beginning of the 19th Century.

GIWW has been developed in segments, each section built to serve the needs of a specific local area. In 1828 the first federal act authorizing construction of a segment of channel connecting Mobile Bay and Mississippi Sound was passed. In 1873, Congress authorized a survey to select a suitable route for an inland waterway connecting the Mississippi to the Rio Grande. In 1892, a federal project channel 3½ feet deep by 200 feet wide in Galveston Bay was authorized. This was to connect with the "Galveston and Brazos Canal" which had been built between Oyster Bay and the Brazos River in the 1850's by private interests. In 1902, Congress authorized extension from Galveston to the Brazos River and in 1903 the private "Galveston and Brazos Canal" was purchased for $30,000 to form a link in the chain of inland waterways. In 1905, Congress authorized construction of a channel between Franklin and the Mermentan River, Louisiana. Plaquemine Lock, completed in 1909, provided a navigable waterway from the Mississippi River to Morgan City, Louisiana. Several surveys between 1907 and 1925 resulted in construction of numerous disconnected reaches of channel along the coast between Saint Georges Sound, Florida and New Orleans, with dimensions ranging from 5 feet by 40 feet to 12 feet by 90 feet.

In 1934, a significant milestone was reached with completion of a continuous waterway between New Orleans and Galveston Bay, to dimensions of 9 feet by 100 feet.

Extension of the 9 foot by 100 foot channel from Galveston Bay to Corpus Christi, Texas, was completed in 1941.

The last link in the main channel of the Gulf Intracoastal Waterway from Florida to the Rio Grande was completed in June 18, 1949 in the mud flats of Laguna Madre between Corpus Christi and Brownsville. In

more recent years, along with improvement of the main channel, many tributary and feeder channels have been provided to keep pace with the rapid growth and expansion that have occurred.

Sediment may be deposited in a waterway in a number of ways: (1) by density currents, (2) from bank erosion caused by wind-generated as well as ship-generated waves and (3) by wind-blown action.

GIWW is maintained by the Galveston District, U.S. Army Corps of Engineers. There are four area offices located at Port Arthur, Fort Point, Corpus Christi and Brownsville. Each area office supervises a section of the Waterway, i.e. Port Arthur Area Office is responsible for the section of the Waterway from the Louisiana border to High Island. The extent of each area's responsibility is shown graphically in Figure 1.

DENSITY CURRENTS

It appears that one of the areas where sediment deposition may occur by density current is near Port Arthur. However, even at that location, there are very few salinity measurements taken, and no positive statement regarding siltation due to density currents can be made.

BANK EROSION

In channels which were dredged originally in land areas, bank erosion is particularly serious as a result of very heavy traffic and the resulting waves generated by ships (Table I).

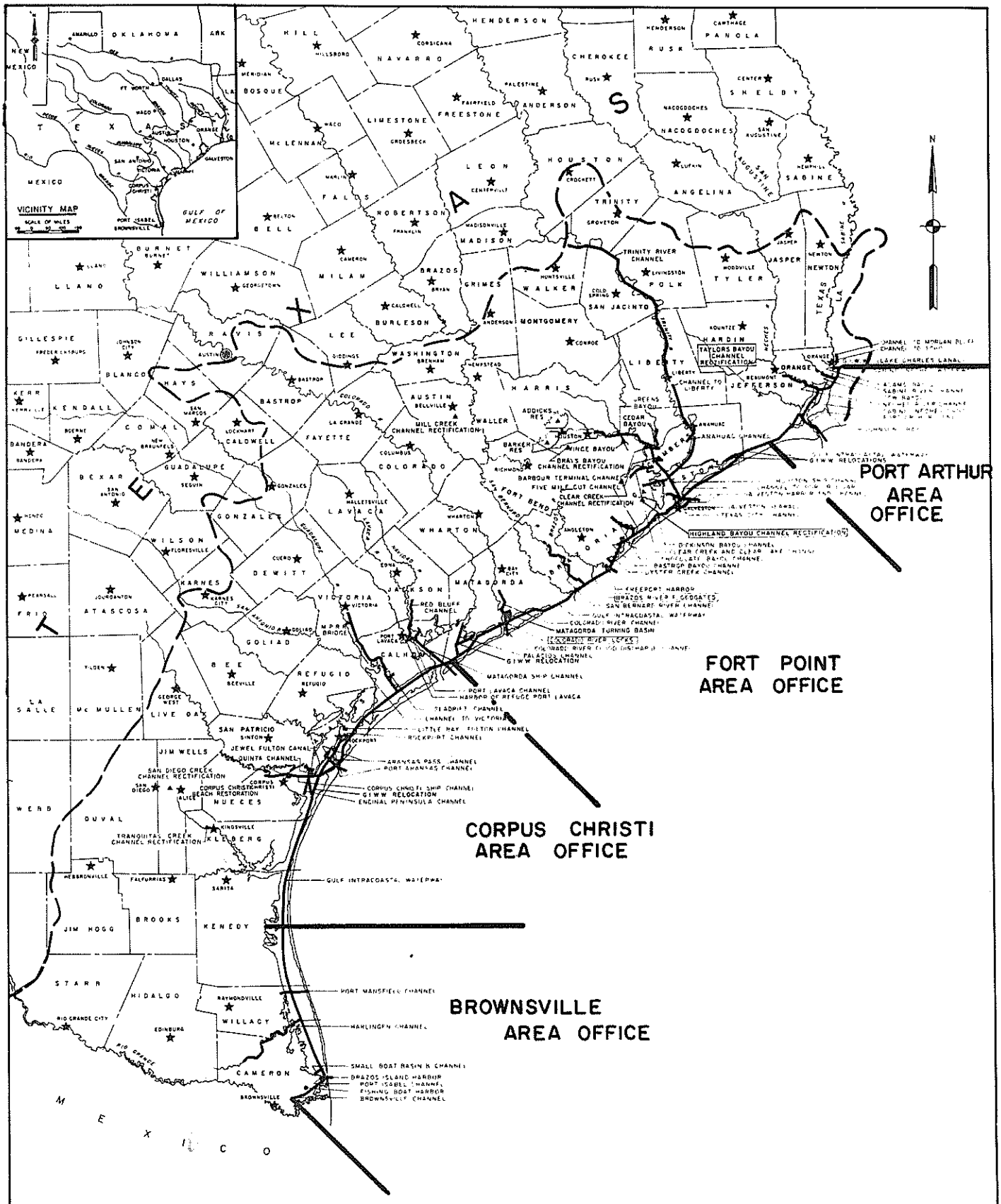
TABLE 1

WAVES GENERATED BY VARIOUS BOATS OPERATING AT 10 KNOTS IN THE OAKLAND ESTUARY

(DEPTH = APPROX. 35')

Boat	Length (ft.)	Beam (ft.)	Draft (ft.)	Displacement (tons)	Distance from sailing line 100 ft. H max ft.	100 ft. T/2 sec.	500 ft. H max ft.	500 ft. T/2 sec.
Cabin Cruiser	23	8.25	1.66	3	1.1	-	0.8	-
Coast Guard Cutter	40	10	3.5	10	1.6	1.0	1.0	1.0
Tugboat	45	13	6	29	1.6	1.2	0.9	1.2
Fishing Boat	64	12.8	3	35	1.8	1.0	0.7	1.0
Fireboat	100	28	9.12	343	1.6	1.3	1.0	1.3

SOURCE: Shore and Beach, April 1969, p. 12.



U. S. ARMY ENGINEERS AREA OFFICES
AND THE EXTENT OF THEIR AREAL COVERAGE

FIGURE 1

The accompanying photographs show bank erosion between High Island and Port Arthur. In open areas bank erosion is usually caused by wind-generating waves. This is evident in a number of locations in Matagorda Bay, Corpus Christi and Laguna Madre. A series of drawings was prepared to show the critical and non-critical erosion along the Waterway and the bays. Directors of Coastal Fisheries, Texas Parks and Wildlife Department at La Porte and Rockport were contacted and supplemented the information on bank erosion.

Figures 2 through 8 present erosion patterns observed along the GIWW and in the surrounding bays and estuaries. Figure 2 is for Galveston Bay Area where critical and non-critical erosion is evident in many parts of Galveston and East and West Bays. Critical erosion occurred in many locations, including Trinity Bay, Figure 3.

Figures 4a and 4b indicate the extent of non-critical erosion in Matagorda Bay and Figure 5 shows the extent of critical and non-critical erosion in Espiritu Santo Bay area. Figures 6a and 6b show erosion in San Antonio Bay. Figure 7 shows the critical and non-critical erosion in Aransas Bay and Figure 8 shows non-critical erosion in Redfish Bay and parts of Aransas Bay. Figure 9 shows the critical and non-critical erosion in Corpus Christi bay and Figure 10 shows limited non-critical erosion in Laguna Madre.

WIND-BLOWN SAND

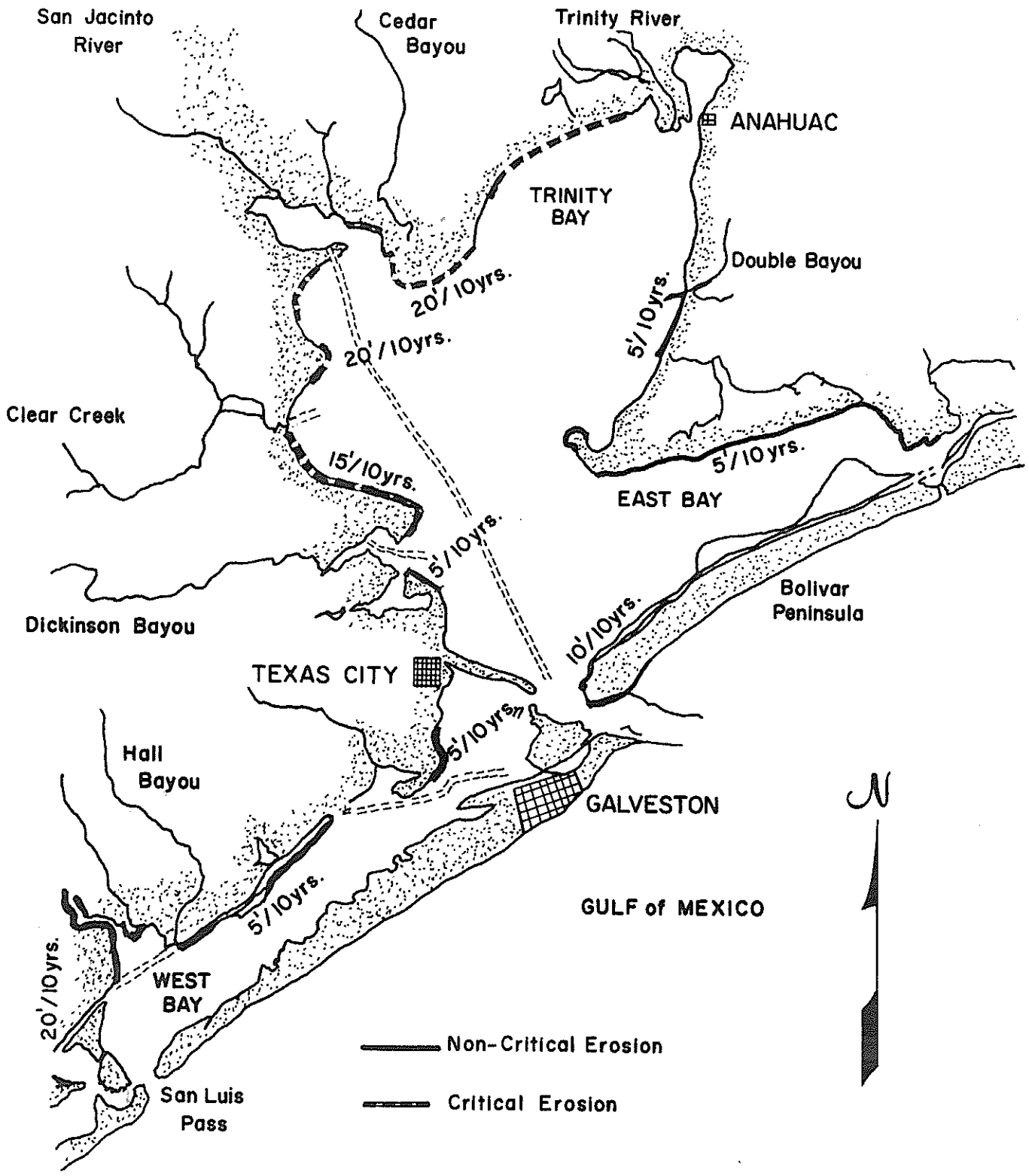
The effect of wind blown action is serious only in the Laguna Madre area. A research project has been sponsored by the Sea Grant Office, "Silting Mechanisms-Intracoastal Waterway: Kennedy County Area". The objective of this study is to measure the rate of sediment infilling in the Intracoastal Waterway in the Kenedy County area. An attempt is being made to measure the amount of sediment which enters the Gulf Intracoastal Waterway and engineering recommendations will be made on the control of deflation in active dune areas needed to reduce the landward transport of sand insilting on GIWW.

No published reports are available on this project to date; however, a final report will be published by the Sea Grant Program Office at the completion of this study.

ENGINEERING ASPECTS

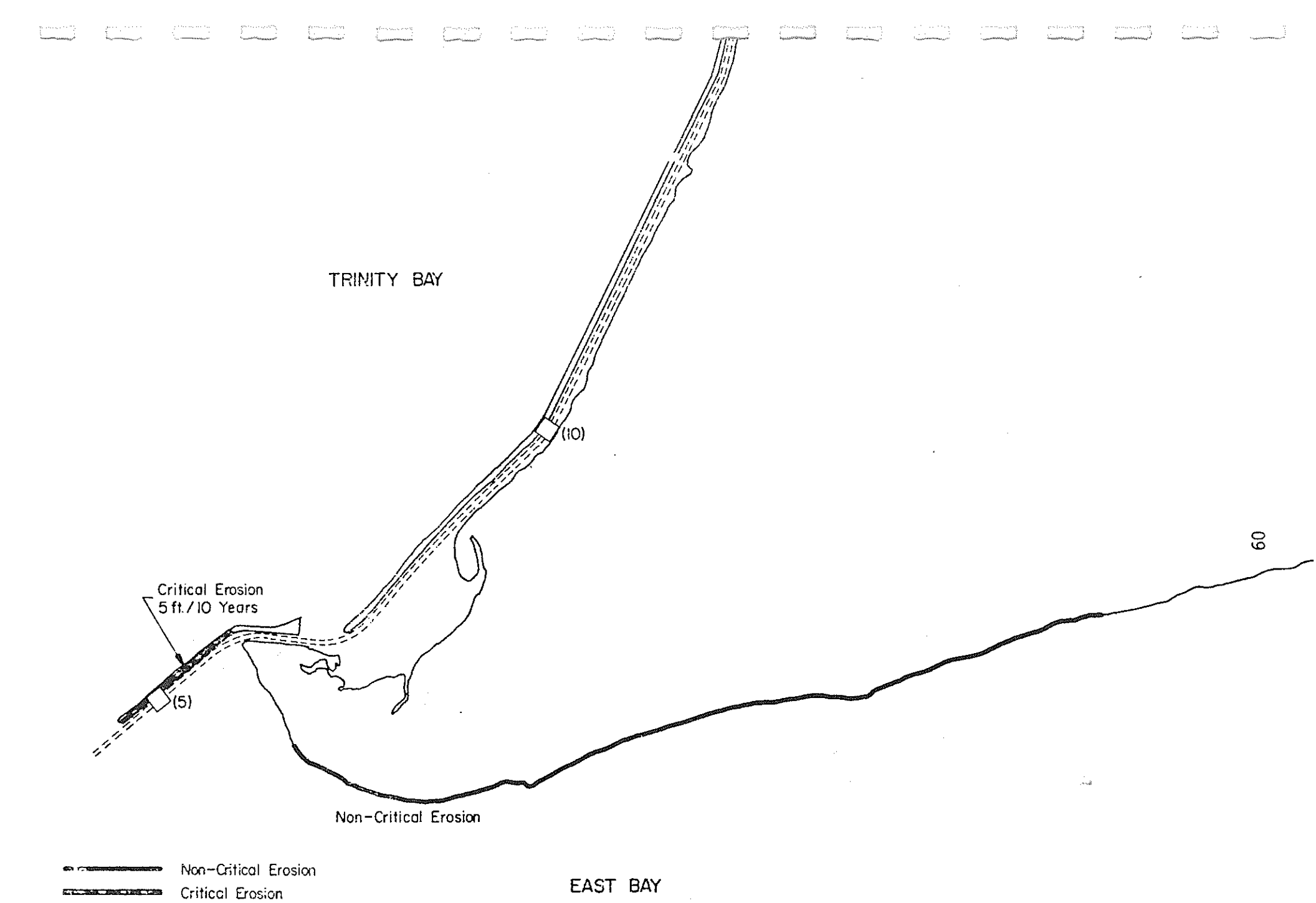
The purely engineering aspects of maintenance of the Gulf Intracoastal Waterway (GIWW) are not particularly difficult; however the constraints placed by regulations, particularly of an environmental nature, make the maintenance of the Waterway difficult, if not impossible.

The siltation of the Waterway is caused by a variety of processes including density-induced currents, bank erosion, sediment carried by rivers and sediment blown by wind. Density currents and sediment carried by rivers or wind are natural phenomena and little can be done to control them economically. However, the bank erosion is to a large extent man-made and can be corrected.



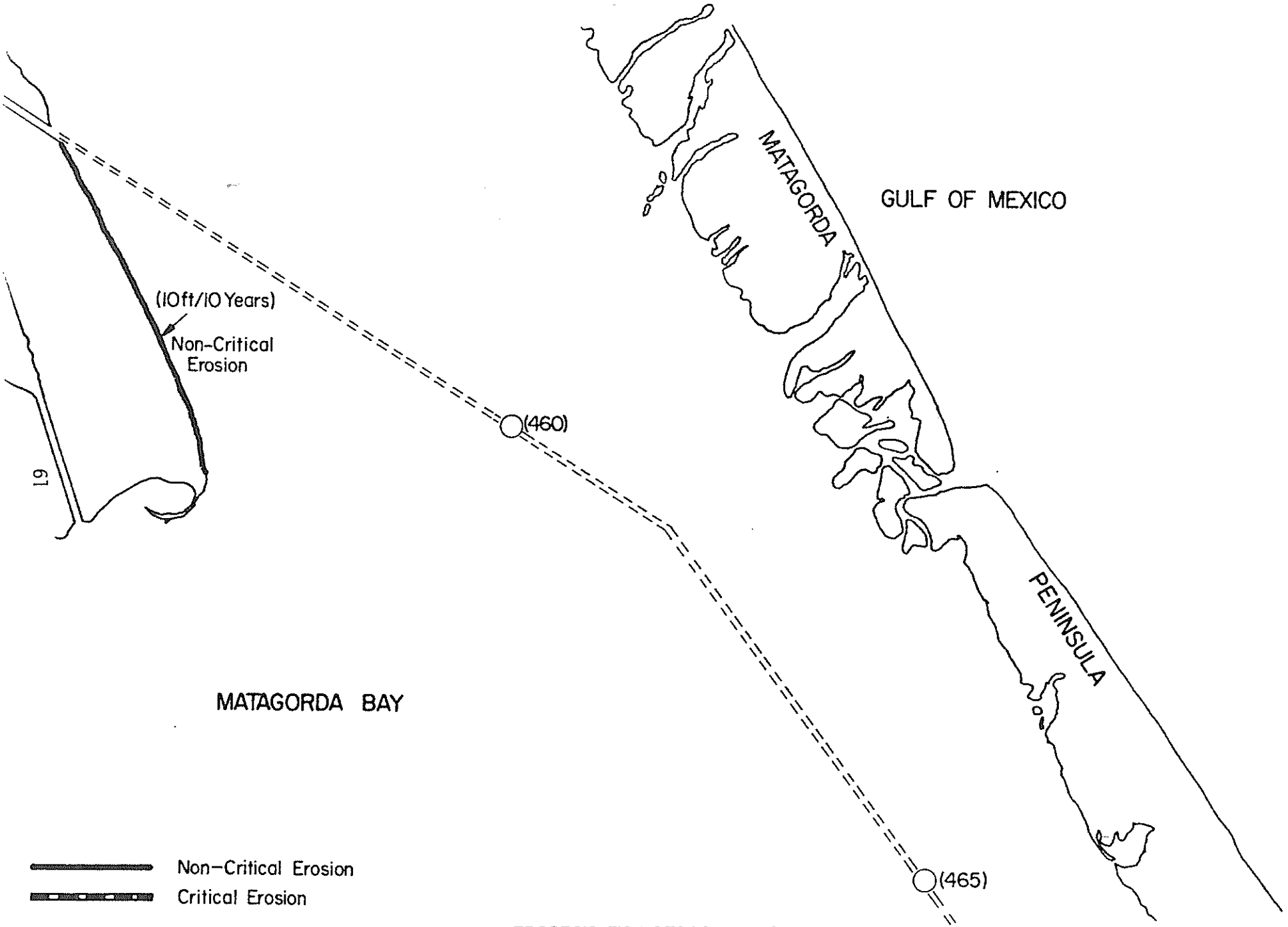
EROSION IN GALVESTON BAY AREA

FIGURE 2



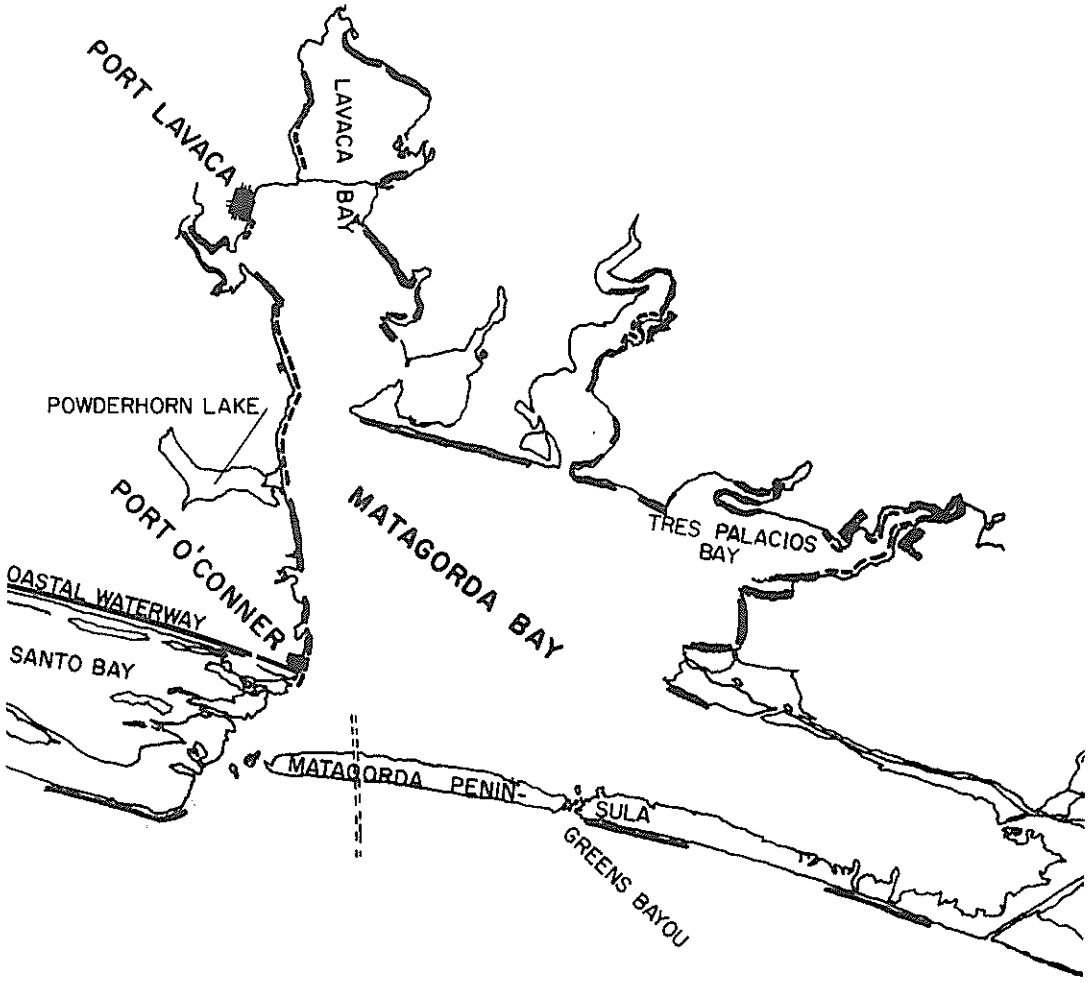
EROSION IN EAST BAY-TRINITY BAY AREA

FIGURE 3



EROSION IN MATAGORDA BAY AREA

FIGURE 4a

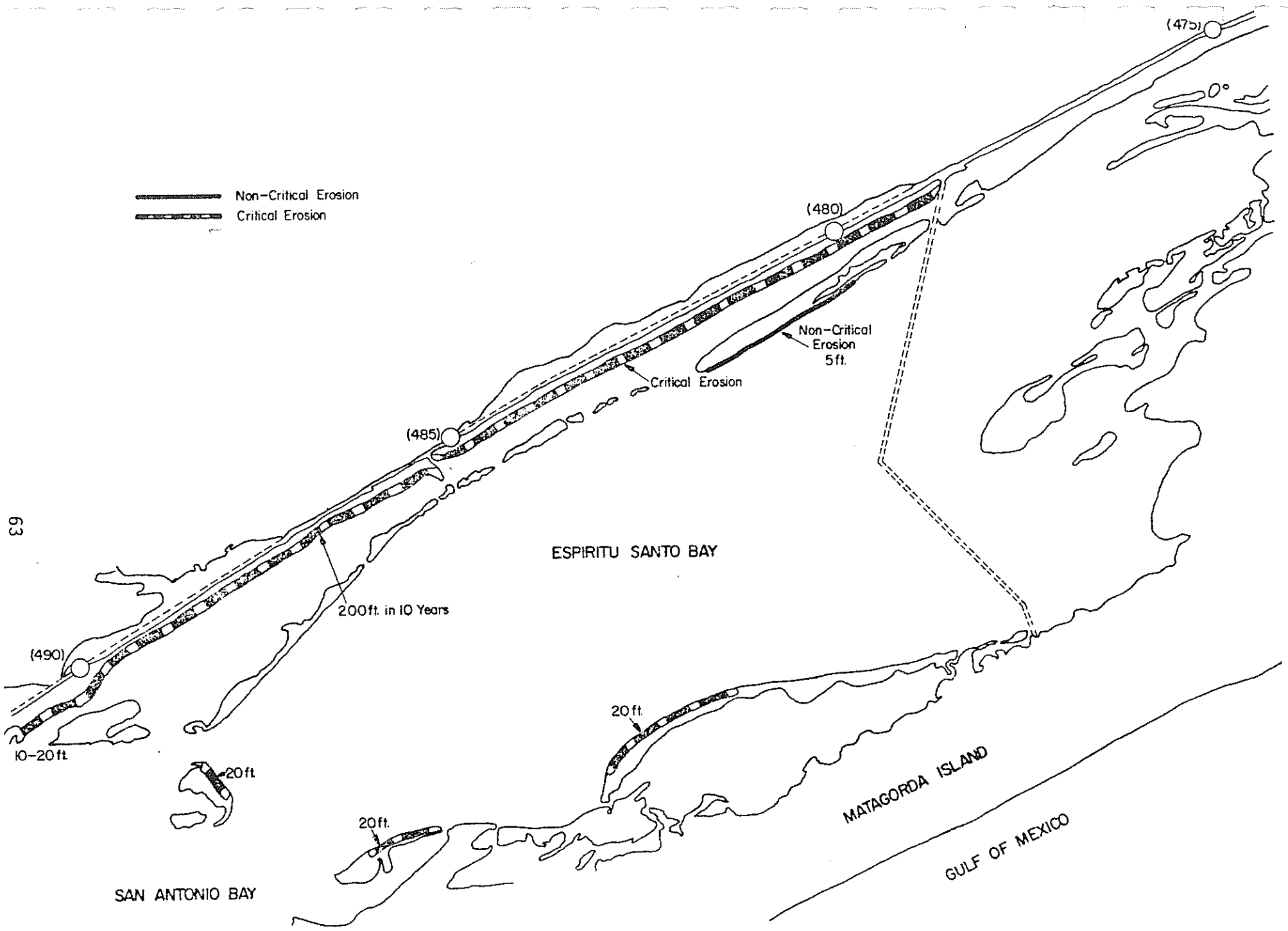


LEGEND

------- CRITICAL EROSION
——— NON-CRITICAL EROSION

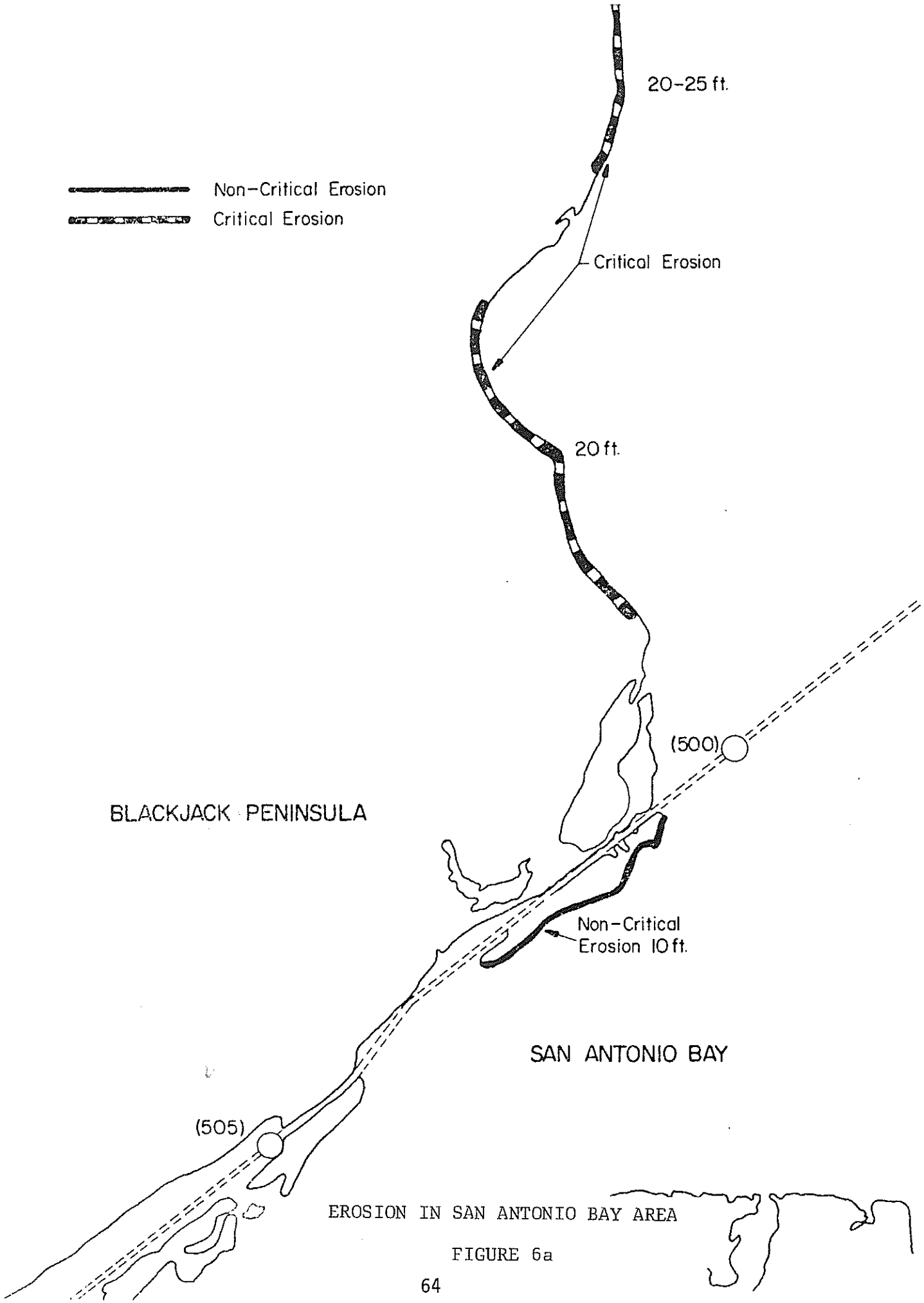
EROSION IN MATAGORDA BAY

FIGURE 4b



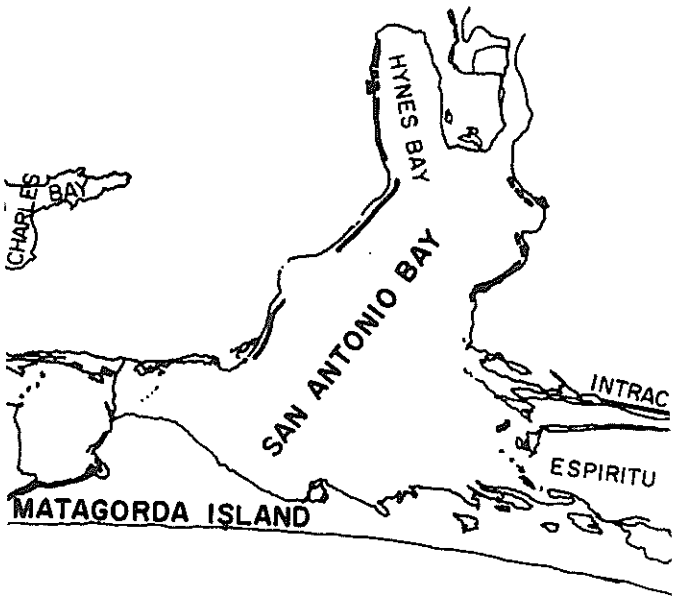
EROSION IN ESPIRITU SANTO BAY AREA

FIGURE 5



EROSION IN SAN ANTONIO BAY AREA

FIGURE 6a



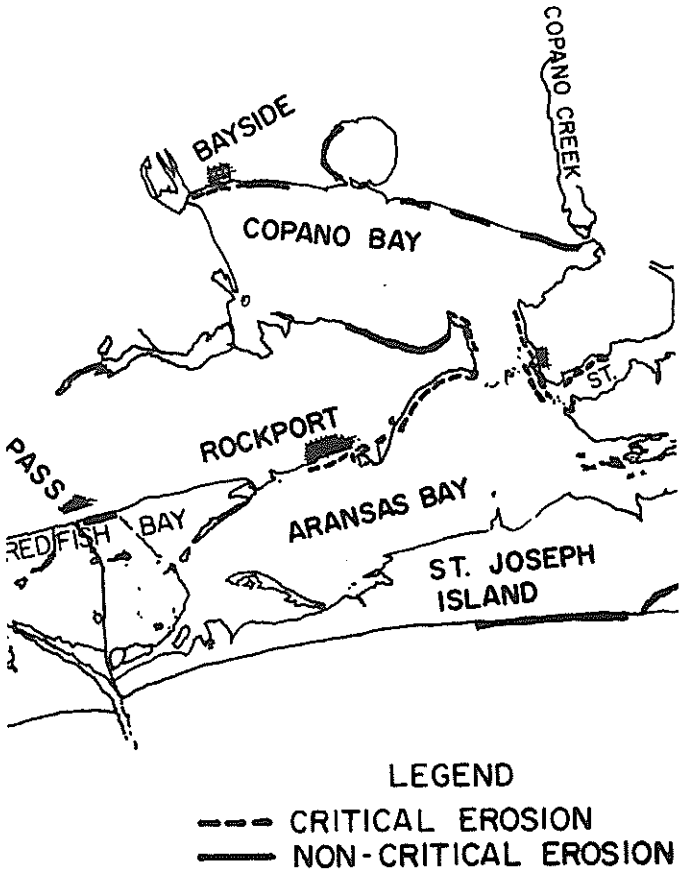
LEGEND

---- CRITICAL EROSION

—— NON-CRITICAL EROSION

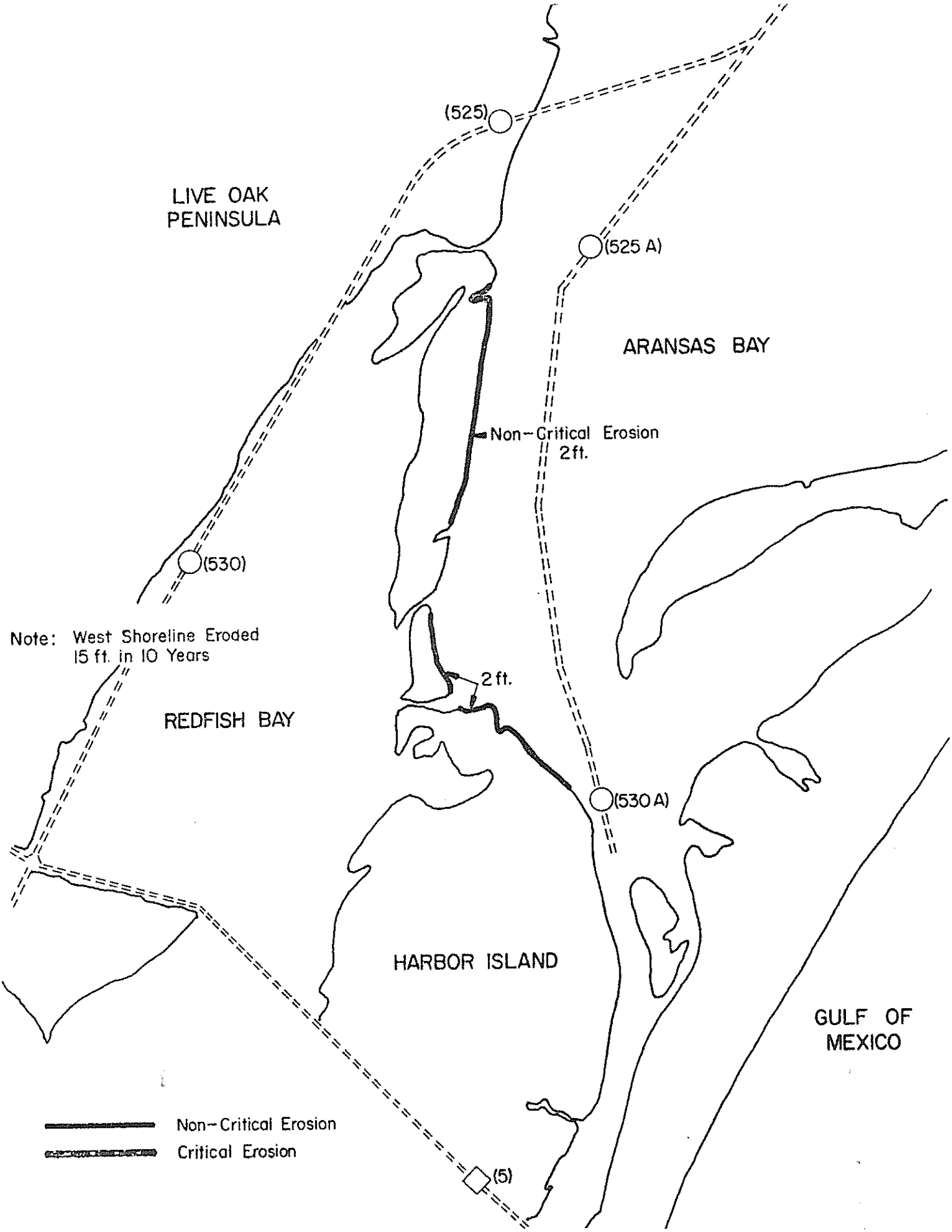
EROSION IN SAN ANTONIO BAY

FIGURE 6b



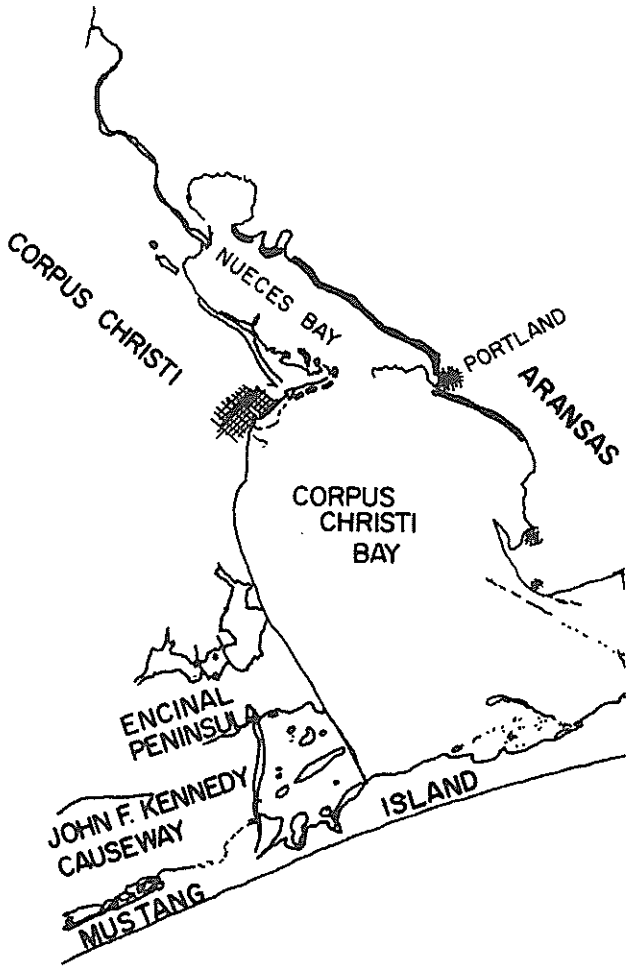
EROSION IN ARANSAS BAY AREA

FIGURE 7



EROSION IN REDFISH AND ARANSAS BAYS

FIGURE 8



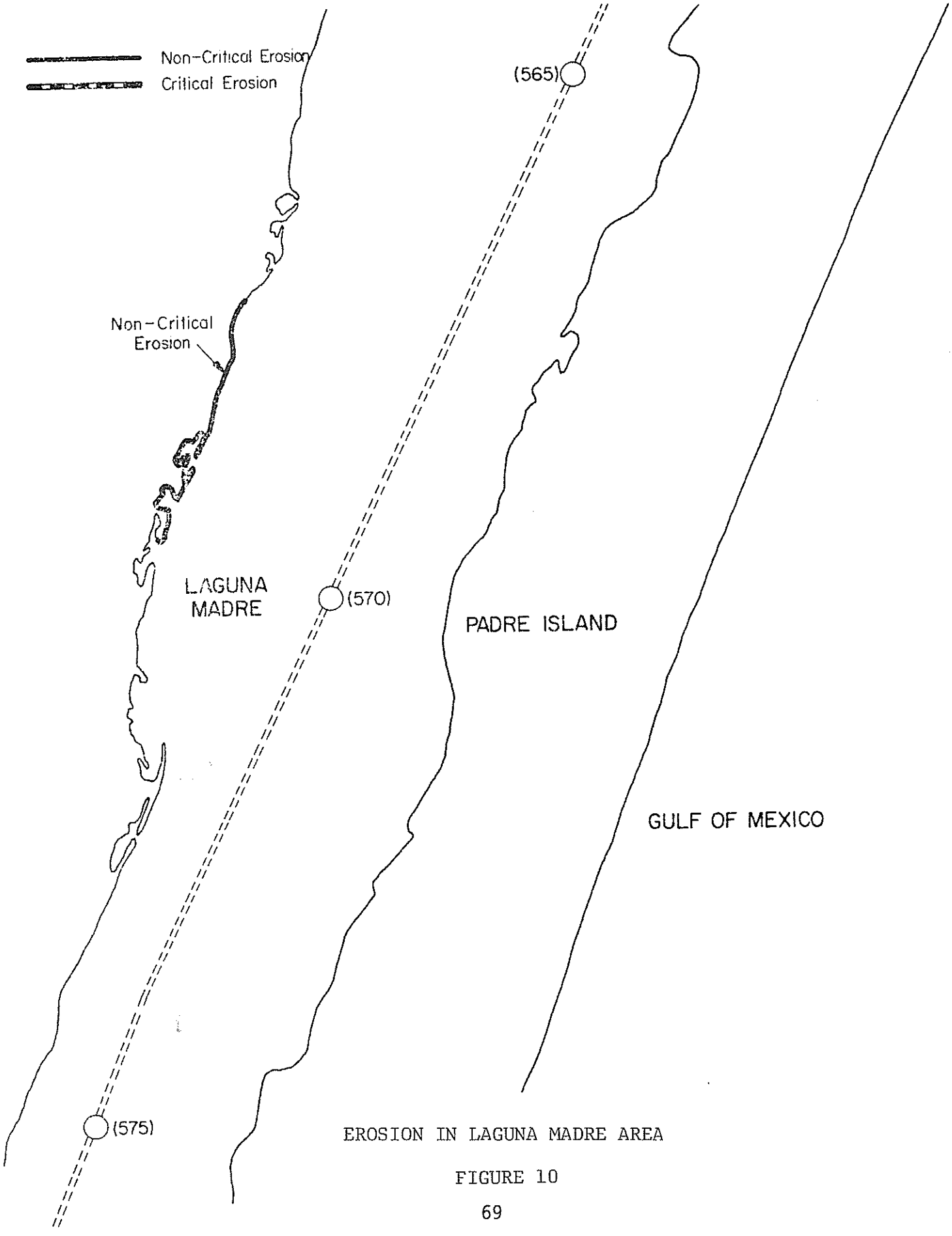
LEGEND

------- CRITICAL EROSION

——— NON-CRITICAL EROSION

EROSION IN CORPUS CHRISTI BAY

FIGURE 9



EROSION IN LAGUNA MADRE AREA

FIGURE 10

The maintenance of the Waterway is accomplished principally by cutterhead-type pipeline dredges; however, a variety of other types of equipment and/or methods may be used in maintenance or improvement of the Waterway.

Disposal of dredged material is becoming increasingly difficult because of opposition by the land owners and regulations of the Parks and Wildlife Department and the Environmental Protection Agency. Both the maintenance and improvement of the Waterway are in jeopardy at the present time and in the future until new land disposal sites are found or new offshore disposal areas are designated.

PROBLEM AREAS

(a) Introduction

There are a number of problem areas in the Waterway where siltation occurs due to a variety of causes, thus reducing the design depth and requiring maintenance. Some of the siltation is occurring naturally, some is caused by man. In some cases, excessive siltation could be minimized by protective or corrective engineering solutions. At present, fairly extensive dredging operations in many areas must be conducted to maintain the required project depths. The dredging volume could be reduced by bank protection and, in some cases, deepening of the Waterway.

(b) Neches River

The Beaumont section of the Neches River is under the jurisdiction of the Beaumont Navigation District, and that section from the Neches River east to the Sabine River is controlled by the Orange County Navigation District. Concerning dredging frequency, the dredging between mile 270 and mile 277 is conducted every three to four years. Approximately 1.5 million cubic yards are dredged under contract each time. From mile 270 to 266.13, little dredging is required. The channel was last dredged in 1963 when it was widened from 125 to 200 feet. The channel has a deep depth of 30 feet which does not permit movement of large ships and tankers. The principal traffic is composed of tow boats and barges.

(c) Sabine River - Neches Waterway

This is a deep channel 40 feet deep and 400 feet wide. Dredging frequency from mile 18 to mile 10 is approximately every five to six years. One and one-half to two million cubic yards of material are removed each time. There is some sediment coming down-river, the amounts depending on magnitude of rainfall. The sediment usually is composed of fine to medium sand. From mile 10 to mile 0, dredging is conducted every three years and each time about 3 to 4.5 million cubic yards are handled.

(d) Mile 276 to mile 287

Dredging frequency between mile 276 and mile 287 is every four to five years. Each time about 4 million cubic yards are dredged. The critical area is at mile 287, which includes a turning basin. Dredging here is done every year and a half, and some 2 million cubic yards are dredged each time.

(e) Mile 287 to mile 289

Approximately 1.25 million cubic yards are dredged in this section every year. This is a problem area and it is not known what causes excessive siltation in this area; however, two possible sources of sediment are suggested: dumping of chemicals from two refineries which causes flocculation of the sediment and its deposition in the channel, and the other possible reason is that a salt wedge coming from the Sabine Pass some 16 miles away may reach this point and siltation occurs as the velocities are reduced in this wider section of the channel.

