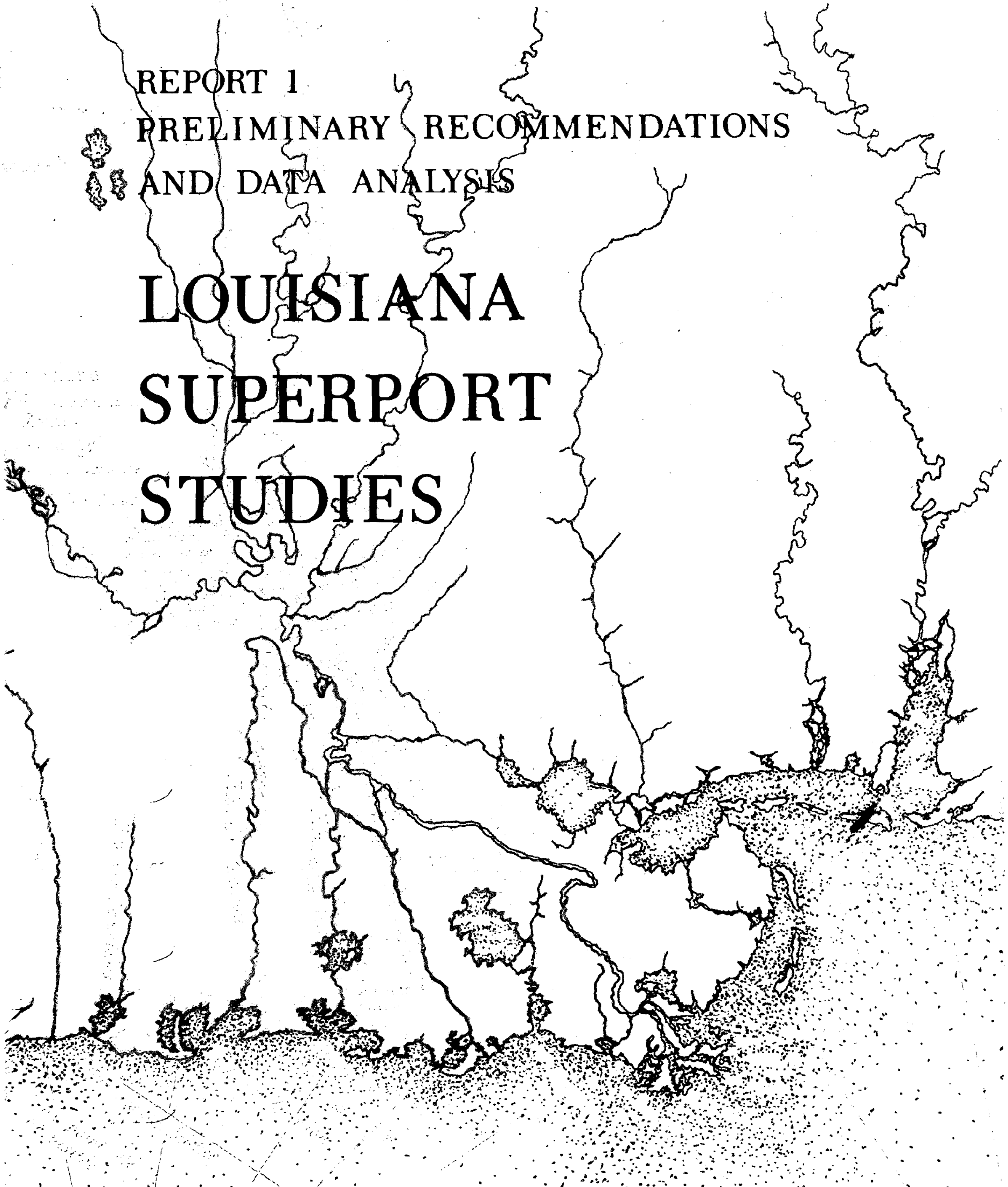
REPORT 1
PRELIMINARY RECOMMENDATIONS
AND DATA ANALYSIS

LOUISIANA SUPERPORT STUDIES



CENTER for WETLAND RESOURCES

LOUISIANA STATE UNIVERSITY · BATON ROUGE

Publication No. LSU-SG-72-03

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LOUISIANA SUPERPORT STUDIES

Report No. 1

Preliminary Recommendations
and Data Analysis

Publication No. LSU-SG-72-03

Center for Wetland Resources
Louisiana State University
Baton Rouge, Louisiana

August 1972

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Center for Wetland Resources
COASTAL STUDIES INSTITUTE • OFFICE OF SEA GRANT DEVELOPMENT • DEPARTMENT OF MARINE SCIENCES

2 August 1972

Mr. P. J. Mills, Acting Secretary
Board of Commissioners of the
Deep Draft Harbor and Terminal Authority
29th Floor, International Trade Mart
New Orleans, Louisiana 70130

Dear Mr. Mills:

I am pleased to submit Report No. 1 in a series of Louisiana Superport Studies. The report documents initial data analysis activities and provides preliminary recommendations concerning the development of a deep water port for Louisiana.