(f) Port Arthur Canal mile 16 to mile 10

The channel is 40 feet deep and 500 feet wide. Frequency of dredging is between two and a half to three years at the upstream end of the canal. The Sabine Channel between mile 10 and mile 5 is also the same width and depth and frequency is also between two and one-half to three years. The jettied channel from mile 5 out to the Gulf of Mexico is 21,500 feet long. It is between 5 and 800 feet wide. Dredging here is maintained by hopper-dredges. In the past three or three and one half years, channel has been deepened to 40 feet as a major improvement of the Sabine Channel. The dredging was done by hopper-dredges, principally by the Dredge McFarland. The tide in the channel is about a foot and a half inland and about three feet at the mouth of the Sabine Pass. From 21,500 feet to outer-bar, the frequency of dredging has been once a year and the amount dredged between 2 and 2.5 million cubic yards. The maintained channel is about 42 feet deep. The outer channel extends about 8,000 feet into the Gulf. The disposal areas for the main Sabine Channel are shown on USGS charts nos. 517, 533, 1279.

(g) Mile 288½ to mile 319

This is the main Gulf Intracoastal Waterway extending from the Port Arthur area to High Island. The main difficulty in maintaining this section of the Waterway is lack of local sponsorship. In most areas, there is no objection to the building of dikes to contain disposal areas and prevent silty water from reaching the Intracoastal Waterway to satisfy the EPA requirements. In this area, the landowners are cattle raisers who object to the construction of dikes which interfere with cows moving around in the fields. Consequently, the Corps of Engineers is caught between the devil and the deep blue sea. The EPA requirements call for diked disposal areas and the farmers object to the building of dikes by the Corps or the contractors.

The greatest cause of siltation in this area is bank erosion. The Corps of Engineers is not permitted to protect the banks in any way, as there are no funds allotted for this purpose. Natural erosion of canal banks is caused by wind action producing waves in the direction parallel to the channel, but this type of erosion is not significant. By far, the greatest problem is caused by ships passing and generating

waves in their wake. The sediment in this section of the Waterway is very fine and consequently even small waves cause erosion. The present width of the channel is only 125 feet and the wave action caused by passing vessels is quite considerable in such a narrow waterway. In some areas the erosion has progressed beyond the boundary line of property originally donated to the Government for construction of the canal.

The problem of bank erosion is a serious one since the Corps of Engineers cannot protect the banks and erosion will continue indefinitely, particularly in view of the increased use of the channel. Bank erosion contributes directly to the siltation of the channel which in turn increases the amount of material that must be dredged. The present depth of the waterway is 12 feet and the width 125 feet. The allowable water depth for landlocked canal is 12 feet plus 2 feet plus 1 foot. The 2 feet represents the advanced dredging; an extra foot also is allowed. Consequently, any maintenance dredging of the GIWW usually is conducted to a 15 foot depth. In the deeper channels, such as in the Sabine River, the design depth is 42 feet plus 2 feet advanced dredging plus additional 2 feet allowable, Frequency of dredging in the GIWW is eight to nine years and the amount of dredging, about 2.5 million cubic yards each time. The major shoaling of the waterway occurred during Hurricane Carla and no excessive shoaling has been observed since.

Deepening of the canal to a 16 foot depth and 300 foot width was authorized in 1963, but never accomplished because of the lack of local sponsorship. It is believed that this is one of the main arguments for authorizing state sponsorship of the Waterway. A deeper Waterway is economically sound, but no deepening can proceed without either local or state sponsorship.

(h) Corpus Christi Bay - Laguna Madre

The main shoaling area is at the entrance of the Waterway to Laguna Madre between Corpus Christi Bay and Laguna Madre. The shoaling is believed to be caused by waves generated by northerly and north easterly winds. The waves move silty sediments which are deposited at the entrance to the GIWW. At one time, it was found that the side channel to the Naval Air Station in Corpus Christi was completely shoaled and the channel could not be found even by soundings taken. Some sediment is carried by Lavaca Navidad near Port Comfort in Lavaca Bay. It is believed that the channel to Victoria contributes little to shoaling.

Bank erosion has been observed along the channel to Victoria, particularly near the turning basin. Bank slides were also noted along the channel. It appears that barge traffic is principally responsible for this bank erosion.

(i) Matagorda Bay

The only problem encountered is at the junction of the Waterway and Matagorda Ship Channel. Shoaling is experienced at that location and

yearly dredging is necessary. It is thought that shoaling is caused by strong currents in the channel.

(j) St. Bernard River

Bank slides have been experienced in the vicinity of station 150+000 to 140+000; these are fairly extensive , being several hundred feet in length and 40 feet in width.

(k) Channel to Port Mansfield

Extensive shoaling has been experienced, probably due to currents. Dredging has been performed nine times since 1956.

(l) Brownsville Channel

Bank erosion experienced between Marathon-LeTourneau Plant and the Fishing Bait Harbor. Shoaling of the channel is thought to be due to bank erosion. Dredging has been performed 10 times since 1960.

(m) Port Isabel Channel

No particular problem areas exist, but dredging has been conducted four times since 1957.

DREDGING EQUIPMENT

BASIC TYPES

All dredges are of two main types: mechanically operating and hydraulically operating.

MECHANICAL DREDGES

Due to their simplicity and analogy with land based excavating machines, mechanical dredges were the first to be developed. Mechanical dredges can be further classified into the grapple dredge, the dipper dredge and the bucket-ladder dredge.

The grapple dredge consists of a derrick mounted on a barge and equipped with a "clamshell" bucket. Its best usege is obtained in very soft underwater deposits.

The dipper dredge is the floating counterpart of the more familiar land based mechanically excavating shovel. Due to its great leverage and "crowding" action it works best in hard, compact material or rock.

The bucket-ladder dredge consists of an endless chain of buckets, the top of the chain being thrust into the underwater deposit to be dredged so that each bucket digs its own load and carries it to the surface. Since the work cycle is continuous, bucket-ladder dredges are more efficient than either the grapple or dipper dredge. Bucket-ladder dredges are particularly useful to sand and gravel suppliers since the end of the bucket-ladder can be terminated high above the supporting barge and the buckets made to discharge their contents onto vibrating screens. Thus, the different material sizes may be separated and stored on the barge, all by gravity. (Figure 11)

Mechanical dredges are all characterized by their inability to transport the dredged materials for long distances, their lack of self-propulsion, and relatively low production. Their chief advantage lies in their ability to operate in restricted locations such as docks and jetties.

HYDRAULIC DREDGES

Hydraulic dredges which are more suitable for dredging of GIWW are self-contained units and handle both phases of the dredging system. The hydraulic dredges not only dig the material, but also dispose of it either by pumping the material through a floating pipeline to a spoil area or by storing it in hoppers which can be subsequently emptied over the spoil area. It can be seen that hydraulic dredges are more efficient, more versatile and more economical to operate due to this continuous, self-contained digging and disposal operation.

With a hydraulic dredge, the material to be removed is first loosened and mixed with water by cutterheads or by agitation with water jets, and then pumped as a fluid.

The three basic units in a hydraulic dredge are dredge pumps, agitating machinery, and hoisting and hauling equipment. The latter is used primarily to raise and lower the cutter and suction dragheads.

Hydraulically operating dredges can be classified into three basic types - Dustpan Dredge, Hydraulic Pipeline Cutterhead Dredge and Self-Propelled Hopper Dredge.

The Dustpan Dredge

It is so named because its suction head resembles a large vacuum cleaner or dustpan. The dustpan dredge is a hydraulic, plain suction, self-propelled dredge. It consists essentially of a dredge pump which draws in a mixture of water and dredged materials through the suction head which is lowered by winches to the face of the deposit to be removed. The suction head, which is about as wide as the hull of the dredge, is outfitted with high velocity water jets for agitating and mixing the material. After sucking the mixture to the surface, the dredge pumps it to a disposal area, either at sea or shore, through a floating pipeline. Due to its lack of a cutterhead, which loosens up hard, compact materials, the dustpan dredge is best suited for high volume, soft material dredging. (Figure 12).

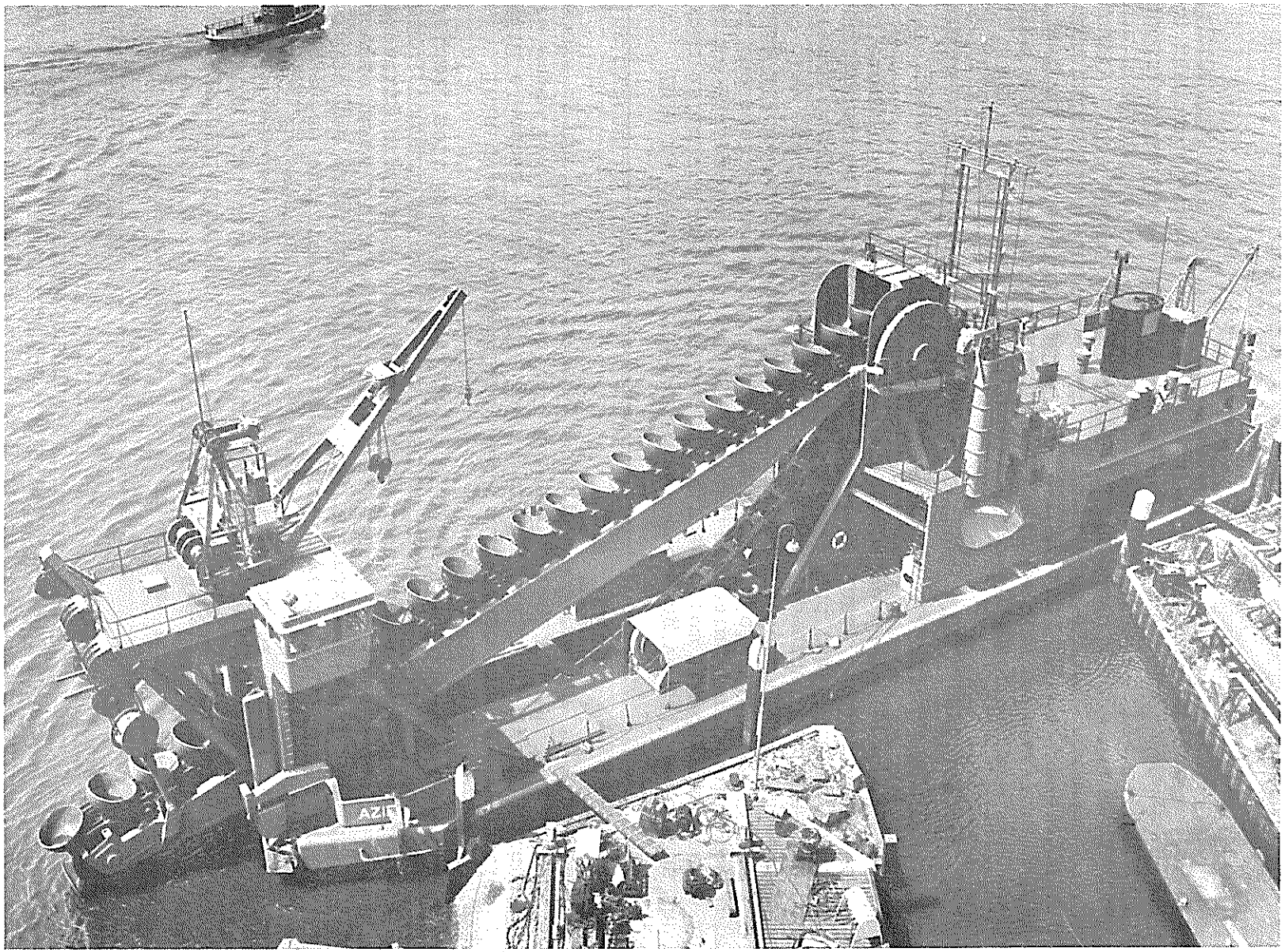
This type is particularly well suited for use in conjunction with a hopper dredge. The hopper dredge makes its cycle, returning to empty its hoppers next to a dustpan dredge. Next, the dustpan dredge sucks up the deposited material and pumps it ashore to a disposal area.

The Hydraulic Pipeline Cutterhead Dredge

This is probably the best-known dredging vessel as well as the most efficient and versatile. It differs from the dustpan dredge in that it is equipped with a rotating cutter apparatus surrounding the intake end of the suction pipe. These dredges can efficiently dig (Figure 13) and pump all types of alluvial materials, and also compacted deposits such as clay and hardpan. The larger and more powerful machines are used to dredge rocklike formations such as coral and the softer type of basalt and limestone without blasting. Some of these dredges have been known to excavate and transport boulders in sizes up to 30 inches in diameter.

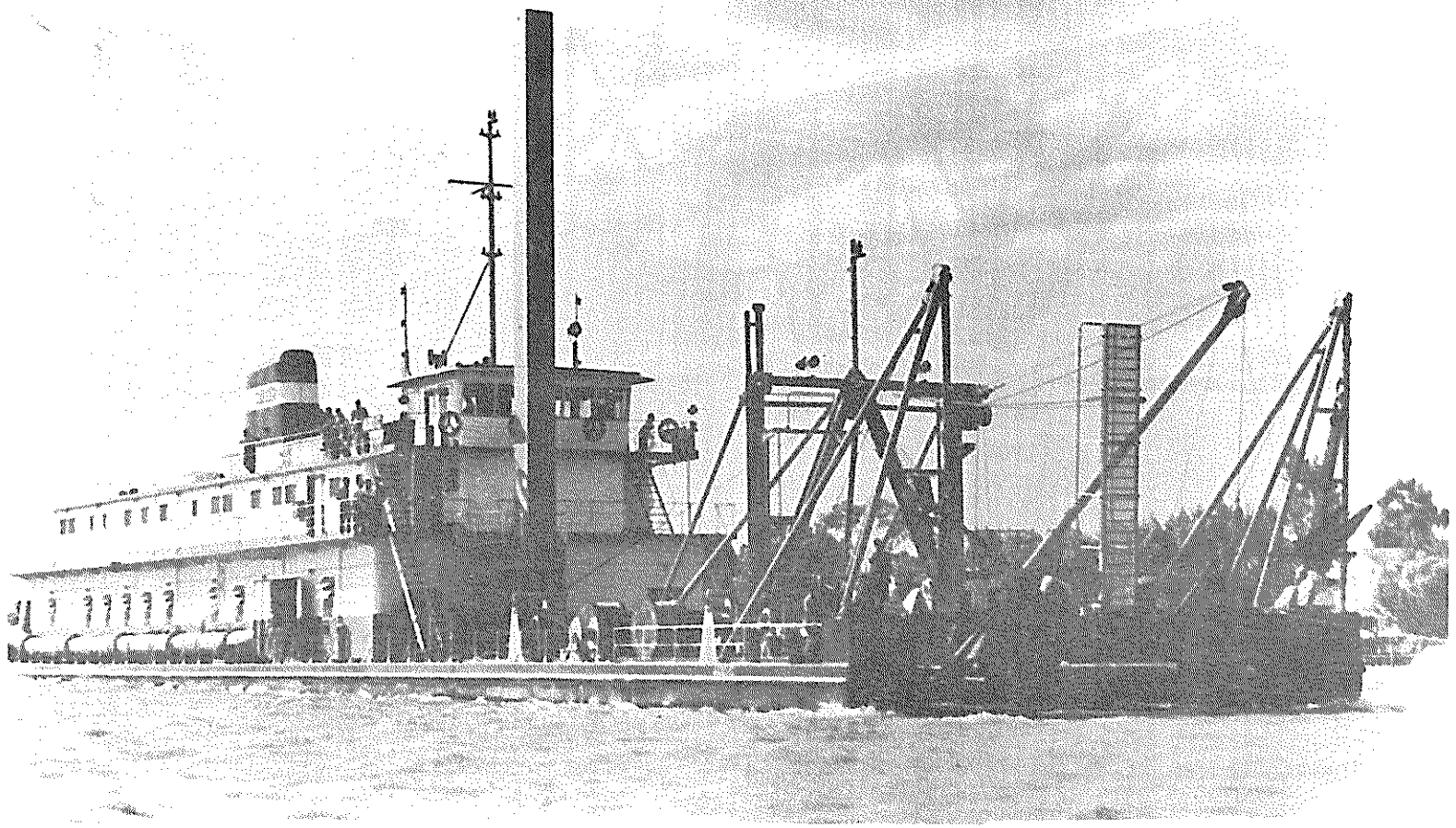
This dredge is generally equipped with two stern spuds. These spuds are used to advance the dredge into the cut or excavating area.

In a typical application of cutterhead dredging, the discharge line from a dredge is connected with a flexible pipe or ball-joints to a floating pipeline. The pipeline is supported on small pontoons and is made quite flexible to permit the dredge to advance and pump continuously. The additional sections may be added at the discharge end of the pipeline to increase the conveyance distance. Booster pumps may be added in the discharge line to permit the pumping of dredged material to greater distances. A 22-inch floating discharge line is shown in Figure 14.



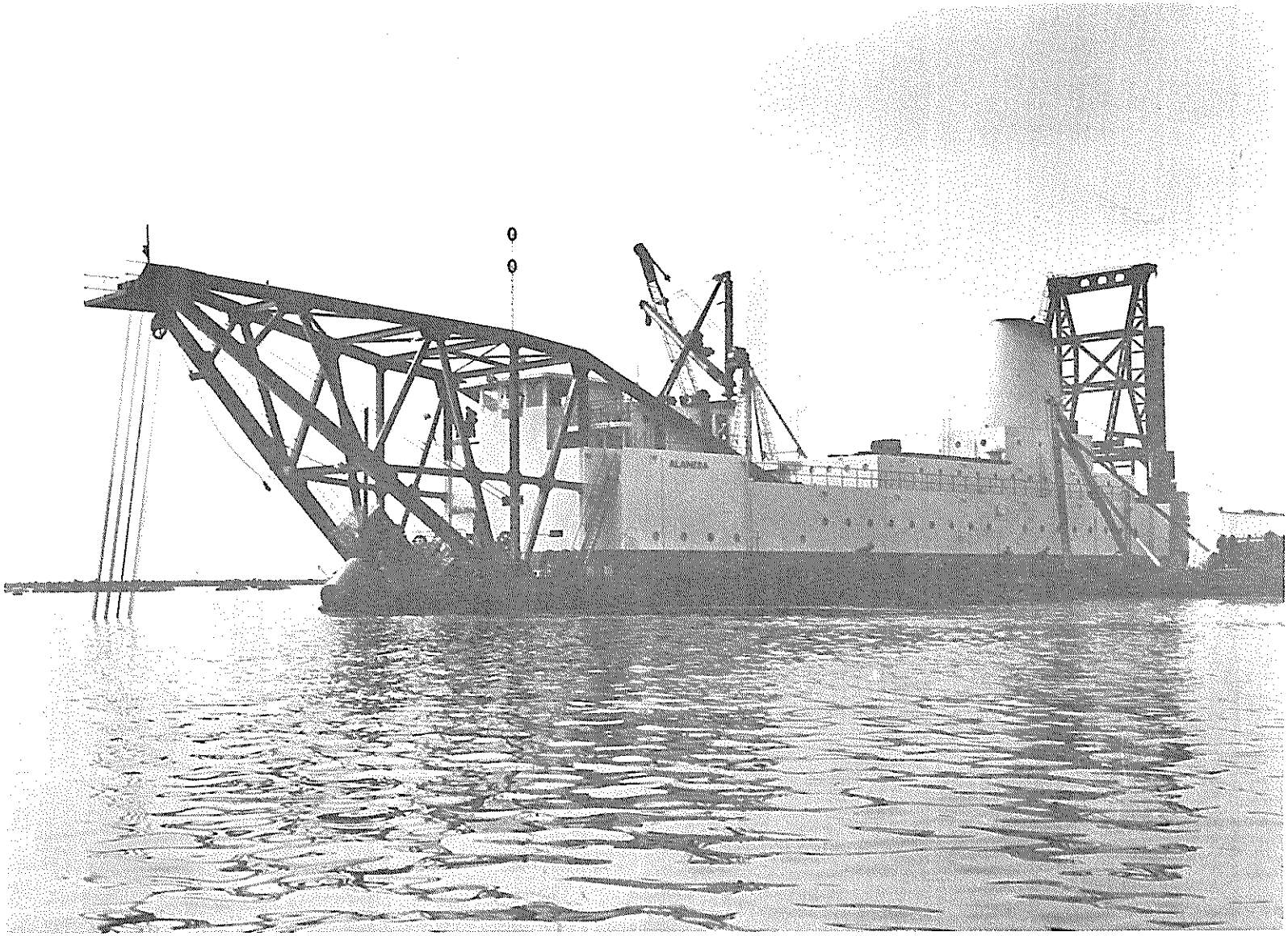
BUCKET DREDGE
(Courtesy IHC Holland)

FIGURE 11



DUSTPAN DREDGE

FIGURE 12



CUTTERHEAD DREDGE

FIGURE 13

FLOATING DISCHARGE LINE (22-INCH)
SHOWING BALL AND BELL CONNECTION AT THE STEM OF A DREDGE
(Courtesy Williams-McWilliams Company, New Orleans, La.)

FIGURE 14

A well-designed 30-inch dredge (size is stated in the diameter of the discharge pipe) with 5000 to 8000 horsepower on the pump and 2000 horsepower on the cutter will pump 2000 to 4500 cubic yards per hour in soft material, and 200 to 2000 cubic yards per hour in soft to medium hard rock through pipeline lengths up to 15,000 feet.

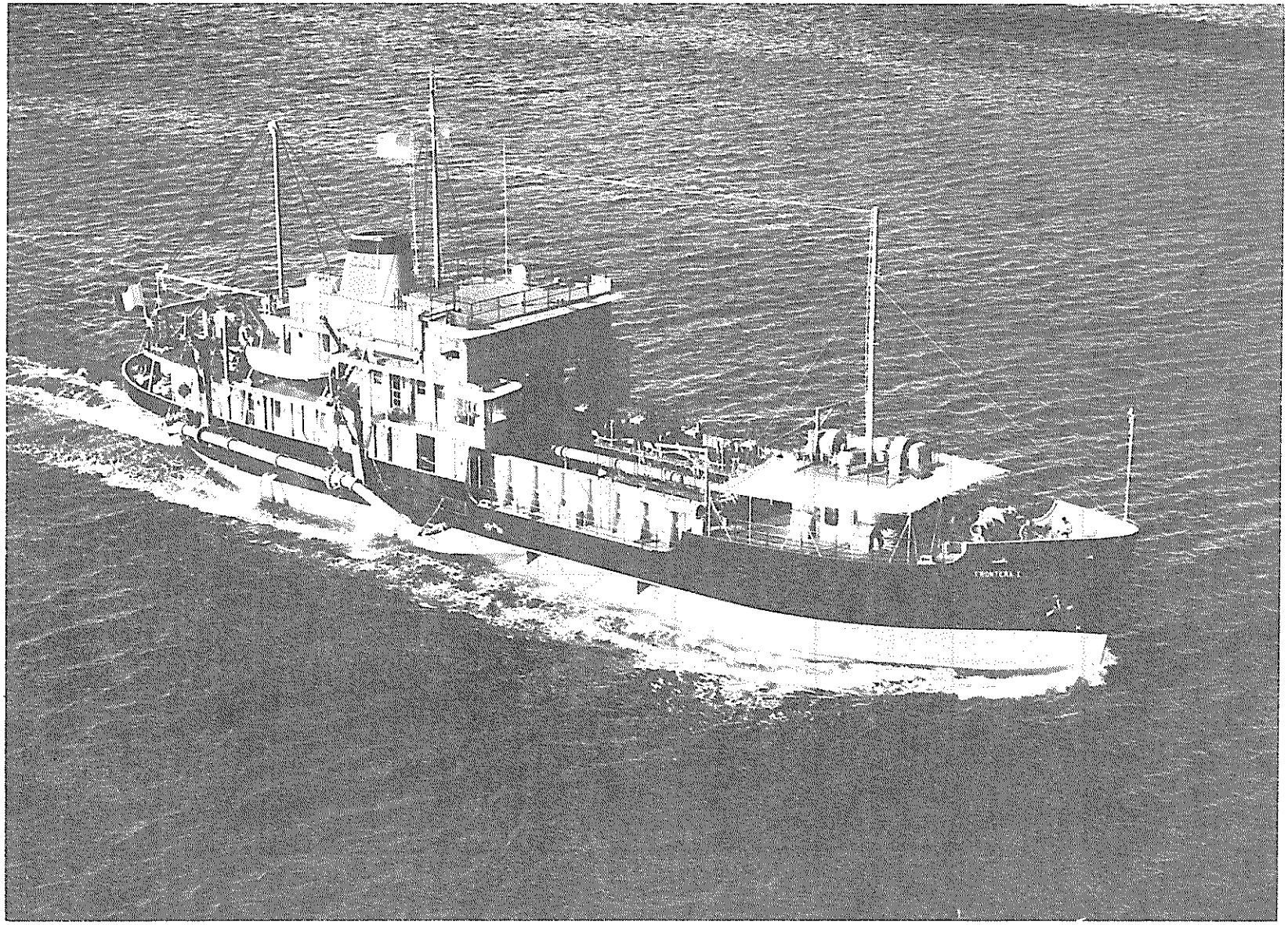
The cutterhead dredge is considered an American specialty. Bond reports that nowhere in the world has this type of machine been so highly developed and so widely used in submarine excavation. This type of dredge is best suited for maintenance and improvement of the Waterway and for most of the dredging work currently being done by cutterhead dredges.

A seagoing type hopper dredge has the molded hull and lines of an ocean vessel and functions in a manner similar to the cutterhead suction type. The bottom material is raised by dredge pumps through dragarms which are connected to the ship by trunions. The dredge pumps lift the mixture of solids and water through the dragheads to the surface where it is discharged into hoppers. After the hoppers are filled, the dragarms are raised and the dredge proceeds at full speed to the disposal area where it empties the loaded hoppers through bottom doors. Figure 15 shows a hopper dredge.

Hopper dredges require a greater draft than cutterhead dredges and could not operate in GIWW unless the depth of the Waterway were greatly increased. However, hopper dredges can be used in deeper, tributary ship channels.

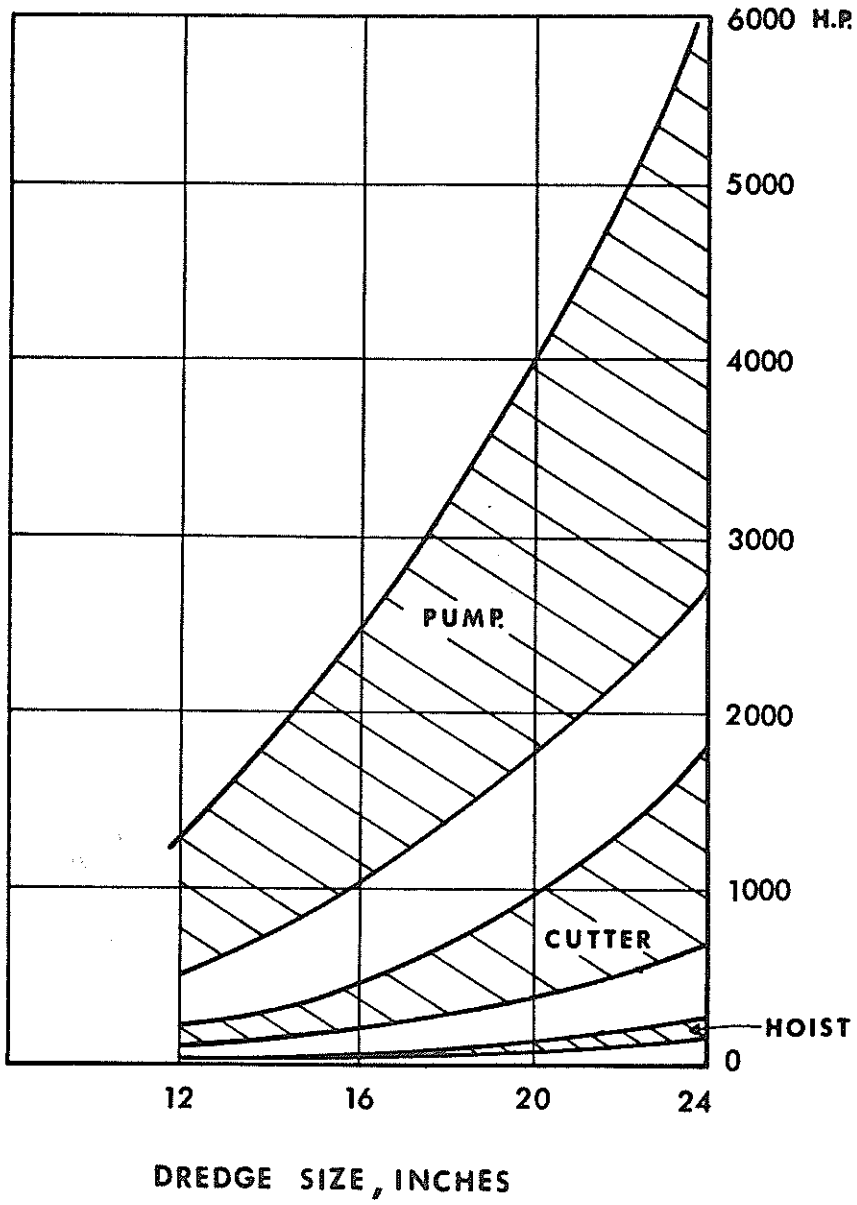
POWER REQUIREMENTS AND DREDGE PRODUCTION

Figure 16 indicates power requirements for dredges of sizes between 12 inches and 24 inches and distribution of power between the pump, the cutterhead and the hoist. Although the actual horsepower requirements may vary from one category of dredge to another, this figure may be used as a rough guide for selection of power requirements of a cutterhead dredge. Figure 17 indicates typical dredge production for the same size of dredges. For example, a 16-inch dredge should pump between 200 and 700 cubic yards per hour while a 20-inch dredge may pump between 300 and 1160 cubic yards per hour.



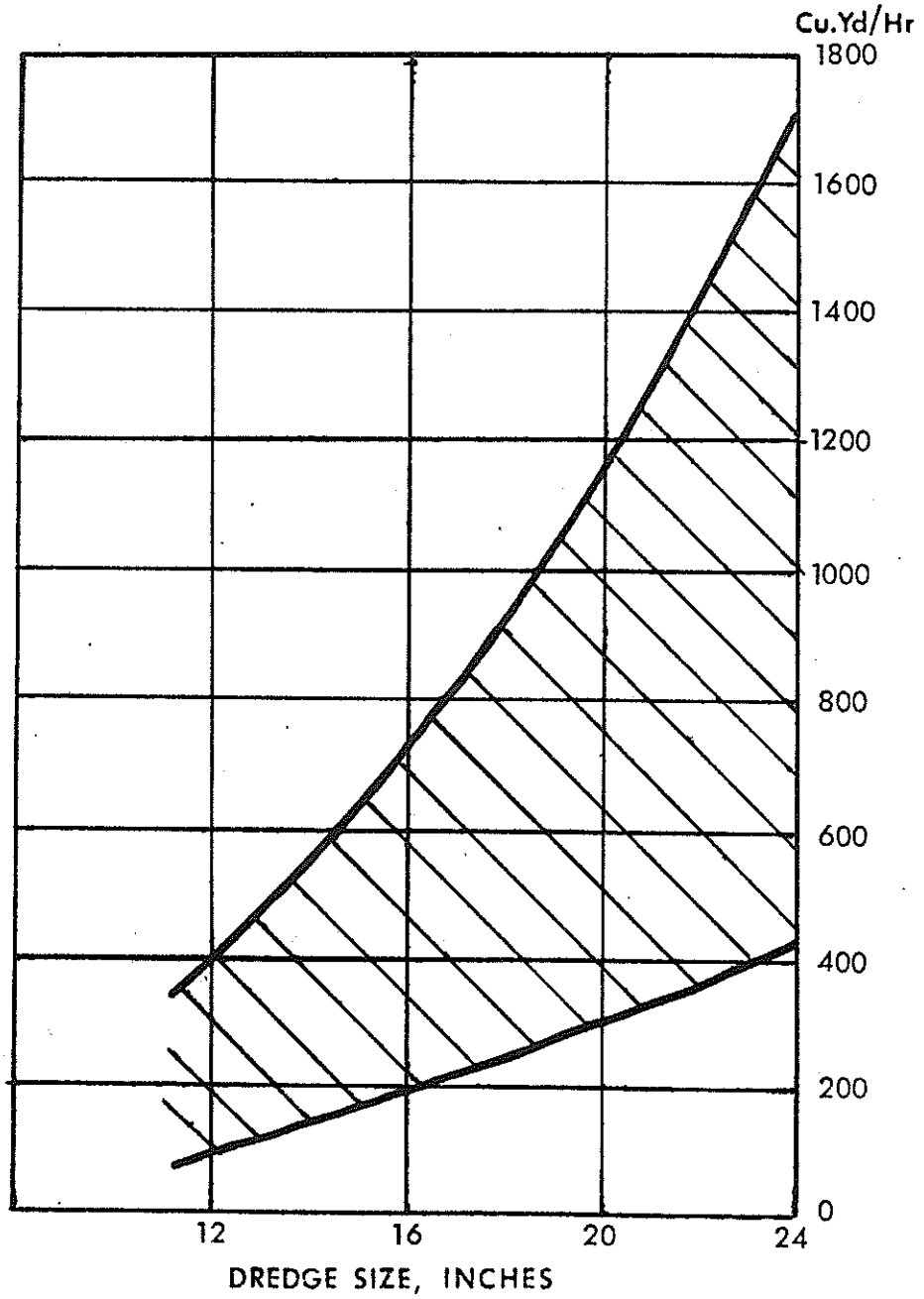
HOPPER DREDGE "FRONTERA I"
(Courtesy Ellicott Machine Corporation)

FIGURE 15



TYPICAL CUTTERHEAD DREDGE POWER APPLICATION
AFTER WOODBURY
(Courtesy of World Dredging Conference)

FIGURE 16



TYPICAL CUTTERHEAD DREDGE PRODUCTION
AFTER WOODBURY
(Courtesy of World Dredging Conference)

FIGURE 17

DREDGING OF GIWW

MAINTENANCE

(a) General Comment

Maintenance of the canal is done by hydraulic cutterhead suction dredges. The present depth of the Waterway is 12 feet and the width is 125 feet. The allowable depth for the landlocked channel is 12 feet. plus 2 feet plus 1 foot. The 2-foot extra depth represents the advanced dredging; an extra foot also is allowed and the dredging contractor is paid for that additional foot if dredging is done to that depth. Consequently, any maintenance dredging usually is done to a 15-foot depth. In the deeper channels in the Sabine River, the water depth is 42 feet plus 2 feet advanced dredging plus an allowable additional 2 feet. (Figure 18) Frequency of dredging in the GIWW between High Island and Port Arthur is once in eight to nine years and the amount of dredging about 2.5 million cubic yards each time. Major shoaling of the Waterway occurred during Hurricane Carla and no excessive shoaling has been observed since that time.

Considerable shoaling in the southern portion of Laguna Madre was caused by Hurricane Beulah. It is estimated that some 20 million cubic yards of shoaling occurred as a result of this disastrous hurricane. No major shoaling resulted from Hurricane Celia.

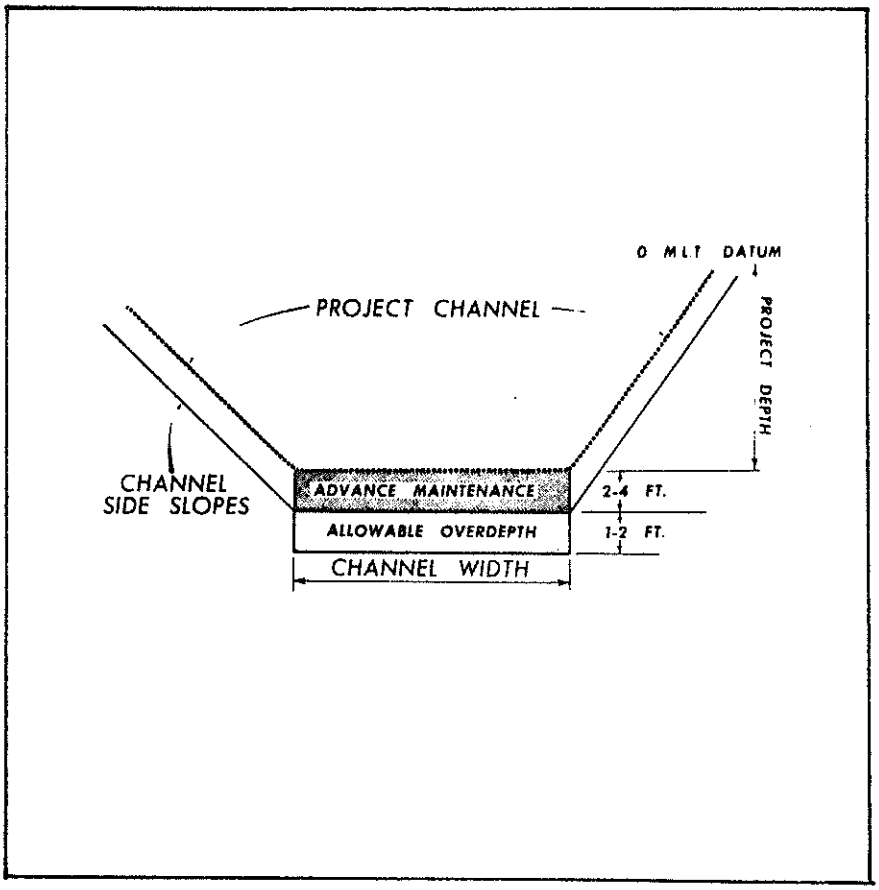
(b) Laguna Madre

Most of the disposal areas in the Laguna Madre are about 1500 feet from the centerline of the channel limit and open water disposal is generally practiced. In other areas, disposal in diked areas is quite common. The diked disposal areas are interspaced with open areas to provide for water interchange. The present planning is to fill the designated emerging disposal areas and eventually to bring them up to the level or 2.5 feet above mean low tide. After disposed material consolidates, dikes may be built on the emerged area to contain future dredged material and provide areas for disposal for many years to come. Initially, such disposal areas were built on both sides of the Waterway; at present, most of the disposal areas are on the Gulf side of the channel.

All the planning of dredged disposal areas must be coordinated with state and federal agencies. Soundings must be taken just before dredging is commenced since, in some cases, many changes occur between the time initial soundings are taken in connection with the proposed project and the actual commencement of dredging operations.

(c) Red Fish Bay

In Red Fish Bay, no agreement has been reached between various agencies regarding disposal areas. Originally, disposal areas were on the east side of the channel; however, both the Parks and Wildlife Department and Bureau of Sport Fisheries objected to this and disposal areas were



TYPICAL CHANNEL CROSS SECTION

FIGURE 18

selected on the west side of the Waterway. The disposal is on dry land and on some marshy areas; in this case contracts originally signed by the Corps of Engineers had to be amended to permit disposal of dredged material on privately owned land. Easement from landowners was required to accomplish this. In another case, disposal on the east side of the Waterway was permitted between stations 954+500 and 951+000.

(d) San Antonio Bay

In yet another case in San Antonio Bay, near the Wildlife Refuge, more marsh areas are being created using dredged material, at the request of the National Wildlife Refuge. This is an excellent example of beneficial effects of dredging in which new marsh areas are created to provide additional feeding grounds for wildlife.

In San Antonio Bay, most of the dredged material is disposed of in open water; however, it is hoped that new land areas will be created adjacent to the Waterway and that diked disposal areas eventually will be built on the emerged land.

Initially, a 1.5-foot elevation above mean low tide was used on all contracts. This requirement, in most cases, did not permit establishment of emerged areas above high tide. Consequently, it was difficult, if not impossible, to build dikes on such areas to contain future disposal. In recent years and on more recent contracts, a figure of 2.5 feet above mean low tide has been used. This apparently does not represent a general policy, but to date no major objection has been raised regarding this practice. This practice, if continued, will provide many new disposal areas for future years.

(e) Matagorda Bay to San Antonio Bay, Barroom Bay

Several disposal areas were selected on the southeast side of GIWW. Across from Port O'Connor, a diked area has been provided with a spillway for overflow. Other dikes have been constructed, most as modifications to original contracts. Barroom Bay cut is protected by dikes, most of which were constructed by draglines walking on mats. Smaller dikes have been constructed with bulldozers.

DREDGING FREQUENCY

Complete records of dredging since the 1930's have been obtained from the Corps of Engineers Office in Galveston and frequency of dredging for each of the sections on GIWW is being evaluated. It is believed that this will be the only complete summary of all dredging conducted and the most accurate summary of dredging frequency ever compiled.

Table II summarizes the dredging frequency at various locations along the waterway. A complete summary of the dredging completed over the years is shown in the Appendix. A frequency curve showing dredging frequency in months for different locations listed in Table II is shown in Figure 19. Figure 20 depicts dredging frequency for different locations along the coast. Length of line represents frequency in months, i.e. the shorter the line, the more frequently maintenance dredging occurs.

TABLE 2

DREDGING FREQUENCY AT VARIOUS LOCATIONS ALONG THE WATERWAY

SECTION	MAIN CHANNEL LOCATION	APPROXIMATE MILE LOCATION	FREQUENCY (MONTHS)
1	Port Arthur to Star Lake	288.6-305	96
2	Star Lake to High Island	305-319.4	96
3	High Island to East Bay Bayou	319.4-321.5	24
4	East Bay Bayou to Roller Bay	321.5-329.4	15
5	Roller Bay to Yates Cove	329.4-335	20
6	Yates Cove to Pepper Grove Point	335-341.3	48
7	Pepper Grove Point to Baffle Point	341.3-347.1	36
8	Baffle Point to Texas City Channel	347.1-350.8	36
9	Texas City Channel to Virginia Point	350.8-356.4	48
10	Virginia Point to North Deer Island	356.4-360.6	36
11	North Deer Island to Cow Bayou	360.6-370.8	36
12	Cow Bayou to Chocolate Bay	370.8-377.7	72
13	Chocolate Bay to Christmas Bay	377.7-386.4	72
14	Christmas Bay to Freeport Harbor	386.4-395	84
15	Freeport Harbor to Brazos River	395-400.6	30
16	Brazos River Crossing	400.6-400.8	32

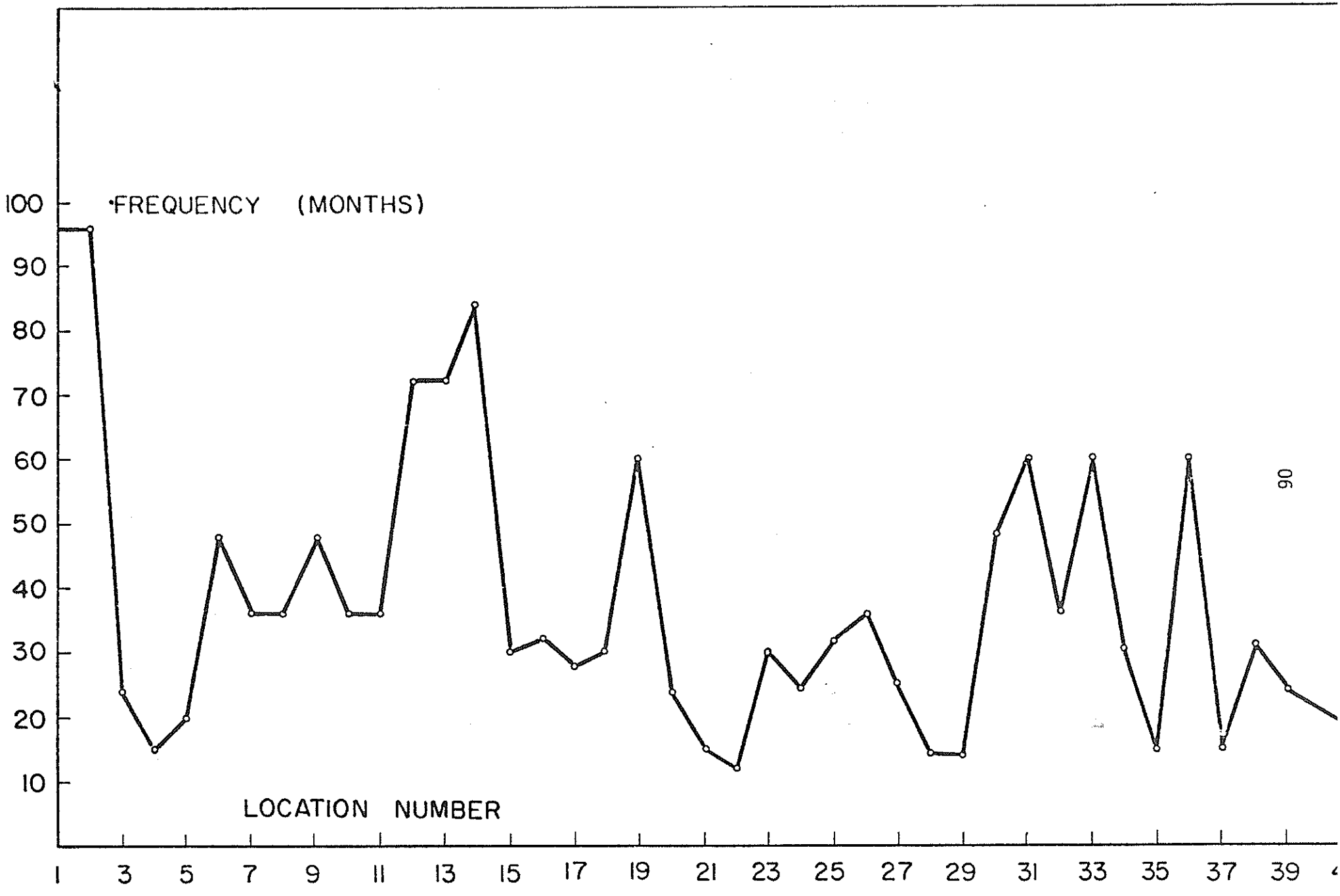
TABLE 2 (Cont'd.)

SECTION	MAIN CHANNEL LOCATION	APPROXIMATE MILE LOCATION	FREQUENCY (MONTHS)
17	Brazos River to San Bernard River	400.8-405	28
18	San Bernard River to Cedar Lakes	405-412.6	30
19	Cedar Lakes to Caney Creek	412.6-418.8	60
20	Caney Creek to Live Oak Bay	418.8-427.2	24
21	Live Oak Bay to Colorado River	427.2-441.2	15
22	Colorado River Crossing	441.2-441.9	12
23	Colorado River to Shell Island Reef	441.9-447.9	30
24	Shell Island Reef to Matagorda Bay	447.9-458.6	24
25	Matagorda Bay Vicinity	458.6-472.6	32
26	Matagorda Bay to San Antonio Bay	472.6-491.5	36
27	San Antonio Bay Vicinity	491.5-501	24
28	San Antonio Bay to Aransas Bay	501-511.2	24
29	Aransas Bay Vicinity	511.2-524.7	24
30	Aransas Bay to Conn Brown Harbor	524.7-533	48
31	Conn Brown Harbor to Corpus Christi Bay	533-539.5	60
32	Corpus Christi Bay Vicinity	539.5-550	36

TABLE 2 (Cont.d)

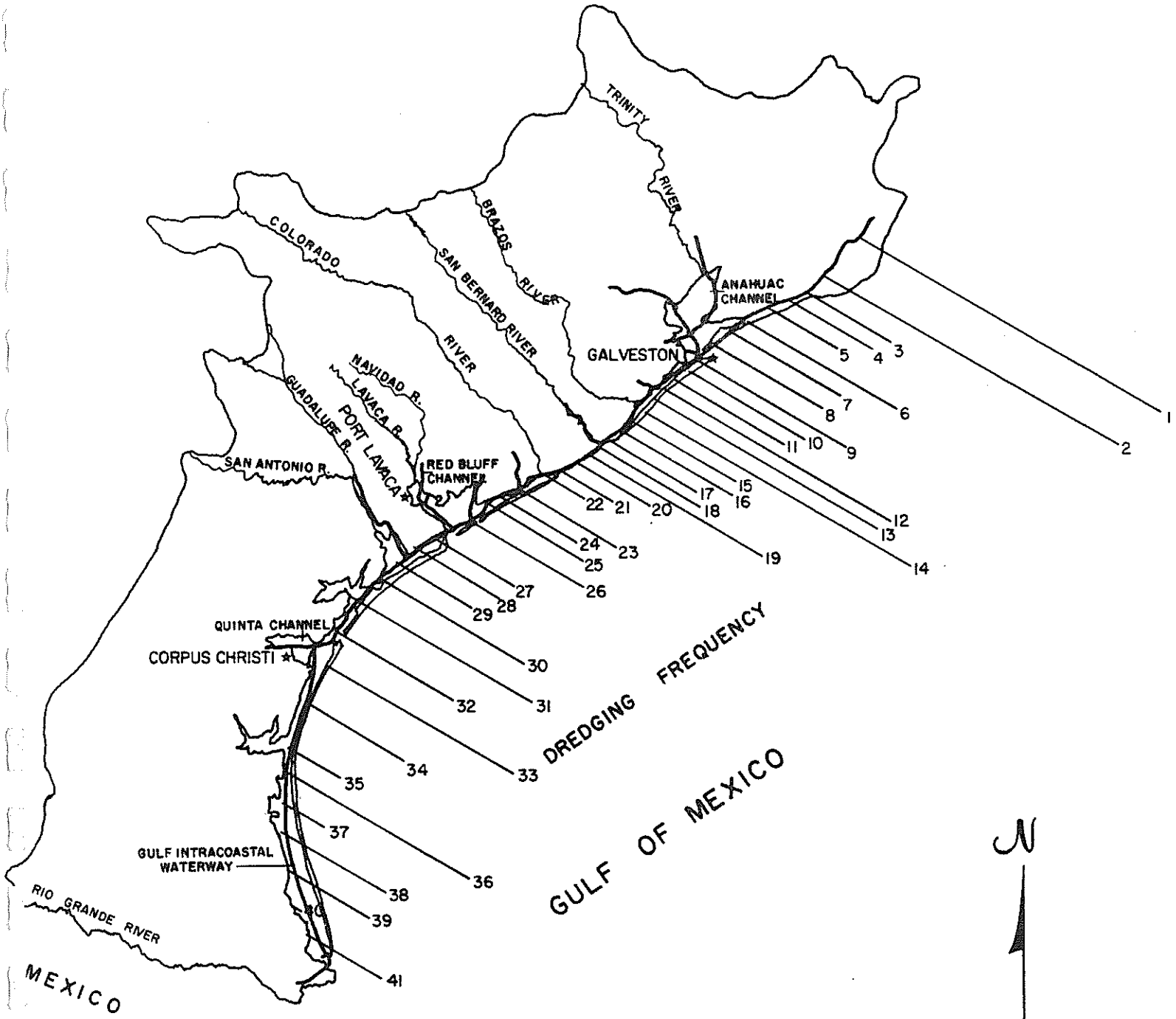
SECTION	MAIN CHANNEL LOCATION	APPROXIMATE MILE LOCATION	FREQUENCY (MONTHS)
33	Corpus Christi Bay to North Bird Island	550-563	60
34	North Bird Island to Buffin Bay	563-579	30
35	Buffin Bay to Banderia Point	579-608.8	15
36	Banderia Point to Mud Flats	608.8-612.8	60
37	Mud Flats to Redfish Bay	612.8-625.7	15
38	Redfish Bay to Port Mansfield	625.7-631.8	32
39	Port Mansfield to Arroyo Colorado	631.8-646	24
40	Arroyo Colorado to Primero Island	646-653	18
41	Primero Island to Port Isabel	653-669	18

SOURCE: U.S. Army and Coastal, Hydraulic and Ocean Engineering Division, Texas A&M University.



GIWW DREDGING FREQUENCY CURVE

FIGURE 19



Source: Coastal, Hydraulic & Ocean Engineering Group, Texas A&M University

DREDGING FREQUENCY

FIGURE 20

DISPOSAL OF DREDGED MATERIAL

DISPOSAL METHODS

Disposal of dredged material is done in several ways:

a. Disposal on land areas adjacent to the canal.

b. Disposal of dredged material on land area with a dike system. The diked disposal area has become quite common in view of the Environmental Protection Agency requirement that difference between the discharge and the original turbidity not to exceed 8 grams per liter.

c. Open water disposal of dredged material. This method of disposal is quite common in Matagorda Bay, Corpus Christi Bay and Laguna Madre.

In general, when coordination between the various agencies such as the Parks and Wildlife Department and Environmental Protection Agency is obtained, the open water disposal is conducted in specified areas, and, until recent times, the dredged material was allowed to be deposited up to an elevation of 1.5 feet above mean low tide (MLT). Many of such disposal areas now exist along the GIWW in open waters; the vegetation usually has taken over quite rapidly and some of the areas are fairly well consolidated and quite stable. However, if an attempt is made to dispose of additional material on such areas, it can only be done if dikes are built to contain the material. It has been extremely difficult to contstruct retaining dikes because of poor foundations and the poor quality of the material that is generally available for building such dikes. It is not practical to construct dikes on islands which have an elevation of only 1.5 feet above MLT, as such areas are under water during certain times of the year due to high tides. Consequently, in more recent contracts the height of the disposal area has been increased to 2.5 feet above MLT, and this should provide suitable disposal areas for future dredging. In most cases, such islands will stay above water level even during high tides but not during the storm stages created by hurricanes. The increase in elevation of disposal areas to 2.5 feet above MLT apparently does not represent a general policy at the present time, but no objections were raised in recent contracts from the environmental protection agencies.

The policy relative to dredge disposal should take into account the variations and the physical characteristics of the material being dredged. The following examples are typical of the materials discharged from hydraulic dredges.

a. Heavy clays are generally suitable for construction of stable fills and dikes.

b. Materials high in shell content usually form quite stable mounds and are good for constructing dikes in a disposal area.

c. Sand usually will result in flat disposal areas and only low mounds unless the disposal area is contained by a dike.

d. The silts, usually found in maintenance dredging, are usually quite light and in some cases flocculent and are not suitable for construction of dikes or elevated disposal areas.

DISPOSAL OF DREDGED MATERIAL IN OPEN WATER CONTAINED AREAS

Retaining dikes for open water containment may be constructed by:

a. Hydraulic dredging methods.

b. Mechanical methods (dragline or clamshell).

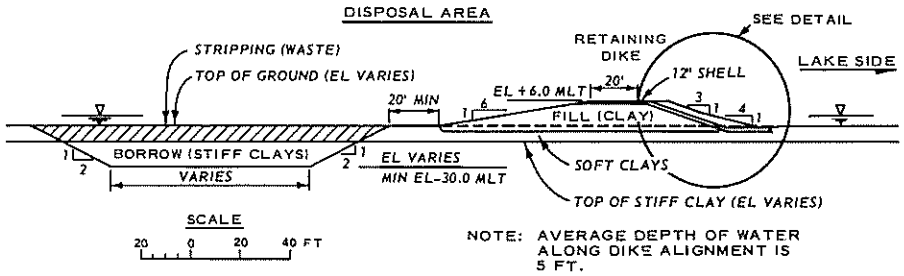
c. Dumping methods.

Hydraulic dredging is an economical method for construction of wide-based dikes on very soft foundations. Commonly, the wide base section is constructed to initial height above the surrounding water. The upper portion of the dike is then constructed by mechanical means (draglines, bulldozers, etc.).

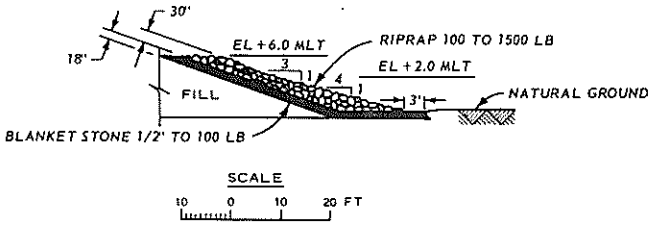
The Sabine Lake retaining dikes were constructed mainly by dragline from borrow areas adjacent to the dike and shaped by bulldozer. Typical cross-section of dike and borrow area are shown in Figure 21-A. A portion of the dike was built by hydraulic dredging since no suitable borrow material could be located next to that part of the dike. To protect the dike from wave action, 100 to 1500 pounds of riprap was placed on the Sabine Lake side of the dike (Figure 21).

Incremental dike construction methods are shown in Figure 22; two methods are proposed for containing dredged material. A retaining dike for an industrial fill project is shown in Figure 23. A large amount of dredged material can be contained behind a dike of this type.

The dredged material disposal area in Sabine Lake is an excellent example of not only finding an area for disposal, but also creating an island which will become a recreational area or new land for light industry after several years. Figure 24 shows the Pleasure Island disposal area.



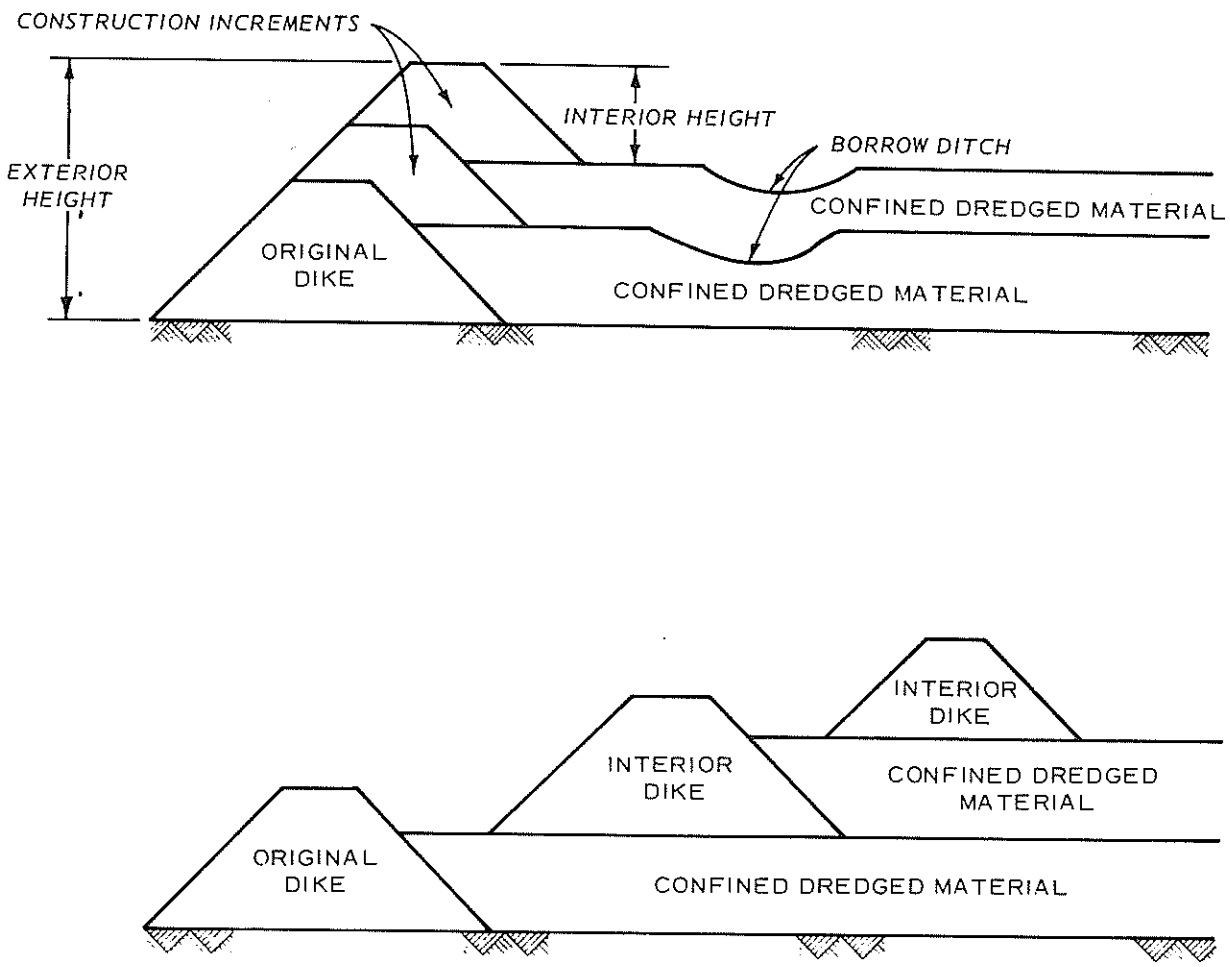
a. TYPICAL CROSS SECTION OF DIKE AND BORROW AREA



b. DETAILS OF EXTERIOR SLOPE PROTECTION

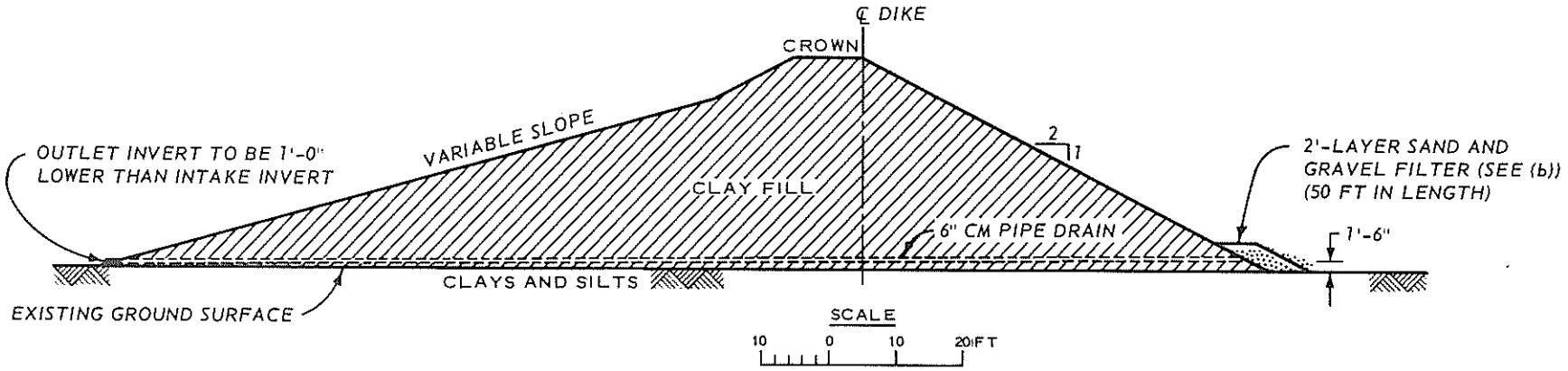
SABINE LAKE RETAINING DIKES
(U. S. ARMY DRAWING)

FIGURE 21

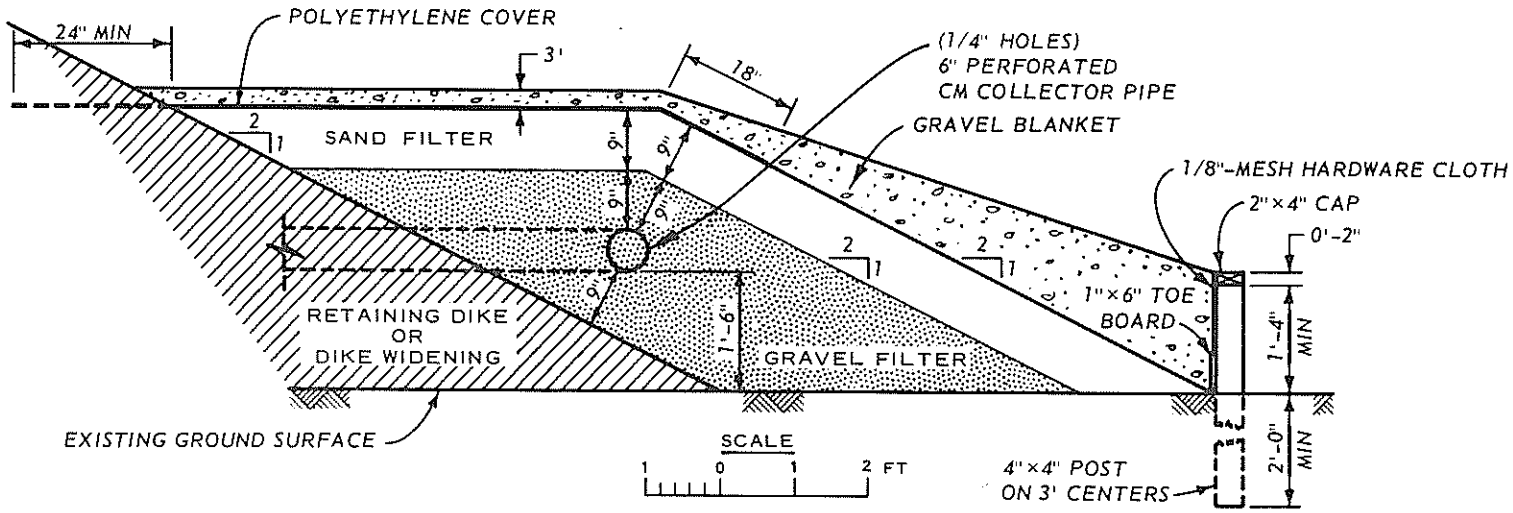


DIKE RAISING METHODS
(U. S. ARMY DRAWING)

FIGURE 22



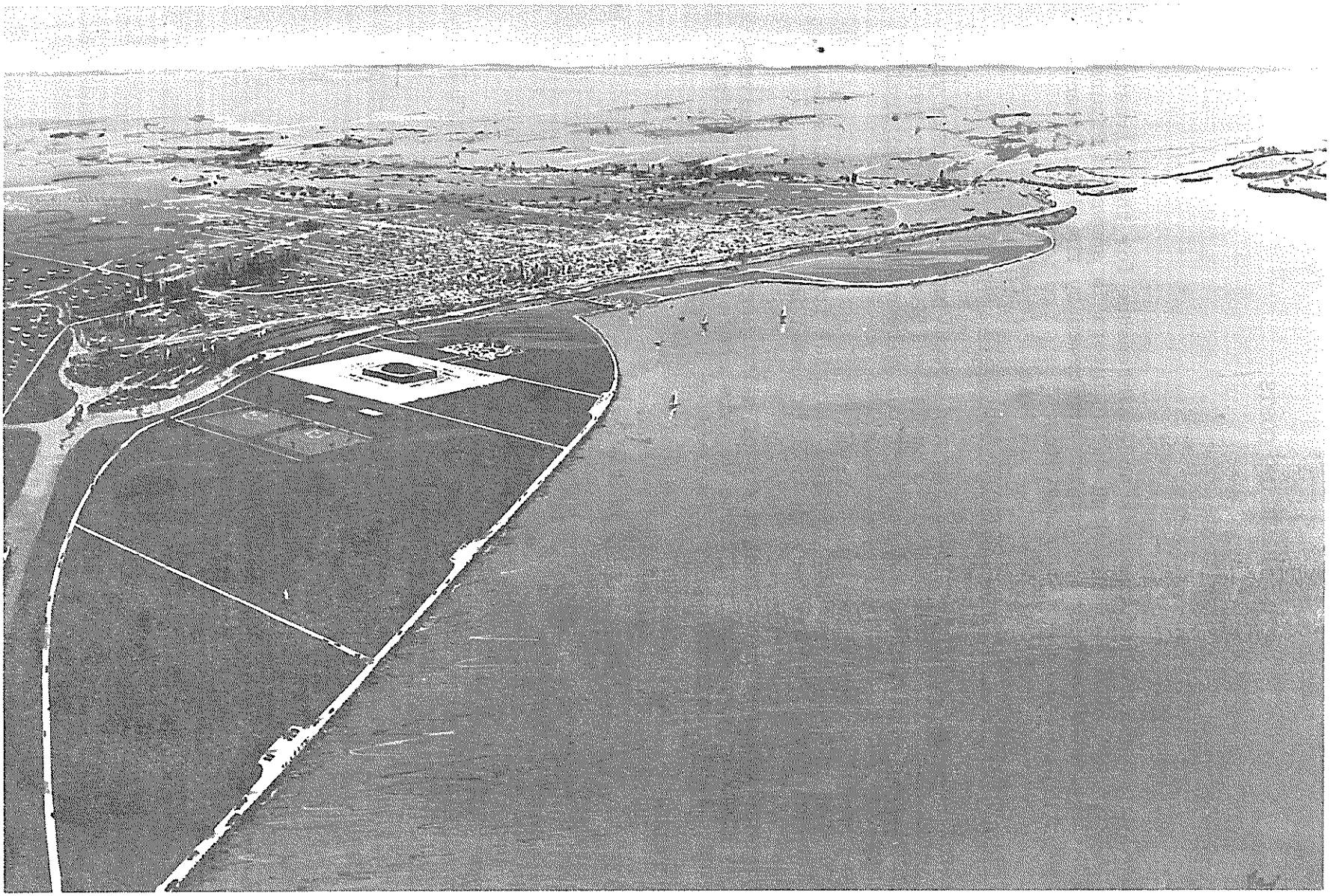
a. CROSS SECTION OF RETAINING DIKE AND INTERIOR TOE DRAIN



b. DETAILED CROSS SECTION OF INTERIOR TOE DRAIN

RETAINING DIKE FOR INDUSTRIAL FILL PROJECT
(U. S. ARMY DRAWING)

FIGURE 23



PLEASURE ISLAND DISPOSAL AREA IN SABINE LAKE
(Photograph by Watkins Studio, Port Arthur, Texas)

FIGURE 24

DREDGING COSTS

DREDGING WORKLOAD

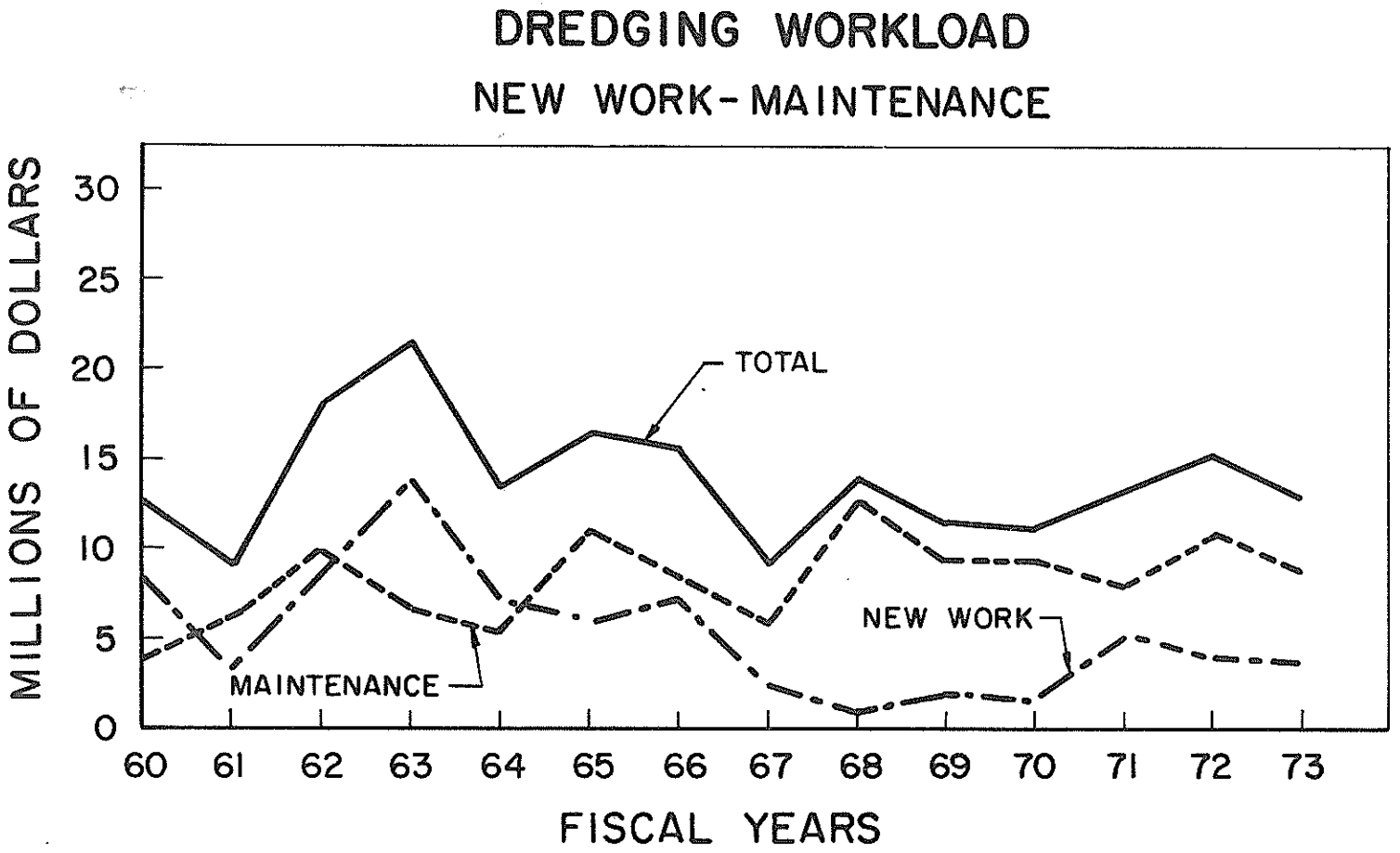
Dredging workload for new work and maintenance for the Galveston District of the U.S. Army Corps of Engineers is shown in Figure 25. Figure 26 represents dredging performed by the U.S. Government plant in the Galveston District.

TOTAL VOLUMES OF DREDGED MATERIAL AND COSTS

Total volumes of dredged material and actual costs for a six year period (1968-1973) are presented in Table III. Unit costs per cubic yard of material and the cost per mile of canal also are shown.

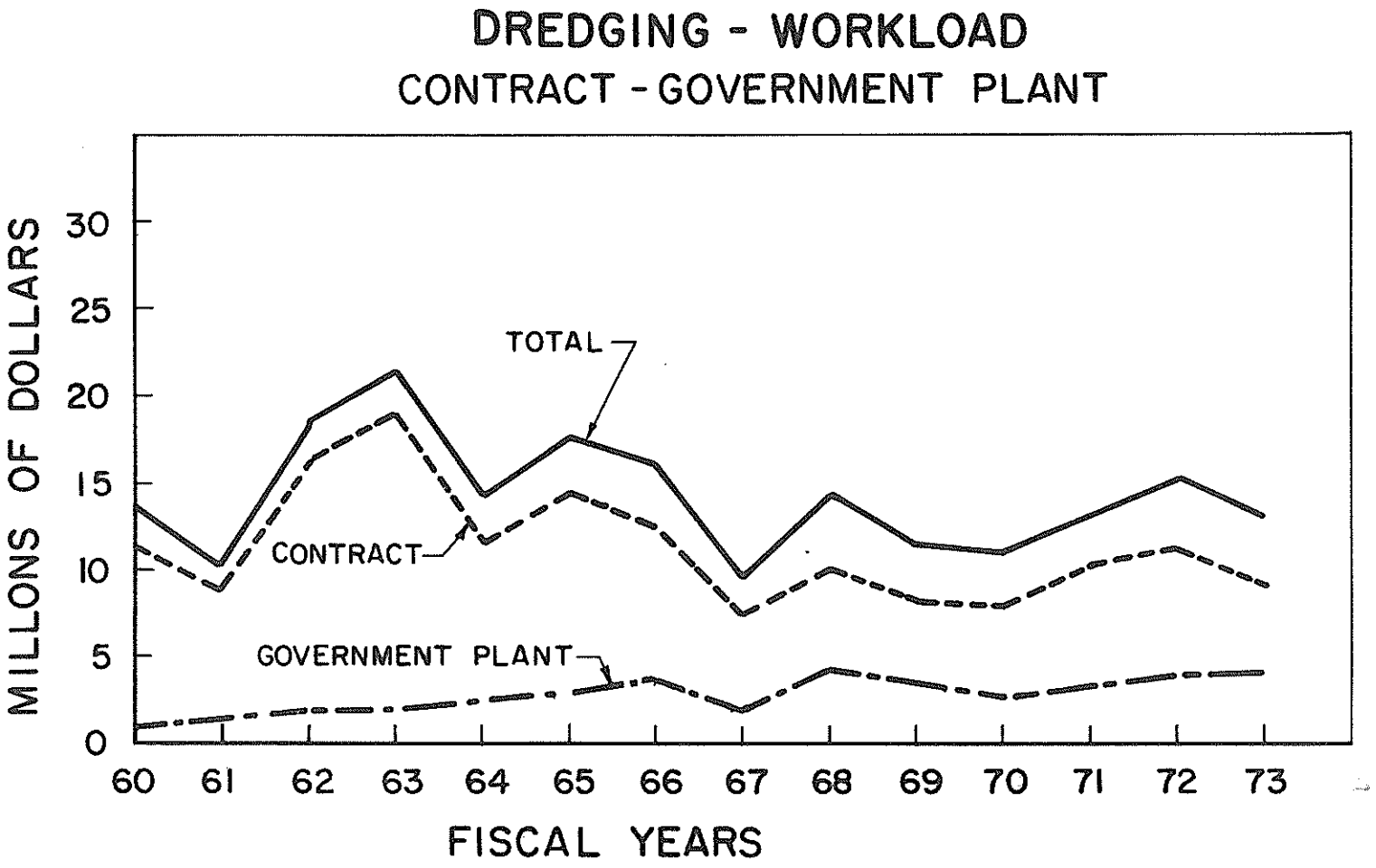
The cost per cubic yard of dredged material for different sections of GIWW for 1965 through 1973 is shown in Table IV.

The appropriated and actual costs of all dredging for the Galveston District are shown in Table V. The costs are separated for work, maintenance and rehabilitation for 1961 through 1973.



DREDGING WORKLOAD - NEW WORK AND MAINTENANCE

FIGURE 25



DREDGING WORKLOAD CONTRACT - GOVERNMENT PLANT

FIGURE 26

TABLE 3

TOTAL VOLUMES OF DREDGED MATERIAL, ACTUAL COSTS, UNIT COSTS AND COST PER MILE, PER YEAR

FISCAL YEAR / LOCATION	1968 Cubic Yards of Material	1968 Cost($)	1969 Cubic Yards of Material	1969 Cost($)	1970 Cubic Yards of Material	1970 Cost($)	1971 Cubic Yards of Material	1971 Cost($)
1. High Island to Port Bolivar	1,502,422	189,004	318,668 1,011,478	66,702 173,553	192,000	77,690	1,790,684	403,815
2. Texas City Junction to Galveston Causeway					603,924	96,400	419,402	66,792
3. North Deer Island to Chocolate Bay							2,299,899	422,698
4. Chocolate Bay to Oyster Creek			563,931	115,030				
5. Freeport to Cedar Lakes	1,182,950	182,680	10,809	36,186	1,321,935	282,354	858,635	239,064
6. Cedar Lakes to Colorado River	1,470,000	158,820	769,035	84,098			1,462,185	301,588
7. Colorado River to Matagorda Bay	1,283,452	146,480	77,150 74,857	14,990 12,406	1,858,537	244,552		
8. Freeport Harbor to Brazos River			145,141	40,422				
9. Brazos River Crossing and Vicinity			192,400	65,718	152,591	51,916		
10. Mud Flats to Arroyo Colorado	295,147	82,425					1,565,100 1,748,036	271,919 300,920
11. Turnstake Island to Live Oak Point	674,164	72,040	1,052,488	110,877			2,191,813	273,155
12. Corpus Christi Bay to Mud Flats	1,745,693	222,100						
13. Port Isabel to Arroyo Colorado Tributary	2,063,032	31,820			176,000	39,700	1,112,107	218,662
14. Port Isabel to Mud Flats			852,859 1,305,241	109,540 193,267				
15. Mud Flats to Corpus Christi Bay			2,911,848	347,360	92,380 1,482,718	32,997 227,356		
16. San Antonio Bay to Aransas Bay			405,255	51,100	1,003,707	118,431		
17. Port Mansfield to Mud Flats								
Summation of Every Year	10,216,860	1,085,369	9,691,160	1,421,249	6,883,792	1,171,396	13,447,861	2,498,613

SOURCE: U.S. Army, Corps of Engineers and Coastal, Hydraulic and Ocean Engineering Group, Texas A&M University.

TABLE 3 (cont.)

FISCAL LOCATION	1972 Cubic Yards of Material	1972 Cost($)	1973 Cubic Yards of Material	1973 Cost($)	Total (From 1968-1973) Cubic Yards of Material	Total (From 1968-1973) Cost($)	Unit Cost($) Cost/Cubic Yard of Material	Distance (Miles)	Cost Per Mile($) (Cost/Mile/Year)
1. High Island to Port Bolivar	1,222,496	428,591			6,037,748	1,339,355	0.222	29.8	7,491
2. Texas City Junction to Galveston Causeway			1,084,176	257,830	2,107,502	421,022	0.200	5.6	12,530
3. North Deer Island to Chocolate Bay					2,299,899	422,698	0.184	14.8	4,760
4. Chocolate Bay to Oyster Creek					563,931	115,030	0.204	17.4	1,102
5. Freeport to Cedar Lakes			885,000	281,800	4,259,329	1,022,084	0.240	10.4	16,380
6. Cedar Lakes to Colorado River	842,699	158,740			4,543,919	703,246	0.155	36.1	3,247
7. Colorado River to Matagorda Bay	1,904,264	251,150	88,890	43,809	5,287,150	713,387	0.135	14.0	8,493
8. Freeport Harbor to Brazos River					145,141	40,422	0.278	5.6	1,203
9. Brazos River Crossing and Vicinity					344,991	117,634	0.341	0.2	98,028
10. Mud Flats to Arroyo Colorado	73,653	18,302			3,681,936	673,566	0.183	32.1	3,497
11. Turnstake Island to Live Oak Point					3,918,465	456,072	0.116	6.5	11,694
12. Corpus Christi Bay to Mud Flats					1,745,693	222,100	0.127	40.1	923
13. Port Isabel to Arroyo Colorado Tributary	1,842,324	304,838			3,351,139	290,182	0.087	20.0	2,418
14. Port Isabel to Mud Flats			1,323,530	225,044	5,323,954	832,689	0.156	52.9	2,623
15. Mud Flats to Corpus Christi Bay			1,718,562	395,576	6,205,508	1,003,289	0.162	40.1	4,170
16. San Antonio Bay to Aransas Bay	2,491,723	237,178			3,900,685	406,709	0.104	14.4	4,707
17. Port Mansfield to Mud Flats			1,174,754	351,801	1,174,754	351,801	0.299	18.3	3,204
Summation of Every Year	8,377,159	1,398,799	6,274,912	1,555,860	54,891,744	9,131,286	0.166	358.3	4,247

SOURCE: U.S. Army, Corps of Engineers and Coastal, Hydraulic and Ocean Engineering Group, Texas A&M University.

TABLE 4

COST PER CUBIC YARD

GIWW BETWEEN APALACHEE BAY AND THE MEXICAN BORDER (GALVESTON DISTRICT)

MAIN CHANNEL DREDGING OPERATION

FISCAL YEAR Location	1965	1966	1967	1968	1969	1970	1971	1972	1973
1. High Island to Port Bolivar	0.168	0.141	0.175	0.126	0.181	0.405	0.225	0.350	
2. Texas City Junction to Galveston Causeway						0.160	0.159		0.237
3. North Deer Island to Chocolate Bay	0.141	0.143	0.120				0.184		
4. Chocolate Bay to Oyster Creek					0.204				
5. Freeport to Cedar Lakes	0.164			0.154	3.347	0.213	0.278		0.318
6. Cedar Lakes to Colorado River	0.139	0.186		0.108	0.109		0.206	0.188	
7. Colorado River to Matagorda Bay	0.123	0.125	0.0975	0.114	0.180	0.131		0.132	0.493
8. Freeport Harbor to Brazos River					0.278				
9. Brazos River Acrossing and Vicinity	0.278	0.141				0.340			
10. Mud Flat at Arroyo Colorado				0.279			0.173	0.248	

TABLE 4 (cont)

11. Turnstake Island to Live Oak Point				0.107	0.105		0.124		
12. Corpus Christi to Mud Flats			0.130	0.127					
13. Port Isabel to Arroyo Colorado Tributary				0.0154		0.225	0.196		
14. Port Isabel to Mud Flats	0.126	0.193	0.202		0.140			0.165	0.170
15. Mud Flat to Corpus Christi Bay	0.116	0.132			0.119	0.165			
16. San Antonio Bay to Aransas Bay			0.080	0.080	0.126	0.118		0.0951	
17. Port Mansfield to Mud Flats									0.299

SOURCE: U.S. Army, Corps of Engineers and Coastal, Hydraulic and Ocean Engineering Group, Texas A&M University.

TABLE 5

APPROPRIATED AND ACTUAL COSTS OF DREDGING (1961-1973)

Fiscal Year	1961	1962	1963	1964	1965	1966	1967
NEW WORK							
Cost	3,438,416	3,948,919	745,933	655,639	1,339,324	2,074,115	329,830
Appropriated	3,922,829	3,225,893	513,392	1,326,758	2,265,000	1,019,126	-120,504
MAINTENANCE							
Cost	1,073,298	4,363,071	1,685,145	2,319,758	3,968,894	3,231,029	2,763,935
Appropriated	1,593,893	3,888,461	1,860,173	2,951,476	3,427,334	3,321,713	2,629,371
REHABILITATION							
Cost	-----	176,697	168,868	54,808	598,867	269,964	1,307
Appropriated	-----	351,000	44,000	650,500	65,000	179,638	-19,627
TOTAL COST	4,511,714	8,488,687	2,599,946	3,030,205	5,907,085	5,575,108	3,095,072

(continued next page)

TABLE 5 (continued)

Fiscal Year	1968	1969	1970	1971	1972	1973	TOTAL TO June 30, 1973
NEW WORK							
Cost	184,128	129,249	6,492	88,607	126,402	141,959	43,389,919
Appropriated	-31,700	723,500	-62	45,935	378,507	-4,995	44,044,673
MAINTENANCE							
Cost	3,789,846	3,129,887	2,522,901	4,608,511	3,903,054	4,096,097	67,073,876
Appropriated	4,576,102	2,144,302	2,813,142	4,512,017	3,888,236	5,406,285	68,674,916
REHABILITATION							
Cost	-----	-----	-----	-----	-----	-----	1,270,511
Appropriated	-----	-----	-----	-----	-----	-----	1,270,511
TOTAL COST	3,973,974	3,259,136	2,529,393	4,697,118	4,029,456	4,238,056	111,734,306

SOURCE: U.S. Army, Corps of Engineers and Coastal, Hydraulic and Ocean Engineering Group, Texas A&M University.

EXPANSION OF THE WATERWAY

House Document number 556 of the 87th Congress, Second Session, contains a letter dated July 6, 1962, from the Secretary of the Army transmitting a report and all the accompanying papers and illustrations from the Chief of Engineers to the Speaker of the House of Representatives.

The following agencies and interested parties were consulted in connection with the recommendation for widening and deepening of the canal between Galveston and Port Arthur.

1. American Waterways Operators, Inc.
2. Oil companies
3. Towing companies
4. U.S. Bureau of Public Roads
5. U.S. Fish and Wildlife Service
6. Louisiana Department of Public Works
7. Louisiana Department of Wildlife and Fisheries
8. Policy Juries of Louisiana
9. Louisiana Department of Highways
10. Navigation districts in Texas
11. Texas Game and Fish Commission
12. Texas Highway Department
13. County authorities in Texas

The recommendation of the Army Engineers was that in view of the restricted dimensions of the existing channel (12-feet by 125-feet), which produce existing losses to tows and large vessels now using the Waterway, it should be deepened and widened. The Gulf Intracoastal Waterway is one of the most important inland waterways of the United States. The tonnages of crude oil, chemicals, sulphur and other commodities have reached large proportions, and futher increases are expected in the future. Exploitation of the inshore and offshore oil lands and development of petrochemical and light industries along the Gulf shore assure the future heavy use of the Waterway, with tonnages increasing over those being handled at present.

The existing traffic and future economic projections for the waterway justify its enlargement to provide:

a. A channel 16 feet deep and 150 feet wide from the Mississippi River, via Algiers Canal and a bypass route at Houma, Louisiana, to Atchafalaya River.

b. A channel 16 feet deep and 200 feet wide through the reach from Atchafalaya River to the Sabine River.

c. A channel 16 feet deep and 150 feet wide through the reach from the Sabine River to the Houston Ship Channel with two relocations:

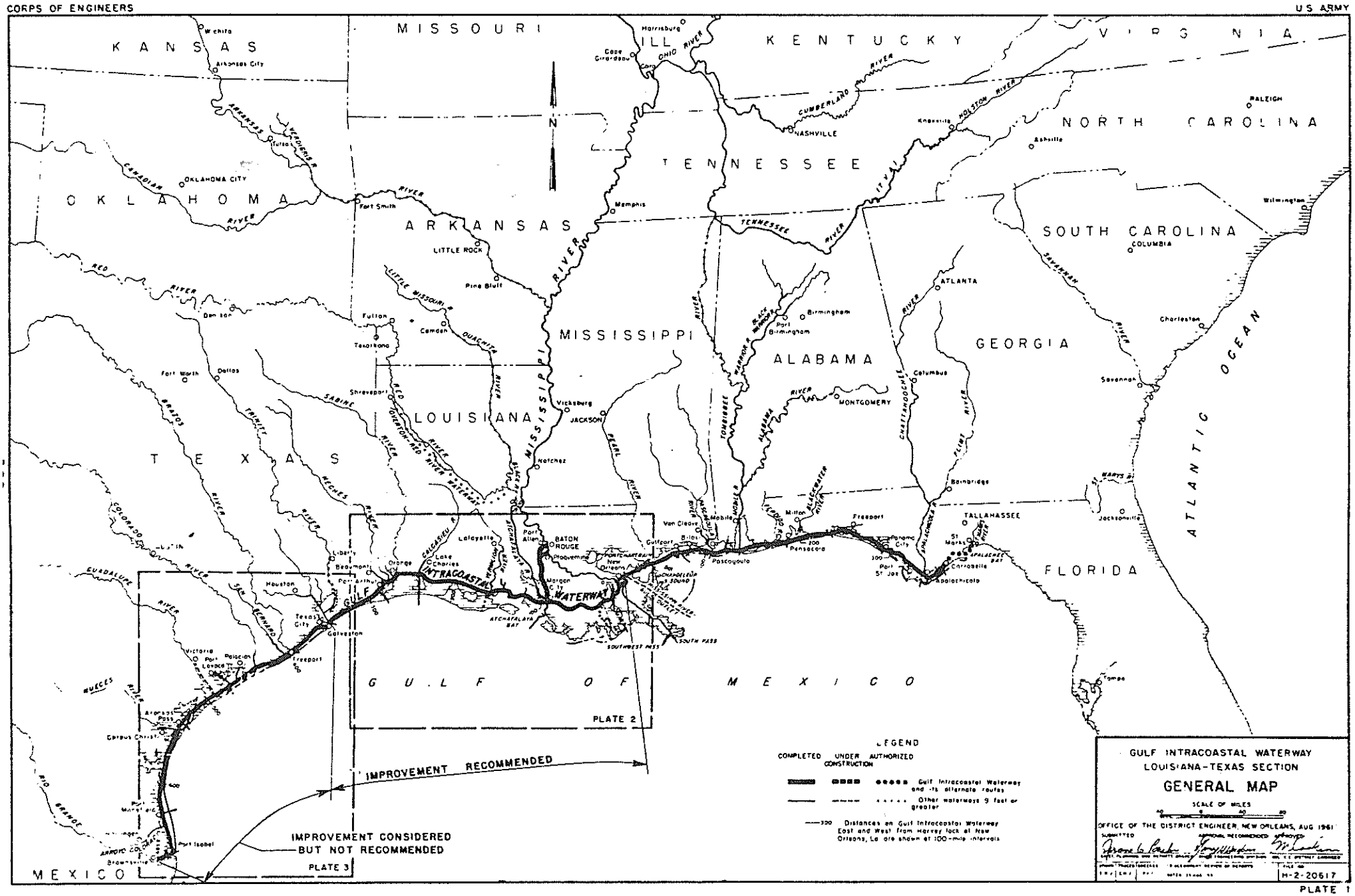
    (1) A channel 12 feet deep and 125 feet wide through a relocated route in Matagorda Bay (mile 454.3 and mile 471.3).

    (2) A channel 12 feet deep and 125 feet wide through a relocated route in Corpus Christi Bay (mile 439.4 and mile 550).

d. Maintenance of the channel 12 feet deep and 125 feet wide through the existing Lydia Ann Channel between Aransas Bay and Aransas Pass.

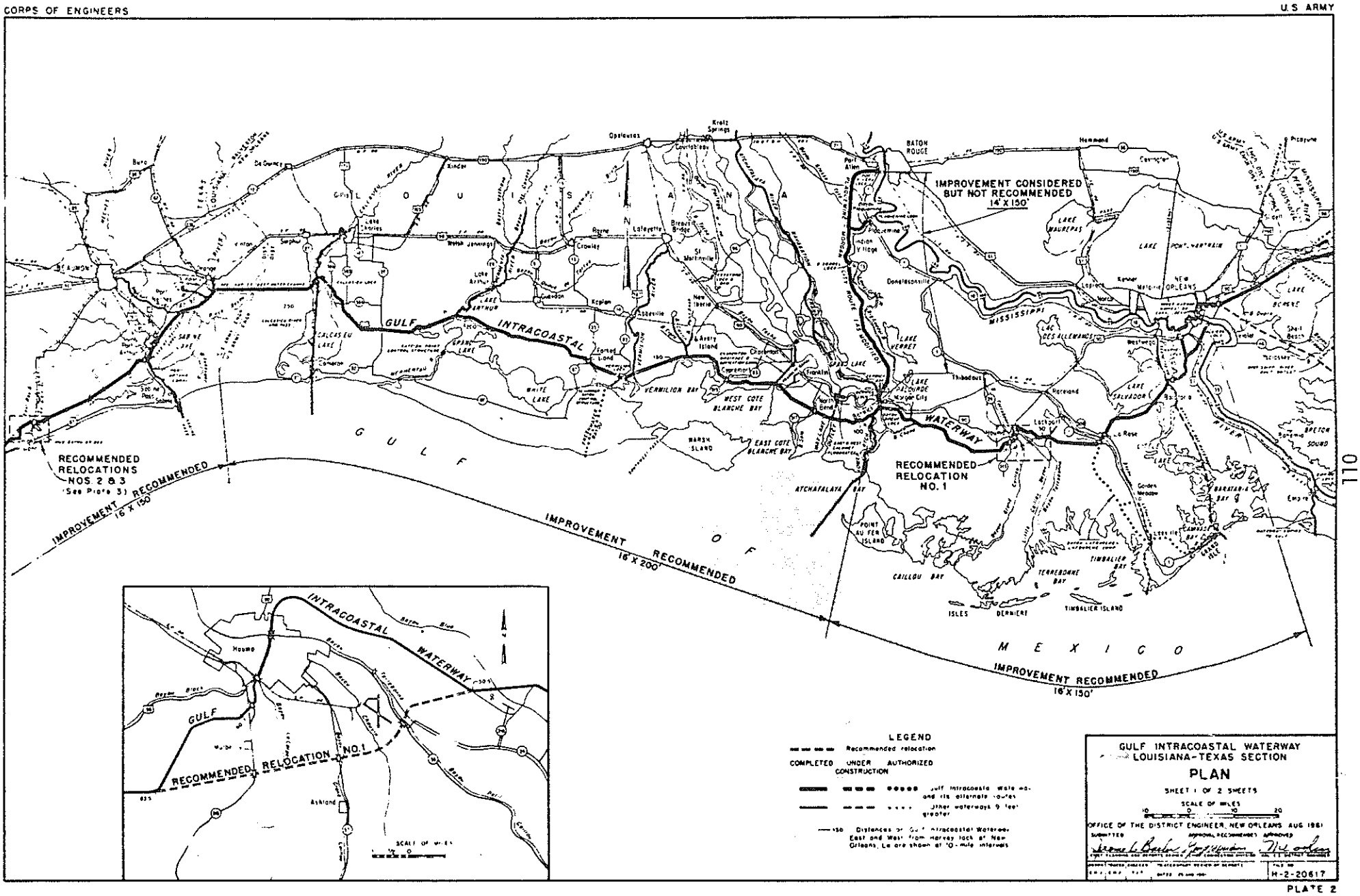
e. Maintenance of the existing waterway to 12 feet deep and 125 feet wide between mile 50.5 and mile 63.5, the reach which would be shunted by the Houma Bypass.

Figure 27 shows the section of the waterway where improvement is recommended (between Brownsville and New Orleans) and the section where improvement was considered but not recommended (between Galveston and Brownsville). Figure 28 shows the recommended improvements and relocations between High Island and New Orleans, and Figure 29 shows the relocations recommended between High Island and Brownsville.



GIWW LA-TEXAS SECTION

FIGURE 27



GIWW LA-TEXAS SECTION

FIGURE 28

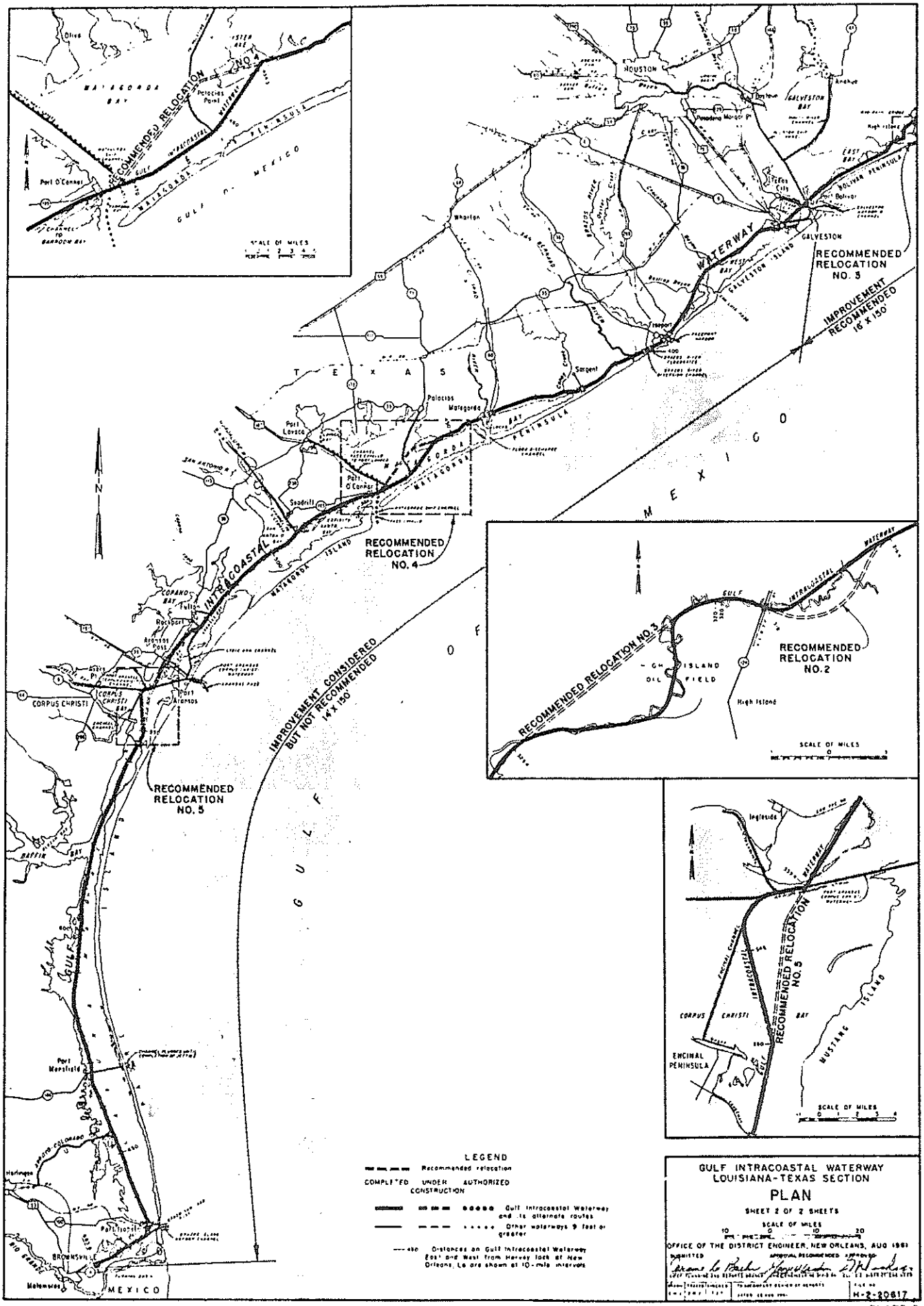


PLATE 3

GIWW PLAN
FIGURE 29

ACKNOWLEDGEMENTS

The assistance of the Galveston District of the Corps of Engineers, U.S. Army, is greatly appreciated. Col. Don S. McCoy, District Engineer, was most helpful in letting me scan through the files and in arranging my visits to various offices. Appreciation is also due to Messrs. G. R. Rochen, E. Cobb, Jr., V. C. Kessecker and Mr. Owen Ralston, District Office, Mr. Jim Bissell, Port Arthur Area Office, Mr. Marcus De la Rosa, Fort Point Area Office, Mr. W. A. Sky-Eagle, Corpus Christi Area Office and Mr. Alex Garcia, Brownsville Area Office.

Mr. Dow Wynn, Director of the Port of Port Arthur, and his staff also provided a considerable amount of valuable information.

APPENDIX 1

A-I DREDGING FREQUENCY - DETAILED SUMMARY

PORT ARTHUR to HIGH ISLAND

YEAR	STATION	VOLUME DREDGED (cu. yds.)
Oct. 1931	63 + 64 to 1571 + 16.2	7,892,930
March - Aug. 1933	-1 + 38 to 65 + 00	276,000
May - Sept. 1952	-2 + 00 to 1617 + 14.4	2,653,582
May - Aug. 1965	150 + 00 to 1050 + 00	824,319
	1050 + 00 to 1614 + 00	1,137,673
Feb. - May 1973	1020 + 00 to 1613 + 97	N. A.
	TOTAL	12,784,504

HIGH ISLAND to PORT BOLIVAR

Jan. - July 1938	2215 + 00 to 3145 + 00	1,024,000
June 1940	1945 + 00 to 1990 + 00 2355 + 00 to 2555 + 00 2958 + 00 to 3012 + 00	494,000
Dec. - Jan. 1949-50	3120 + 00 to 3201 + 40	288,300
March - July 1951	6 + 00 to 9 + 500	124,000
	1920 + 00 to 2200 + 00	702,500
Dec. - Apr. 1951-52	1622 + 00 to 1920 + 00	845,922
	2700 + 00 to 3201 + 40	1,344,164
	2200 + 00 to 2700 + 00	972,107
Oct. - Feb. 1955-56	1920 + 00 to 2200 + 00	392,485
	2850 + 00 to 2880 + 00	113,519
Sept. - Jan. 1958-59	2080 + 00 to 2300 + 00	502,849
	2620 + 00 to 2730 + 00	190,000
	2910 + 00 to 2930 + 00	322,151
	3025 + 00 to 3090 + 00 3140 + 00 to 3200 + 00	186,068
	SUBTOTAL	1,201,068
Feb. 1960	2970 + 00 to 3010 + 00	118,000
July - March 1961-62	1920 + 00 to 2910 + 00	2,009,345
	3020 + 00 to 3200 + 00	808,141
	3323 + 00 to 3357 + 00	88,261
	34 + 00 to 122 + 00	1,847,385
	SUBTOTAL	4,843,132
Oct. - Feb. 1962-63	1622 + 00 to 1920 + 00	390,000
	2910 + 00 to 3020 + 00	210,266
	SUBTOTAL	600,266
March - June 1964	1890 + 00 to 3200 + 00	1,614,200

Nov. - Feb. 1964-65	1622 + 00 to 3020 + 00	627,000	
Nov. - Jan. 1965-66	1890 + 00 to 3200 + 00	1,479,800	
Sept. - Feb. 1966-67	1622 + 00 to 1890 + 00	324,900	
	2500 + 00 to 3025 + 00	674,300	
	SUBTOTAL	999,200	
March - July 1968	1890 + 00 to 2200 + 00	674,200	
Jan. - April 1969	1622 + 00 to 1735 + 00	172,020	
	1870 + 00 to 1890 + 00	28,000	
	3000 + 00 to 3202 + 00	584,040	
	SUBTOTAL	784,060	
June - March 1970-71	1735 + 00 to 3000 + 00	1,616,725	
Nov. - May 1971-72	1622 + 00 to 1735 + 00	225,174	
	2450 + 00 to 3203 + 00	631,409	
	SUBTOTAL	856,583	
Jan. - April 1973	1735 + 00 to 2350 + 00	N. A.	
	TOTAL	22,218,080	

PORT BOLIVAR to GALVESTON CAUSEWAY

Jan. - May 1954	3275 + 00 to 3580 + 00	2,692,498	
Aug. - Dec. 1954	3025 + 00 to 3090 + 00	522,774	
	3140 + 00 to 3200 + 00	436,463	
	SUBTOTAL	959,237	
Dec. - March 1956-57	3120 + 00 to 3200 + 00	105,541	
	3291 + 00 to 3320 + 00	240,569	*
	3352 + 00 to 3430 + 00	267,144	
	2 + 00 to 11 + 00		
	18 + 00 to 21 + 00	531,215	
	33 + 400 to 43 + 00		
	SUBTOTAL	1,144,469	
N.A.	3284 + 00 to 3400 + 00	196,500	
	3400 + 00 to 3570 + 00	169,000	
	SUBTOTAL	365,500	
April - May 1963	3284 + 00 to 3400 + 00		*
	3400 + 00 to 3575 + 00		
	-6 + 00 to 11 + 00		
	18 + 00 to 23 + 00		
	SUBTOTAL	964,761	

* includes Texas City Channel

Aug. - Jan. 1965-66	3284 + 00 to 3570 + 00	
	-7 + 500 to -1 + 00	
	5 + 00 to 11 + 00	
	18 + 00 to 26 + 00	
	SUBTOTAL	1,283,800
March - July 1968	5 + 00 to 40 + 00	
	3284 + 00 to 3570 + 00	
		795,200
April - Sept. 1970	3284 + 00 to 3420 + 00	
	5 + 00 to 40 + 00	
	-6 + 600 to 11 + 00	
	SUBTOTAL	706,673
Feb. - June 1973	3284 + 00 to 3571 + 82	
	5 + 00 to 40 + 00	
	-2 + 00 to 13 + 00	
	SUBTOTAL	N.A.
	TOTAL	8,912,143

GALVESTON CAUSEWAY to BASTROP BAYOU

April - Feb. 1933-34	-3 + 520 to 84 + 341.76	3,936,000
Nov. - Oct. 1938-39	84 + 341.76 to 145 + 00	2,871,000
Aug. - Sept. 1939	33 + 500 to 69 + 00	935,000
1940	15 + 548 to 27 + 325	284,000
Aug. - May 1941-42	-1 + 416 to 10 + 518	
	35 + 467 to 39 + 291	
	69 + 00 to 84 + 500	
	95 + 500 to 145 + 00	
	SUBTOTAL	2,520,000
March - July 1944	84 + 500 to 144 + 500	1,441,000
	104 + 00 to 121 + 00	560,000
Dec. - Jan. 1949-50	35 + 500 to 54 + 000	713,700
May - July 1952	-1 + 00 to 6 + 00	
	20 + 500 to 23 + 00	695,395
	33 + 00 to 43 + 00	
	121 + 00 to 150 + 00	689,075
Feb. - July 1955	44 + 00 to 121 + 00	876,193
Dec. - Sept. 1964-65	33 + 00 to 122 + 00	1,799,900
Dec. - March 1966-67	34 + 00 to 56 + 00	301,200
	102 + 00 to 118 + 00	197,800

Sept. - Feb. 1970-71	33 + 00 to 124 + 00	1,815,143
	TOTAL	19,635,406

BASTROP BAYOU to FREEPORT HARBOR

July - March 1939-40	145 + 00 to 213 + 200	3,550,000
Dec. - July 1943-44	180 + 800 to 279 + 971.41	2,822,000
Sept. - May 1962-63	122 + 00 to 192 + 00	799,173
July - Dec. 1968	122 + 00 to 180 + 00	381,462
	TOTAL	7,552,635

FREEPORT to CEDAR LAKES

July 1940 - Nov. 1941	213 + 500 to 340 + 00	6,827,268
May - Dec. 1954	226 + 00 to 242 + 00	
	244 + 900 to 257 + 00	197,504
	257 + 00 to 269 + 00	185,722 *
	378 + 00 to 389 + 00	130,895
	399 + 00 to 410 + 00	30,995
	SUBTOTAL	545,116
July - Aug. 1956	221 + 00 to 295 + 00	
	399 + 00 to 410 + 00	
	453 + 800 to 455 + 600	
	520 + 00 to 556 + 00	
	SUBTOTAL	2,003,252
Nov. - Jan. 1957-58	218 + 500 to 242 + 00	619,872
	245 + 00 to 267 + 00	613,460
	SUBTOTAL	1,233,332
March - June 1960	230 + 500 to 266 + 500	
	0 + 70 to 5 + 95	
	SUBTOTAL	965,597
Feb. - May 1962	230 + 500 to 267 + 00	
	284 + 00 to 303 + 00	
	335 + 00 to 451 + 00	
	SUBTOTAL	3,111,093
March - Aug. 1964	220 + 00 to 230 + 00	95,850
	279 + 00 to 290 + 00	87,850
	303 + 00 to 430 + 00	746,025
	SUBTOTAL	929,725
Oct. - Jan. 1964-65	213 + 600 to 220 + 00	
	230 + 500 to 279 + 00	
	SUBTOTAL	1,170,000
March - July 1966	220 + 00 to 269 + 00	942,500
Oct. - Aug. 1967-68	213 + 600 to 269 + 00	858,769

* Includes San Bernard River

July - Aug. 1968	236 + 00 to 242 + 00	125,691
Oct. - May 1969-70	213 + 600 to 269 + 00	1,154,587
March - May 1971	230 + 00 to 267 + 00	630,848
	213 + 800 to 230 + 00	159,408
	TOTAL	20,657,186

BRAZOS RIVER CROSSING

1945	242 + 365.79 to 244 + 197.18	140,000
May 1953	242 + 400 to 244 + 100	158,170
Feb. - March 1958	241 + 250 to 244 + 100	130,043
May - July 1959	242 + 400 to 244 + 143	203,803
Dec. - Jan. 1960-61	242 + 400 to 244 + 143	170,000
Feb. - March 1961	238 + 00 to 242 + 00	112,600
	243 + 500 to 248 + 500	169,700
March - April 1961	242 + 400 to 244 + 143	92,000
June - July 1969	242 + 400 to 248 + 00	293,320
	TOTAL	1,469,636

CEDAR LAKES to COLORADO RIVER

July 1940 - Nov. 1941	340 + 00 to 454 + 935	6,594,046
Sept. 1943 - Feb. 1946	401 + 00 to 455 + 00	770,738
Dec. - July 1943-44	340 + 00 to 420 + 00	3,321,258
July 1945	368 + 500 to 385 + 00	
	395 + 00 to 405 + 00	
	429 + 00 to 436 + 500	
	447 + 00 to 453 + 200	
	456 + 100 to 461 + 00	
	SUBTOTAL	1,380,000
Oct. - Aug. 1949 - 50	379 + 00 to 554 + 00	1,490,500
Jan. - April 1952	395 + 500 to 429 + 00	793,952
Oct. 1959	373 + 00 to 466 + 00	2,337,950
Jan. - June 1965	290 + 00 to 455 + 700	1,695,500
Nov. - June 1965-66	285 + 00 to 290 + 00	
	379 + 00 to 430 + 00	
	SUBTOTAL	802,000
May - Aug. 1968	284 + 00 to 452 + 00	1,777,150
Aug. - Oct. 1970	356 + 00 to 452 + 00	1,146,000
Aug. - Dec. 1971	284 + 00 to 455 + 700	606,575
April 1973	225 + 00 to 372 + 50	N. A.
	TOTAL	22,715,669

SAN BERNARD RIVER

Aug. - Nov. 1943	0 + 50 to 52 + 00 etc.	297,000
Jan. 1956	265 + 00 to 266 + 500	77,736
April - May 1957	0 + 80 to 26 + 00	55,766
Feb. - March 1959	0 + 80 to 20 + 00	50,175
Sept. - June 1963 - 64	265 + 00 to 266 + 200	26,000
March - Aug. 1964	265 + 500 to 266 + 200	44,874
Oct. - Jan. 1964-65	0 + 70 to 20 + 00	
	0 + 70 to 6 + 95	20,800
	TOTAL	572,351

COLORADO RIVER CROSSING

June - July 1950	453 + 550 to 455 + 750	148,000
1951	454 + 604 to 458 + 979	235,000
May 1953	435 + 700 to 455 + 600	184,220
May 1957	455 + 400 to 455 + 800	
	458 + 00 to 459 + 100	34,187
May 1957	453 + 900 to 454 + 400	
	458 + 200 to 463 + 650	345,393
Oct. - Nov. 1957	454 + 300 to 455 + 200	38,600
Oct. 1957	454 + 200	35,000
March - May 1958	453 + 600 to 455 + 800	160,225
May - July 1959	453 + 200 to 455 + 700	96,196
July 1960	467 + 600 to 468 + 600	18,500
March - April 1961	453 + 700 to 455 + 700	60,100
	TOTAL	1,355,421

COLORADO RIVER to MATAGORDA BAY

May 1939 - Aug. 1940	455 + 35 to 555 + 500	6,443,013
Oct. - March 1941-42	455 + 00 to 472 + 00	
	484 + 800 to 498 + 00	
	505 + 00 to 555 + 500	
	SUBTOTAL	1,470,018
Dec. - Aug. 1943-44	420 + 00 to 520 + 00	1,790,000
May - July 1944	526 + 253.14 to 626 + 500	3,791,000
1945	468 + 800 to 492 + 00	
	504 + 00 to 510 + 00	
	529 + 00 to 545 + 00	
	SUBTOTAL	754,000
Dec. - Oct. 1947-48	461 + 00 to 546 + 00	1,941,000
1951	458 + 00 to 546 + 00	1,956,000

Nov. - Feb. 1952-53	502 + 500 to 508 + 00	
	525 + 00 to 550 + 00	
	626 + 00 to 628 + 300	
	SUBTOTAL	1,004,872
June - Sept. 1954	440 + 00 to 451 + 500	
	458 + 300 to 546 + 00	
	SUBTOTAL	1,108,476
Dec. - Jan. 1958-59	466 + 00 to 472 + 644.77	133,336
	478 + 361.18 to 547 + 00	1,920,170
	SUBTOTAL	2,053,506
Sept. 1961	457 + 400 to 555 + 00	3,122,365
Sept. 1963	480 + 00 to 486 + 00	68,265
	503 + 00 to 510 + 00	100,765
	520 + 00 to 550 + 00	202,765
	SUBTOTAL	371,795
March - Aug. 1965	457 + 400 to 545 + 00	1,126,000
Jan. - April 1967	457 + 400 to 550 + 00	1,582,600
March - Sept. 1968	453 + 800 to 455 + 700	
	502 + 00 to 508 + 00	
	520 + 00 to 554 + 00	
	SUBTOTAL	1,087,259
Dec. - June 1969-70	453 + 700 to 546 + 00	1,559,917
Jan. - May 1972	470 + 00 to 555 + 00	1,522,162
	TOTAL	32,683,983

MATAGORDA BAY to SAN ANTONIO BAY

July 1938 - Oct. 1939	626 + 500 to 733 + 00	5,173,000
Dec. - Oct. 1942-43	627 + 00 to 640 + 00	
	643 + 00 to 660 + 00	
	690 + 00 to 705 + 00	
	SUBTOTAL	1,163,543
Dec. - June 1943 - 44	626 + 500 to 720 + 00	1,813,000
Feb. - July 1944	720 + 00 to 765 + 00	2,739,000
Aug. 1946	626 + 400 to 627 + 00	
	689 + 500 to 706 + 00	
	796 + 00 to 808 + 00	
	SUBTOTAL	260,000
May - Oct. 1949	626 + 500 to 689 + 500	3,846,000
	723 + 00 to 775 + 00	
July - Sept. 1956	626 + 600 to 629 + 00	177,244
	727 + 00 to 775 + 00	1,321,070
	SUBTOTAL	1,499,214

March - Oct. 1964	625 + 00	to 629 + 00	109,187
	666 + 00	to 689 + 00	89,141
	725 + 00	to 978 + 215	
		SUBTOTAL	2,180,488
Nov. 1972	613 + 400	to 616 + 200	67,156
		TOTAL	18,741,401

CHANNEL to VICTORIA

Only GIWW	626 + 600	to 629 + 00	62,800
		TOTAL	62,800

SAN ANTONIO BAY to ARANSAS BAY

May 1939 - July 1940	733 + 00	to 866 + 00	4,300,000
Oct. - March 1941-42	723 + 00	to 867 + 00	1,049,000
1942	720 + 00	to 791 + 00	3,395,000
1943	775 + 00	to 829 + 00	3,185,013
	866 + 00	to 932 + 00	
Aug. 1944	765 + 00	to 775 + 00	3,661,929
	829 + 00	to 866 + 00	
Aug. 1945	723 + 00	to 791 + 00	2,735,200
May - Oct. 1951	775 + 00	to 796 + 00	495,000
	830 + 500	to 884 + 00	
		SUBTOTAL	2,013,200
April - May 1953	727 + 00	to 775 + 00	1,425,074
July - Oct. 1954	775 + 00	to 808 + 400	
	821 + 00	to 885 + 400	
	899 + 00	to 927 + 800	
		SUBTOTAL	2,158,915
Dec. - June 1958-59	775 + 00	to 791 + 00	1,475,843
	831 + 500	to 866 + 500	
Feb. - March 1960	727 + 00	to 775 + 00	1,155,550
Feb. - May 1962	629 + 00	to 666 + 00	
	689 + 00	to 809 + 00	
	819 + 00	to 866 + 00	
		SUBTOTAL	4,827,201
June - April 1966-67	725 + 00	to 775 + 00	2,087,184
	830 + 00	to 844 + 00	

Jan. - Aug. 1967	642 + 00	to 652 + 00	
	689 + 00	to 705 + 00	
	713 + 00	to 725 + 00	
	976 + 900	to 977 + 100	
		SUBTOTAL	244,761
May - Dec. 1968	724 + 00	to 775 + 00	1,347,858
May - Oct. 1969	775 + 00	to 844 + 00	1,042,714
Sept. - March 1970-71	724 + 00	to 616 + 200	1,723,206
		TOTAL	37,777,653

ARANSAS BAY to CORPUS CHRISTI BAY

May - June 1943	903 + 167	to 928 + 00	428,000
1948	829 + 00	to 885 + 315	2,659,900
	903 + 200	to 916 + 800	389,150
		SUBTOTAL	3,049,000
Feb. 1959 - March 1960	889 + 811	to 944 + 00	2,925,879
	950 + 00	to 978 + 450	2,261,600
		SUBTOTAL	5,187,479
Aug. - Sept. 1961	626 + 500	to 629 + 00	
	866 + 00	to 890 + 00	
	929 + 400	to 935 + 200	
	938 + 200	to 944 + 500	
	977 + 650	to 978 + 200	
		SUBTOTAL	796,255
March - July 1963	890 + 500	to 901 + 00	
	906 + 00	to 929 + 00	
	947 + 500	to 960 + 00	
		SUBTOTAL	281,865
Jan. - April 1968	842 + 00	to 905 + 600	1,095,737
April - June 1972	829 + 00	to 900 + 00	1,911,997
		TOTAL	12,750,333

CORPUS CHRISTI BAY to MUD FLATS

1946	2 + 00	to 73 + 00	6,587,500
April 1947 - May 1948	73 + 00	to 163 + 00	6,532,700
Jan. - Dec. 1948	163 + 00	to 240 + 00	7,067,000
May - July 1950	5 + 500	to 7 + 200	45,000
	109 + 00	to 113 + 00	82,000
	155 + 00	to 174 + 00	432,000
	180 + 00	to 186 + 500	120,000
	209 + 00	to 214 + 00	141,000
		SUBTOTAL	820,000

Feb. - July 1953	204 + 00	to 321 + 00	3,867,455
April 1955	2 + 00	to 8 + 00	163,000
Nov. - Jan. 1957-58	156 + 200	to 217 + 00	1,337,117
	278 + 00	to 285 + 00	468,886
		SUBTOTAL	1,806,003
July - Sept. 1959	3 + 00	to 8 + 00	500,000
	48 + 00	to 62 + 00	
	89 + 00	to 122 + 00	1,261,886
		SUBTOTAL	1,761,886
Jan. - Dec. 1961	130 + 00	to 174 + 00	942,600
	206 + 00	to 215 + 00	196,700
	230 + 00	to 239 + 00	128,300
	252 + 00	to 278 + 00	859,600
	284 + 500	to 301 + 00	353,600
	309 + 500cc	to 325 + 00br	176,400
	312 + 00	to 302 + 00	
		SUBTOTAL	2,657,200
July - April 1961-62	31 + 00	to 48 + 00	304,280
	62 + 00	to 89 + 00	562,354
	122 + 00	to 130 + 00	448,170
	174 + 00	to 206 + 00	427,257
	215 + 00	to 230 + 00	370,400
	239 + 00	to 252 + 00	165,500
	278 + 00	to 284 + 500	122,320
	301 + 00	to 309 + 500	
		SUBTOTAL	2,400,551
April - July 1962	2 + 00	to 12 + 00	184,882
	89 + 00	to 122 + 00	787,366
		SUBTOTAL	972,248
June - August 1963	108 + 00	to 113 + 00	100,952
	140 + 00	to 150 + 00	133,696
	155 + 00	to 162 + 00	110,596
	162 + 350	to 170 + 00	149,180
	206 + 00	to 217 + 00	178,204
		SUBTOTAL	672,628
June - Aug. 1964	110 + 00	to 124 + 00	132,400
	130 + 00	to 140 + 00	97,045
	170 + 00	to 206 + 00	471,248
		SUBTOTAL	700,693
Nov. - Aug. 1964-65	239 + 00	to 311 + 00	1,934,000
July - Feb. 1965-66	2 + 00	to 10 + 00	93,596
	88 + 00	to 109 + 00	269,637
	140 + 00	to 171 + 00	395,866
	206 + 00	to 221 + 00	170,011
	227 + 00	to 239 + 00	103,407
		SUBTOTAL	1,032,517

Aug. - March 1966-67	49 + 00	to 65 + 00	82,037
	109 + 00	to 140 + 00	304,042
	172 + 00	to 190 + 00	173,804
		SUBTOTAL	559,889
March - Oct. 1968	0 + 00	to 10 + 00	148,093
	89 + 00	to 129 + 00	571,204
	137 + 00	to 172 + 00	514,206
	179 + 00	to 227 + 00	700,956
	247 + 00	to 285 + 00	332,583
	285 + 00	to 311 + 00	405,574
	327 + 739	to 366 + 00	194,075
		SUBTOTAL	2,866,691
April - June 1970	99 + 00	to 122 + 00	293,508
	129 + 00	to 183 + 00	562,568
		SUBTOTAL	856,076
July - Nov. 1972	156 + 00	to 174 + 00	288,538
	179 + 00	to 193 + 00	223,321
	205 + 00	to 216 + 00	178,228
		SUBTOTAL	690,087
		TOTAL	43,948,124

PORT ISABEL to MUD FLATS

January 1946	6 + 400	to 97 + 00	6,411,110
May 1947 - Nov. 1948	97 + 00	to 122 + 00	
(Arroyo Colorado)	6 + 00	to 40 + 00	
	126 + 00	to 165 + 00	
		SUBTOTAL	10,049,900
1948	165 + 00	to 216 + 00	3,307,800
Nov. - June 1948-49	240 + 00	to 317 + 00	7,900,000
Sept. - Nov. 1950	14 + 400	to 20 + 00	226,000
	72 + 00	to 74 + 500	29,300
	291 + 500	to 298 + 500	129,500
		SUBTOTAL	382,800
March 1952	11 + 263	to 11 + 833	27,804
	46 + 00	to 66 + 00	714,887
	126 + 800	to 130 + 628	82,932
	0 + 400	to 7 + 600	218,962
	216 + 00	to 237 + 00	511,015
	275 + 00	to 291 + 500	639,713
		SUBTOTAL	2,195,263
May - July 1952	251 + 00	to 275 + 00	636,861
	291 + 500	to 305 + 00	466,652
		SUBTOTAL	1,103,519

March 1953 - June 1954 (Arroyo Colorado)	41 + 00 to 68 + 00 3 + 00 to 15 + 00 3 + 00 to 3 + 972	818,835
(Pt. Mansfield)	197 + 600 to 213 + 00 0 + 00 to 7 + 606	330,162
	0 + 22.6 to 2 + 979.9 293 + 00 to 305 + 00	486,881
	305 + 00 to 321 + 00	214,721
	SUBTOTAL	1,750,601
Feb. - July 1956	14 + 400 to 20 + 00 54 + 00 to 63 + 00	547,715
(Channel to Port Mansfield)	2 + 979.9 to 7 + 470 213 + 00 to 237 + 00	636,451
	293 + 00 to 298 + 00	132,445
	SUBTOTAL	1,316,611
Oct. - Nov. 1957	281 + 00 to 296 + 00	513,922
April - June 1960	45 + 00 to 66 + 00	669,041
	127 + 200 to 130 + 200	82,170
	175 + 00 to 186 + 00	254,541
	220 + 00 to 227 + 00	162,541
	252 + 00 to 262 + 00	236,892
	290 + 00 to 302 + 00	298,174
	SUBTOTAL	1,703,359
Jan. - July 1962	40 + 00 to 45 + 00	114,337
	55 + 00 to 69 + 00	343,318
	199 + 00 to 220 + 00	570,936
	238 + 00 to 252 + 00	289,967
	SUBTOTAL	1,318,558
May - Nov. 1963	220 + 00 to 238 + 00	688,003
	252 + 00 to 270 + 00	786,968
	284 + 00 to 290 + 00	187,074
	306 + 00 to 308 + 00	78,877
	311 + 600 to 320 + 00	157,477
	SUBTOTAL	1,898,379
Nov. - Jan. 1964-65	14 + 400 to 20 + 00	154,315
	45 + 00 to 72 + 00	722,826
	126 + 00 to 131 + 00	116,450
	155 + 00 to 190 + 00	597,874
	277 + 00 to 284 + 00	154,959
	290 + 00 to 302 + 00	273,144
	308 + 00 to 311 + 600	45,362
	SUBTOTAL	2,064,930

Dec. - July 1964-65	270 + 00	to 277 + 00	129,044
	320 + 00	to 327 + 739	145,534
		SUBTOTAL	274,578
June - Nov. 1965	36 + 00	to 46 + 00	110,137
	149 + 00	to 155 + 00	78,481
	238 + 00	to 252 + 00	278,018
	283 + 00	to 290 + 00	105,366
	302 + 00	to 306 + 00	47,526
		SUBTOTAL	619,528
Feb. - Aug. 1966	54 + 00	to 64 + 00	244,315
	214 + 00	to 229 + 00	360,303
		SUBTOTAL	604,618
Dec. - April 1966-67	45 + 00	to 54 + 00	195,266
	127 + 00	to 130 + 00	64,626
	277 + 00	to 296 + 00	328,945
		SUBTOTAL	588,837
Sept. 1967 - March 1969	54 + 00	to 67 + 00	390,201
	100 + 00	to 121 + 00	161,884
	126 + 167	to 130 + 928	56,536
	251 + 800	to 270 + 00	358,947
	121 + 00	to 126 + 167	71,759
		SUBTOTAL	1,039,327
May - Aug. 1969	47 + 00	to 72 + 00	546,601
	272 + 00	to 299 + 600	349,404
		SUBTOTAL	896,005
July - Oct. 1970	172 + 00	to 186 + 00	200,865
	220 + 00	to 252 + 00	597,476
		SUBTOTAL	798,341
June - Sept. 1970	40 + 00	to 66 + 00	606,852
April - June 1971	186 + 00	to 220 + 00	959,654
	252 + 00	to 266 + 00	232,963
	279 + 00	to 290 + 00	92,788
		SUBTOTAL	1,285,405
July - Feb. 1971-72	4 + 030	to 5 + 344	8,691
	14 + 400	to 22 + 00	75,305
	66 + 00	to 76 + 00	515,873
	126 + 600	to 131 + 00	62,782
	155 + 00	to 172 + 00	131,827
		SUBTOTAL	794,278
Aug. - Dec. 1972	40 + 00	to 72 + 00	425,428
	125 + 00	to 131 + 00	52,637
	172 + 00	to 186 + 00	155,090
		SUBTOTAL	633,155

Feb. - June 1973	200 + 00	to 204 + 994	
	205 + 94	to 206 + 934	34,072
	220 + 00	to 295 + 00	195,124
		SUBTOTAL	229,196
		TOTAL	49,773,000

APPENDIX 2

Table - A II

ESTIMATED DREDGING FREQUENCY FOR GIWW (GALVESTON DISTRICT)

	Main Channel Location	Frequency Months	Annual Maintenance Material (cubic yards)
1	High Island to Port Bolivar	24	1,000,000
2	Texas City Junction to North Deer Junction	24	500,000
3	North Deer Island thru Chocolate Bay	24	750,000
4	Chocolate Bay to Freeport Harbor	36	750,000
5	Freeport Harbor to Cedar Lakes	24	1,000,000
6	Cedar Lakes to Colorado River	24	1,000,000
7	Colorado River to Matagorda	24	1,000,000
8	Matagorda Bay to San Antonio Bay	30	600,000
9	Across San Antonio Bay	24	750,000
10	San Antonio Bay to Aransas Bay	48-72	300,000
11	Across Aransas Bay	24-48	100,000
12	Aransas Bay to Corpus Christi Channel	60	100,000
13	Corpus Christi Bay to Baffin Bay	36	600,000
14	Baffin Bay to Mud Flats	30	2,000,000
15	Mud Flats to Ports Mansfield	15	540,000
16	Port Mansfield to Arroyo Colorado	20	245,000
17	Arroyo Colorado to Port Isabel	18	390,000

APPENDIX 3

DEFINITION OF TERMS

ACCRETION - may be either natural or artificial. Accretion on a beach may occur by natural deposition of waterborne or airborne material or by artificial deposition of material on a beach by dredging.

BAR - an offshore ridge or mound of sand, gravel or other unconsolidated material submerged, at least at high tide.

BARRIER BEACH - a bar essentially parallel to the shore, the crest of which is above water.

BEDLOAD - coarse material moving on or near the channel bed.

BREAKWATER - a structure protecting a shore area, harbor, anchorage or basin from waves.

CONTROLLING DEPTH - the least depth of water in navigable parts of a waterway, which limits the allowable draft of vessels.

CURRENT, EBB - the movement of the tidal current away from shore or down a tidal stream.

CURRENT, FLOOD - the movement of the tidal current toward the shore, or up a tidal stream.

CURRENT, TIDAL - a current caused by the tide-producing forces of the moon and the sun.

DATUM PLANE - the horizontal plane to which soundings, ground elevations or water surface elevations are referred. For the Atlantic Coast MEAN LOW LOW WATER and for the Pacific Coast MEAN LOWER LOW WATER is used.

DIKE - a wall or mound built around a low-lying area to prevent flooding.

DIKE, DREDGED MATERIAL DISPOSAL - a mound built in the vicinity of GIWW to contain dredged material.

EROSION - the wearing away of land by the action of natural forces.

EROSION BANK - erosion of channel banks by natural or artificial means.

GRAVITY WAVE - a wave whose velocity of propagation is controlled primarily by gravity.

HEIGHT OF WAVE - distance between a crest and the preceding trough.

LAGOON - a shallow body of water, as a pond or lake, which usually has a shallow, restricted outlet to the sea.

LITTORAL DRIFT - the material moved in the littoral zone under the influence of waves and currents.

MEAN LOW WATER (MLW) - the average height of the low waters over a 19-year period.

MEAN LOWER LOW WATER (MLLW) - frequently abbreviated lower low water. The average height of the lower low water over a 19-year period.

MEAN SEA LEVEL - the average height of the surface of the sea for all stages of the tide over a 19-year period.

REVETMENT - a facing of stone, concrete, etc., built to protect a scarp embankment or shore structure against erosion.

RIPRAP - a layer, facing or protective mound of stones randomly placed to prevent erosion, scour or sloughing of a structure or embankment.

RUBBLE-MOUND STRUCTURE - a mound of random-shaped and random-placed stones protected with a cover layer of selected stones or specially shaped concrete armor units.

SCOUR - removal of underwater material by waves and currents.

Sociological Aspects

SOCIOLOGICAL CHARACTERISTICS OF THE GULF INTRACOASTAL WATERWAY IN TEXAS

CARLTON E. RUCH
Industrial Economics Research Division
Texas Engineering Experiment Station
Texas A&M University

INTRODUCTION

In the light of the energy problems the nation has experienced in the past year, the critical nature of the Gulf Intracoastal Waterway to the national economy has become apparent. About 25 percent of the nation's petroleum, petrochemical, and related industries are located in the Texas Coastal Area and are dependent to some degree on the GIWW.

On the state level nearly 75 percent of all goods are shipped by water.[1] The major waterway users in Texas are petroleum and petroleum refining industries. They account for about 60 percent of all waterborne commerce in Texas. Two other major users are the chemical industry with 17.4 percent and the non-metallic minerals industries with 16.7 percent. The portion of these industries located in the coastal counties pay over 700 million dollars in wages.[2]

The jobs supported by over 700 million dollars in wages are the key to the social and economic well-being of the Texas Coastal Area. Table 1 indicates the distribution of additional non-manufacturing employment due to an increase in manufacturing employment while Table 2 pictures the distribution of annual retail sales associated with each 100 new manufacturing employees.

A recent study of the impact of 100 factory workers on ten rural counties illustrates the critical nature of employment.

"It shows that every new 100 factory workers in such counties means also:

- Personal income - up $1,036,000 yearly.
- One more retail establishment.
- Retail sales - up $565,000 per year.
- Bank deposits - up $490,000.
- Nonmanufacturing jobs - up 68.
- Population - up 351, including 97 more families.
- School enrollment - up 79."[3]

---

[1] Bureau of the Census, 1967 Census of Transportation, Area Series - Texas, Washington, D.C.: U.S. Department of Commerce, May, 1970, p. 3.

[2] Miloy, John and Christian Phillips, Primary Economic Impact of the Gulf Intracoastal Waterway in Texas, Texas A&M University: Sea Grant Program, TAMU-SG-74-211, 1974.

[3] The study was conducted by the Economic Analysis and Study Group of the Chamber of Commerce of the United States and constituted an update of 1954 and 1962 studies. Reported in the March, 1973 issue of Nation's Business, p. 818.

TABLE 1

DISTRIBUTION OF ADDITIONAL NONMANUFACTURING EMPLOYMENT DUE TO INCREASE IN MANUFACTURING EMPLOYMENT
1973

CATEGORY	NUMBER OF WORKERS
Manufacturing	100
Nonmanufacturing:	
Wholesale and retail trade	21
Professional and related services	17
Transportation, communication and other public utilities	11
Finance, insurance, and real estate	6
Business and personal services	5
Construction	3
Other industries	5

SOURCE: Chamber of Commerce of the United States, Washington, D.C.

TABLE 2

DISTRIBUTION OF ANNUAL RETAIL SALES ASSOCIATED WITH EACH 100 NEW MANUFACTURING EMPLOYEES
1973

CATEGORY	SALES
Grocery stores	$119,000
Motor vehicle dealers	89,000
Department stores	59,000
Eating and drinking places	43,000
Gasoline service stations	41,000
Clothing and shoe stores	30,000
Furniture, home furnishings and household appliance stores	26,000
Lumber, building materials and hardware dealers	23,000
Drug stores	19,000
Other retail stores	116,000
	$565,000

SOURCE: Chamber of Commerce of the United States, Washington, D.C.

The study also showed the effect of 100 factory workers in 127 metropolitan areas.

An increase of 100 jobs in these areas means:
"- Personal income up $872,000 yearly.
- Two more retail establishments.
- Retail sales - up $395,000 per year.
- Bank deposits - up $481,000.
- Population - up 245, including 69 families.
- School enrollment - up 80."[4]

The fact that the GIWW does create jobs which lead to the better socio economic well-being of the population can be seen in a relationship which appears to exist between the degree of utilization of the GIWW and the socio economic well-being of the residents of those counties through which the main channel of the GIWW flows.

Figures 1 through 11 illustrate that in areas where the GIWW is more fully utilized there are greater socio economic benefits. In these figures the fifteen coastal counties through which the main channel of the GIWW flows are listed in order from Cameron County to Orange County. The low utilization portion of the GIWW is that section of the GIWW which flows from the Mexican border to Corpus Christi over which only 2,345,252 tons[5] were moved in 1970. This segment includes Cameron, Willacy, Kenedy, Kleberg, and a portion of Nueces Counties. The medium utilization segment of the GIWW is the section from Corpus Christi to Galveston over which 20,212,427 tons were moved in 1970. This segment includes Nueces (a portion only), San Patricio, Refugio, Calhoun, Jackson, Matagorda, Brazoria, and a portion of Galveston Counties. The high utilization section of the GIWW includes the segment from Galveston to the Sabine River over which 42,843,601 tons were moved in 1970. This segment includes Galveston (a portion only), Chambers, Jefferson, and Orange Counties.

The three socio economic measures utilized will be income levels, housing characteristics, and welfare, health and education indicators. These measures should take on added significance in light of the fact that over 50 percent of the Texas population lives within 100 miles of the coast and that population movement in the future is projected to be in the direction of coastal areas.

Income Levels

Income levels measure the economic well-being of families.

---

[4] Ibid., p. 819.

[5] Tonnage rates are derived from Waterborne Commerce of the United States, Part 2, 1970, Corps of Engineers, Department of Army, Washington, D.C.

Figure 1 shows that median family income for 1970 tends to be much greater in those counties where more tonnage is carried on the GIWW. Counties in the low utilization segment have a composite average median family income of $5,789[6], the median utilization segment of $8,184, and the high utilization segment of $9,069. It may be noted that only Brazoria, Galveston, Jefferson, and Orange Counties are above the State average of $8,490.

Figure 2 illustrates the percent of families in counties in 1970 with incomes less than the poverty level. In the GIWW low utilization segment a composite average of 30.78 percent of the families were below the poverty level, in the medium utilization section it was 17.51 percent, and in the high utilization portion only 12.82 percent, or less than half that of the low utilization section. Only Brazoria, Galveston, Jefferson, and Orange Counties has percentages lower than the State average of 14.6 percent.

In Figure 3 the percent of families with incomes of $15,000 or over for counties in 1970 is shown. In the low utilization segment of the GIWW the composite average was 11 percent, the medium utilization portion 13.5 percent, and the high utilization section 15.4 percent. Only three of the fifteen coastal counties had percentages of family incomes of $15,000 or more which exceeded the Texas average of 16.5 percent. It may be seen from Figures 1, 2, and 3 that county incomes are significantly greater in areas of higher GIWW usage. Further, it should also be noted that these income figures show the economic status of the fifteen counties through which the main channel of the GIWW flows as being well beneath the overall state averages.

Housing Characteristics

Another indicator of the socio economic status of a particular population is the quality of their homes. Figure 4 shows the median value of owner occupied homes for counties in 1970. The composite median value for counties in the low utilization segment of the GIWW is $8,020, for the medium use section $10,688, and for the high utilization portion $11,175. Only Brazoria and Galveston Counties have median owner occupied home values above the State average of $12,000.

According to Figure 5 the composite median contract rent for counties in 1970 in the low utilization segment was $52.40 per month, in the medium usage section $59.90, and in the high utilization portion $62.50. All of the counties were below the State average of $76 except Kleberg which had a median rent of $77.

---

[6] Composite averages were derived by totaling the median incomes in the low utilization section and then dividing that amount by the number of counties in that segment. The same method was used for the medium and high utilization segments. This methodology was used for Figures 1 through 11.

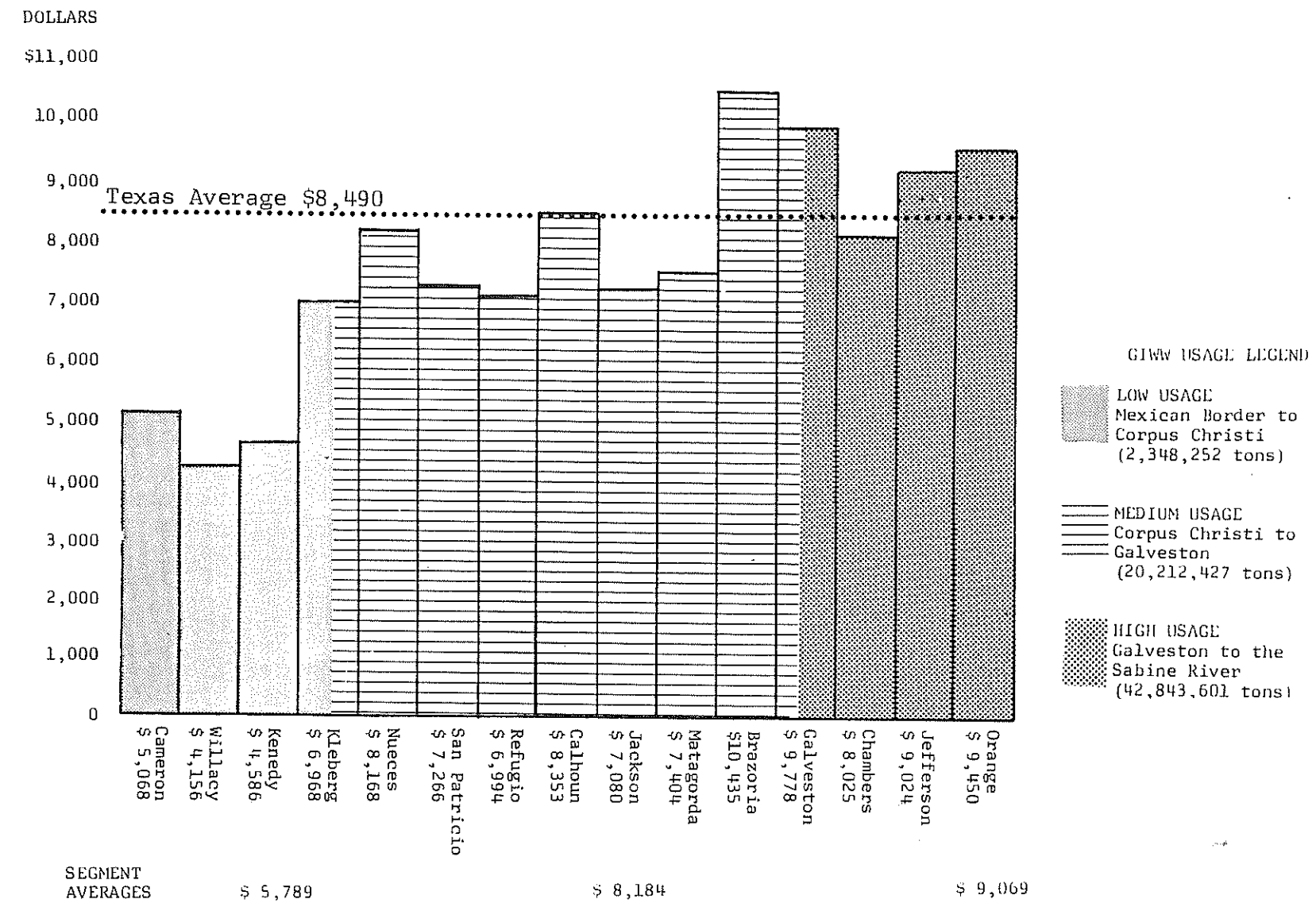


Figure - 1

MEDIAN FAMILY INCOME (DOLLARS) BY COUNTIES 1970

SOURCE: Table 44, "Summary of Economic Characteristics by Counties: 1970" of General Social and Economic Characteristics: Texas, PC(1) - 45 Texas and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

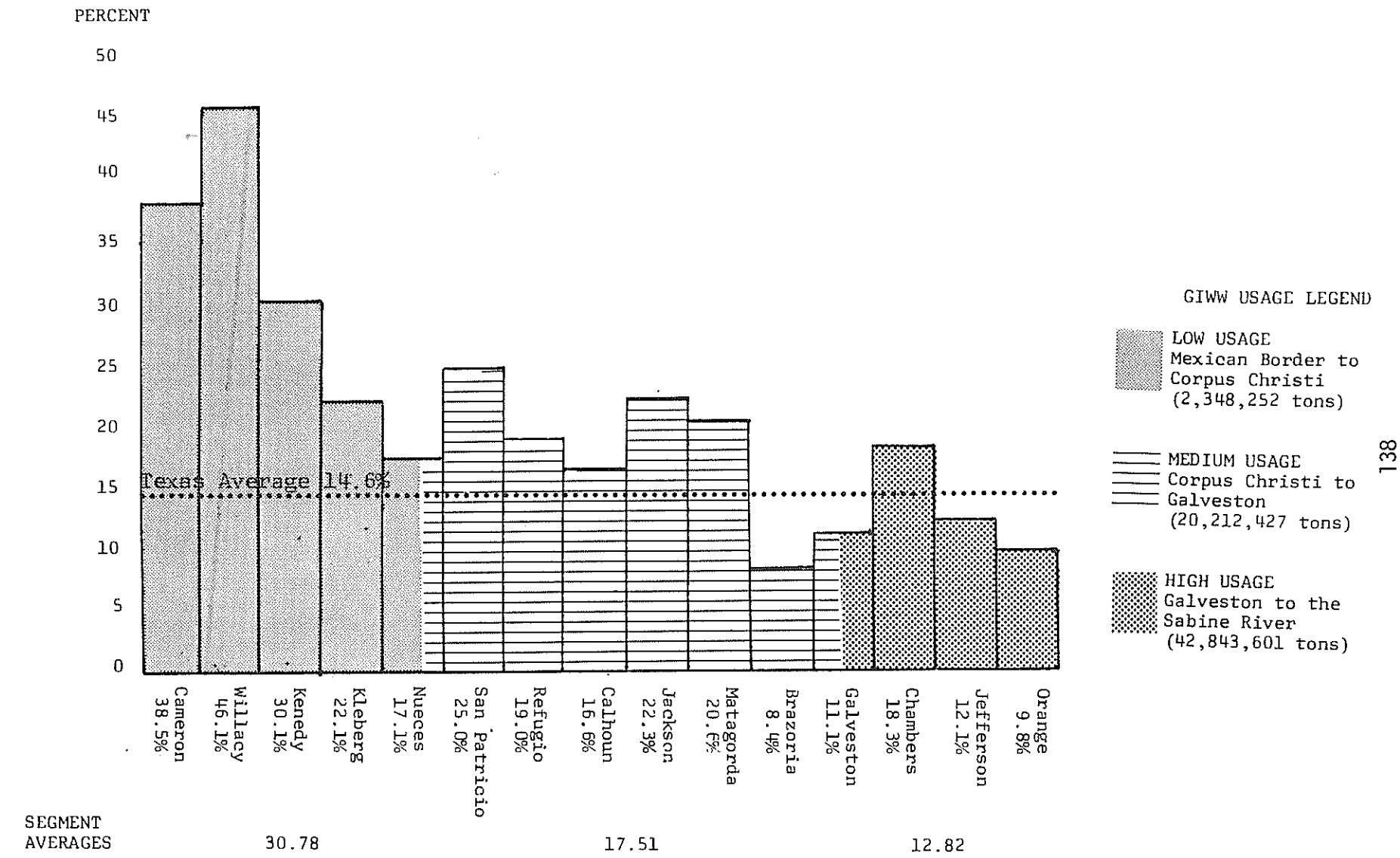


Figure - 2

PERCENT OF POPULATION WITH INCOMES LOWER THAN POVERTY LEVEL BY COUNTIES 1970

SOURCE: Table 44, "Summary of Economic Characteristics by Counties: 1970" of General Social and Economic Characteristics: Texas, PC(1) - 45 Texas and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

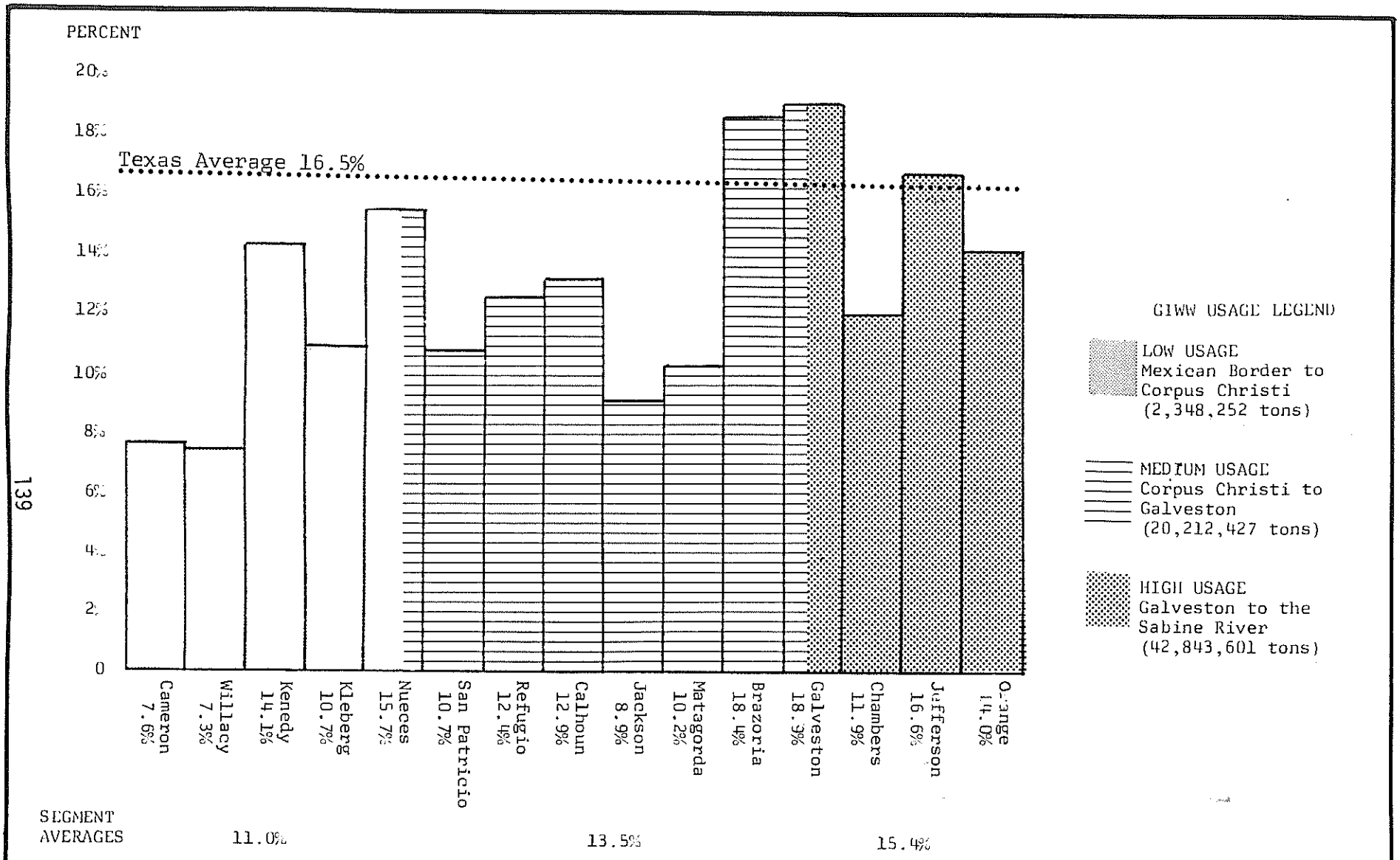


Figure - 3

PERCENT OF FAMILIES WITH INCOME OF $15,000 OR MORE BY COUNTIES 1970

SOURCE: Table 44, "Summary of Economic Characteristics by Counties: 1970" of General Social and Economic Characteristics: Texas, PC(1) - 45 Texas and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

The final indicator of housing conditions is seen in Figure 6. It indicates the percentage of housing units in counties in 1970 lacking some or all plumbing facilities. In the low use segment the composite average shows 16.66 percent had houses which lacked some or all plumbing facilities, the medium usage section had 11.01 percent, and the high utilization portion had only 6.26 percent. The State average was 8.5 percent. In general, housing conditions are significantly better in areas of higher GIWW utilization. Also, the coastal counties, according to Figures 4, 5, and 6, have housing conditions below the overall Texas averages.

Welfare, Health, and Education Indicators

In addition to income levels and the quality of homes, there are a number of other socio economic indicators which need to be considered in welfare, health, and education areas. Figure 7 indicates the percentage receiving monthly welfare in counties in 1970. For the low utilization segment the composite average was 6.72 percent, for the medium usage portion it was 5.31 percent, and for the high use section 4.19 percent.

Figure 8 shows the number of physicians per 1,000 population for counties in 1970. Only Nueces, Galveston and Jefferson Counties had more physicians per 1,000 persons than the Texas average of 1.01[7]. In the low utilization segment the composite average is .4392, the medium usage section .9314, and in the high use portion 1.242.

According to Figure 9 in Texas there was .4162[8] dentists per 1,000 persons in 1970. Only Jefferson County exceeds the State average. In the low utilization segment the composite average is .2126, the medium usage section .2889, and in the high use portion .3353.

Figure 10 shows the number of hospital beds per 1,000 population in counties for 1970. The low usage section had a composite average of 3.078, the medium use portion 5.020, and the high utilization segment 5.3618. It should be noted that the Texas average of 4.10 is low in contrast to the national average of 7.9. Figures 7, 8, 9, and 10 picture better living conditions in terms of welfare and health for those counties where there is greater utilization of the GIWW. They also indicate that these counties are below Texas and national averages in most of these categories.

The final socio economic indicator considered is educational level. Figure 11 shows the median number of years of education for persons 25 and over by counties for 1970. The low utilization segment had a composite average of 9.02 years, the medium use section

---

[7] The United States average was 1.71.

[8] The United States average was .58.

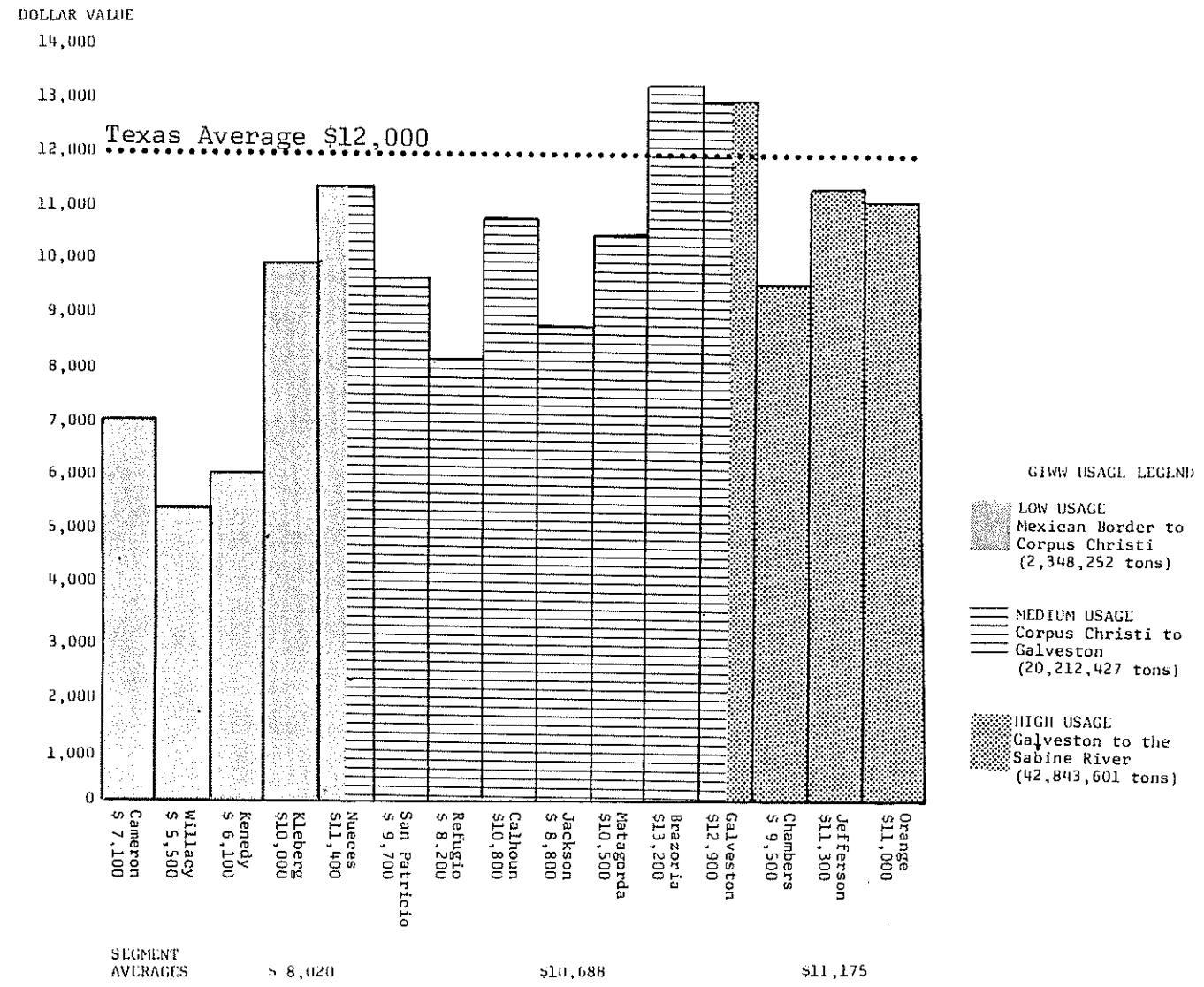


Figure - 4

MEDIAN VALUE OF OWNER OCCUPIED HOMES BY COUNTIES 1970

SOURCE: Table 29 "Selected Characteristics for Counties: 1970" of General Housing Characteristics: Texas, HC(1) - A45 Texas and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

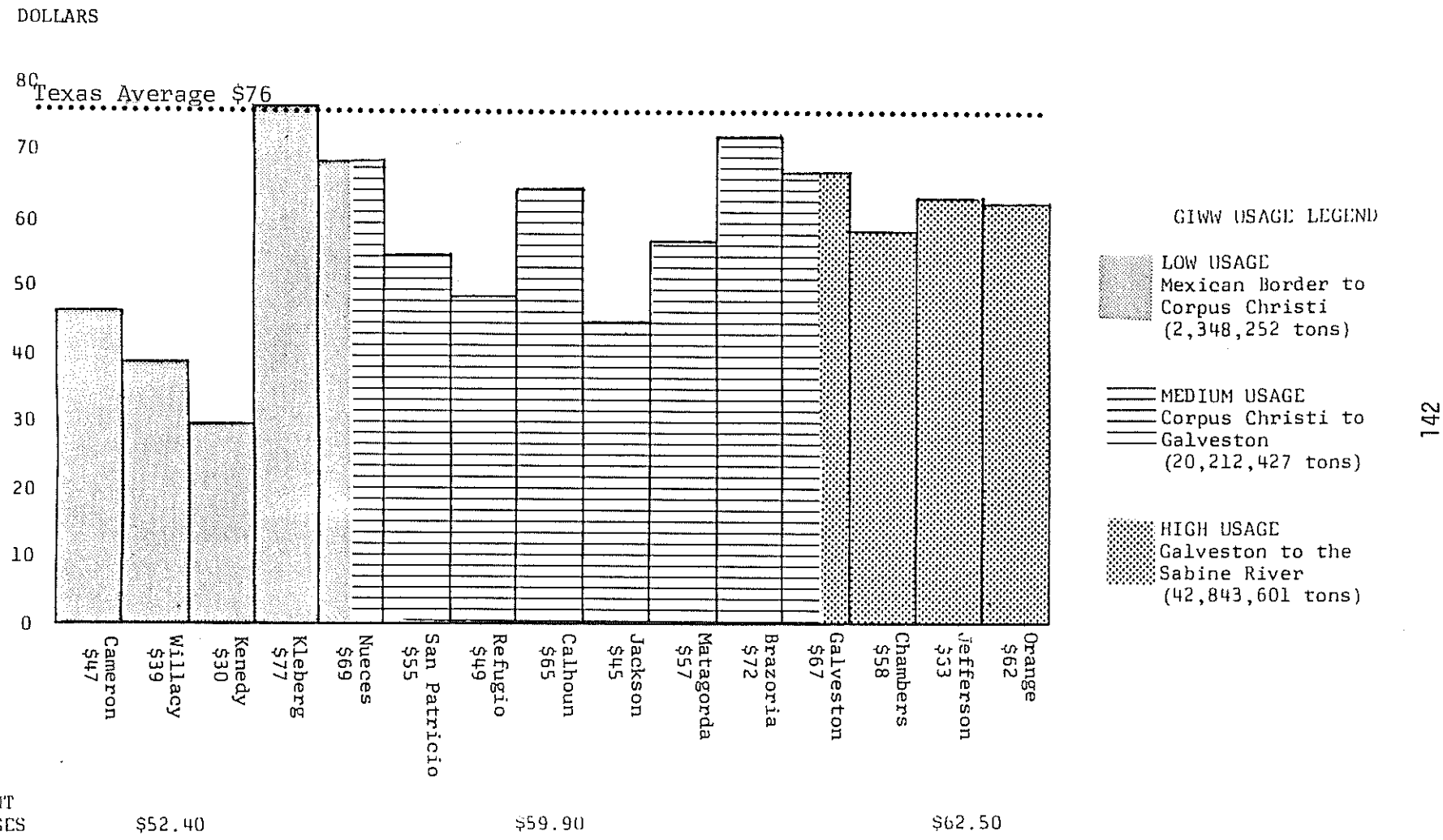


Figure - 5

MEDIAN CONTRACT RENT FOR COUNTIES 1970

SOURCE: Table 29, "Selected Characteristics for Counties: 1970" of General Housing Characteristics: Texas, HC(1) - A45 Texas and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

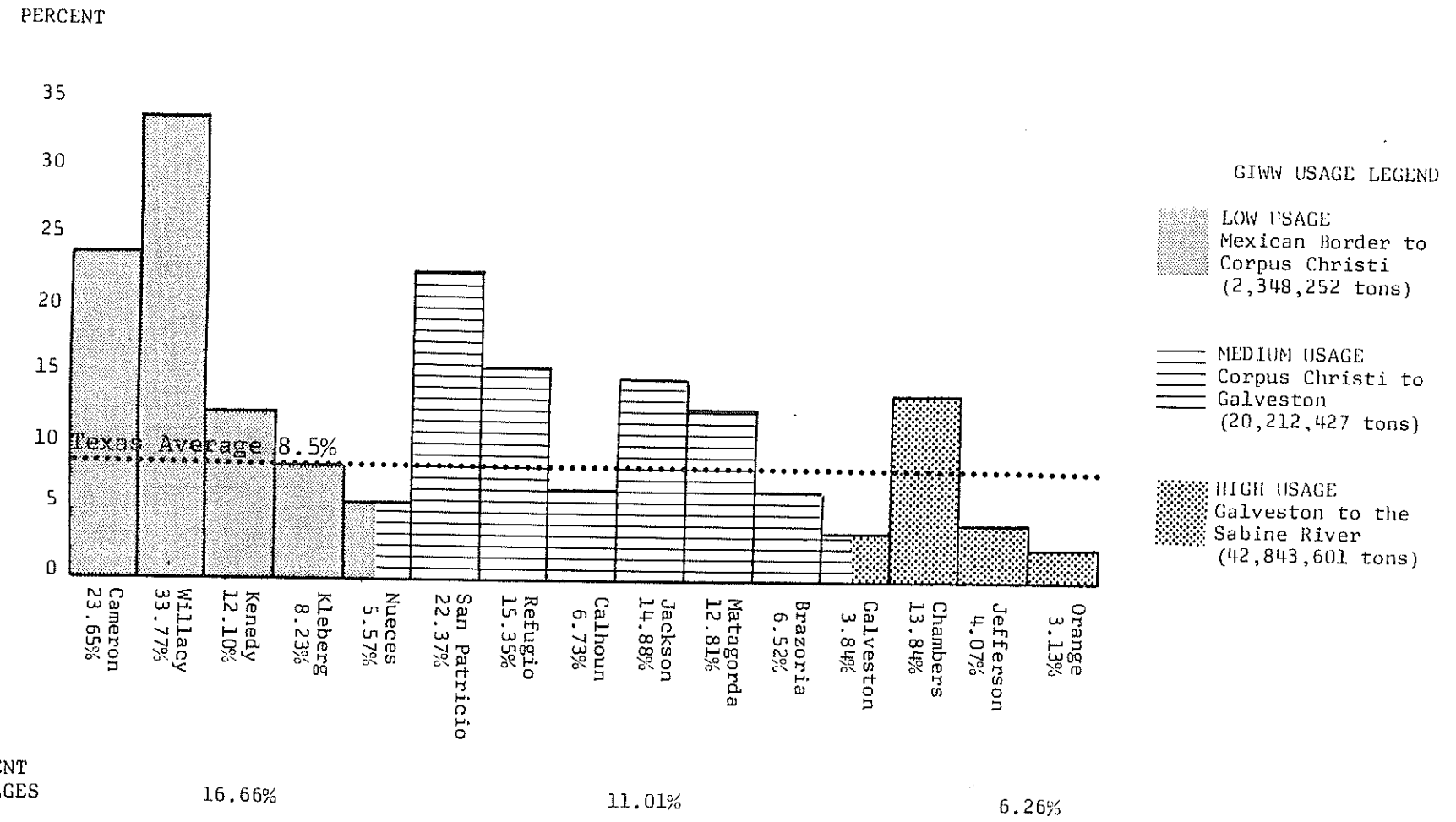


Figure - 6

PERCENT OF YEAR ROUND HOUSES LACKING SOME OR ALL PLUMBING FACILITIES BY COUNTY IN 1970

SOURCE: "Selected Characteristics for Counties: 1970" of General Housing Characteristics: Texas, HC (1) - A45 Texas. Industrial Economics Research Division, Texas A&M University, College Station, Texas.

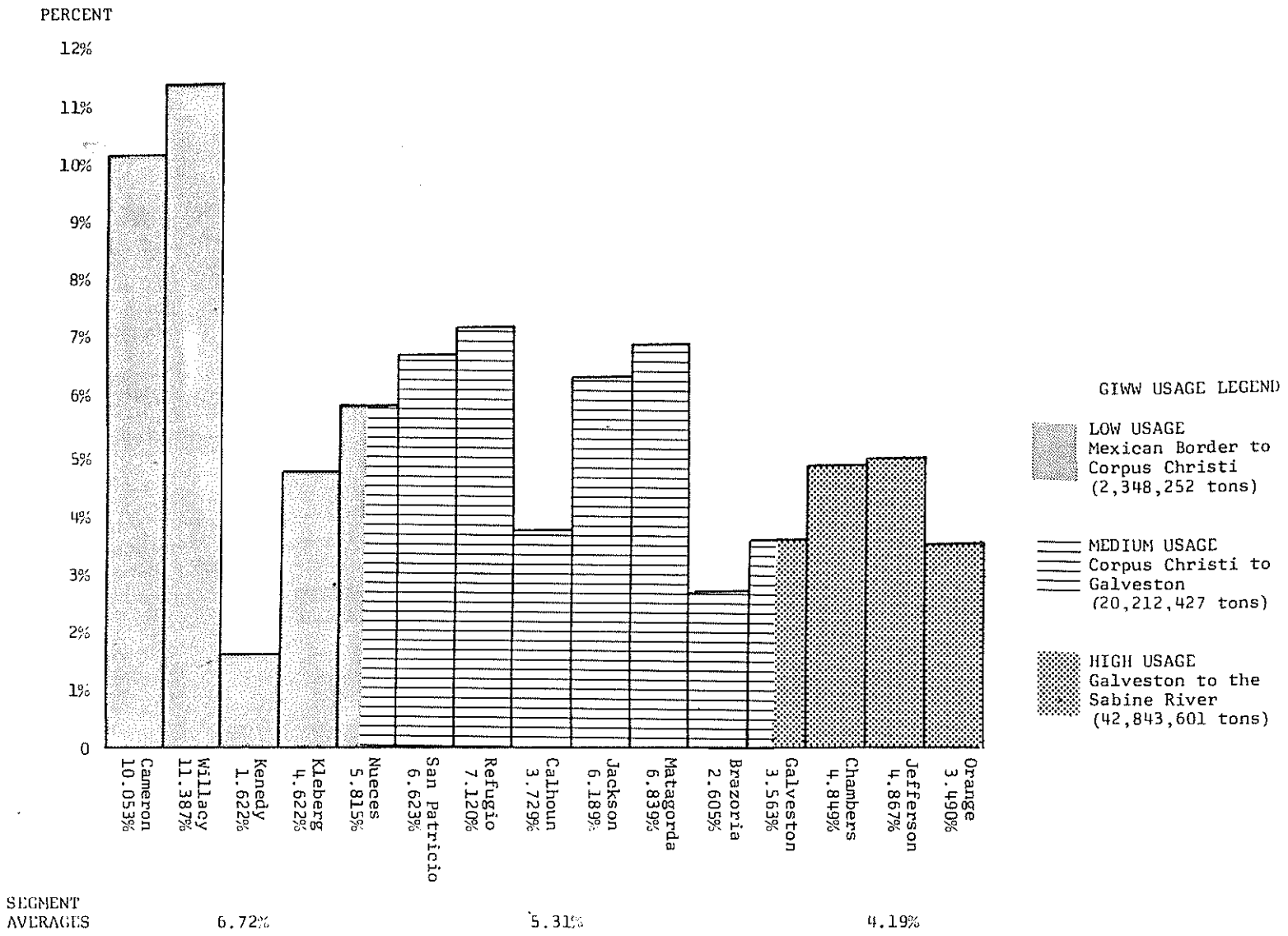


Figure - 7

PERCENT OF POPULATION RECEIVING MONTHLY WELFARE BY COUNTIES 1970

SOURCE: Selected Demographic and Health Characteristics 71-GR-001, prepared by the Texas Health Data Institute, Statistical Abstract of the United States by the U. S. Department of Commerce and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

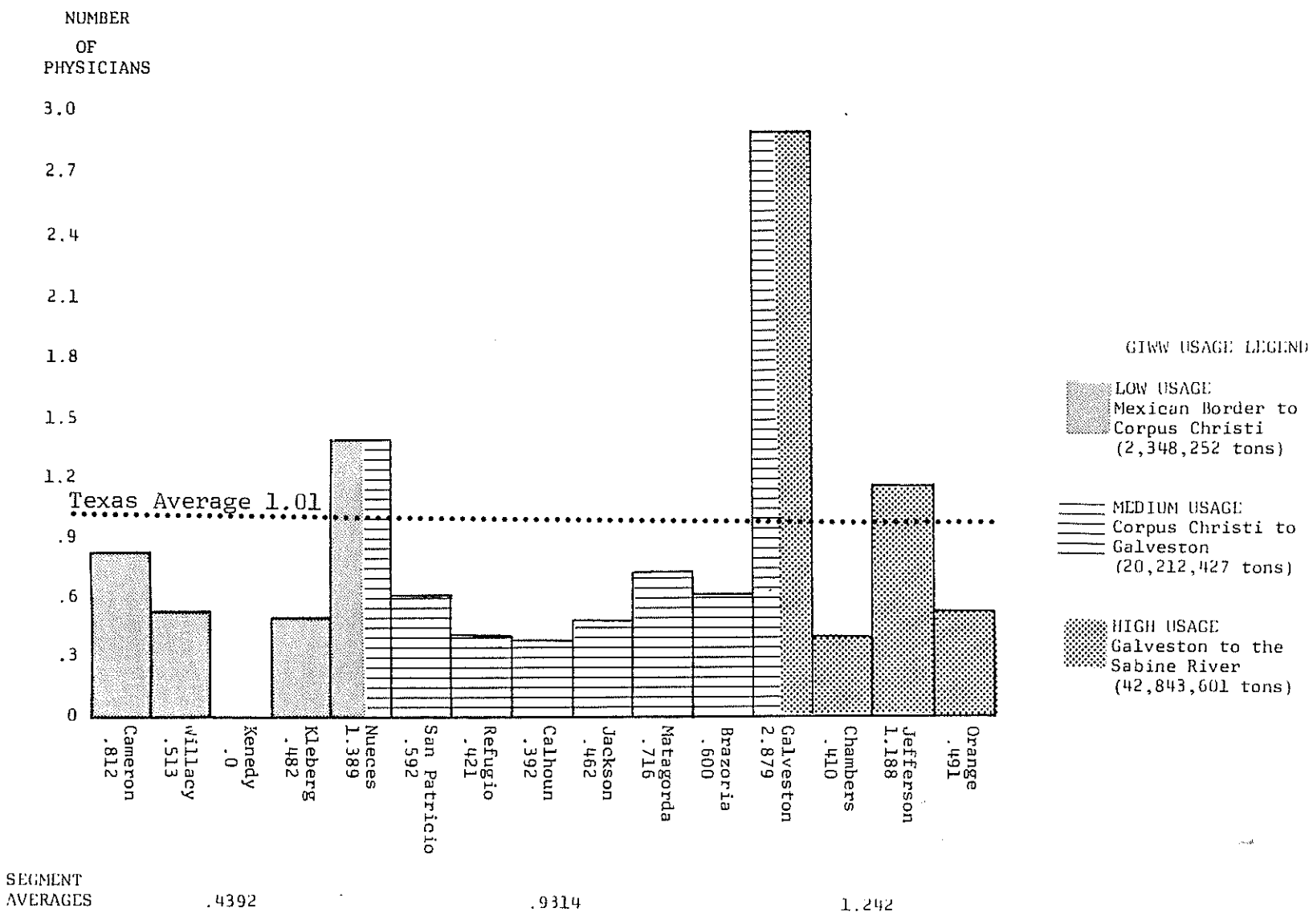


Figure - 8

PHYSICIANS PER 1,000 POPULATION BY COUNTIES 1970

SOURCE: Selected Demographic and Health Characteristics 71-GR-001, prepared by the Texas Health Institute, and Statistical Abstract of the United States by the U. S. Department of Commerce and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

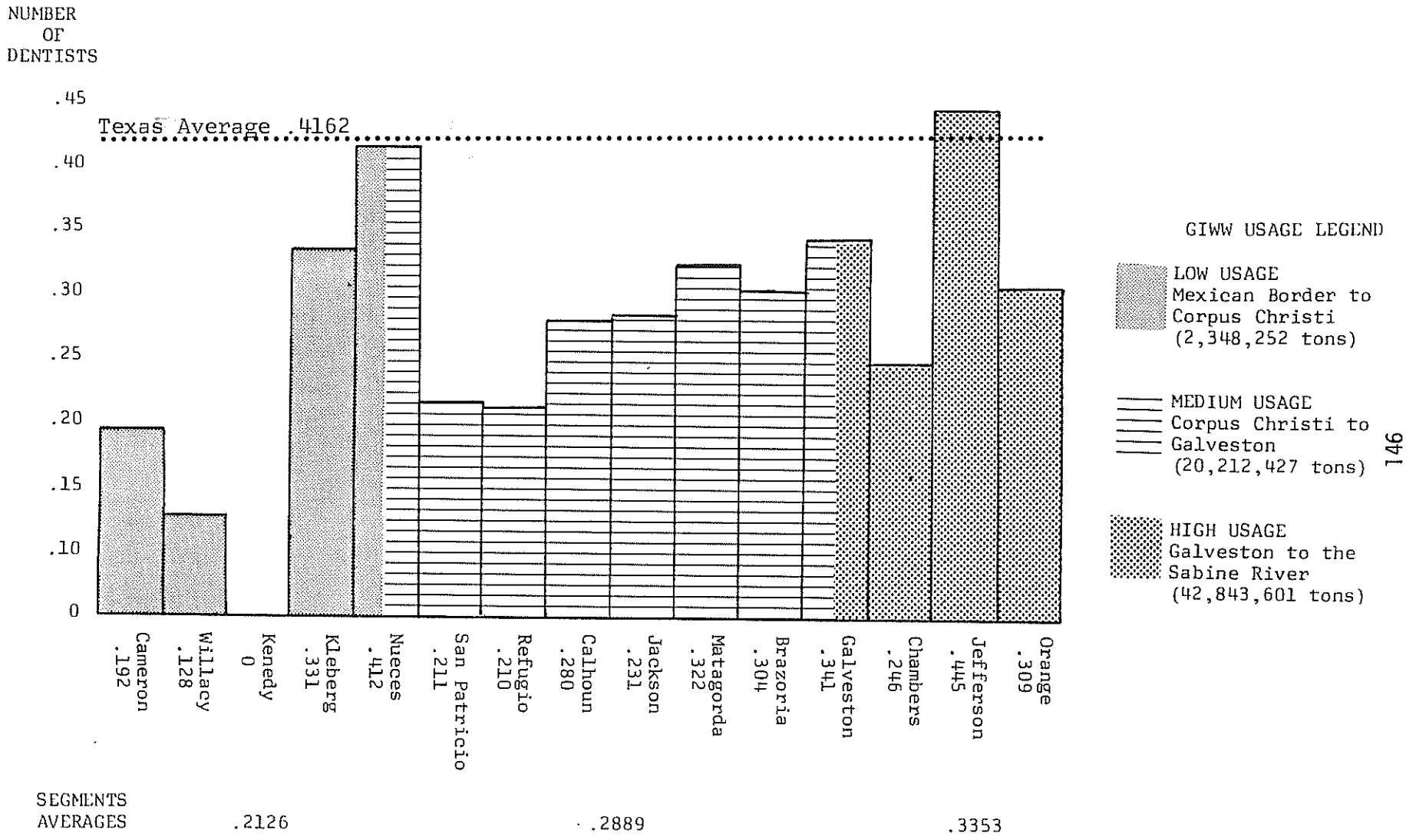


Figure - 9

DENTISTS PER 1,000 POPULATION BY COUNTIES FOR 1970

SOURCE: Selected Demographic and Health Characteristics 71-GR-001, prepared by the Texas Health Data Institute, Statistical Abstract of the United States by the U. S. Department of Commerce and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

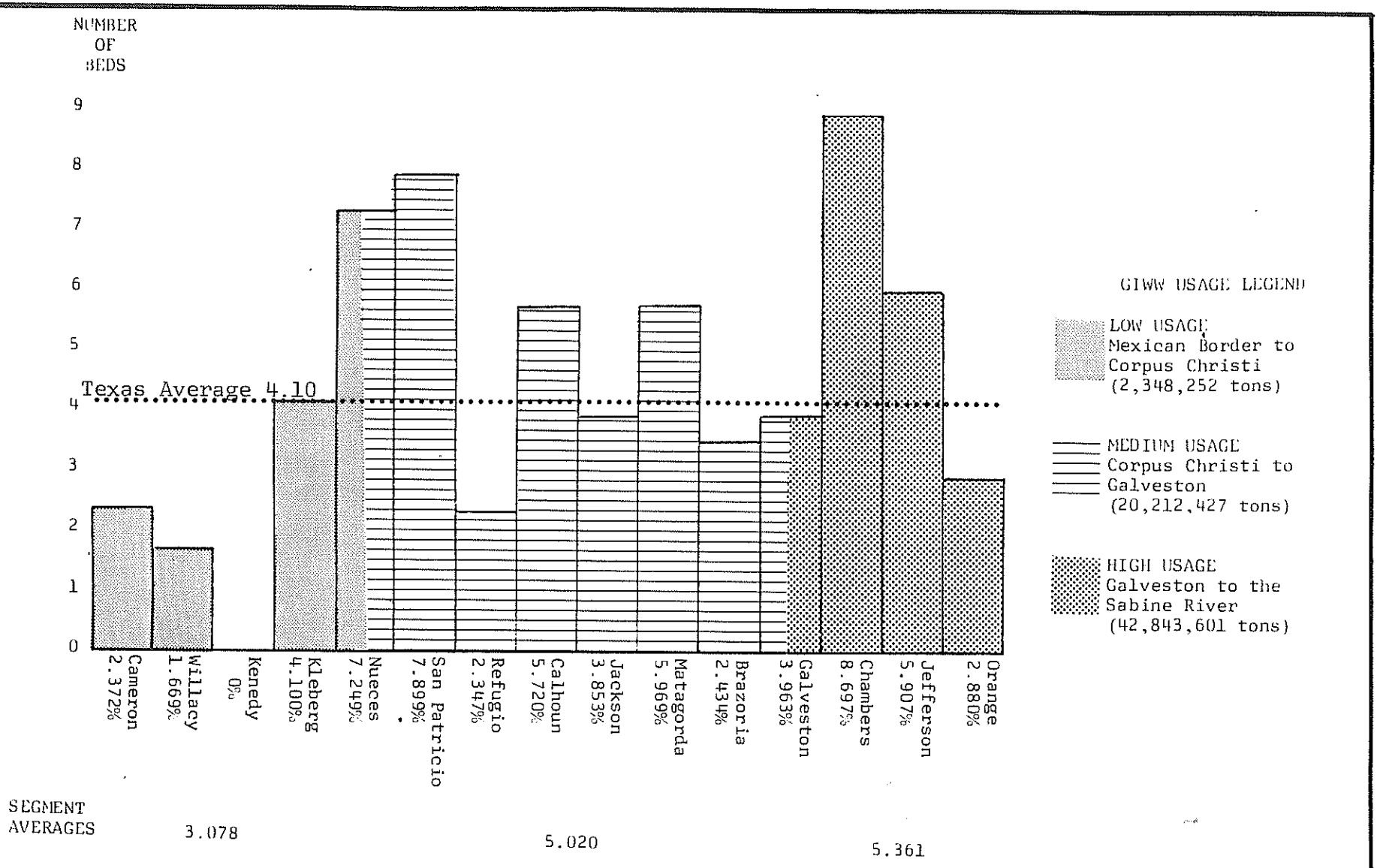


Figure - 10

HOSPITAL BEDS PER 1,000 POPULATION BY COUNTIES 1970

SOURCE: Selected Demographic and Health Characteristics 71-GR-001, prepared by the Texas Health Data Institute, Statistical Abstract of the United States by the U. S. Department of Commerce and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

10.49, and the high use portion was 11.23. In Texas the median years of education was 11.6.

Summary

Table 3 is a composite summary of the eleven socio-economic indicators presented in Figures 1 through 11. It can be clearly seen that the socio economic conditions are better where the GIWW is utilized to a greater degree.[9]

Part of the socio economic well-being of the counties where the GIWW is utilized to a greater degree would appear to be the competitive advantage of shipping by barge. This may be seen in Tables 4 and 5. Table 4 pictures the fuel advantage, while Table 5 illustrates the price advantage.[10]

---

[9] It should be noted that these socio economic indicators are not presented as proof that the greater utilization of the GIWW leads to higher levels of socio economic well-being of residents in the proximity of the GIWW, but merely to indicate that such a relationship does exist. Other possible explanations for the decreasing socio-economic well-being of residents the further South they are located on the Texas Gulf Coast may be distance from Houston or the increasing percent of the population with Spanish ancestry.

[10] The impact of waterway transportation on a county's economy may also be seen in Victoria County where the Victoria Barge Canal was opened in 1965. In 1970 the county had a total income of $58,954,528. Of this amount $5,437,351, or almost 10 percent, could be attributed to the Victoria Barge Canal. This figure was arrived at by using the methodology which appeared in the "American Association of Port Authorities" for February of 1970 to estimate the value of various commodities for the economy of an area.

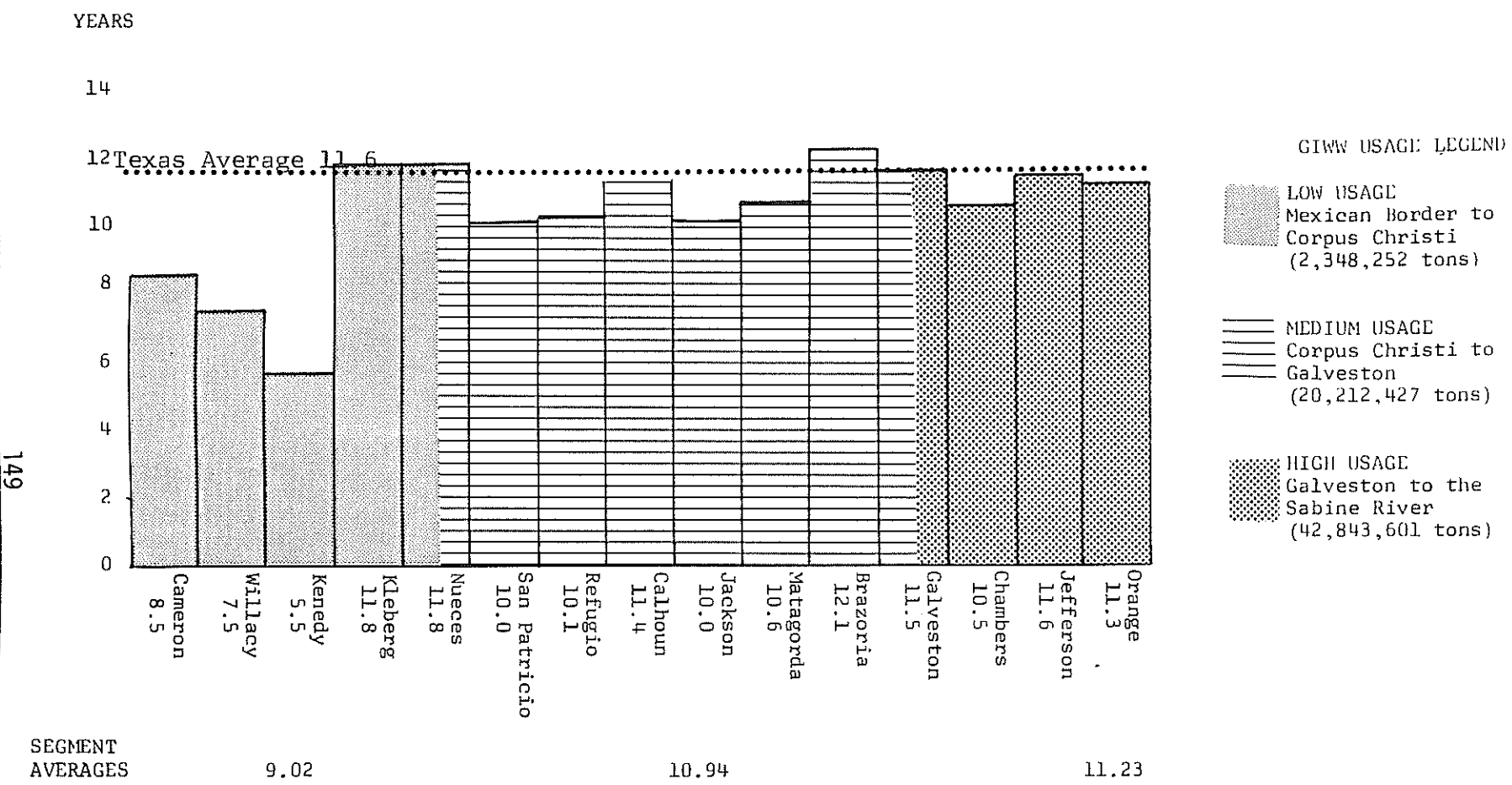


Figure - 11

MEDIAN YEARS OF EDUCATION BY COUNTY FOR 1970

SOURCE: Table 43 of Social and Economic Characteristics of Texas and Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 3

1970 SUMMARY OF SOCIO-ECONOMIC INDICATORS

INDICATORS	GIWW USAGE AREAS LOW	MEDIUM	HIGH
Median Family Income (Texas $8,490)	$5,789	$8,184	$9,069
Percent of Population With Incomes Below Poverty Level (Texas 14.6%)	30.78%	17.51%	12.82%
Percent of Families With Incomes of $15,000 or More (Texas 16.5%)	11.0%	13.5%	15.4%
Median Value of Owner Occupied Homes (Texas $12,000)	$8,020	$10,688	$11,175
Median Contract Rent (Texas $76)	$52.40	$59.90	$62.50
Percent of Year Round Houses Lacking Some or All Plumbing Facilities (Texas 8.5%)	16.66%	11.01%	6.26%
Percent of Population Receiving Monthly Welfare	6.72%	5.31%	4.19%
Physicians Per 1,000 Population (Texas 1.01)	.4392	.9314	1.242
Dentists Per 1,000 Population (Texas .4162)	.2126	.2889	.3353
Hospital Beds Per 1,000 Population (Texas 4.10)	3.078	5.020	5.3618
Median Years of Education (Texas 11.6)	9.02	10.94	11.23

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

TABLE 4

FUEL PER TON MILE OF CARGO

MODE	GALLONS*	B.T.U.**
Barge	3.15	500
Rail	4.21	750
Pipeline	N.A.	1,850
Truck	8.33	2,400
Air	N.A.	6,300

* Per 1,000 ton-miles
** B.T.U.--British Thermal Units
N.A.-- Not available.
SOURCE: Dr. William Mooz, Rand Corporation, Washington, D.C.; and Braxton B. Carr, American Waterways Operators, Inc., Washington, D.C.

TABLE 5

MOVEMENT OF A TON OF CARGO PER ONE DOLLAR BY MODES

MODES	DISTANCE (Miles)
Barge	333.3
Rail	66.6
Truck	15.4
Air	5.0

SOURCE: American Waterways Operators, Inc., Washington, D.C.

BIBLIOGRAPHY

Bureau of the Census, 1967 Census of Transportation, Area Series - Texas, (Washington, D.C.: U.S. Department of Commerce, 1970).

General Housing Characteristics - Texas, 1970 Census of Housing, HC (1) - A45 Texas.

General Social and Economic Characteristics of Texas, 1970 Census of Population, PC (1) - C45 Texas.

Miloy, John and Christian Phillips, Primary Economic Impact of the Gulf Intracoastal Waterway on Texas, (Texas A&M University: Sea Grant Publication, 1974).

Selected Demographic and Health Characteristics, (Austin, Texas: Texas Health Institute, 1972).

United States Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 2, (Washington, D.C.: Department of the Army, 1970).

Economic Impact

ECONOMIC IMPACT OF THE GULF INTRACOASTAL WATERWAY IN TEXAS

CHRISTIAN PHILLIPS
Industrial Economics Research Division
Texas Engineering Experiment Station
Texas A&M University

INTRODUCTION

Commodity flows on America's inland waterways have risen at tremendous rates over the last decade. Preliminary estimates by the U.S. Corps of Engineers revealed that more freight was moved on the waterways than in any previous year. More than 1.7 billion tons, equivalent to a 7.4 percent increase over total 1972 tonnages, was moved by water, 600 million of which traveled on the inland waterway system. While unemployment was rising and production in many plants was reduced, 301 new plants and plant enlargements appeared along the waterways for a total investment of $5.5 billion.

To further illustrate industry's need for water transportation, consider the fact that since 1950 nearly 9,000 waterside plants have been constructed.

Texas inland waterways are similarly affected. During the fourth quarter of 1973 the following construction and expansions either occurred or are in active planning stages along the Texas waterways according to the American Waterways Operators, Inc.

> "Brazos River--At Chocolate Bayou, Tex., General Crude Oil Co. and Monsanto Co. are negotiating construction of a joint venture refinery on General Crude's properties at the above site.
>
> Galveston Bay--At Galveston, Tex., Todd Shipyards plans to enlarge its Galveston shipyard by dredging an area approximately 1,250 feet along the Galveston Ship Channel and 1,000 feet back from the channel's existing bank.
>
> Gulf Intracoastal Waterway--Standard Oil Refinery has begun a $1 million expansion to enable the facility to process foreign-high-sulfur crude oils . . . At Texas City, Tex., GAF Corporation plans a $2 million expansion program to boost its production of butanediol . . . Union Carbide Corporation plans to construct a multi-million dollar vinyl acetate plant at its chemical complex . . . At Freeport, Tex., Robintech, Inc. and Shin-Etsu Chemical Co. of Japan, in a joint venture, will construct a polyvinyl chloride resin plant . . . At Beaumont, Tex., Goodyear Tire & Rubber Co. is expanding the production capacity of a resin at a cost of $1.5 million.
>
> Houston Ship Channel--At Houston, Tex., Newell Salvage Co. is moving into a new plant which will house a scrap metal processing operation at a cost of $2 million . . . Arco Chemical Co. plans to construct a $200 million petrochemical plant . . . Chronister Valve Co. has moved to a new plant and office building costing about $1 million . . . Atlantic Richfield Co. plans to expand the capacity at its Houston refinery 95,000 barrels a day, to a total of 300,000 barrels daily. Cost of the program will be $150 million . . . Power & Propulsion Systems, Inc., a supplier of

power systems for offshore tug and supply vessels, has leased a building to be used for a manufacturing operation facility . . . At Bayport, Tex., Hercules, Inc. plans to build a new plant for production of polypropylene . . . Armak Co. is building a peroxydicarbonate plant. Mid-1974 is scheduled for completion date for the multi-million dollar hydrodesulfurization catalyst plant . . . Blemer Chemical Corporation, the first joint venture between two major Japanese companies in the U.S. , Marubeni America Corp. and Nippoin Oils & Fats Co., Ltd., will dedicate a new plant."

To this list, the Southern Industrial Development Council adds the following projects.

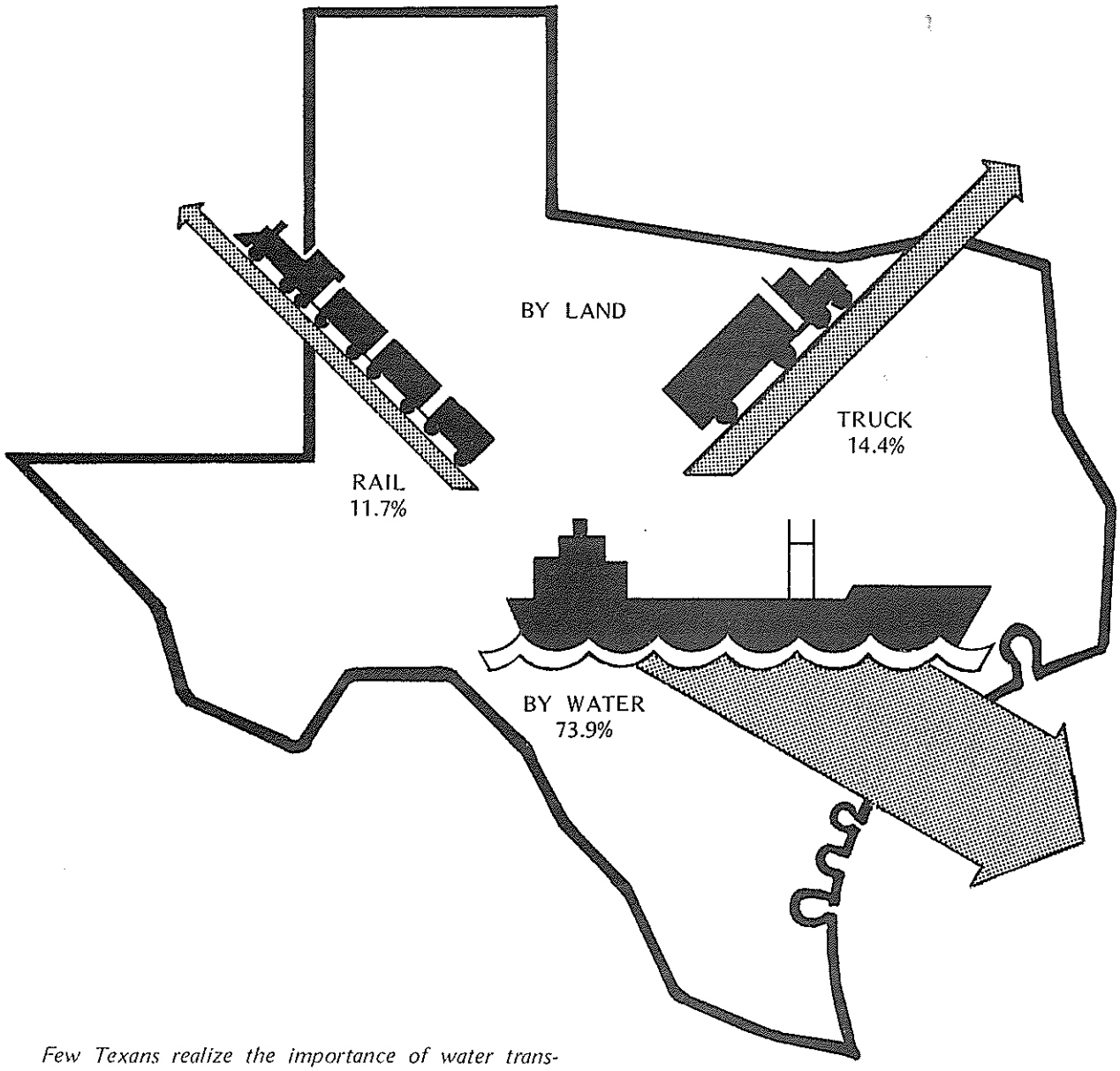
"General Crude Oil Co. and Monsanto Co. will construct jointly a $150 million refinery in the Chocolate Bayou area of Brazoria County . . . Atlantic Richfield Co.'s Houston refinery will undergo a $150 million expansion . . . Texaco is adding major desulfurization units, including sulfur recovery, to its Port Arthur refinery as part of a $240 million expansion program involving four U.S. facilities . . . Xerox has bought a 495-acre tract at Lewisville for $4.8 million and will build a plant that may employ up to 4,000 persons in manufacturing computer-related products . . . At Channelview, ARCO Chemical Co., an Atlantic Richfield subsidiary, is constructing a $200 million petrochemical plant . . . Monsanto Polymers & Petrochemicals Co. will erect the largest acrylonitrile plant in the world at Texas City . . . Nearly $100 million will be spent by Mobay Chemical Company to construct five additional plants at its 550-acre Baytown site, almost tripling present capacity there . . . At Wichita Falls, Certainteed Products Corporation is building a $55 million textile-grade fiber glass plant that will provide 800 to 1,000 jobs . . . A $40 million, 1,000-man mill to produce steel wire rods will be built across the Neches River from Beaumont by Georgetown Texas Steel Corporation . . ."

The economic stimulus from such vast expenditures on the regional economy are significant not only for industrial purposes but they provide increased employment, income, and greater quantities of output to meet the ever-growing consumer demands. Figure 1 delineates the modal distribution of goods shipped from Texas.

HISTORICAL TRENDS

An historic overview reveals the marine environment to have a strategic economic role in the world which is confirmed by the following facts:

1. All major industrial nations have extensive coastlines,
2. An estimated two-thirds of the gross world product is produced in coastal zones,
3. More than 80 percent of the world metropolitan areas are coastal areas,
4. Of the 25 largest United States cities, 18 are coastal cities,
5. More than 75 percent of the total population of the United



Few Texans realize the importance of water transportation to the Coastal Zone and to Texas. Over 120 million tons of goods are shipped by water from Texas ports each year. This represents almost 75% of all goods shipped from the State as a whole.

Modal Distribution of Goods Shipped from the Texas Coastal Zone

FIGURE 1

States resides in coastal or Great Lakes states,
6. More than 45 percent of the nation's urban population resides in coastal counties, and,
7. All of the major megalopoli now projected for the year 2000 are located in coastal zones.[1]

Discovery of oil and natural gas along the state's coastal region and the subsequent development of port and harbor facilities along the eastern half of the Texas coast provided the primary thrust for industrial growth and population expansion. Increased population, greater industrial diversification, and specialized industrial growth stemming from oil and gas contributed to the transformation of coastal regions from a rural to an urban industrial complex.

The Texas Gulf Coast currently has the world's largest petrochemical capacity and contains the most important sources of natural gas in the United States with its more than one trillion cubic feet.

The Texas marine environment has experienced a development pattern similar to the other regions of the world. Economic growth in Texas has a direct correlation with accessability to the Gulf of Mexico and to the rich mineral resources found along the Gulf Coast.

The extent of this urbanization process can be readily observed from the fact that 50 percent of Texas residents live within a 100-mile radius of the coastline and thus reflects the general trend of population concentration in all the coastal areas. Population predictions for the year 2000 indicate the movement to coastal areas to continue.

PHYSICAL CHARACTERISTICS

The Gulf Intracoastal Waterway is a complex network extending for approximately 1,100 miles from Apalachee Bay, Florida to Brownsville, Texas. The controlling dimensions of the main channel are 12 feet deep by 125 feet wide, with the exception of those areas where locks are located. The Texas portion of the Waterway is 426 miles long and extends from the Sabine River to Brownsville.[2] Waterborne commerce entering or leaving Texas is to a great extent restricted by locks located on the Texas-Louisiana Border.

---

[1] Marine Science Affairs--Selecting Priority Programs, Annual Report of the President to the Congress on Marine Resources and Engineering Development, Washington, D.C.: Government Printing Office, April, 1970, p. 31.

[2] U.S. Department of the Army, Corps of Engineers, The Intracoastal Waterway: Gulf Section, Washington, D.C.: Government Printing Office, 1961.

INDUSTRIAL USERS

In general, water transportation is especially attractive to producers of low cost bulk goods, as transportation costs may be a major factor in the cost of their products. Therefore, it is not surprising that the major Waterway users in Texas are the petroleum and petroleum refining industries as shown in Figure 2. These two activities account for approximately 60 percent of all waterborne commerce in Texas. Other industries which are major users are the chemical and non-metallic minerals industries, accounting for 17.4 and 16.7 percent of all waterborne commerce in Texas, respectively. The importance of these four industries to Texas' economy is indicated by the fact that in the coastal counties alone, they pay over 700 million dollars in wages, and ship goods valued at over $9.2 billion each year.[3]

COMMODITY FLOWS

In terms of commerce, the Gulf Intracoastal Waterway of Texas has experienced steady growth in recent years. The 67 million tons carried by the Texas portion of the Waterway in 1971 represent nearly a 90 percent increase over 1961, when approximately 36 million tons were moved.[4]

Commodity flow on the Texas Intracoastal Waterway may be broken down into foreign commerce, intrastate, and interstate flows.

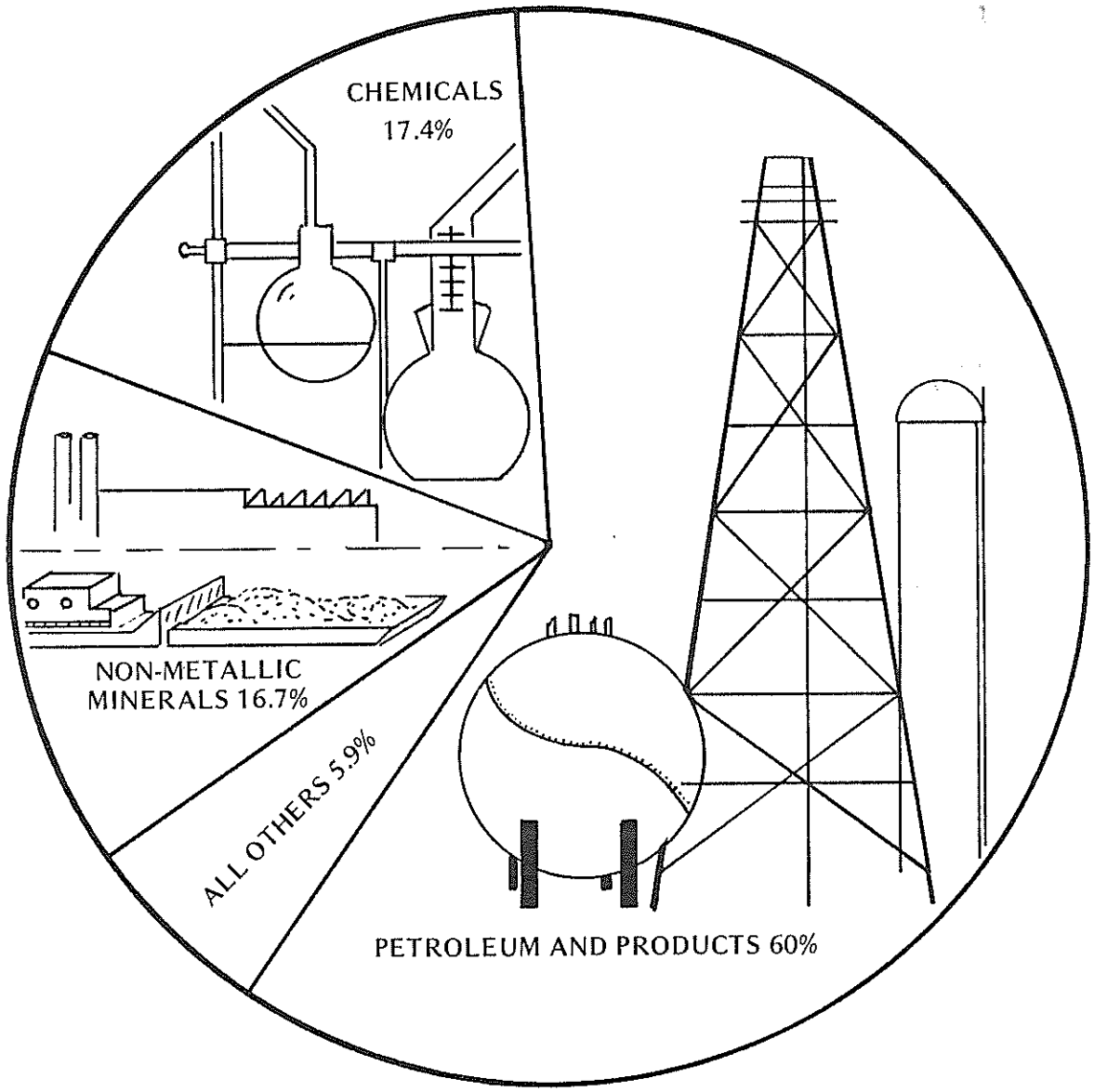
Texas is unique in that annually, more goods are exported than imported. This in direct contrast to the United States as a whole, which faces an ever increasing gap between the quantities of goods exported and the amount imported according to Figure 3. In Texas, imports are gradually catching up with exports, primarily because of an increased inflow of foreign petroleum and natural gas. Table 1 shows major types of products which Texas imports and exports. Our major exports consist of farm products, which amounted to approximately 55.3 percent of all exports in 1971, and chemicals, which accounted for 18.4 percent. Over 25 million tons were exported from Texas in 1971. Approximately 42 percent of all Texas imports were non-fuel minerals such as bauxite and iron ore. Crude etroleum accounted for 26.2 percent, and primary metal imports were 10.1 percent of the total. Total imports were nearly 18 million tons in 1971.[5] The ports of Brownsville, Galveston and Houston handle the majority of Texas' foreign commerce.

---

[3] Miloy, John and Christian Phillips. Primary Economic Impact of the Gulf Intracoastal Waterway in Texas. Sea Grant Program, TAMU-SG-74-211, Texas A&M University. College Station, Texas. March, 1974.

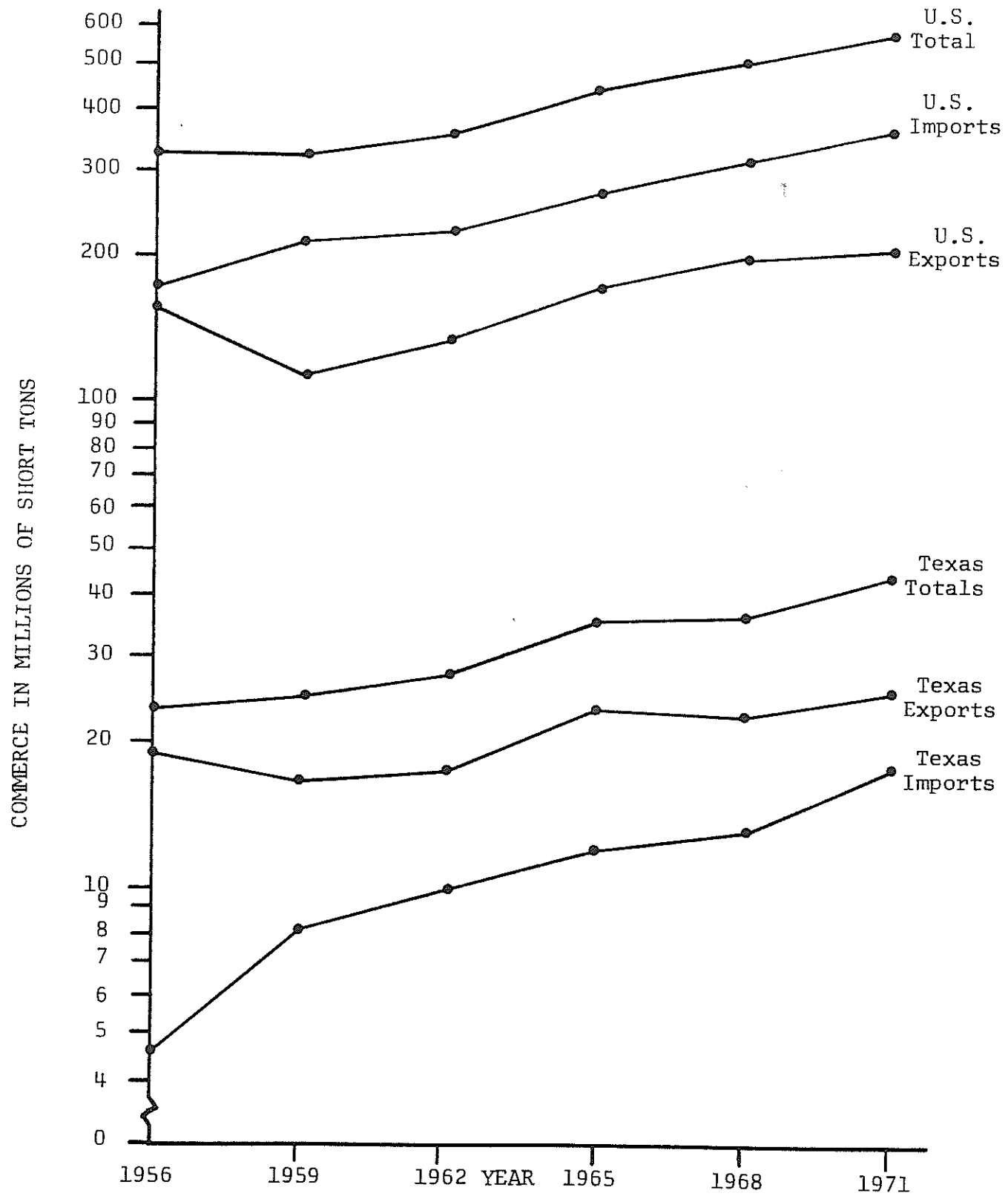
[4] Ibid.

[5] Ibid.



Major Waterway Users

FIGURE 2



SOURCE: U.S. Army Corps of Engineers, Waterborne Commerce of the United States

GROWTH OF UNITED STATES AND TEXAS FOREIGN COMMERCE

FIGURE 3

TABLE 1

MAJOR IMPORTS AND EXPORTS OF PRODUCTS
(1971)

COMMODITY TYPE	PERCENT
EXPORTS	
FARM PRODUCTS	55.3
CHEMICALS	18.4
IMPORTS	
NON-FUEL MINERALS	42.0
CRUDE PETROLEUM	26.2
PRIMARY METALS	10.1

SOURCE: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

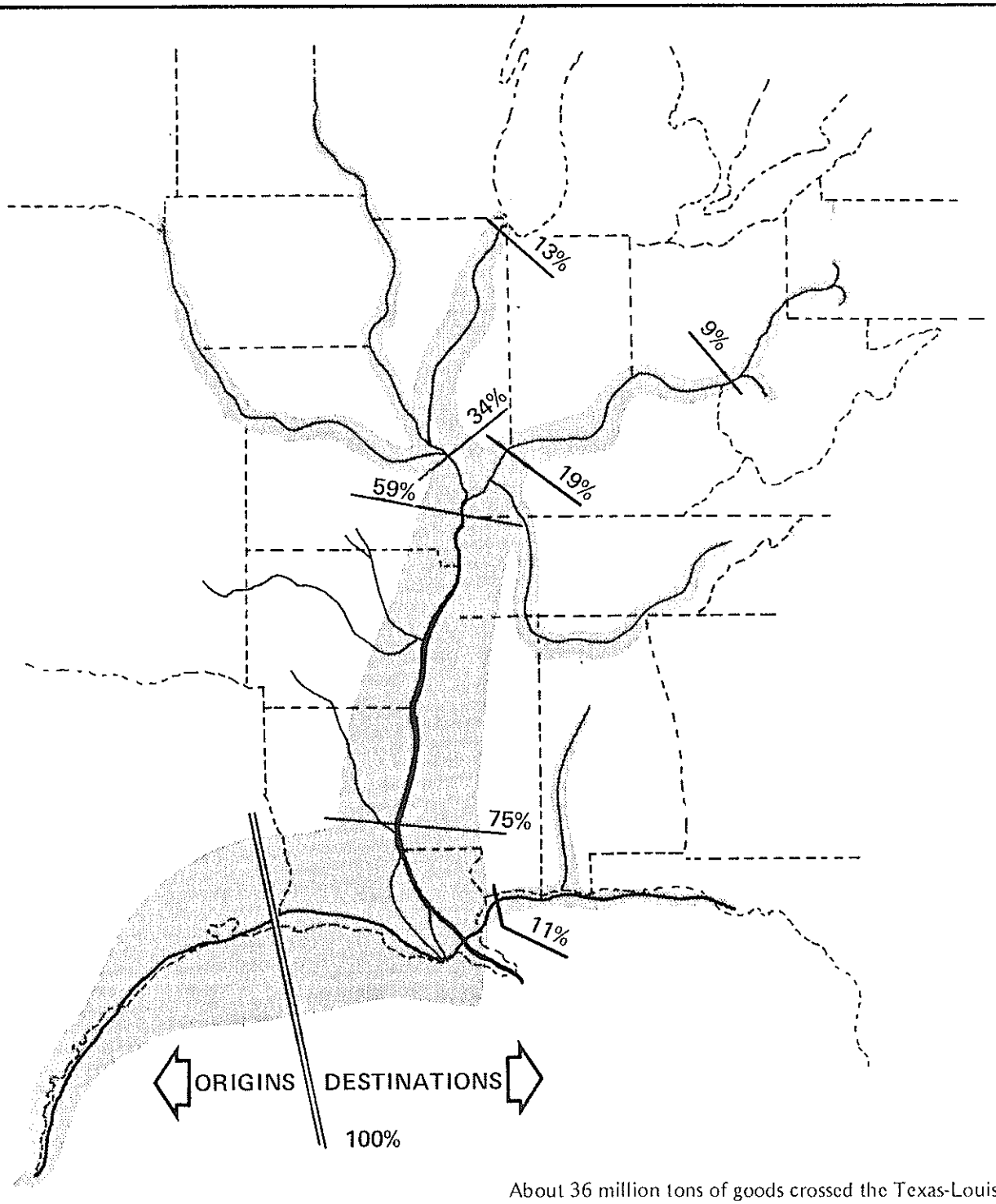
INTRASTATE AND INTERSTATE FLOWS

By analyzing intra-and interstate commodity flows, some concept of the Waterway's importance to Texas industry may be gained. A major handicap in discussing these flows is that the Corps of Engineers keeps track of only five major commodity groupings: Farm Products; Coal, Logs and Lumber; Petroleum and Related Products; Iron and Steel; and Chemicals and Related Products.

Interstate Flows

Of the five commodity groups mentioned, Petroleum and Related Products and Chemicals are by far the most important, comprising approximately 95 percent of interstate shipments and receipts, which totaled over 34 million tons in 1970. The remaining five percent is primarily composed of iron and steel shipments and receipts. About one-half of all interstate commerce on the Waterway involves the Galveston Bay region. Nearly 89 percent of Texas' interstate commerce on the Waterway arises from points north of Galveston County. Louisiana accounts for 53 percent of all Texas interstate receipts, while shipments from Texas are sent to a multitude of areas via the Mississippi River System.[6] Figure 4 gives the distributional movement, by percent, of Texas goods on the inland waterways.

[6] Ibid.



About 36 million tons of goods crossed the Texas-Louisiana border on the inland waterway in 1970. Shipments from Texas went to such far-flung markets as Pittsburgh, Chicago, and Minneapolis. All of this traffic must pass through several locks between the Mississippi River and Texas which cause severe delays.

Movement of Texas Goods on Inland Waterways

FIGURE 4

Intrastate Flows

Of the five commodity groups on which information is available, chemicals and petroleum and petroleum products are also the most important commodities moving in intrastate commerce, and account for nearly 99 percent of intrastate commerce involving these groups. As was the case with interstate commerce, the Galveston Bay area is the most active with respect to intrastate commerce.

ECONOMIC IMPACT

The Waterway's direct economic contribution to the state can be calculated from:

1. Value of cargo to ports;
2. Expenditures on the Waterway;
3. Economic impact of water transportation and water transportation industries.
4. Reduced transportation cost from waterway utilization versus railroad usage.

Value of Cargo to Ports

Each ton of cargo arriving in a port generates a certain amount of dollar expenditures in that jobs and businesses are needed to handle and store the cargo and to perform other miscellaneous services related to port activities. As Table 2 shows, general cargo is by far the most important in that each ton received generates approximately $19 in expenditures. Based on Texas ports receipts in 1970 and assuming that 40 percent of their receipts are due to the Gulf Intracoastal Waterway, the economic impact of cargo value would total approximately 888 million dollars.

Maintenance and Expenditures

Maintenance and new work expenditures in the Intracoastal Waterway and its major tributaries were 10.5 and 6.3 million dollars respectively in 1970. The total economic impact of these expenditures in Table 3 comes to 18.9 million dollars for new work, and 33.5 million dollars for maintenance and repair.[7]

Water Transportation and Related Industries

These industries include firms engaged in carriage of goods, loading and unloading of vessels and many other activities pertaining to water transportation. As Table 4 shows, the total economic impact of these industries amounts to 876.7 million dollars when the appropriate regional multipliers are applied to payrolls and revenue figures. (See Appendix)

---

[7] United States Department of the Army, Corps of Engineers. Annual Report. Washington, D.C.: U.S. Government Printing Office.

TABLE 2

VALUE OF ONE TON OF CARGO TO A PORT'S ECONOMY
(In Dollars)

CARGO	1966	1968	1970
General Cargo	17.71	18.46	19.21
Tanker Cargo (crude and refined)	4.20	4.38	4.57
Coal	2.89	3.02	3.14
Grain	6.79	7.06	7.35
Ore	3.36	3.51	3.65
All Other	1.29	1.34	1.40

SOURCE: American Association of Port Authorities, February, 1970.

If the economic impacts of the three facets previously described are combined, we can see from Table 5 that the Waterway's total direct economic contribution for Texas amounts to over 1.8 billion dollars annually.

Comparative Transportation Costs

The closest substitute mode of transporting low-cost high-volume bulk commodities presently classified as waterborne commerce is via the railroads and pipelines.

Since the predominant share of waterborne barge commodity volume consists of liquid products, movement by pipeline would be the most efficient and economical transportation method should a sufficiently large pipeline complex to satisfactorily serve that purpose exist. Realistically, the costs for expansion of such a network would be prohibitive to the point where added construction expenses would be reflected in higher transportation cost and therefore higher consumer prices. Similarly, the current waterway commodity flow can not be handled by railroads without substantial and extremely costly improvements to the railway system, not to mention the added costs of revamping or even replacing existing port facilities to include cargo processing systems, equipment, and procedures.

TABLE 3

ECONOMIC IMPACT OF MAINTENANCE AND NEW WORK
(1970)

SECTOR	EXPENDITURE ($ MILLION)	MULTIPLIER	ECONOMIC VALUE ($ MILLION)
MAINTENANCE	10.5	3.18	33.5
NEW WORK	6.3	3.00	18.9

SOURCE: Miloy, John and Christian Phillips. Primary Economic Impact of the Gulf Intracoastal Waterway in Texas, Industrial Economics Research Division, Texas Engineering Experiment Station, Texas A&M University. Sea Grant Program Publication TAMU-SG-74-211. March, 1974.

TABLE 4

ECONOMIC IMPACT OF WATER TRANSPORTATION
AND RELATED INDUSTRIES
(1970)

PAYROLLS & REVENUES	DOLLAR VALUE ($ MILLION)	MULTIPLIER	ECONOMIC IMPACT ($ MILLION)
	WATER TRANSPORTATION INDUSTRY		
PAYROLLS	48.8	1.93	94.2
REVENUES	222.1	2.77	615.2
	WATER TRANSPORTATION SERVICES		
PAYROLLS	18.0	1.93	34.7
REVENUES	41.7	3.18	132.6
TOTAL ECONOMIC IMPACT			876.7

SOURCE: Miloy, John and Christian Phillips. Primary Economic Impact of the Gulf Intracoastal Waterway in Texas, Industrial Economics Research Division, Texas Engineering Experiment Station, Texas A&M University. Sea Grant Program Publication TAMU-SG-74-211. March, 1974.

TABLE 5

DIRECT ECONOMIC IMPACT
OF THE INTRACOASTAL WATERWAY
(1970)

ECONOMIC SECTOR	ECONOMIC VALUE ($ MILLION)
NEW WORK	18.9
MAINTENANCE	33.5
WATER TRANSPORTATION AND RELATED INDUSTRIES	876.7
CARGO VALUE	888.0
TOTAL ECONOMIC IMPACT	1,817.1

SOURCE: Miloy, John and Christian Phillips. Primary Economic Impact of the Gulf Intracoastal Waterway in Texas, Industrial Economics Research Division, Texas Engineering Experiment Station, Texas A&M University. Sea Grant Program Publication TAMU-SG-74-211. March, 1974.

Based on the route from Beaumont to Brownsville, the railroad distance measures 441 miles while the same route measures only 378 miles by barge.

In comparing rates between these two modes, cost information supplied by the Texas Railroad Commission and the Port of Houston pertained to Chemical and Petroleum product commodity classifications.

When the most recent surcharge due to increased fuel costs is included, the railroad average charge per ton over 441 miles is $22.25 opposed to $10.82 per ton over 378 miles for barge transportation.

Applied to a minimum railroad carload of 60,000 pounds, equivalent to 30 short tons, total cost comparisons reveal a transportation cost of $681.51 for railroads versus $342.55 by barge from Beaumont to Brownsville.

Omitting the obvious cost of expanding railroad and supporting service facilities, transportation expenditures would nearly double if all waterborne commerce were to be moved via railroads.

Another alternative would be to transport commodities through intracoastal shipping between ports creating a new set of problems associated with even greater costs. Again, handling procedures, equipment and processing methods would require revision while locations between ports would remain without water transportation services.

It clearly follows that industries currently located along a once highly efficient yet inexpensive transportation artery could no longer utilize the waterway for interfirm or interindustry resource movement. Firms will relocate sparking an adverse chain reaction beginning with diminishing output, reduced employment and income, less consumer spending resulting in a final reduction in regional and state GNP. Decreasing GNP and a reduced number of firms in turn point to a significant decline in the tax base which would place an even larger burden of supporting the state budget on the individual. As its output declines in the face of rising demands for consumer products due to increased population growth if not from increased personal income, individuals will be forced to compete for a limited quantity of goods causing consumers to pay higher prices.

THE REGIONAL EFFECT

Regional economics asserts that changes in any one geographical or functional area of the economy will impact neighboring areas as well. In the case of the GIWW which is linked to an intricate and far-reaching inland waterway network not only within Texas, but on a national scale, disuse of the GIWW will cause many of its tributaries to become inoperative while the commodity flow to and from other parts of the nation will be severely reduced.

Simply stated, without proper maintenance and improvement of this important transportation artery, Texas state production of approximately $88.8 billion will be significantly reduced.[8] When preliminary estimates of total primary and indirect economic effects of $19 billion attributable to the GIWW are considered, Texas may lose around 20 percent of its Gross State Product.

Finally, the possible indirect impact of a deepwater terminal on the Gulf Intracoastal Waterway must be considered. It is clear that larger imported volumes of crude oil will place an additional burden on the Gulf Intracoastal Waterway in addition to the growth of barge sizes and tug horsepower. As demonstrated in Figure 5, average barge sizes have increased from 400 to 600 tons in 1807 to over 2,000 tons today. Likewise, in 1807, tugs averaged under 1,000 horsepower, and today the average horsepower of tugs operating on our waterways is over 7,000 horsepower.

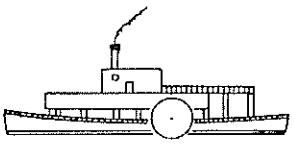
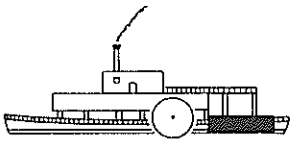
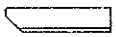
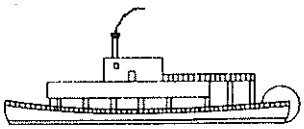
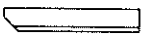
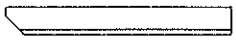
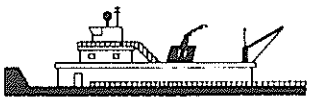
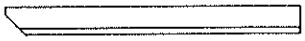
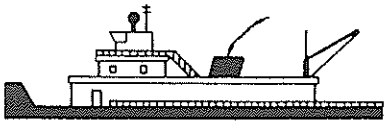
SUMMARY

As the barging industry employs available technology to take advantage of the economies of scale inherent in water transportation, and as barge and tug sizes increase, the volume of commerce on our waterway will also increase. These pressures force us to realize that we may be approaching the carrying capacity of the Waterway. Future industrial growth along the Waterway appears to be a certainty - growth that will further congest this valuable traffic artery.

Texans have a vital resource in the Gulf Intracoastal Waterway. Maintaining a high level of future benefits for each individual Texas consumer requires immediate attention and decisive action by the individual citizen, state legislator and industry.

---

[8] Office of Information Services, Governor's Office, Austin, Texas.

	CAPACITY (TONS)	POWER (HP)
1807 STEAMBOAT	 400 – 600	<1,000
1832 STEAMBOAT with BARGE (BOX)	 400 – 600	1,000
1910 STEEL BARGE (STREAM LINE RAKES)	 600 – 800	 1,400
1945 STANDARD HOPPER BARGE	 900	 1,800
1950 JUMBO HOPPER BARGE	 1400 – 1500	 3,200
TODAY BARGES	 >2000	 > 7,000

Trend in Barge and Tow Sizes

FIGURE 5

APPENDIX

THE MULTIPLIER EFFECT

The multipliers, as they are applied to water transportation expenditures in Table 4, are a product of the Texas Input-Output model prepared by the Office of the Governor. As the most prominent of the regional interdependence approaches, this model accounts for the underlying processes which bind together the separate facets of regional economies. It accounts for the respending cycle stimulated by initial expenditures or income from basic employment. Expenditures by one individual become income to another, who in turn spends part of his newly acquired income in the form of an expenditure. Any change in income will change consumer behavior and therefore, consumer spending. This change in spending will mean increased income, which will generate additional employment, to produce a multiplicative effect described as the multiplier effect.

BIBLIOGRAPHY

American Waterway Operators, Inc. 1971 Waterside Plant Locations and Expansions. Washington, D.C.: American Waterway Operators, Inc., 1972.

Chatfield, Mary. Inland Waterways Transportation. Cambridge: Harvard University, 1966.

Fulkerson, Frank B. Gulf Coast Export-Import of Mineral Commodities. Washington, D.C.: United States Department of the Interior, Bureau of Mines, Information Circular 8508, 1971.

Fulkerson, Frank B. Transportation of Mineral Commodities on the Inland Waterways of the South-Central States. Washington, D.C.: United States Department of the Interior, Bureau of Mines, 1969.

Gulf Intracoastal Canal Association. The Gulf Intracoastal Waterway. Houston, Texas: Gulf Intracoastal Canal Association, 1972.

Interstate Commerce Commission, Bureau of Accounts. Transport Statistics of the United States, Part 5. Washington, D.C.: Interstate Commerce Commission.

Lamkin, Jack T. Jr. and Lowrey, W. R. Texas Waterborne Commerce Commodity Flow Statistics. Texas A&M University. Sea Grant Publication No. 207, 1973.

Miloy, John and Christian Phillips. Primary Economic Impact of the Gulf Intracoastal Waterway on Texas. Texas A&M University. Sea Grant Publication, TAMU-SG-74-211.

Office of Information Services, Governor's Office, Austin, Texas.

United States Department of the Army, Corps of Engineers. Annual Report. Washington, D.C.: Government Printing Office.

United States Department of the Army, Corps of Engineers. Gulf Intracoastal Waterway, Louisiana and Texas. Washington, D.C.: U.S. Government Printing Office.

United States Department of the Army, Corps of Engineers. The Intracoastal Waterway: Gulf Section. Washington, D.C.: U.S. Government Printing Office, 1961.

United States Department of the Army, Corps of Engineers. Transportation Lines on the Mississippi River System and the Gulf Intracoastal Waterway, 1972. New Orleans, Louisiana: Commerce Statistics Center.

United States Department of the Army, Corps of Engineers. Waterborne Commerce of the United States, Part 2. Washington, D.C: U.S. Government Printing Office.

Funding Alternatives

8-10?

AN EVALUATION OF FUNDING ALTERNATIVES FOR STATE SPONSORSHIP OF THE GULF INTRACOASTAL WATERWAY IN TEXAS

WAYNE E. ETTER
Department of Finance
College of Business Administration
Texas A&M University

and

CHARLES A. NICKERSON
Department of Accounting
College of Business Administration
Texas A&M University

INTRODUCTION

The cost of maintaining the Gulf Intracoastal Waterway (GIWW) is borne by the U.S. government and by states and/or local governments. The U.S. government, operating through the U.S. Army Corps of Engineers, bears the actual costs of dredging and maintaining the GIWW. In return, states and/or local governments are required to provide the following:

1) Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and of aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material and necessary retaining dikes, bulkheads, and embankments therefore or the cost of such retaining works;

2) Hold and save the United States free from damage that may result from construction and subsequent maintenance of the project; except for damages due to the fault or negligence of the United States or its contractors.

3) Accomplish, without cost to the United States, all alterations of pipelines, powerlines, cables, and other utility facilities when and as required for construction of the project.[1]

In the case of maintaining an existing portion of the GIWW the principal nonfederal costs are for disposal of dredged material. For the Texas portion of the GIWW, the U.S. Army Corp of Engineers is concerned that the present arrangements for materials disposal are not adequate. In their opinion, an unknown number of present arrangements with private landowners for materials disposal may need to be renegotiated to allow for the erection of dikes around disposal areas. It is not the purpose of this study to evaluate the validity of this assumption or the need for diking these areas. Rather it is to estimate the cost of renegotiating these arrangements should it become necessary to do so. Because of the uncertainty of the eventual need (or advisability) of renegotiation, this study should not be viewed as a recommended course of action until the need for renegotiation is established.

---

[1] U.S. Department of Army, Corps of Engineers, Review of Reports on Galveston Harbor and Channel, Texas (Galveston, Texas: U.S. Army Engineer District, Galveston, 1970), p. 21.

If it becomes necessary to renegotiate the arrangements with private landowners along the GIWW, the State of Texas, a local governmental unit on or about the GIWW, or private interests will have to provide the funds required to secure appropriate agreements with the landowners. This study is concerned with estimating the amount of funds required for securing these agreements and with evaluating alternative public sources for these funds.

ESTIMATED FUND REQUIREMENTS

An estimate of the amount of funds that potentially might be required to renegotiate the materials disposal easement agreements with private landowners was made as follows:

1) Each parcel of real estate desired by the Corps of Engineers for disposal of dredged materials was identified according to size, location and ownership.

2) The cost per acre for renegotiating the materials disposal easement agreements was estimated for each parcel.

3) The size, location, ownership and cost data were aggregated.

Each of these steps is discussed below.

A. Identification of Parcels

Charts of the GIWW were obtained from the Corps of Engineers. The maps indicated, among other things, the land areas desired by the Corps of Engineers for use as materials disposal areas; in some instances those areas were well defined, but in other cases only partial perimeters were provided. Land areas, measured in acres, were estimated for each of the individual parcels by averaging three planimeter measurements of each parcel. Each measured parcel was graphically identified on the several maps, and the averaged measurements were recorded both on the charts and on collateral worksheets.

The measurements of land area are subject to error due to 1) inaccuracies in the basic documentation, 2) inaccurate planimeter readings, 3) errors in averaging readings, 4) erroneous estimation of certain boundaries, and 5) the rounding of results. It is thought that the net effect of such errors as may be incorporated in the results is insignificant with respect to the total project.

B. Unit Cost of Improvements

The original documentation, annotated as indicated above, was delivered to the Corp of Engineers (Real Estate Section). They agreed to perform the following tasks:

1) Review annotations for completeness and general reasonableness.

2) Indicate for each parcel the character of ownership--public or private--and whether the land area is existing, submerged or emergent.[2]

---

[2] Emergent land is defined as land that has been created by spoiling in open water. This land may only be emergent at low tide and is generally considered to be public land.

3) Indicate for each area the estimated cost per acre of renegotiating the easement agreements.

After these tasks were completed, the charts were reviewed, necessary corrections were made, and a deck of data processing cards were prepared on which was recorded for each chart appropriate document identification, number of acres, estimated cost per acre, location, and ownership information.

C. Aggregate Costs

A computer software package titled Statistical Analysis System was employed to compute the products of acres and costs per acre and to analyze the data by relevant variables. Summaries of these analyses appear herein as Tables 1,2, and 3. As indicated by the Tables, the total acreage involved is 30,382 acres, and the estimated total cost of desired improvements is $5,445,400. The Corps of Engineers estimates that the funds will be required ratebly over a period of not less than five years. Figure 1 illustrates the location, acreage and cost of the required dredge material disposal areas along the Texas coast.

TABLE 1

DREDGE MATERIAL DISPOSAL AREAS REQUIRED BY COUNTY

COUNTY	ACRES	COST
Aransas	515	0
Brazoria	7,297	742,100
Calhoun	2,556	$1,533,600
Cameron	2,120	0
Chambers	175	21,400
Galveston	4,467	1,665,400
Jefferson	3,122	575,600
Kenedy	27	0
Kleberg	2,846	0
Matagorda	3,781	710,300
Nueces	1,987	197,200
Willacy	1,489	0
TOTAL	30,382	$5,445,400

SOURCE: Data derived from maps obtained from Corps of Engineers, Galveston District, Galveston, Texas.

TABLE 2

DREDGE MATERIAL DISPOSAL AREAS REQUIRED BY TYPE OF OWNER

TYPE	ACRES	COST
Local Sponsor	390	0
*Possible Emergent	5,399	829,200
Public Land	12,258	0
Private Land	12,335	$4,616,200
TOTAL	30,382	$5,445,400

*There is some question as to whether some of these parcels are privately owned. Emergent land is defined as land that has been created by spoiling in open water. This land may be emergent at low tide and is generally considered to be public land.

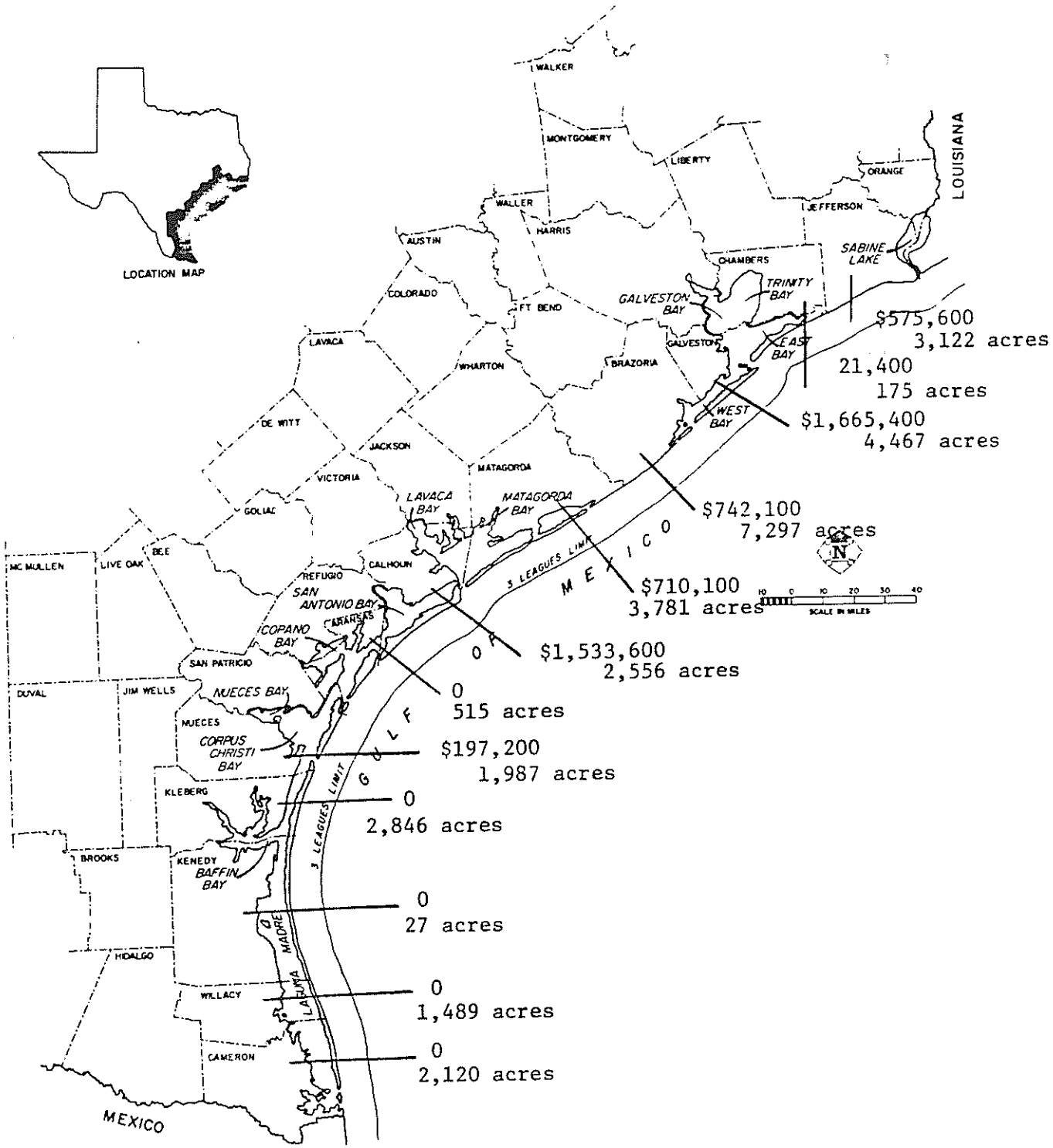
SOURCE: Data derived from maps obtained from Corps of Engineers, Galveston District, Galveston, Texas.

TABLE 3

DREDGE MATERIAL DISPOSAL AREAS REQUIRED BY LOCATION AND BY TYPE OF OWNER

COUNTY	LOCAL SPONSOR		POSSIBLE EMERGENT LAND		PUBLIC LAND		PRIVATE LAND		TOTAL	
	ACRES	COST	ACRES	COST	ACRES	COST	ACRES	COST	ACRES	COST
Aransas	390	0			125	0			515	0
Brazoria			45	0	4,988	0	2,264	$742,100	7,297	$742,100
Calhoun			668	$697,200	514	0	1,374	836,400	2,556	1,533,600
Cameron			347	0	1,773	0			2,120	0
Chambers					68	0	107	21,400	175	21,400
Galveston			330	132,000	914	0	3,223	1,533,400	4,467	1,665,400
Jefferson					244	0	2,878	575,600	3,122	575,600
Kenedy			27	0					27	0
Kleberg			628	0	2,218	0			2,846	0
Matagorda					1,414	0	2,367	710,100	3,781	710,100
Nueces			1,865	0			122	197,200	1,987	197,200
Willacy			1,489	0					1,489	0
TOTAL	390	0	5,399	$829,200	12,258	0	12,335	$4,616,200	30,382	$5,445,400

SOURCE: Data derived from maps obtained from Corps of Engineers, Galveston District, Galveston, Texas.



LOCATION AND COST OF DREDGE MATERIAL DISPOSAL AREAS REQUIRED
FIGURE 1

AN EVAULATION OF FISCAL ALTERNATIVES FOR FINANCING THE GIWW

If the State of Texas supplies the nonfederal share of the maintenance costs of the GIWW, the method by which these funds are to be raised will have to be considered. As developed in the previous section the potential fund requirements are approximately $5.5 million. While there is no way to forecast the time within which these funds will ever be required, the Corps of Engineers suggest that the total amount will probably not be needed in less than five years. Based on these forecasts of potential financial need several financial alternatives for the State of Texas are examined. There are five categories of funds theoretically available to the state: borrowing, intergovernmental transfers, user charges, state taxes, and funds supplied by private interests.

A. Borrowing by the State of Texas

The State of Texas cannot borrow for the purpose of obtaining these funds without amending the present state constitution unless revenue bonds are issued which do not pledge the state's credit. Article III, Section 49 states: "Purpose for Which Debts May Be Created: No debt shall be created by or on behalf of the state, except to supply casual deficiencies in the revenue, shall never exceed in the aggregate at any one time $200,000." Because of the estimated amount of funds required it does not seem likely that a constitutional amendment to approve tax bonds could be justified. But, the use of revenue bonds which do not pledge the state's credit is an alternative that could be considered.

The legislature can authorize the sale of revenue bonds; to make them salable the legislature would also need to create a mechanism for the collection of revenue by the state either directly or indirectly. Revenue could take the form of some type of user's fee levied directly by the state or indirectly by a subordinate government; these topics will be covered in following sections. The drawbacks of such a plan are obvious: the cost of collecting the revenue, the higher interest cost that an issue of this type would have to bear. The principal advantages would be spreading the repayment period over twenty or more years. The annual payments to ammortize $5,000,000 at current rates are as follows:

	20 years	25 years	30 years
7%	$471,965	$429,055	$402,930
7.5%	490,460	448,555	423,355
8.0%	509,260	468,395	444,135
8.5%	528,355	488,560	465,255

This alternative does not appear to be financially realistic based on tax rate calculations presented in the following section; therefore, this alternative is not developed in greater detail.

B. Intergovernmental Transfers

The bulk of the GIWW maintenance cost are already supplied by the federal government; the federal government specifically requires the

the balance of the funds be provided by a local sponsor. Since many areas along the GIWW do not receive greater benefits from the waterway than areas far removed from it, counties, cities or other governmental units adjacent to the waterway may not willingly supply funds for the purpose of maintaining the GIWW.

Despite this, it may be possible to create additional navigation/port districts, enlarge the present ones (so that all of the GIWW will be within the boundaries of a navigation district) or create a "GIWW" district. These governmental units would be subordinate to the state which could require them to levy taxes or collect fees from the users of the GIWW. The collected funds could be used to service debt issued by the "GIWW" district, turned over to the state for meeting the debt service requirements of revenue bonds issued by the state or used directly for purchasing the necessary easement modifications.

If each county along the GIWW were included in a "GIWW" district (all present navigation/port districts to be included) this district would have an assessed valuation (A.V.) of more than $7.2 billion.[3] For this district to provide the state with $1 million per year would require an ad valorem tax of 1.4 cents per $100 of A.V. (net of collection costs). To provide for annual debt service as calculated in the section on borrowing would require a tax rate of 0.7 cents per $100 of assessed valuation. (This assumes borrowing $5 million at one time with an average annual debt service of $500,000 for 20 to 30 years.) Since the district would have to raise approximately $500,000 per year for 20 to 30 years to service the debt but only $1 million for 5 years if the funds were applied directly, the use of debt appears financially unrealistic. In either case the required tax rate is quite low.

C. User Charges

Tolls, a form of user charges, are probably prohibited by the U.S. Constitution. In Article I, Section 9 the following appears: "No preference shall be given by any Regulation of Commerce or Revenue to the Ports of one State over those of another: nor shall vessels bound to, or from, one state, be obliged to enter, clear or pay duties in another."

User Charges disguised as boat licenses fees could conceivably be levied to finance the nonfederal share of the GIWW. The advisability of this course of action is open to question. To apply user charges one must consider the following:

1) Are there externalities in consumption? In the case of the GIWW, the benefits are broadly received throughout the state and are not restricted to the users.

---

[3] This amount is based on recently reported county assessed valuations reported in Moody's Investors Service, Inc., Moody's Municipal and Government Manual, (New York: Moody's Investors Service, Inc., various years).

2) What are the costs of exclusion? Could the GIWW be policed to insure that nonpaying users are excluded? Would this be legal?

User charges are most applicable when the government can identify the beneficiaries of particular government outputs and can exclude nonpayers. Although the users of the GIWW can be identified it is doubtful that all of the beneficiaries of the GIWW can be charged for its benefits because of the secondary economic impact of the waterway. These externalities mean that the benefits are widely enjoyed even though the direct users can be identified.[4]

If it were decided to apply a boat license fee, would it be levied against all users including tugs, barges, commercial and industrial vessels, commercial fishing vessels and recreational vessels? If only some direct users are charged but all groups are allowed to use the GIWW, there will be resistance. This reluctance will be present despite the fact that 1) the marginal cost to the paying group of additional users is zero and 2) the presence of nonpaying users will not hamper the paying group's use of the waterway.

If there is an attempt to exclude a group of nonpaying users from the GIWW two difficulties will become evident:

1) the cost of exclusion
2) The act might be unconstitutional

It is probably impossible to exclude nonpayers. Thus the use of boat license fees would probably have to fall on certain user groups who would have to consent to the existence of a group of nonpaying users or all direct users will have to be charged. The direct users would probably resent having to obtain a special license to use the GIWW because the benefits of the GIWW accrue far beyond the immediate areas of the GIWW. These problems would be present if the State of Texas directly charges the users of the GIWW or if the state requires a subordinate government to charge the fee.

D. Use of State Tax Funds

A final source of funding is the appropriation of general tax revenues by the Texas legislature. There are several strong arguments for this approach.

1) This approach may be the only available approach.

2) This approach would be simple. A special district would not have to be created; user charges or additional taxes would not have to be collected.

---

[4] For an excellent treatment of user charges see Werner Z. Hirsch, The Economics of State and Local Government (New York: McGraw-Hill Book Company, 1970), pp. 29-48.

3) In terms of all feasible activities that could be considered by the State of Texas, maintaining the GIWW as a waterway should have an extremely high priority. Indeed the adoption of zero-base budgeting by Texas should accentuate the attractiveness of this expenditure. The estimated cost to the state, when compared with the demonstrated economic impact of the GIWW, should establish the continued existence of the GIWW as an item of high priority in the state budget.

4) An appropriation of general tax revenue would be fairer because the cost of maintaining the GIWW would fall on all beneficiaries, not just the direct users or the taxpayers in adjacent counties.

5) According to the U.S. Bureau of the Census, the state and local government tax burdens borne by Texans are low. On a per capita basis, the burden of state and local taxes in the U.S. is as follows:

Item	1971-72
U.S. Average	$522.49
Median State	461.15
Texas	384.25

There are eight states with lower total state and local government tax burdens: Alabama, Arkansas, Kentucky, Mississippi, North Carolina, Oklahoma, South Carolina, and Tennessee.[5]

E. Funds Supplies by Private Interests

Although this report focuses on the ways in which the state could provide funding for the nonfederal share of maintaining the GIWW, it is possible that trade associations and/or industries that utilize the waterway could supply all or part of the funding by donation. Such an approach would reduce or eliminate the need for the State of Texas to supply the funds directly. If the principal industrial and commercial users were given reason to believe that the GIWW would not be maintained in the future without such support their cooperation might be secured. These costs may be transferred in the form of higher prices by the direct users of the GIWW; if they were, the costs of maintaining the GIWW would be paid by the beneficiaries, assuming the donations were properly apportioned among the direct users.

CONCLUSION

If funds are needed to renegotiate the easement agreements with private landowners along the GIWW, the easiest and fairest approach would be an appropriation by the State of Texas. The funds could be

---

[5] United States Bureau of the Census, Governmental Finances in 1971-72 (Washington: Government Printing Office, 1973), p. 45.

provided as required and the program could be terminated when no longer needed. The second choice is the creation of a special GIWW district which would levy an ad valorem tax and remit to the state as funds are required. Borrowing is financially unrealistic; a user charge would be difficult to impose and administer--in some forms user charges may even be illegal.

Legal Aspects

LEGAL ASPECTS RELATING TO THE GULF INTRACOASTAL WATERWAY IN TEXAS

JOHN L. SEYMOUR
Management Department
College of Business Administration
Texas A&M University

INTRODUCTION

The legal issues pertinent to the Gulf Intracoastal Waterway (GIWW) center around the federal requirements for local sponsorship. These requirements, recent environmental legislation, and the lack of a designated "local sponsor" for much of the main channel of the Waterway have combined to place in jeopardy the continued maintenance of the canal.

Modern environmental legislation has increased the concern which must be given to water quality and the fish and wildlife that may be affected by the operation of the canal. These laws have occasioned the United States Army Corps of Engineers to reassess their techniques for maintaining the existing Waterway. Some of these techniques may require the acquisition of additional spoil disposal areas and easements or the alteration of the present easements for disposal of dredged spoil.

In the various Federal acts authorizing the construction of the waterway, local interests were required to provide the spoil disposal easements. This was provided and the various portions of the waterway were constructed. Only recently has there been a question of whether additional local sponsorship would be needed to provide or obtain these easements. Unfortunately, no specific arrangements were made when the Waterway was constructed to identify an entity or entities who would provide this function on a continuing basis. An institutional mechanism now is being sought which would correct this situation.

Because the GIWW has been constructed in parts over a considerable time period, Texas has not developed a state policy toward the GIWW. The Corps of Engineers is the federal agency responsible for the operation and maintenance of the canal, and it would be in their interest for Texas to establish one agency which could coordinate the state's policies and desires with the Corps and be the state sponsor for the main channel of the Waterway.[1]

The main channel of the Gulf Intracoastal Waterway has been authorized and built in a piecemeal fashion through a series of separate Congressional Rivers and Harbors Acts including P.L. 68-585 (1925), P.L. 69-560 (1927), P. L. 77-675 (1942), and P. L. 79-14 (1945). Public Law 87-874 in 1962 authorized substantial modifications of the Waterway's main channel; however, this work has

---

[1] The Corps of Engineers presently has to coordinate various aspects of their maintenance program regarding the GIWW with several state agencies.

not yet been implemented. Other congressional authorizations have dealt with specific tributary channels to the main intracoastal Waterway. All of the tributary channels presently have a local sponsor to provide the necessary support required of local interests. The main channel of the Gulf Intracoastal Waterway which lies within Texas does have local sponsors in some locations but there is not a unitary sponsor designated for all of it at the present time.

There is one short reach near Aransas Pass which has a local sponsor. In addition, the Arroyo Colorado Navigation District of Cameron and Willacy Counties appears to have been given the authority to exercise those powers necessary to provide the local sponsor's requirements for the Waterway south of Corpus Christi to the southern end of the GIWW.[2] The Sabine-Neches Waterway was authorized and constructed as a separate federal project but is in essence a link in the Gulf Intracoastal Waterway. It does have local sponsorship as do the tributary channels, and the requirements for local cooperation are met by them. Texas, by statute, has provided to the United States Government rights of way and easements across certain bays and other inland navigable waters.[3]

Generally, the requirements for a local sponsor provided in the congressional authorizations to construct a waterway were provided by counties through which the Waterway ran or by private land owners along the Waterway. At the time it appeared that once the initial sponsorship requirements were obtained there would be no future need for a local interest to continue the sponsorship. The requirements for local sponsorship vary from one Congressional act to the next. The requirements are found partially in the Congressional acts themselves and in specific Corps of Engineers reports submitted to Congress which are then referred to in the authorizing statute. Those reports become House Documents and are adopted as law by reference to the report. Due to more recent federal legislation, particularly the National Environmental Policy Act[4] and

---

[2] Vernon's Ann. Civ. St. Art. 8263 i. See Appendix 7. The Arroyo Colorado Navigation District of Cameron and Willacy Counties citing the above act deeded to the United States Government the spoil disposal and right of way easement shown in appendix.

[3] Vernon's Ann. Civ. St. Art. 5248 a. and Art. 5248b. See Appendix 8.

The Congressional authorizations for the various portions of the Gulf Intracoastal Waterway and the requirements for local cooperation found in the acts themselves and in the House Documents are presented in Appendix 1.

[4] 42 U.S.C. 4321-4347

the Fish and Wildlife Coordination Act,[5] it has become apparent that there may need to be a renewal of effort to provide the requirements of local sponsorship. This is especially true in the area of contribution requirements to provide easements for materials disposal, because of the questions already being raised regarding the adequacy of the present easements. This issue was not foreseen until recently, and there may be others not presently recognized which will arise in the future.

The Corps of Engineers has been providing the maintenance on the Waterway since its construction. Keeping the Waterway open requires the periodic dredging and disposal of the dredged material, and the annual maintenance costs to the Federal government are substantial. Recent maintenance operations have resulted in at least one law suit being filed against a contractor of the Corps of Engineers in which the court was asked to enjoin certain material disposal methods. The suit was dismissed, and there has been no judicial interpretation regarding the adequacy of the presently held material disposal easements.

Some institutional questions regarding the GIWW for Texas include: 1) should the State of Texas sponsor the main channel of the Gulf Intracoastal Waterway and coordinate the policies and operation of it; 2) should the waterway continue to be sponsored on a piecemeal basis by county, navigation district, or private contribution; or 3) should the State of Texas institute efforts to establish an interstate compact with Louisiana, Mississippi, Alabama, and Florida to coordinate the local sponsorship effort for the entire Waterway?

---

[5] 16 U.S.C. 661-667e

ENVIRONMENTAL IMPACT STATEMENTS

One of the more significant problems relating to the Gulf Intracoastal Waterway is the requirement of the National Environmental Policy Act (NEPA) that an environmental impact statement be prepared by a federal agency proposing or involved with any project which would significantly affect the environment.

The Corps of Engineers presently is developing an environmental impact statement for the maintenance of the Gulf Intracoastal Waterway within Texas; however, this statement has not been submitted at this time. This has some possible detrimental consequences for the Corps of Engineers. They must be concerned with the possibility that a citizen may institute legal proceeding seeking an injunction which would suspend operations of their maintenance dredging on the canal. An argument could be made that no environmental impact statement is required under NEPA since the Corps is involved in only the maintenance of a project already completed. Any new project even though authorized by Congress before NEPA was enacted in 1970 would have to have an environmental impact statement prepared before that project was undertaken by any federal agency. Even though the GIWW was begun and completed before the Corps of Engineers began its present maintenance operations, those operations are extensive and probably require the preparation of an environmental statement. It has been held that in a project started before NEPA was enacted, if a significant amount of the work is to be completed after NEPA's enactment, then a statement would have to be prepared. The Corps could argue that the project was completed before NEPA and that the maintenance operations were not of such a significant character as to require the preparation of an environmental impact statement.

In section 102 of NEPA, it is stated that:

> all agencies of the federal government shall...
> (C) include in every recommendation or report on proposals for legislation and other major federal actions significantly affecting quality of the human environment, a detailed statement by the responsible official on--
> (i) the environmental impact of the proposed action,
> (ii) any adverse environmental affects which can not be avoided should the proposal be implemented,
> (iii) alternatives to the proposed action,
> (iv) the relationship between local short term uses of man's environment and

the maintenance enhancement of long term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should be implemented.

In the Council on Environmental Quality's guidelines, the content of the statement, in addition to those requirements above, are to fully describe the intended work, the relationship of the proposed action to land use plans, policies, and controls for the affected area, to the interests and consideration of Federal policy which are thought to offset the adverse environmental effects.

There are some broad substantive requirements in the NEPA which perhaps would require the Corps to conduct their project in a manner so as not to damage the environment. In other words, once the Corps has described in a statement some environmental factors of importance they may be required to take that action which would prohibit damaging the environment. The question is whether once the Corps has been advised by the Texas Parks and Wildlife Department or any other agency that environmental damage would occur even though on private lands, and the Corps has described this possibility in its impact statement, whether or not the Corps would then have to avoid these environmental consequences in the prosecution of their work. The substantive requirements are to be found in section 101 of NEPA:

(b) in order to carry out the policies set forth in this act, it is the continuing responsibility of the federal government to use all practicable means, consistent with other plans, functions, programs, and resources to the end that the nation may--

(1) Fulfill the responsibilities of each generation as trustees of the environment for succeeding generations;

(2) Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

(3) Obtain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable unintended consequences;

(4) Preserve important historic, cultural, natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;

(5) Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of lifes amenities; and

(6) Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

There have been no Supreme Court decisions stating that the substantive requirements are to be followed and that those requirements could prohibit a project from being undertaken because they were described in the environmental impact statement. There have been some lower court decisions which have determined that substantive rights are provided in NEPA and that they must be complied with; however, there have been other lower court decisions holding the opposite.

EASEMENTS

The adequacy of the Corps' present material disposal easements is of central importance to the question of whether or not additional monies provided by local sponsorship are needed. The question really is whether the present easements which the Corps of Engineers have are adequate or whether their environmentally directed methods of disposal (in containment dikes to confine the material and water in a confined area) are an alteration of the easement such that new easements need to be obtained. Did the many older easements which the Corps has along the GIWW contemplate the use of any disposal techniques?[6] Has there been an alteration in the technique of materials disposal so great as to substitute a new and different servitude on the land? If the building of the containment dikes are determined to be within the easements granted, then the Corps can continue to dispose and use the diking methods. If, in fact, the procedures for disposal have been so altered as to go beyond the purpose and character of the existing easements, then a taking of private property has in fact occurred; and there would be a need to compensate the land owners for that taking. Another

---

[6] A review of many of the materials disposal easements which the Corps of Engineers have on private property along the waterway shows that those easements were generally for "...the further perpetual right and easement to enter upon, occupy and use any portions of said tract or parcel of land as herein conveyed, not so cut away and converted into public navigable water as afore said, for the deposit of dredged material, and for such other purposes as may be needful in the preservation and maintenance of the said work of improvement..." The easements which have been obtained in recent times have provided for "...the perpetual right, privilege and easement in the hereinafter described land to deposit thereon spoil material and debris resulting from dredging operations performed in the construction, operation, maintenance, improvement and enlargement of the Gulf Intracoastal Waterway project, including the rights to construct, repair, relocate, and remove dikes, levees, spillways, discharge pipelines, ditches, drains, culverts, sluices, flumes and all other works, structures or improvements connected with or incidental to the performance connected with or incidental to the performance of such dredging work..." (See Appendix). Not all of the older easements read the same, however, most merely speak of the easements being for materials disposal and there is no specific provision made for containment dikes as there is in the newer easements. Even in the newer easements the easements are for materials disposal and not of flowage.

alternative would be to acquire new easements. Acquisition of the property in fee or the acquisition of an easement may be done through the power of eminent domain since there is a legitimate public interest.

The rights which the Corps of Engineers have in its easements in the private lands of others are to be determined essentially by looking at the purpose and the character of the easement. There are no reported cases having close similarities to the Corps' easement question. Thus, the only precedent that can be referred to are quite general in nature. In Fendall v. Miller, 196 P. 381 (1921), the Supreme Court of Oregon stated that, "the easement is only such as is reasonably necessary and convenient for the purpose for which it is created." They went on to point out, "The servient estate will not be burdened to a greater extent than was intended at the time of the creation of the easement."

A case in point as to the nature of the enjoyment of the easement is Allan v. San Jose Land and Water Company, 28 P. 215 (1891). In that case the Supreme Court of California stated, "For the purpose of determining its /easement's/ terms, we must look to the nature of defendants enjoyment for which it was acquired. ...It is quite apparent that the nature of defendants enjoyment of this case was the right of conducting water in an open ditch over and across plaintiffs land; that right was acquired by actually conducting the water in an open ditch over plaintiffs land, and the servitude resting upon their realty is exactly of the same character, and no more or less burdensome than though plaintiffs had expressly granted to defendant the right to conduct water in an open ditch across their land." In that case the owner of the easement (to carry water across the land of another) had wanted to put in a pipe and bury the pipe along the line where an open ditch had previously been. The court seemed to believe that this was a change in the easement, one which would materially alter the nature of the easement. Running water through a pipe line would, in fact, be a "substantial" change from running water in a ditch, and the court would not permit this under the existing easement.

While the Corps of Engineers has the dominant estate in the land on which it has the easements, its rights are not absolute or uncontrolled but are to be exercised so that due and reasonable enjoyment might be given to the land owner's servient estate in the surface. The Corps has the right to reasonable enjoyment of its easement. Normally, it is a fact question for a jury to decide whether or not a particular use is an unreasonable interference with the surface estate.[7] The owner of the easement generally has the right to do those things which are necessary to the reasonable enjoyment of it.

---

[7] Hasselbring v. Koepke, 248 NW 869, 93 A.L.R. 1170

Easements should be construed by ascertaining and giving effect to the party intention at the time the easement was granted.[8] However, the dominant owner has the right to unlimited reasonable use of the easement for its proper purposes exercised in the future even though they were not required when the easement was granted.[9] The older Corps easements are general easements and make no mention of the necessity to employ containment levees. Whether or not these new techniques were intended by the parties to be within the easement to dispose would have to be determined in court.

The requirements of the Fish and Wildlife Coordination Act have resulted in the Texas Parks and Wildlife Department recommending that containment levees be built in numerous areas where the Corps has easements to dispose material along the GIWW.[10] While these recommendations are given considerable attention by the Corps and it is their policy to implement such recommendations whenever possible, it is probably not required to follow the proposals of the state agency exercising administration over the wildlife resources of the state. The Corps does have to comply with the act which states, "The reporting offices in project reports of the Federal agencies shall give full consideration to the report and recommendations of the Secretary of the Interior and to any report of the State agency on the wildlife aspects of such projects, and the project plan shall include justifiable means and measures for wildlife purposes as the reporting agency finds should be adopted to obtain maximum overall project benefits."[11]

In Zable v. Tabb, 420 F.2d 199, (1970), the court determined that the Corps of Engineers could take into account environmental quality (under both the National Environmental Quality Act and the Fish and Wildlife Coordination Act) in denying a dredge and fill permit applied for under the Rivers and Harbors Act of 1899. The court stated that considerations regarding the quality of the environment could form the basis of such a denial just as much as considerations about obstructions to navigation. The courts have not, however, ruled that the Corps or any other Federal agency is bound to follow all or any of the recommendations made to them concerning protection of wildlife. The courts would require that Federal agencies not systematically, arbitrarily or capriciously ignore the recommendations.

Where a state agency such as the Texas Parks and Wildlife Department makes a recommendation to the Corps of Engineers concerning

---

[8] Bland Lake Fishing and Hunting Club v. Fisher, 311 SW2d 710.

[9] Kentucky and W.V. Power Co. v. Elkhom City Land Co. 279 SW 1082.

[10] The general Texas Parks and Wildlife Commission Policy concerning dredged materials is shown in Appendix 4.

[11] Fish and Wildlife Coordination Act 16 U.S.C. 662(b)

the protection of wildlife on private property, the Corps should give consideration to the proposal. The Corps then has to determine whether the recommendation would be feasible within the context of the easements which they have on the private lands. If the recommended action would result in the Corps' exceeding or substantially altering the easements which it possesses, it is faced with a dilemma. One alternative would be to not follow the recommendation and point to the fact that the course of action recommended would result in a "taking" of private property. It would then be able to say that within its objective of seeking to "obtain maximum overall project benefits," the recommended action will not be adopted. If, on the other hand, the Corps feels that it should implement the suggestion and this would result in a taking, it would need to obtain additional easements (perhaps flowage easements). If new easements are needed, local sponsors will probably be asked to provide these.[12] As a result, it will be necessary that a considerable sum of money be provided through local cooperation. The cost of new easements of this type would probably be the same as the fair market value of the property on which the easement was obtained.

When an easement is granted, the owner of the land becomes the holder of the servient estate. He may not do anything which would

---

[12] There may be a question of who should bear the additional costs necessitated by the operation of the Fish and Wildlife Coordination Act. It is this act passed half a century after some of the requirements for local sponsorship were established which has brought into question the adequacy of present spoil disposal easements. Should the Federal agency bear the cost or should the costs be bourne by local interests. The Fish and Wildlife Coordination Act is somewhat vague on the allocation of costs necessitated by the act. The Act states:

(c) Federal agencies authorized to construct or operate watercontrol projects are authorized to modify or add to the structures and operations of such projects, the construction of which has not been substantially completed on the date of enactment of the Fish and Wildlife Coordination in order to accommodate the means and measures for such conservation of wildlife resources as an integral part of such projects: Provided, That for projects authorized; (2) the cost of such modifications or land acquisition, as means and measures to prevent loss of and damage to wildlife resources to the extent justifiable, shall be an integral part of the cost of such projects; and (3) the cost of such modifications or land acquisition for the development or improvement of wildlife resources may be included to the extent justifiable, and an appropriate share of the cost of any project may be allocated for this purpose with a finding as to the part of such allocated cost, if any, to be reimbursed by non-Federal interests. /Underlining added/

Have the requirements for local sponsors (contemplated in the legislation requiring them) been altered so much that local interests have been denied due process as a result of no grandfather clause being included in the Fish and Wildlife Coordination Act?

interfere with or obstruct the enjoyment of the easement. It has been reported that some structures have been built on lands where the Corps of Engineers have materials disposal easements. This problem seems to be greatest where "squatters" have built structures on emergent or nearly emergent disposal banks along the Waterway where it traverses bays and estuaries. The easements in these areas have been obtained from or authorized by the State of Texas. Texas recently passed the Coastal Public Lands Management Act of 1973,[13] which provides in Section 7 that,

> (b) the board /School Land Board/ may grant the following interests in coastal public lands for the indicated purposes: ... (3) Permits authorizing limited continued use of heretofore unauthorized structures on coastal public lands, not connected with ownership of littoral property; ...

The General Land Office presently is implementing this section of the law by accepting permits for these previously unauthorized structures.[14] The Corps of Engineers places a warning note on all such structures prior to its maintenance dredging operations when materials will be deposited close to one of these structures. Where the structures are on easements held by the Corps, there would be no liability on the Corps' part for damage resulting to such structures.

---

[13] VATS, Art. 5415e- et seq.

[14] Section 10 of the Coastal Public Lands Management Act of 1973 and the General Land Office's permit form may be found in Appendix 5.

J. T. WHITE JR., ET AL V. CRANE BROTHERS, INCORPORATED, ET AL

In 1973, J. T. White, Jr. and other owners of a tract of property in Jefferson County, Texas located along the Gulf Intracoastal Waterway, filed suit against Crane Brothers Corporation of Louisiana.[15] Crane had a contract from the Corps of Engineers to maintain the portion of the Intracoastal Waterway that passed through White's property. When the Waterway was originally authorized the owners of this property, through a series of deeds, deeded to the U.S. Government the right of way through their property and easement for the disposal of materials on their property. The easement for the disposal of materials given to the United States provided for the Corps "to enter upon, occupy or use any portion of said tract or parcel of land as herein conveyed not so cut away and converted into public navigable water as aforesaid, for the deposit of dredged material and for such other purposes as may be needed for the preservation and maintenance of said work of improvement, and the further perpetual right and easement to deposit dredged material during construction and maintenance of the waterway on the land of the party of the first party adjoining the tract or parcel conveyed."[16]

Early in 1973 the defendant began to dig ditches some 1,650 feet diagonally from the canal and began to cut a ditch parallel to the canal, along which a levee was being built. The purpose of this levee was to impound materials and water pumped out of the canal. The Corps of Engineers had provided in their contract with the defendant (Crane) that materials containment levees would be built in order that the material would not continue to flow away from an immediate disposal area close to the canal. This provision had been the result of the Corps' asking for and receiving comments concerning their project pursuant to the Fish and Wildlife Coordination Act. They received the comments of the Bureau of Sport Fisheries and Wildlife of the Department of the Interior, the National Marine Fisheries Service of the Department of Commerce, and the Texas Parks and Wildlife Department. The Texas Parks and Wildlife Department suggested that the Corps provide containment levees so that the material would not flow great distances from the canal and damage the natural habitat of the area. The area is generally marshy, and the department felt that continued disposal would injure a large area of natural habitat. This would result,

---

[15] Suit filed in United States District Court for the Eastern District of Texas, Beaumont Division on February 14, 1973 (Civil Action File number B-73-CA-49). The suit was styled J.T. White, Jr., et al, plaintiffs v. Crane Brothers, Inc., Paul Lower, George R. Rochen, and Leroy Peltier, defendants. The defendants Lowe, Rochen, and Peltier were employed by the Corps of Engineers while Crane Brothers, Inc. was a subcontractor of the Corps to provide maintenance of the waterway.

[16] Deed filed August 19, 1929 and recorded in the Deed Record, Jefferson County, Texas, in volume 330, page 150.

they felt, in reduction of wildlife in the area. Thus, it was in response to the requirements of the Fish and Wildlife Coordination Act that the Corps provided in its contract to deviate from the previous spoil disposal methods, for which they had a valid easement.

The question the plaintiff raised was whether or not the Corps had a right under its easement to dispose of materials in the new manner. The plaintiff claimed that the defendant's actions were in excess of the rights granted under the easement and that the acts were destroying and appropriating the plaintiffs property. The plaintiff felt this was a violation of his property rights and a taking without compensation under the constitution of the United States. The plaintiff stated that the land was being used for ranching and cattle raising operations and that "the confinement of the spoil in the levees results in a quagmire which is a trap for cattle, and when the cattle attempt to go through this area they will become bogged down and eventually die." The plaintiffs also pointed out that the levees would become obstructions to the cattle in their movement to feeding grounds.

The central question in the case was whether or not the easement granted to the U.S. which had been provided by local sponsorship (private contributions) in 1927 was adequate to allow the contractor to dispose of materials in this fashion. A temporary restraining order had been entered by the court the day the suit was filed. The order stated that the "...defendants, are temporarily enjoined and restrained from digging canals and constructing levees on the properties of plaintiff outside of the 300 foot canal right of way easement..." The case was dismissed and the restraining order removed March 7, 1973 after a memorandum agreement was entered into between Mr. White and the Corps of Engineers. The agreement called for the materials disposal area along Mr. White's property to alternate between areas where disposal was to be done in the open and areas where disposal could be confined. The agreement also called for the confined areas to be fenced and for the Corps to continue to maintain repairs of the fence. Consequently, there has been no court decision as to whether or not the easements would in fact be adequate to include disposal material in the new manner. There are no previous cases which deal with this matter specifically.

The filing of this suit has brought to light the fact that if a court should hold that the materials disposal easements are not adequate to include disposal in the new manner, there would be a need, under the local sponsorship requirement, to provide for any new type of easement for materials disposal. This would require the local sponsor to initiate acquisition of new materials disposal easements to include the new methods. The problem here, of course, is that the local interest involved in granting the earlier right of way and materials easement was in fact the private land owner (generally at little or no cost). The private land owner now sees himself being damaged considerably if he were to allow the expanded operations without compensation.

If the Corps of Engineers finds that they must have additional easements or the old easements must be altered in order to maintain the Waterway, it believes it would be necessary to designate a local sponsor who would obtain the additional easements. Since it had been felt that all of the requirements of a local sponsor had been fulfilled long ago, no local sponsor presently exists for this portion of the Waterway. This is an example of the type of problem which may result in a critical dilemma being faced by the Corps of Engineers. As long as it disposes of materials in the old-fashioned manner, there is no further requirement for local interests to fill additional sponsorship requirements, as they have already been met.

Under the Fish and Wildlife Coordination Act, there is considerable question as to whether or not the Corps of Engineers would be required to be guided by the recommendations of the Texas Parks and Wildlife Department regarding the containment of material where only private lands are affected. Where the material may enter the public waters of Texas, that question would not arise. The Corps' policy to comply with the state's suggestions should be followed with great care for property rights where the land belongs to private individuals. Can the Corps acting under its own regulations and the Coordination Act be required to implement and not simply consider establishment of containment levees, which are environmentally sound disposal methods?

The only lands which would require additional monies to be expanded for the acquisition of easements would be those where the easements were on private property. If the Corps does not have to follow the recommendations submitted to them under the Fish and Wildlife Coordination Act and uses the new disposal techniques because they are placing material on private property, then no additional funds would have to be spent for new easements. No monies would have to be paid to obtain new easements where the easement for the materials disposal was on state-owned submerged lands or islands. In the area where Mr. White has his property, the Corps seems to have a choice: disregarding the recommendations of the Texas Parks and Wildlife Department which they have received under the Fish and Wildlife Coordination Act because it related to private property, or accepting those recommendations and attempting to adjust its disposal project, in which case it may find additional easements are necessary.

OTHER GULF COAST STATES AND LOCAL SPONSORSHIP

In addition to Texas, the Gulf Intracoastal Waterway passes through Louisiana, Mississippi, Alabama and Florida. The federal requirements for local sponsorship of the Waterway are generally the same in those states as in Texas. Louisiana, Mississippi and Alabama have the same problems regarding local sponsorship that Texas has. In other words, there is no single state mechanism for state sponsorship, and the sponsorship has come from individual counties or private individuals. While Florida does not provide local sponsorship for the Waterway itself it has taken a more comprehensive approach to the question of sponsorship, and the Department of Natural Resources ultimately coordinates the implementation of local cooperation.

In Louisiana the Louisiana Department of Public Works is the state agency which carries out the administrative functions that relate to coordination for improvement and maintenance of navigation.[17] Navigation districts in Louisiana must obtain the advice of the Department of Public Works regarding the improvement and maintenance of navigation projects in that state. That state agency, however, generally does not supply the funding to fulfill the requirements of local sponsorship for federal projects.[18] The actual local sponsorship requirements normally are provided by the various parishes and other local interests. Consequently, local sponsorship is not provided on a systematic statewide basis. However, in an informal fashion, the Department of Public Works provides assurances that the requirements of local sponsorship will be met and would find state appropriations on an ad-hoc basis if parish or private sponsors could not provide it.

Louisiana has an occupational license tax which is charged on businesses operating "one or more tow-boats or tugs

---

[17] L.S.A.-R.S. 38:1.

[18] The Louisiana Department of Public Works does have statutory authority to provide the requirements of local cooperation. This is found in L.S.A.-R.S. 38:5 shown below.

> COOPERATION WITH FEDERAL GOVERNMENT IN DRAINAGE AND RECLAMATION PROJECTS
>
> The Department of Public Works may also co-operate with the federal government or any federal agency, and may receive and expend grants of money by the federal government or any federal agency for the purpose, upon any terms and conditions prescribed by the Congress or any agency of the federal government under authority of the Congress, and to this end may contract for the acceptance of any grant of money upon the terms and conditions, including any requirement of matching the grants in whole or part, which may be necessary.

and for those businesses which transport freight or passengers or both by boat or barge or other floating property."[19] If Louisiana chose to provide the funding for local sponsorship at the state level, these monies might be a source of revenue which they could dedicate to this purpose. They presently are not used for this purpose. Ad valorem taxes also are charged in Louisiana on ferry boats, boats, tugs, barges and other water craft.[20] In fact, these taxes are imposed on all property that is used in connection with the water transportation of persons or property. In Ott v. Mississippi Valley Barge Line Company, 336 U.S. 169, (1949), it was held that those ad valorem taxes which had been levied against "foreign interstate carriers transporting freight on the Mississippi and Ohio rivers by barge and tow boat" could be assessed as long as Louisiana based this on a ratio between the total miles of a carrier's lines in Louisiana and the total number of miles of the entire line. The court stated that this "did not violate the due process or commerce clauses, though during the course of the year, vessels were within Louisiana for a comparatively short period of time." Texas provides that boats and other watercraft shall be listed on the assessment and taxation roles as personal property in the county where the vessel is registered.

Louisiana also has a Louisiana Coastal Commission which includes most but not all of the Gulf Coast counties in that state. That commission has broad powers with respect to canals, i.e., the Gulf Intracoastal Canal[21], but it does not provide the local sponsorship for the main channel of the GIWW throughout Louisiana. The Louisiana Intracoastal Seaway Association has been established as a private association to promote the Waterway but does not have any statutory authority.

Even though the Gulf Intracoastal Waterway is relatively short in both states, neither Alabama nor Mississippi have state agencies acting as the local sponsor for the main channel of the Gulf Intracoastal Waterway. The Mississippi Agricultural and Industrial Board does provide a coordination effort for local

---

[19] L.S.A.-R.S. 47:355.

[20] V.A.T.S. Art. 7157, "All persons, companies, and corporations in this state owning steamboats, sailing vessels, wharf boats, and other water craft shall be required to list the same for assessment and taxation in the county in which the same may be enrolled, registered or licensed, or kept when not enrolled, registered, or licensed."

[21] L.S.A.-R.S. 34:2253. Powers of the Commission
The commission shall have the power to plan, establish, construct, own, operate and maintain within the aforesaid area: (1) a system of navigation channels, together with the necessary basins, locks and control structures to maintain and improve navigation

navigation districts.[22] The Alabama State Docks Department[23] does not provide local sponsorship for the Gulf Intracoastal Waterway throughout Alabama, but provides sponsorship for only those federal navigation projects relating to its ports, docks, and tributary channels.

In Florida the Department of Natural Resources through its Bureau of Waterways oversees and coordinates the activities of its various inland navigation districts.[24] Florida now has two inland navigation districts for the Intracoastal Waterways. The Florida Inland Navigation District is a special purpose district comprised of the Atlantic coast counties through which the

---

conditions for water traffic and to provide navigation channels for ocean going vessels; (2) canals, levees, salt water barriers, locks, pumping stations, pipes, culverts, gates and other structures necessary to form a fresh water supply system to provide fresh water for agricultural, industrial and domestic use for the improvement of wildlife ecology; (3) such canals, oxidation lagoons, pumping stations, pipelines, culvert gates and other structures as may be necessary to control the domestic and industrial water so as to prevent the pollution of the fresh water system and the pollution of wild life inhabitants; (4) such levees, hurricane barriers, locks, gates and structures as may be necessary for protection from the high tides and salt water intrusion from the Gulf of Mexico; and (5) levees, canals, flood gates, spillways and other structures to improve drainage and expedite the removal of flood waters. The commission is authorized to disseminate information concerning the activities, programs and needs of the commission to federal, state and local governing bodies and agencies and to the general public.
In furtherance of the powers granted herein, the commission shall have the authority to expropriate property in those parishes comprising the district in accordance with the expropriation laws of the state; provided, however, that the commission first shall obtain approval for such expropriation by formal resolution of the governing authority of the parish in which the property to be expropriated is situated. Amended by Acts 1970 No. 397, §1.

[22] Mississippi Code, Sections 59-5-1 et seq.

[23] Alabama Statutes, Tit. 38, Sec. 1 et seq.

[24] F.S.A. Chap. 370.06 and 374. In F.S.A. Chap. 374.761 it is provided "Any navigation district created pursuant to the provisions of this chapter, or any navigation district heretofore or hereafter created by special acts of the legislature, shall act in conjunction with but at all times under and subject to, the control and supervision of the division of interior resources. Laws 1965, c. 65-502, § 1, eff. June 25, 1965. Amended by Laws 1969, c. 69-106, §§ 25, 34, eff. July 1, 1969.

Atlantic Intracoastal Waterway runs. On the Gulf Coast, the West Coast Inland Navigation District has been established as a special purpose district composed of those counties on the Gulf through which the Gulf Intracoastal Waterway runs. Consequently, one Florida district provides all of the requirements for local sponsorship on the Gulf Intracoastal Waterway in Florida. That special purpose district is created specifically to oversee and manage the activities of the Waterway.

The Bureau of Waterways within the Florida Department of Natural Resources was created to provide Florida with a statewide program to develop an integrated system of navigable waterways, ports, and harbors. This has permitted a state level process for supervision and coordination of state and local level plans, programs, and projects relating to waterborne transportation.[25] Within the Department of Natural Resources there is also a Bureau of Water Resources which provides the same type of coordination effort for water conservation and development and flood control. That bureau coordinates efforts to provide local sponsorship for federal water resources projects.

The Department of Natural Resources also contains a Division of Marine Resources in its Bureau of Salt Water Fisheries and a Division of Game and Fresh Water Fish. The Department of Natural Resources is the state agency which responds to the Corps of Engineers and other federal agencies with comments concerning environmental matters under the Fish and Wildlife Coordination Act. One agency then provides the comments and recommendations for federal water transportation projects and also is responsible for coordinating the requirements of local sponsorship of those projects.

While Michigan is not on the Gulf Intracoastal Waterway, it has a great dependence on the inland waterways, and it has taken a fairly comprehensive approach to matters concerning its waterways. It has created a five member Michigan State Waterways Commission and given it the following powers and duties:[26]

---

[25] The Department of Natural Resources is also authorized to provide a portion of the funds necessary to implement the requirements of local cooperation. In F.S.A. Chap. 374.83, it is provided, "The division of interior resources is authorized to equally match out of state funds any moneys or funds raised by any special taxing district now in existence or hereafter created as herein provided for the purchase or acquisition of rights of way for any waterway development project authorized by the state or federal government or appropriate agency thereof. Laws 1961, c. 61-121, § 8. Amended by Laws 1969, c. 69-106, §§ 25, 35, eff. July 1, 1969.

[26] M.C.L.A. Art. 281.501 et seq.

281.504 Waterways Commission; powers and duties

Sec. 4. The commission shall have and be vested with the following powers and duties:

(a) To acquire, construct, and maintain harbors, channels, and facilities for vessels in the navigable waters lying within the boundaries of the state of Michigan.

(b) To acquire, by purchase, lease, gift or condemnation such lands, rights of way and easements necessary for harbors and channels: and the commission shall be considered a state agency under the provisions of Act No. 149 of the Public Acts of 1911, relative to construction by state agencies.

(c) To acquire, by purchase, lease, gift or condemnation suitable areas on shore for disposal of the material from dredging.

(d) To enter into any contracts or agreements that may be necessary in carrying out the provisions of this act, including agreements to hold and save the United States free from damages due to the construction and maintenance by the United States of such works as the United States shall undertake.

(e) To provide for the granting of concessions within the boundaries of harbors, so as to furnish the public gas, oil, food and other facilities.

(f) To represent the state of Michigan and the governor of Michigan in it and his relationships with the chief of engineers, United States army, and his authorized agents for the purposes set forth herein.

The Commission also is authorized to provide the requirements for local cooperation for navigation projects within the state.[27]

---

[27] The statute concerning the commission and local cooperation follows:

281.507 Waterways commission; financing of local agencies to obtain United States participation; contracts with war department

Sec. 7. The commission is hereby authorized to take such action as may be necessary to provide the finances required of local agencies as condition for United States' participation in any project in which the commission is empowered to act and to use any part or all of the appropriation and funds otherwise available to meet such part of the requirement of local participation as the commission may deem proper, and to enter into

The Michigan State Waterways Commission receives funding through a tax on marine gasoline. The state imposes a privilege tax of nine cents per gallon on gasoline used in waterway transportation. The Commission then receives through the state waterways fund 1.25 percent "of all state-imposed taxes collected on sale of gasoline, fuel, oil, naphthene or any other propellant used in internal combustion engines (except fuel consumed in airplanes or diesel engines) shall be credited to the state waterways fund, to be administered by the commission in accordance with this and other acts."[28]

---

agreements with any political subdivision of the state in connection with participation with the United States in any project in which the commission is empowered to act, and to provide such adjustments which in the judgment of the commission are deemed to be in the best interest of the state of Michigan.

The commission may enter into any contract or agreement with the war department of the United States, or any other agency or instrumentality of the United States for the dredging of harbors, the erection of breakwaters, piers or any other device for the protection of vessels, and may do any act or enter into any contract or agreement desirable in carrying out the purposes of this act. The commission is further authorized to take such steps as may be necessary to take advantage of any act of congress heretofore or hereafter enacted which may be of assistance in carrying out the purposes of this act.

[28] M.C.L.A. 281. 509, Sec. 9 (2).

ALTERNATIVES FOR STATE SPONSORSHIP

The decisions to be made regarding local sponsorship of the Texas portion of the Gulf Intracoastal Waterway will necessarily be political ones. The purpose of this section is not to provide recommendations concerning the merits or deficiencies of any of the many approaches that may be taken, it is merely to illustrate some of the many institutional arrangements which could be employed.

The present arrangements for providing local sponsorship along the main channel of the Gulf Intracoastal Waterway do not seem to be adequate to solve some of the more recent problems that have arisen concerning the GIWW. The sponsorship requirements originally called for the local interests to provide rights-of-way and materials disposal easements. These were obtained from counties and private individuals for the most part (at least where the GIWW traverses land). The State of Texas has provided the Corps of Engineers with rights-of-way and disposal easements in many open water areas of the various bays and estuaries.[29] In one instance a navigation district has apparently been authorized by the state to provide these rights-of-way and disposal easements for a portion of the main channel of the Waterway.[30]

The present system of counties and private individuals providing the various requirements for local sponsorship has resulted in a situation whereby those local interests believe their responsibilities to have been completed. The Corps of Engineers procedure during those early days were not so precise that they obtained contractual guaranties from the various counties and other local

---

[29] V.A.T.S. Arts. 5248a and 5248b. See Appendix 8

[30] Pursuant to Art. 8263i., V.A.T.S., the Arroyo Colorado Navigation District of Cameron and Willacy Counties has deeded a right of way and materials disposal easement to the Federal government. The deed executed Aug. 21, 1947, provides in part,

> NOW, THEREFORE, in consideration of the sum of One Dollar ($1.00), the receipt of which is hereby acknowledged, and the benefits to the party of the first part that will result from the proposed improvement and extension of the Louisiana-Texas Intracoastal Waterway from Corpus Christi, Texas to the Mexican Border, the party of the first part does hereby grant, bargain, sell, and convey unto the party of the second part and its assigns the perpetual right and easement to enter upon, dig or cut away, and remove any and all of the hereinafter described Tract No. 1 as may be required at any

interests for continuing local sponsorship. Once the immediate local cooperation requirements were satisfied, even the Corps of Engineers assumed that the requirements were completed.[31] Since the responsibilities for continuing support were not contractual, they exist in perhaps only a moral sense.

The individual land owners who donated many of the rights-of-way and the materials disposal easements did so because the land at the time had little or no value. Those source lands now are valued quite highly. The private landowners no longer are willing to "donate" rights-of-ways and easements across their properties.

The counties through which the Gulf Intracoastal Waterway runs could be approached to determine their willingness to assume further responsiblities for local sponsorship. It should be pointed

---

time in the prosecution of the aforesaid work of improvement, or any enlargement thereof, and maintain the portion so cut away and removed as a part of the navigable waters of the United States; and further grant, bargain, sell, and convey unto the party of the second part the perpetual right and easement to enter upon and use any portion of said Tract No. 1 not so cut away and converted into public navigable waters as aforesaid, and any portion of Tract No. 2, hereinafter described, for the deposit of dredge material, and for such other purposes as may be needful in the preservation and maintenance of said work of improvement, together with the perpetual right and easement of flow water from spoil areas over and across said Tracts Nos. 1 and 2.

Tract No. 1 is described as a strip of land nine hundred (900) feet wide, being four hundred and fifty (450) feet on each side of the center line of the Louisiana-Texas Intracoastal Waterway as it is to be surveyed and constructed in Corpus Christi Bay and Laguna Madre from a point on the corporate limits of the City of Corpus Christi, Texas extending southerly through Nueces County, Kleberg County, Kenedy County, Willacy County, and Cameron County to a point near the mouth of the Rio Grande on the Mexican Border between the State of Texas in the United States of America and the State of Tamaulipas in the Republic of Mexico.

Tract No. 2 is described as a strip of land five thousand (5,000) feet wide parallel and contiguous to the eastern boundary line of said Tract No. 1 and extending from the corporate limits of the City of Corpus Christi to the Mexican Border.

[31] See paragraph 8 of H.D.556, 87th Congress in Appendix 1.

out that some counties do not see themselves benefitting from the waterway as much as others. Often the counties which see the least benefit would be asked to supply the most in the way of local support. The counties where the waterway traverses private property are the ones where the greatest amount of local cooperation may be needed to obtain expanded or additional easements.

Private sources might be approached to provide the necessary local cooperation. The Gulf Intracoastal Waterway Association might be asked to assume these responsibilities. It has in the past agreed that it would provide assistance in the local sponsorship process.[32] That association is a private organization whose membership includes both private and public members interested in the Intracoastal Waterway. These interests generally are considered to be those most directly benefitting from the operation of the Waterway. The association is composed of members from the five Gulf states, and basically it is a promotional group. Given their present funding arrangements it is doubtful that they could or would want to assume these responsibilities. The association would provide a ready mechanism for assumption of the local cooperation requirements on an interstate basis if they wanted to assume such a role. Another approach might be to ask the industries in the state which benefit most directly from the Waterway to develop a private fund from which monies could be spent for additional demands for local sponsorship.

Should Texas decide that it is in the State's interest for it to assume the responsibilities of local sponsorship and coordination for the main channel of the Gulf Intracoastal Waterway, there are numerous institutional mechanisms it might use.

---

[32] In House Document 238, 68th Congress it was stated:

> To sum up the local cooperation promised, the association /Intracoastal Association of Louisiana and Texas/ ——speaking for the various interests of Louisiana and Texas, which it represents, pledge its assistance and cooperation in respect to the following matters in the event the proposed project is adopted and its construction authorized:
>
> First. That all necessary rights of way are furnished to the government free of charge.
>
> Second. That adequate wharfage and terminal facilities are provided at such points along the waterway as the United States Government may deem advisable or necessary. /Does this mean that the Federal Government can require Texas to develop wharfage and terminal facilities wherever it wants them located?/
>
> This assurance given by the Intracoastal Canal Association of Louisiana and Texas was for the waterway being proposed from New Orleans, La. to Corpus Christi, Texas. That portion of the waterway lying in Texas was authorized by the

Texas could follow the Florida design and develop legislation providing for one special purpose district composed of counties through which the Gulf Intracoastal Waterway runs. This special purpose district would have as its major purpose the management of the Waterway. An additional method of using special purpose districts might be to allow the various navigation districts to expand their jurisdiction over the Gulf Intracoastal Waterway in those locations immediately adjacent to their waterways so that the entire Waterway would have local sponsorship provided for by the various navigation districts in the state. The Arroyo Colorado Navigation District experience could be used as a model. Legislation would be required similar to that found in Art. 8263i and 5244a V.A.T.S.

In looking at other possibilities for the state to take over local sponsorship, the Governor of Texas has the power under Art. 5240 V.A.T.S. to condemn all lands which are to be used for a public purpose. Thus, the Governors office could presently provide those items of local sponsorship which are necessary. In the 1962 Rivers and Harbors Appropriations Act authorizing the deepening and widening of GIWW from the Louisiana border to Galveston, the governor did, in fact, agree to cooperate in furnishing items of local cooperation.[33] If the requirements for the local cooperation were developed through the Governors office, no new legislation would be necessary. However, matters of this type are not routinely handled through that office. The Governor also appoints a director for the Office of State Federal Relations. The director of that office functions as a liaison from the state to the federal government.[34]

Another possibility might be a wholly new state agency whose purpose would be the management of the Gulf Intracoastal Waterway within Texas. This would of course require new legislation. On the other hand, several state agencies already have functions, powers, or responsibilities which deal in one or more respects to the Waterway.

Rivers and Harbors Act of 1925 and 1927 (P.L. 68-585 and P.L. 69-560). The majority of the easements and rights of ways across private lands were obtained as a result of these two public laws. These include the majority of the easements which now appear to be in question.

[33] On page 78 of H.D. 556-87th Cong., it was stated, "...The Governors of the States of Louisiana and Texas have agreed to cooperate in furnishing items of local cooperation."

[34] Art. 4413d-1, V.A.T.S.

One of the requirements for local sponsorship found in the various Rivers and Harbors Appropriations Act is that the local interests remove or alter any bridges which go over the area to be used for the Waterway. The Texas State Highway Department is the agency which provides this function at the state level.[35] That Department has available to it money from the State Highway Fund.[36] The monies paid into that Fund come from several sources, including the diesel fuel tax[37] and the motor fuel tax.[38] Presently many boat owners pay these diesel and motor fuel taxes at the time of purchase; however, these taxes are refundable if the fuel is used for the purpose of operating or propelling a watercraft.[39] This Fund could perhaps be altered so that a percentage of it corresponding to the amount of monies obtained from the sale of fuel to waterway users could be allocated to waterways maintenance.

The General Land Office, which manages the submerged lands of Texas, would be another possible agency to assume responsibility for managing the Gulf Intracoastal Waterway. Much of the Waterway crosses submerged lands, and the Land Office's programs regarding submerged lands will be an important factor in any program of state sponsorship of the Waterway. It should also be pointed out that the Land Commissioner has been directed by the Governor to develop the state's response to the Coastal Zone Management Act.

The Texas Water Development Board has available to it the Texas Water Development Fund, and that fund "shall be used only for. . . the conservation and development of the water resources of this state, including the control, storing, and preservation of its storm and flood waters and the waters of its rivers and streams, for all useful and lawful purposes by the acquisition, improvement, extension for construction of dams, reservoirs and other water storage projects, including any systems necessary for the transportation of water from storage to points of treatment and/or distribution, including facilities for transporting water therefrom to wholesale

---

[35] Art. 6797c, V.A.T.S. That act provides, "The State Highway Commission of Texas, at the request of the U.S. Government, . . . is hereby authorized, out of any funds available for such purpose, to remove highway bridges obstructing the construction of the Intracoastal Waterway of Louisiana and Texas now being dredged by the U.S. Government, and to replace and maintain such of said bridges as the State Highway Commission of Texas deems necessary. . ."

[36] Art. 6694, V.A.T.S.

[37] V.A.T.S. Tax Gen. Art.10.01 et.seq.

[38] V.A.T.S. Tax Gen. Art.9.01 et.seq.

[39] V.A.T.S. Tax Gen. Arts. 10.14 and 9.13.

purchasers, or for any one or more such purposes or methods."[40] It seems unclear whether this fund could be used to provide local sponsorship. The Texas Water Development Board is specifically designated to be the agency to provide coordination and cooperation with the Corps of Engineers or the Bureau of Reclamation in planning water resources projects.[41] Where water resources projects are proposed by the federal government and no local sponsor is able to undertake the requirements imposed, the Texas Water Development Board may be designated as the agency to provide the necessary local cooperation.[42] It has been the general policy that the Board does not include navigation projects in those they are helping to plan or sponsor.

The Texas Water Rights Commission reviews all proposed federal water projects and determines whether or not they are appropriate for implementation in Texas.[43]

The recent concern of the Corps of Engineers as to whether additional requirements for local cooperation will be necessary has developed as a result of the Fish and Wildlife Coordination Act. The Texas Parks and Wildlife Department made recommendations to the Corps pursuant to this act. When the Corps tried to implement the proposals in their dredging projects,[44] they found that there may be future requirements for additional local support. It is the desire to protect wildlife and fisheries, then, that is forcing the issue of additional sponsorship.

The Texas Parks and Wildlife Department has available to it a Special Game and Fish Fund,[45] the Land and Water Recreation Safety Fund,[46] and the State Land and Water Conservation Fund.[47] The object of the various recommendations on the waterways projects is to

---

[40] Texas Constitution Article 3, Section 49-C.

[41] Tex. Wat. Code, Sect. 11.251

[42] Texas Wat. Code, Sect. 11.252(i)

[43] Art 7472e, V.A.T.S.

[44] There seems to be some disagreement between the Corps of Engineers and the Texas Parks and Wildlife Department concerning the degree and manner of implementation

[45] Art. 4386b., V.A.T.S.

[46] V.A.T.S., Tax Gen. Art. 9.13(6a)B.

[47] Art. 6081r(6), V.A.T.S.

protect wildlife and their habitats. The special game fish fund comes from hunting and fishing licenses and fines. Those people paying into those funds are the beneficiaries of any habitat protection resulting from the recommendations of the Texas Parks and Wildlife Department. It would appear that the Parks and Wildlife Department might be called upon to provide the local sponsorship requirements.

State agencies may use taxation (ad valorem or fuel taxes) as a means of collecting revenue, however; they would be specifically prohibited from charging tolls on the Waterway as long as it is a federal navigation project.[48]

Any of these funds or agencies might, in fact, be designated as the agency to provide local sponsorship requirements. There is also a need for whatever agency takes on the requirements of local sponsorship to coordinate all of the activities regarding the Gulf Intracoastal Waterway. Consequently, it would be necessary to develop a systematic coordination effort taking into consideration the submerged lands of the General Land Office, the game, fish, and habitat protection requirements of the Texas Parks and Wildlife Department, the removal or altering of bridges by the Texas Highway Department, the planning coordination required of the Texas Water Development Board and the Review of federal proposals by the Texas Water Rights Commission.

---

[48] 33 U.S.C. Sect. 5 provides, "No tolls or operating charges whatever shall be levied upon or collected from any vessel, dredge, or other water craft for passing through any lock, canal, canalized river, or other work for the use and benefit of navigation, now belonging to the United States or that may be hereafter acquired or constructed, . . ."

APPENDIX 1:

PUBLIC LAW

P.L. 68-585 (1925)

...

The following works are hereby adopted and authorized...in accordance with the plans recommended in the reports hereinafter designated:

...

The Louisiana and Texas Intracoastal Waterway, from the Mississippi River at or near New Orleans, Louisiana, to Galveston Bay, Texas, in accordance with the report submitted in House Document 238, Sixty-eighth Congress, First Session, and subject to the conditions set forth in said document: Provided, that the amount hereby authorized to be expended upon said project shall not exceed the sum of $9,000,000: Provided further, that no expense shall be incurred by the United States for acquiring any lands required for the purpose of this improvement: Provided further, that not more than two Government dredges shall be constructed for use in prosecuting this project.

Sabine Neches Waterway, Texas. The modification of the project recommended in House Document Numbered 234, Sixty-eighth Congress, First Session, and subject to the conditions set forth in said document.

HOUSE DOCUMENT

H.D. 238-68th Congress

WAR DEPARTMENT,
OFFICE of the CHIEF of ENGINEERS
Washington, April 2, 1924.

Subject: Preliminary examination and survey of the intracoastal to Corpus Christi, Texas... (p.2)

A waterway with a least cross section of 9 feet by 100 feet, from Vermilion River to Galveston, at an estimated cost of $5,282,000 and $80,000 for maintenance, when an additional through traffic of 750,000 tons annually is assured.

A waterway from Galveston to Gulf, Texas, 9 feet by 100 feet, at an estimated cost of $2,231,000, with $75,000 annually for maintenance, generally in accordance with previous recommendations, but terminating at Gulf and following the modified route.

The purchase of four 20-inch pipeline dredges at a total cost of $1,600,000.

The provision of all rights of way by local interests without cost to the United States.... (p.4)

subject to the following conditions:

(1) That local interests shall defray the cost of constructing or remodeling all highway bridges, together with their subsequent maintenance and operation, and shall furnish, without cost to the United States, all rights of way and necessary spoil disposal areas.... (p.5)

APP. 1 Continued

BOARD of ENGINEERS
for RIVERS AND HARBORS,
Washington, D.C., March 11, 1924.

To the CHIEF OF ENGINEERS, (p.6)
UNITED STATES ARMY:

The division engineer accordingly recommends the construction of a waterway as follows: ...

(7) All rights of way to be furnished by local interests, without cost to the United States. (p.9)

(16) The board therefore recommends the provision of a waterway 9 feet deep at mean low water, and 100 feet bottom width between New Orleans and Gulf, Texas, ... (p.12)

subject to the following conditions:

(1) That local interests shall defray the cost of constructing of remodeling all highway bridges, together with their subsequent maintenance and operation, and shall furnish, without cost to the United States, all rights of way and necessary spoil disposal areas.

PRELIMINARY EXAMINATION
OF INTRACOASTAL WATERWAY
FROM THE MISSISSIPPI RIVER
TO CORPUS CHRISTI, TEXAS

...

WAR DEPARTMENT,
OFFICE of the DIVISION ENGR.,
GULF DIVISION,
New Orleans, La., June 1, 1923.

Subject: Preliminary examination of intracoastal waterway from Mississippi River at or near New Orleans, La., to Corpus Christi, Texas. (p.13)

LOCAL COOPERATION PROMISED

(25) Nothing has been definitely promised, but it is generally understood to be the consensus of opinion that a 300-foot right of way where necessary will be granted free of cost to the United States. (p.46)

APP. 1 Continued

SURVEY OF INTRACOASTAL WATERWAY
FROM MISSISSIPPI RIVER
TO CORPUS CHRISTI, TEXAS

WAR DEPARTMENT,
OFFICE of the DIVISION ENGR.,
GULF DIVISION,
New Orleans, La., December 5, 1923.

Subject: Survey of intracoastal waterway from the Mississippi River at or near New Orleans, La., to Corpus Christi, Texas.

To: The Chief of Engineers, United States Army. (p.48)

...

(19) Local cooperation.--Local interests through their Intracoastal Canal Association of Louisiana and Texas have already furnished exceptional cooperation in the assembly of data for this survey report, retaining an able engineer and investigator for this purpose. Special attention is invited to the association's letter of November 30, 1923,[1] herewith, transmitting the report of Maj. Gen. George W. Goethals, United States Army, retired, Appendix A,[1] on the present and prospective commerce tributary to the proposed waterway. General Goethal's assistant spent several months on the ground, and with the cooperation of the association, boards of trade, chambers of commerce, other organizations, corporations, and individuals, made a searching investigation and careful compilation of existing commerce, rail and water, and prepared the data in convenient form for judgment as to what the tonnage seeking the waterway might be. General Goethals personally spent two weeks along the route, holding conferences at all the principal cities and towns located on or near the canal. These meetings were impressive with two exceptions for their size, the citizenship represented, and the enthusiasm shown.

---

[1] Not printed

To sum up the local cooperation promised, the association--
speaking for the various interests of Louisiana and Texas, which it represents, pledges its assistance and cooperation respect to the following matters in the event the proposed project is adopted and its construction authorized:

First. That all necessary rights of way are furnished to the Government free of charge. (p.59)

Second. That adequate wharfage and terminal facilities are provided at such points along the waterway as the United States Government may deem advisable or necessary.

Third. That ample assurance, supported if necessary by appropriate guarantees, is given that sufficient facilities are provided for the transportation of such commodities as may seek movement through the canal.

The association "will be pleased to serve as the agency to insure the cooperation above detailed in the event the project is adopted and its construction authorized." (p.60)

138. I therefore recommend the adoption of the waterway project as recommended in the report of survey, excepting that an initial depth of 9 feet should be provided over the entire route, and that suitable passing places be made as found necessary; provided that local interests shall furnish without cost to the United States all rights of way and necessary spoil disposal areas,... (p.96)

P.L. 69-560 (1927)

An Act Authorizing the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

Louisiana and Texas Intracoastal Waterway. The Louisiana and Texas Intercoastal Waterway, from the Mississippi River at or near New Orleans, La., to Corpus Christi, Texas, in accordance with the report submitted in House Document Numbered 238, Sixty-eighth Congress, first session, and

subject to the conditions set forth in said document: Provided however, that the section from Galveston to the vicinity of Gulf, Texas, shall be constructed as recommended by the Board of Engineers for Rivers and Harbors in its report contained in the said document: Provided further, that not more than two Government dredges shall be incurred by the United States for the acquiring of any lands required for the purpose of this improvement.
The House Document referred to here is shown above.

P.L. 77-675 (1942)

AN ACT
To promote the national defense and to promptly facilitate and protect the transport of materials and supplies needful to the Military Establishment by authorizing the construction and operation of a pipe line and a navigable barge channel across Florida, and by deepening and enlarging the Intracoastal Waterway from its present eastern terminus to the vicinity of the Mexican border.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, in order to promote the national defense and to promptly facilitate and protect the transport of materials and supplies needful to the Military Establishment, there is hereby authorized to be constructed under the direction of the Secretary of War and the supervision of the Chief of Engineers ... and that there is also authorized the enlargment of the present Intracoastal Waterway from the vicinity of Apalachee Bay to Corpus Christi, Texas, and its extension to the vicinity of the Mexican border so as to provide throughout the entire length of the canal a channel twelve feet deep and one hundred and twenty-five feet wide:
The specific House Documents regarding the extension of the waterway

H.D. 402-77th Congress

WAR DEPARTMENT,
OFFICE of the CHIEF of ENGINEERS,
Washington, September 15, 1941.

The CHAIRMAN, COMMITTEE on RIVERS AND HARBORS,
House of Rep., Washington, D.C.

(2) After full consideration of the reports secured from the district and division engineers, and after affording local interests full opportunity to be heard, the Board recommends modification of the existing project for the Louisiana-Texas Intracoastal Waterway to provide for a channel 9 feet deep and 100 feet wide from Corpus Christi to Port Isabel via Laguna Madre and for a channel 9 feet deep and 100 feet wide from this waterway to the vicinity of Harlingen vis Arroyo Colo. with turning basin 9 feet deep, 400 feet wide, and 500 feet long at the upper end, all at an estimated first cost of $2,500,000 with $250,000 annually for maintenance in addition to the amount now required, no dredging to be done within 50 feet of any wharf or structure; subject to the condition that local interests furnish assurances satisfactory to the Secretary of War that they will provide free of cost to the United States all necessary lands, easements rights-of-way, and spoil-disposal areas for the initial improvement and its subsequent maintenance, when and as required, provide suitable

authorized are not stated in this act. However, the House Documents followed appears to be H.D. 402, 77th Congress, 1st Session and H.D. 230, 76th Congress, 1st Session.

terminal facilities, suitably reconstruct the highway bridge at Rio Hondo, provide such access roads and servicing facilities for supply of fresh water and fuel along the route as may be required by the Secretary of War upon recommendation of the Chief of Engineers, and hold and save the United States free from claims for damages resulting from the improvement. (p.2)

REEXAMINATION of LOUISIANA AND TEXAS INTRACOASTAL WATERWAY

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
Galveston, Tex., June 30, 1941.

... (p.6)

47. The local interests stated that they are able and willing to furnish free of cost to the United States the necessary rights-of-way and spoil-disposal areas required for the extension of the waterway on a route following the center of the Laguna Madre, known as the bay route, or along a route following the west shore of Padre Island; but that they will be unable to furnish right-of-way and spoil-disposal areas along an inshore route skirting the west shore of the Laguna Madre. The local interests have further stated that they will provide the necessary terminal facilities. (p.18)

166. Accordingly, the district engineer recommends that the existing project for the Louisiana-Texas Intracoastal Waterway be modified to provide for--

(a) Dredging a channel 9 feet deep by 100 feet wide in Corpus Christi Bay and the Laguna Madre from a point on the Port Aransas-Corpus Christi Waterway about 10 miles east of Corpus Christi to a connection with the Brazos Island Harbor project near Port Isabel, a channel distance of about 127 miles,

These recommendations are made subject to the following conditions:

(a) That no dredging shall be done by the United States within 50 feet of any wharf or structure.

(b) That local interests shall furnish free of cost to the United States all necessary lands, easements, rights-of-way, and suitable areas for the disposal of material excavated in the modification of the project and in its future maintenance, as and when required.

(c) That local interests shall hold and save the United States free from any damages that may result from the construction and maintenance of the project. (p.46)

(d) That before any work shall be undertaken by the Federal Government toward extending the project, the local interests shall furnish assurances satisfactory to the Secretary of War that they are ready to undertake the construction of the necessary terminal facilities at Harlingen and to reconstruct the county highway bridge at Rio Hondo in accordance with plans approved by the Secretary of War. (p.47)

H.D. 230-76th Congress

REEXAMINATION of LOUISIANA-TEXAS
INTRACOASTAL WATERWAY
from NEW ORLEANS, LA.,
to CORPUS CHRISTI, TEXAS

...

WAR DEPARTMENT,
U.S. ENGINEER OFFICES,
GALVESTON, TEXAS,
New Orleans, La.,
January 9, 1939.

27. Local Cooperation.--The conditions of local cooperation, specified in House Document No. 238, Sixty-eighth Congress, first session, and enumerated in paragraph 21 supra, have been met for that portion of the Intracoastal Waterway from the Mississippi River at New Orleans, La., to the Galveston-Brazoria County (Texas) line. Local interests have met all the requirements of local cooperation for the Intracoastal Waterway from the Galveston-Brazoria

County line to Corpus Christi, Texas, except furnishing approximately 20 percent of the necessary rights-of-way. They are now actively engaged in securing the remaining rights-of-way. (p.11)

85. Recommendations.--Accordingly, the Board of Officers recommends that the existing project for the Louisiana-Texas Intracoastal Waterway be modified to provide a channel with a cross-section that will afford a depth of 9 feet over a bottom width of 125 feet, and a depth of 12 feet over a bottom width of 100 feet, from the Mississippi River, at or near New Orleans, La., by way of the Harvey Lock to Corpus Christi, Texas, following, in general, the route of the existing project except where realignments are recommended in this report, at an estimated cost of $5,272,000 for new work in addition to that necessary to complete the present project and of an additional $201,000 annually for maintenance, subject to the conditions that local interests will furnish, without cost to the United States, all lands, easements, rights-of-way, and suitable spoil-disposal areas as and when needed. (p.24)

P.L. 87-874 (1962)

AN ACT

Authorizing the construction, repair and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

TITLE I--RIVERS AND HARBORS

Sec. 101. That the following works of improvement of rivers and harbors and other waterways for navigation, flood control, and other purposes are hereby adopted and authorized to be prosecuted under

H.D. 556-87th Congress

CORPS OF ENGINEERS, U.S. ARMY
BOARD OF ENGINEERS
FOR RIVERS AND HARBORS
Washington 25, D.C.
25 January 1962
(p.3)

16. Recommendation.--The Board accordingly recommends that the existing project for the Gulf Intracoastal Waterway be modified to provide for channels of the following dimensions through the reaches listed, except at existing locks and other structures and through intensively developed areas: ... (p.13)

A channel 16 feet deep and 150 feet wide through the reach from the Sabine River to the Houston Ship Channel with two relocations;

direction of the Secretary of the Army and supervision of the Chief of Engineers, in accordance with the plans and subject to the conditions recommended by the Chief of Engineers in the respective reports hereinafter designated: Provided, That the provisions of section 1 of the River and Harbor Act approved March 2, 1945 (Public Law Numbered 14, Seventy-ninth Congress, first session), shall govern with respect to projects authorized in this title; and the procedures therein set forth with respect to plans, proposals, or reports for works of improvement for navigation or flood control and for irrigation and purposes incidental thereto shall apply as if herein set forth in full: ...

Gulf Intracoastal Waterway, La., and Texas: House Document Numbered 556, Eighty-seventh Congress, at an estimated cost of $25,540,000: Provided, That the authority to make such modifications as in the discretion of the Chief of Engineers may be advisable, as set forth in House Document Numbered 556, Eighty-seventh Congress, shall be interpreted to apply to, but not limited to, the improvement of the existing channels at proposed channel relocation sites in lieu of such relocations;

A channel 12 feet deep and 125 feet wide through a relocated route in Matagorda Bay (mile 454.3 and mile 471.3);

A channel 12 feet deep and 125 feet wide through a relocated route in Corpus Christi Bay (mile 439.4 and mile 550); (p.14)

...

This work is recommended subject to the provision that prior to accomplishment of construction and maintenance, other than as now authorized, local interests agree to:

a. Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and of aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of spoil, and necessary retaining dikes, bulkheads and embankments therefor or the costs of such retaining works;

b. Accomplish and maintain without cost to the United States all alterations to pipelines, cables, and any other utilities necessary for the construction of the projects; (p.14)

c. Construct, maintain, and operate all bridges desired in the connection with the bypass route around Houma, Louisiana; and

d. Hold and save the United States free from damages resulting from the construction work and the maintenance of the channels. (p.15)

REPORT OF THE DISTRICT ENGINEER

REVIEW OF REPORTS
ON
GULF INTRACOASTAL WATERWAY,
LOUISIANA-TEXAS SECTION

U. S. ARMY ENGINEER DISTRICT,
NEW ORLEANS CORPS OF ENGINEERS
Foot of Prytania Street
New Orleans, Louisiana, 25 August 1961

LOCAL COOPERATION OF EXISTING
AND PRIOR PROJECTS

The acts authorizing the main channel of the Gulf Intracoastal Waterway required that local interests furnish free of cost to the United States all necessary rights-of-way and suitable spoil disposal areas; defray the cost of constructing or remodeling all highway bridges, together with their subsequent maintenance and operation; and furnish satisfactory assurances to the Secretary of the Army that adequate vessels, terminals, and auxillary equipment would be available on completion of the channel for the economic handling of at least 500,000 tons of commerce annually on the New Orleans-Sabine section; at least 400,000 tons of commerce annually on the Sabine River-Galveston Bay; and at least 300,000 tons annually on the Galveston Bay-Corpus Christi section. Local interests have complied fully with all requirements of local cooperation on the completed portions of the main channel. The cost to local interests of this cooperation is large, but records of its amount are not available. (p.36)

PROPOSED LOCAL COOPERATION

It is proposed that the following local cooperation be prescribed:

(1) Provide without cost to the United States all lands, easements and rights-of-way required for construction and subsequent maintenance of the project and of aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the

Chief of Engineers to be required in the general public interest for initial and subsequent disposal of spoil, and necessary retaining dikes, bulkheads and embankments therefor or the costs of such retaining works.

(2) Accomplish and maintain without cost to the United States all alterations to pipelines, cables, and any other utilities necessary for the construction of the project.

...

(3) Construct, maintain, and operate all bridges desired in connection with the bypass route around Houma, La. The United States will contribute 58% ($1,780,000 based on current estimate) of the construction costs of these bridges. (p.74)

COORDINATION WITH OTHER AGENCIES

...

j. The Governors of the States of Louisiana and Texas have agreed to cooperate in furnishing items of local cooperation.

k. The Department of Commerce has informed the Chief of Engineers that Federal aid highway funds are not available to defray any part of the costs of altering Federal aid highways for water resources projects where local interests are required to assume the cost of such adjustment as part of the local construction. (p.78)

APPENDIX 2

REQUIREMENTS FOR A NEW PORTION OF THE GIWW

The requirements for local sponsorship may change with each individual federal project authorized by Congress. It would be difficult to predict what requirements would be required for alterations, improvements, or enlargement of the Waterway in the future. Presented below are the requirements of local cooperation deemed necessary by the Corps of Engineers for the Gulf Intracoastal Waterway, St. Marks to Tampa Bay, Florida. The requirements appear on page 50 of H. Doc. 396-90/2, September 19, 1968. In determining the extent of the responsibilities of the local interests, the Corps of Engineers takes into account the federal interests and purposes in the project and balances these against the local interest, purposes, and benefits. It is possible for the local responsibilities to be very high and costly for some projects, while on the other hand, the Corps could assume all of the financial burdens for a proposed project. The requirements set out below are far in excess of those required on the portions of the GIWW in Texas.

H. DOC. 386-90/2, SEPTEMBER 19, 1968
Gulf Intracoastal Waterway, St. Marks to Tampa Bay, Florida

...

62. Requirements of local cooperation.--a. Navigation.--In accordance with established procedures, local interests would be required to contribute cash toward the cost of construction in proportion to the degree of local benefits, and to give assurances satisfactory to the Secretary of the Army that they would:

(1) Provide without cost to the United States all lands, easements and rights-of-way required for construction and subsequent maintenance of the project and for aids-to-navigate upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of spoil, and also necessary retaining dikes, bulkheads and embankments therefor or the costs of such retaining works;

(2) Operate and maintain bridges without cost to the United States;

(3) Hold and save the United States free from damages that may result from the construction and maintenance of the project;

(4) Provide and maintain at local expense adequate public terminal and transfer facilities open to all on equal terms;

(5) Accomplish without cost to the United States such utility or other relocations or alterations as are required for project purposes;

(6) Provide, prior to post-authorization planning, a long range plan for development of the region;

(7) Contribute in cash 6.6 percent of the construction cost including engineering and design and supervision and administration of construction of all dredging work to be provided by the Corps of Engineers, an amount now estimated at $5,570,000 to be paid either in a lump sum prior to start of construction, or in installments prior to start of pertinent work items, in accordance with construction schedules as required by the Chief of Engineers, the final apportionment of cost to be made after actual costs have been determined; and

(8) Establish regulations prohibiting discharge of untreated sewage, garbage, and other pollutants in the water of the channel by users thereof which regulations shall be in accordance with applicable laws or regulations of Federal, State and local authorities responsible for pollution prevention and control.

b. The proposed plan of improvement and requirements of local cooperation have been reviewed by local interests. They are generally in agreement with the plan and have indicated their intentions of meeting the requirements of local cooperation. The nine existing highway bridges across the southern section of the waterway are now operated and maintained by local interests. This would continue to be a local responsibility, and in addition, local interests would be required to operate and maintain the two new highway bridges proposed to be constructed as a Federal responsibility. The current qualified local sponsoring organizations consists of three separate navigation districts organized under State Law. In the interest of orderly and economical programing of construction work, it is believed that it would be advisable for local interests to consolidate the pertinent portions of the existing navigation districts into a single fully-qualified sponsoring organization. By resolution dated October 10, 1967, copy of which is included in appendix C, the Florida Board of Conservation has stated its intention of furnishing the requirements of local cooperation through navigation districts under its jurisdiction.

c. At the public hearing held in Tampa on October 24, 1967, the local sponsor was advised that the cash contribution toward the improvement would be about 6 percent, an amount tentatively estimated to be about $4,500,000. Based on subsequent changes in design criteria and other refinements, costs presented herein show that the local cash contribution would be 6.6 percent, a contribution now estimated at $5,570,000.

APPENDIX 3

STATE OF TEXAS

Perpetual Spoil Disposal Easement

COUNTY OF BRAZORIA

This conveyance from _____, hereinafter styled Grantor, to the United States of America and its assigns, hereinafter styled the United States,

W I T N E S S E T H:

THAT WHEREAS, the United States is engaged in the work of constructing, operating, maintaining, enlarging and improving the Gulf Intracoastal Waterway Project as authorized by Congress; and

WHEREAS, Grantor is the owner in fee simple title of a tract of land in Brazoria County, Texas, required for spoil disposal operations to be conducted in the performance of said work and is willing to grant to the United States a perpetual easement therein for such purposes;

NOW THEREFORE, for and in consideration of the benefits which will accrue to it as the result of the Gulf Intracoastal Waterway Project and for other good and valuable consideration the receipt and sufficiency of which is hereby acknowledged, Grantor does by these presents grant and convey unto the United States and its assigns the perpetual right, privilege and easement in the hereinafter described land to deposit thereon spoil material and debris resulting from dredging operations performed in the construction, operation, maintenance, improvement and enlargement of the Gulf Intracoastal Waterway project, including the rights to construct, repair, relocate and remove dikes, levees, spillways, discharge pipelines, ditches, drains, culverts, sluices, flumes and all other works, structures or improvements connected with or incidental to the performance of such dredging work, together with full rights of ingress to and egress from such land with personnel, vehicles and equipment engaged in the performance or inspection of such work.

The land subject to this conveyance is situated in the _____ _____ survey, Brazoria County, Texas and consists of _____ acres, more or less, as more particularly described by metes and bounds as follows:

(insert legal description)

TO HAVE AND TO HOLD the rights and easements herein granted unto the United States and its assigns forever and Grantor for itself, its successors and assigns hereby agrees to warrant and defend title to the same in the United States and its assigns against the claims and demands of all others.

IN WITNESS WHEREOF, Grantor has caused these presents to be executed on this the _____ day of _____ 19 _____.

APPENDIX 4

TEXAS PARKS AND WILDLIFE
COMMISSION POLICY

PART I

Policy No.: 3000-0

Date Approved: January 25, 1974 Effective Date: February 8, 1974

PART II

Title of Policy: Dredge Spoils

CONTENTS

1. It is the policy of the Parks and Wildlife Commission to:

   A. Recognize wetland areas as being of indispensible value to appropriate fish and wildlife;

   B. Recognize that the deposition of dredge spoil in wetland areas, as defined here, often can be detrimental to fish and wildlife resources.

      1. Coastal wetlands include marshes, grass flats, ecologically valuable bay bottoms and island rookeries.

      2. Inland wetlands include marshes, swamps, and oxbow lakes.

   C. Where the deposition of spoil is opposed, any posture of opposition is to be in accordance with: the limits of statutory authority; Public Law 85-624, sections 661-666c cited as the Fish and Wildlife Coordination Act of 1958; and Public Law 91-190 cited as the National Environmental Policy Act of 1969.

      1. In those cases where the staff has determined that a wetland area has particularly valuable or unique esthetic or ecological qualities, spoil disposal proposals which would adversely affect the area will be opposed. Alternate spoil disposal sites may be recommended. In those cases where recommendations are provided, ecological need will be a major determining factor of consideration.

      2. In those cases where the staff determines that detrimental environmental effects can be substantially minimized, the implementation of spoil disposal techniques which result in minimization will be recommended. Ecological need will be a major determining factor of consideration.

a. Spoil should be confined as much as possible in order to cover a minimum amount of bay bottom. Existing spoil dumps should be utilized when available. In valuable, shallow habitat, toe levees on emergent spoil islands or ring levees may be recommended. Construction of permanent levees for spoil containment that would eventually convert large areas of the bays to dry land, however, should be avoided. Where the anticipated volume of spoil indicates a need for such levees, spoil should be either placed on shore or transported from the bay.

b. Existing or newly designated spoil areas on State-owned land should be retained for that purpose subject to IB1 and IB2 above. Conflicting uses of these areas should be brought to the attention of the appropriate authorities.

c. Continuous spoiling, to create lengthy spoil barriers across water areas, alters circulation and can result in shoaling, degradation of water quality, and interruption of fish migratory patterns. Spoilings may be alternated to opposite sides of the channel and openings should be left with sufficient bottom width and cross section to permit water exchange.

d. When physically possible and environmentally desirable, new or greatly enlarged spoil areas should be situated in waters deeper than four foot depth; so oriented as to cause minimum interference with current patterns and migration routes; and so situated that shallower waters offering sancturary and nursery opportunities are not displaced.

e. Toxic spoil materials should be retained on shore with provisions made for settling of solids before the water is returned to the bay or watercourse. Recommendations concerning the disposition of toxic spoil are coordinated with the Texas Water Quality Board.

f. Each policy procedure will be inspected and evaluated by Departmental personnel. Quantity and type of spoil, importance of water over spoil sites, effect on current or water movement, and availability of alternate or on-shore spoil sites will be considered.

2. Special Conditions:

   This policy does not apply to those persons, firms, organizations or agencies which are required to obtain a permit from the Parks and Wildlife Department under articles 4051-52-53 and 53d.

   It is the purpose of this policy to provide guidance to the Department staff when commenting on projects or works proposed by other agencies in the absence of the need for a permit from this Department. Such projects which do require issuance of a permit from this Department will be governed by the Rules and Regulations Governing the Issuance of Permits to Remove Sand, Gravel and/or Fill Material From the Public Waters of Texas, and by the Regulations and Orders for the Issuance of Shell Permits.

3. This policy shall rescind any conflicting former policy and shall remain in effect until withdrawn or amended by the Commission.

APPENDIX 5

COASTAL PUBLIC LANDS MANAGEMENT ACT of 1973.

...

Sec. 10. PERMITS. (a) The board may issue permits authorizing limited continued use of heretofore unauthorized structures on coastal public lands, where such use is sought by one claiming an interest in any such structure but is not incident to the ownership of littoral property.

(b) Permits granted pursuant to this section shall be subject to the following policies, provisions, and conditions, in addition to those generally applicable in this Act:

(1) The board may not grant any permit authorizing the continued use of any structure located within 1,000 feet of:

(i) privately owned littoral property, without the written consent of the littoral owner;

(ii) any federal or state wildlife sanctuary or refuge;

(iii) any federal, state, county, or city park bordering on coastal public lands.

(2) A permit authorizing continued use of an heretofore unauthorized structure on coastal public lands shall be deemed automatically revoked and terminated if the coastal public land where the structure is located is subsequently leased for public purposes or exchanged for littoral property pursuant to this Act, or if such land is conveyed to a navigation district as provided by law.

(3) Every permit shall provide that in the event the terms of the permit are broken, the permit may, at the option of the board, be terminated.

(4) Such structures may be used only for noncommercial, recreational purposes.

(5) Permits may be issued for a period not to exceed five years and may be renewed at the discretion of the board.

(6) The board may not grant any application for a permit which would be in violation of the public policy of this state as expressed in this Act, nor may it grant any permit for any structure not in existence on the effective date of this Act.

(7) In the event a structure for which a permit has been issued is severely damaged or destroyed by any means, no major repairs or rebuilding may be undertaken by the permitholder without the approval of the board.

(c) All structures for which a permit is required pursuant to this section, now existing or which shall be built, are declared to be the property of the state; and any construction, maintenance, or use of such structure, except as authorized in this section, is declared a nuisance per se and is expressly prohibited.

APPENDIX 6

FORM-CPL 3
8-27-73

STATE OF TEXAS
COASTAL PUBLIC LANDS

PERMIT NO._____

THE STATE OF TEXAS } STRUCTURE NO._____

COUNTY OF TRAVIS }

The State of Texas, hereinafter call Grantor, acting by and through the Commissioner of the General Land Office upon authority vested in him by Article 5415e-1 V.A.C.S., does hereby grant to _____Address_____ _____, hereinafter called Grantee, a permit for continued use of the following described structure, to-wit:

ANY USE OF THE RIGHTS SOUGHT HEREUNDER OTHER THAN SPECIFICALLY SET OUT WILL SUBJECT THIS PERMIT TO FORFEITURE.

I, Bob Armstrong, Commissioner of the General Land Office of the State of Texas and Chairman of the School Land Board do hereby issue this permit on the above described structure unto said _____ _____ for a term of _____ _____, beginning on _____ _____, 19_____, at $_____per annum, upon the following terms and conditions:

1. This permit is granted for use of aforesaid structure for recreational purposes.

2. The Grantee shall not assign this permit, either in whole or in part, without prior written approval of the School Land Board.

3. No major repairs or rebuilding may be undertaken without prior written approval of the School Land Board.

4. The Grantee agrees that the rights of the general public shall not be impaired and Grantee will not interfere with public use of the area except for the enclosed areas wherein personal property can be kept under lock and key.

5. The Grantee agrees to aid in the protection of the natural resources of the area and to help preserve this area in its natural state for the protection of all types of marine life and wildlife.

APP. 6 Continued

6. The Grantee agrees to maintain adequate sanitation facilities, properly dispose of all waste and garbage and keep the area litter-free.

7. This permit is issued subject to other easements and leases and shall be subject to forfeiture where a conflict exists. This permit shall terminate if the land is subsequently leased for public purposes.

8. In the event this permit is terminated for any reason, Grantee agrees to remove all structures from the area herein permitted at the discretion of the Commissioner of the General Land Office.

9. Failure to comply with any of the provisions of this permit shall subject this permit to forfeiture by the Commissioner of the General Land Office. The permit shall be considered forfeited by sending a registered letter of such notice to the last address filed in this office by Grantee.

IN TESTIMONY WHEREOF, witness my hand and the seal of the General Land Office of the State of Texas, this the _____ day of _____ _____, 19_____.

THE STATE OF TEXAS

BY _____
Bob Armstrong, Commissioner of the General Land Office and Chairman of the School Land Board.

GRANTOR

_____
GRANTEE

General
Land Office
AUSTIN, TEXAS 78701
BOB ARMSTRONG, COMMISSIONER

Re:

Enclosed herewith is your captioned permit fully executed by the Commissioner of the General Land Office. One copy has been retained for our files.

Your permit number (P-) must be displayed on your cabin in no less than 4" block letter and numerals. The number may be either decals, metal or painted of contrasting color and affixed to the cabin in a location which can be readily seen from the nearest access channel.

If we may be of further service, please advise.

Sincerely,

Bob Armstrong

By

Gene W. Clark, Coastal Supervisor
Sales, Leasing & Mining Division
Phone 512 475-6326

GWC/sb
Enclosure

APPENDIX 7

V.A.T.S.
Art. 8263i. Navigation districts composed of parts of one or more of certain counties; use of public lands and waters; conveyances to United States

Section 1. Any navigation district created under the provisions of Chapter 5 of the Acts of the 39th Legislature in 1925 (Vernon's Texas Civil Statutes, Article 8263i) composed of parts of one or more counties, one of which counties has one or more boundaries coincident with any part of the international boundary between the United States and the Republic of Mexico or is adjacent to any county which has one or more boundaries coincident with any part of the international boundary between the United States and the Republic of Mexico, is hereby granted and conveyed the free and uninterrupted use, liberty and easement in and to all the rivers, streams, bayous, arroyos, resacas, lakes, lagoons, bays, arms of the sea, beds, banks or shores thereof, mud flats or other lands covered or partly covered by the waters of any of the bays or other arms of the sea, and any other submerged land or lands owned by the State of Texas within the county or counties in which such district or districts are located and within the adjoining counties thereto, and along the route of any waterway, a part of which lies within such district, in order to connect such waterway with the Louisiana and Texas Intracoastal Canal Waterway now completed to Brownsville, Texas, for the purpose of navigation. Provided, nevertheless, that nothing in this Act shall be construed to affect or impair any vested rights heretofore granted by the State of Texas in and to such lands and waters; provided further, that nothing in this Act shall be construed to affect or impair private vested rights. As amended Acts 1953, 53rd Leg., p. 453, ch. 139, § 1.

Sec. 2. When any such navigation district may be the owner of any property, land, or interest in land desired by the United States of America to enable any department or establishment thereof to carry out the provisions of any Act of Congress in aid or navigation, flood control, or improvement of water courses in aid of navigation, any such district of this state is hereby authorized and empowered, upon request by the United States through its proper officers for conveyance of title or easement to any part of such property, land, or interest in land, which may be necessary for the construction, operation, and maintenance of such works, to convey the same with or without monetary consideration therefor to the United States of America, and such navigation districts are hereby specifically authorized to acquire such necessary lands and rights of way in order to carry out the provisions or meet the conditions of such Act of Congress.

Sec. 3. This Act shall be cumulative of all existing laws upon the subject of this Act.

Sec. 4. If any section, word, phrase, clause or sentence in this Act shall be declared unconstitutional for any reason, the remainder of this Act shall not be affected thereby. Acts 1947, 50th Leg., p. 267, ch. 163.

APPENDIX 8

V.A.T.S.
Art. 5248a. Granting easement to the United States in certain lands

Section 1. That there is hereby granted and conveyed to the Government of the United States of America the free and uninterrupted use, liberty, and easement of constructing and maintaining the proposed Louisiana and Texas Intracoastal Waterway over and through disconnected portions of the stream beds of Mud Bayou and East Bay Bayou from approximately Station 1519 to approximately Station 1914 as shown on United States Engineer Department map, "Louisiana and Texas Intracoastal Waterway, Sabine River-Galveston Bay Section, Survey of 1926-7, Sheet No. 12, File 16-2-16," the said portions of the stream beds of Mud Bayou and East Bay Bayou covered by this easement being 300 feet wide and located in Chambers and Galveston Counties where the proposed Intracoastal Waterway will intersect the meanderings of the bayous.

Section 2. Provided, however, that should the United States of America fail or refuse to construct said Intracoastal Waterway prior to January 1, 1939, or should said Government cease to maintain or to have maintained said Intracoastal Waterway at any time, then this right of easement shall cease and determine, and all right of whatsoever nature shall revert and be vested in the State of Texas.

Section 3. Provided, further, that nothing in this Act shall be construed to affect or impair any vested rights, or the right to use and maintain any bridge or bridges now in existence on or across said Mud Bayou, or East Bay Bayou, and the right of the owner of any such bridge to use and maintain the same is hereby expressly recognized and confirmed. Acts 1929, 41st Leg., 1st C.S., p. 175, ch. 66.

Art. 5248b. Granting easement to United States for Louisiana and Texas Intracoastal Waterway

Section 1. There is hereby granted and conveyed to the United States of America the free and uninterrupted use, liberty, and easement to construct and maintain the Louisiana and Texas Intracoastal Waterway over and through disconnected portions of bays and tidal lands owned by the State of Texas within an area three hundred (300) feet in width extending from the Galveston-Brazoria County Line to the nine-foot contour in Aransas Bay along the route or the projected Louisiana and Texas Intracoastal Waterway as shown in red on map, in four (4) sheets, prepared by the United States Engineer Office, Galveston, Texas entitled "Louisiana and Texas Intracoastal Waterway, Survey of 1927-1928," Index use, liberty, and easement to deposit dredged material during construction and maintenance of the waterway in bays and on tidal lands owned by the State of Texas within two thousand (2,000) feet of the above described area, said portions of bays and tidal lands located in Brazoria, Matagorda, Calhoun, and Aransas Counties.

Section 2. Provided, however, that should the United States of America fail or refuse to construct said Intracoastal Waterway prior to January 1, 1947, or should said Government cease to maintain or to have maintained said Intracoastal Waterway at any time, then this right of easement shall cease and determine, and all right of whatsoever nature shall revert and be vested in the State of Texas.

Section 3. Provided, further, that nothing in this Act shall be construed to affect or impair any vested rights. Act 1937, 45th Leg., p. 801, ch. 393.

APPENDIX 9

Possible institutional alternatives to furnish the requirements of local sponsorship for the Gulf Intracoastal Waterway.*

I. Private Sources:

A. Gulf Intracoastal Canal Association:
This is a private association made up of private and public members interested in the Waterway from Texas to Florida. Its role is essentially one of promoting the Waterway. The Association's members benefit most directly from the GIWW. It has in the past agreed that it would provide assistance in the local sponsorship process.

B. Private Industries:
Contributions might be solicited from the various industries located adjacent to the Waterway. These contributions would have to be voluntary in nature, and it might prove difficult to have these provided on an equitable basis. They would probably point out that the GIWW is a public waterway and should be financed by public funds.

C. Private Landowners:
Those landowners located along the canal might agree to furnish the rights of way and easements free of charge as they did when the canal was originally being constructed. Because of the tremendous increase in value of the land, it is doubtful that these landowners would agree to do this.

II. Governmental Sources

A. One Special Purpose District:
Legislation could be developed to authorize the creation of a special purpose district with powers to manage the operations of the GIWW. While present legislation authorizing navigation districts might be used, there would probably be a need to formulate new legislation designed specifically to address the issues involved with management of the Waterway. Such a district would provide for local control over the management of the Waterway and would be similar to the River Authorities in Texas. Such a district would have taxing power and the financial capacity to meet the requirements of local sponsorship.

B. Existing Navigation Districts:
It might be possible to extend the jurisdiction of the existing navigation districts to include all portions of the GIWW. It would provide for local control over the management

*This listing is not presented in any order of priority.

of the Waterway. The various navigation districts could then be designated as the local sponsor for their portion of the waterway. The entire GIWW in Texas would then have designated local sponsors.

C. Counties:

Counties do have the taxing authority which would allow them to develop funds which could be used to provide the financial requirements associated with local sponsorship. If all the coastal counties participated, local sponsorship for the entire Waterway would be provided. The principle drawback here is that those counties where the greatest amounts of money would have to be expended are not necessarily the counties which derive the greatest benefit.

D. State Agencies

If a state agency is given the responsibility for state sponsorship, it will be necessary to provide a mechanism to allow that agency to coordinate the activities of the other state agencies which have existing responsibilities or interests in the Waterway.

1. Create a New Agency:

This would require new legislation and would necessitate the development of a new funding source unless existing funding could be transferred to it. There is considerable question as to whether a new bureaucracy should be created merely to manage and sponsor the Waterway.

2. Governor's Office:

The Governor of Texas already has the powers necessary to provide the requirements for local sponsorship. State appropriations would be necessary when the requirements of local sponsorship dictated that funds were needed for specific purposes.

3. General Land Office:

This office manages the submerged lands of Texas, and presently is charged with responsibility for a great portion of the bay and estuarine submerged lands through which the Waterway passes. This agency has the responsibility for developing the State's response to the Coastal Zone Management Act.

4. Texas Water Development Board:

The Board has a ready fund (the Texas Water Development Fund) which might be used to provide the financial requirements of local sponsorship. It also is the agency specifically designated to provide coordination

and cooperation with federal governmental agencies regarding the planning of water resource projects.

5. Texas Water Rights Commission:
Presently has responsibility for reviewing all proposed federal water projects and determining whether or not they are appropriate for implementation in Texas.

6. Texas Highway Department:
The requirements of local sponsorship often require the removal or alteration of bridges in the vicinity of the projects. The Highway Department has in the past assumed this responsibility for the State of Texas. The Department has available to it money from the State Highway Fund.

7. Texas Parks and Wildlife Department
This department is responsible for formulating the state's response to those federal projects which require consideration being given to the protection of fish and wildlife and their habitats. The protection of fish and wildlife has been the immediate reason for the question of additional local sponsorship of the Waterway. The Texas Parks and Wildlife Department has available to it monies in the Special Game and Fish Fund.

BIBLIOGRAPHY

Books:

Anderson, Frederick R., NEPA in the Courts.

Gray, Oscar S., Environmental Law--Cases and Materials, Second Edition.

National Waterways Conference, Inc., The Impact of Waterway User Charges.

Reitze, Arnold W., Jr., Environmental Law, Second Edition.

Reitze, Arnold W., Jr., Environmental Planning.

Cases:

Allan v San Jose Land and Water Company, 28 P. 215 (1891).

Bland Lake Fishing and Hunting Club v Fisher 311 SW2d 710.

Calvert Cliffs' Coordinating Committee v Atomic Energy Commission, 449 F.2d 1109 (D.C.Cir. 1971).

Fendall v Miller, 196 P. 381 (1921).

Hasselbring v Koepke, 248 NW 869.

Kentucky and W. Va. Power Co. v Elkhorn City Land Co., 279 SW 1082.

Miller v Florida Inland Navigation District, 130 SO2d 615.

Sierra Club v Froelke, 359 F. Supp. 289 (S.D. Tex., 1973).

Zable v Tabb, 420 F.2d 199 (5th Cir. 1970).

Statutes:

U.S.

P.L. 68-585

P.L. 69-560

P.L. 77-763

P.L. 79-14

P.L. 87-874

P.L. 91-190

P.L. 92-583

Statutes:

U.S.

P.L. 93-190

16 U.S.C. 661 et seq.

33 U.S.C. 5.

Alabama

Alabama Statutes, Title 38, Section 1 et seq.

Alabama Statutes, Title 38, Section 45 et seq.

Florida

F.S.A. Sect. 370 et seq.

F.S.A. Sect. 374 et seq.

Louisiana

L.S.A.-R.S. 34:345

L.S.A.-R.S. 34:361 et seq.

L.S.A.-R.S. 34:2251 et seq.

L.S.A.-R.S. 47:341

L.S.A.-R.S. 47:355

L.S.A.-R.S. 47:1982

Michigan

M.C.L.A. 281.501 et seq.

Mississippi

Mississippi Code, Sect. 59-1-1

Mississippi Code, Sect. 59-5-1 et seq.

Mississippi Code, Sect. 59-7-1 et seq.

Texas

V.A.T.S. Art. 822f.

V.A.T.S. Art. 4413b(i)

V.A.T.S. Art. 4413d(i)

V.A.T.S. Art. 4386b.

V.A.T.S. Art. 5240

Statutes:
Texas
V.A.T.S. Art. 5242

V.A.T.S. Art. 5244a.

V.A.T.S. Art. 5245

V.A.T.S. Art. 5247

V.A.T.S. Art. 5248a.

V.A.T.S. Art. 5248b.

V.A.T.S. Art. 5261 et seq.

V.A.T.S. Art. 5415e et seq.

V.A.T.S. Art. 6081r.

V.A.T.S. Art. 6674 et seq.

V.A.T.S. Art. 6694

V.A.T.S. Art. 6797c.

V.A.T.S. Art. 7147

V.A.T.S. Art. 7157

V.A.T.S. Art. 7472e.

V.A.T.S. Art. 8263i.

V.A.T.S. Tax Gen. Art. 9.01 et seq.

V.A.T.S. Tax Gen. Art. 10.01 et seq.

Tex. Wat. Code, Sect. 11.251

Tex. Wat. Code, Sect. 11.252(i)

House Documents:

H.Doc. 238, 68th Cong.

H.Doc. 287, 69th Cong.

H.Doc. 230, 76th Cong.

H.Doc. 402, 77th Cong.

House Documents:

H.Doc. 556, 87th Cong.

H.Doc. 386, 90th Cong.

Policies:

Internal Corps of Engineers Regulations, EP-1165-2-1.

Texas Parks and Wildlife Commission Policy, Dredge Spoils, Policy No. 3000-9.

Presentations:

Remarks by Col. Don S. McCoy before the Special Committee of the Texas Ports Association, Galveston, Texas, on October 25, 1973.