The study was sponsored by the Louisiana Superport Task Force--the predecessor of the Authority--and, in part, by NOAA Office of Sea Grant, U. S. Department of Commerce. The work was directed by the Center for Wetland Resources of Louisiana State University at Baton Rouge and conducted during the period 1 January 1972 - 15 June 1972. University personnel from the Center, the College of Business Administration, the College of Engineering, and the Law Center contributed to the study. Dr. James H. Stone served as project director and coordinator. The legal section of the report was prepared by Messrs. Marc J. Hershman, Armin J. Moeller and H. Gary Knight; the economics section, by Dr. David B. Johnson; the environmental section, by Drs. Sherwood M. Gagliano and John W. Day, Jr.; the engineering section, by Dr. Charles A. Whitehurst, Dr. David Modlin, Mr. W. T. Durbin and Mr. Greg Matherne. Technical support and information provided by the staffs of the Louisiana Superport Task Force, the Board of Commissioners of the Port of New Orleans, the Louisiana State Planning Office, the Louisiana Register of State Land Office, and the Lower Mississippi River Field Facility of the U. S. Environmental Protection Agency is gratefully acknowledged.

In addition to preliminary recommendations, an outline of proposed future studies is included in the report. Budget and scheduling estimates for these studies are also provided. Much of the material--in draft form--was previously supplied the Louisiana Superport Task Force and partially incorporated in its June 1972 report entitled A Superport for Louisiana.

We are especially pleased to assist the Authority in achieving its assigned objectives. The LSU Center for Wetland Resources is dedicated to the application of university capabilities in the solution of practical coastal and floodplain problems and the encouragement of cooperative university-government-industry programs. The development of a Louisiana Superport can provide an important--and ideal--mechanism to demonstrate the effectiveness of such cooperation in maximizing benefits for the people of Louisiana and the nation.

Sincerely,

Jack R. Van Lopik
Director
Center for Wetland Resources

jm

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SUMMARY OF RECOMMENDATIONS

We believe that a Superport* can be effectively located off the coast of Louisiana between Bayou LaFourche and Southwest Pass. This general location offers the economic advantages of close proximity to the Mississippi River and other inland waterways and water depths sufficient to handle superships**. We also believe that this project, if carefully conceived, can be implemented between 1976-78 in such a way that environmental constraints and stresses will be minimal.

PREMISES

Before discussing the rationale leading to the above conclusions, the specific site, and recommendations for that site, it is necessary to state explicitly that these preliminary recommendations are based on readily available data. No field investigations or monitoring programs were conducted and, as a result, the data base for certain areas is incomplete. Additional baseline data must be gathered over the next two years. For this study we assumed the following:

1. An oil and gas shortage exists in the United States.
2. Oil refineries in Louisiana will need to import additional crude oil and gas by about 1975.
3. Superships will be increasingly employed in world trade.

---

*"Superport" and "deepwater port" are considered to be synonymous terms and are defined as facilities which are capable of receiving superships and handling their cargoes and related needs.

**Ships with a minimum dead weight tonnage (DWT) rating of 200,000 and drafts up to 90 feet.

PRELIMINARY RECOMMENDATIONS

1. Louisiana should create a governmental agency to deal specifically with Superport (or equivalently, deepwater port) problems as a means of establishing appropriate plans and objectives, such as suitable environmental safeguards and controls.
2. The Superport should be located in waters equal to or greater than 100 feet in depth between Bayou LaFourche and Southwest Pass.
3. To obtain maximum economic advantage for Louisiana, the Superport should be constructed as soon as possible.
4. The Superport should be, initially, only an oil-receiving terminal, and only one such terminal should be developed off Louisiana.
5. The environmental and engineering design of the Superport should be adequate to incorporate the flow of all types of commodities at a later time. Crude oil might be better handled at a (initially constructed) separate and distinct terminal, but this terminal should be contiguous to future terminals receiving other commodities.
6. Work must begin immediately in the following areas:
    a) Formulation of an Environmental Protection Plan as specified according to Louisiana Revised Statute 34:3101-3114.
    b) Clarification of the legal aspects of port operations on the high seas and seabeds beyond the state's jurisdiction.
    c) Acquisition of accurate petroleum-flow data and study of these under varying assumptions.

d) Acquisition of other commodity-flow data.

e) Determination of comparative costs of port construction, operation, maintenance, and finances.

f) Determination of potential economic impact of a Superport on future state revenues and economic development within Louisiana.

g) Initiation of field investigation of various environmental factors such as currents, meteorology, and soil foundations.

h) Initiation of computer model studies of types of Superport structures (such as semisubmerged platforms) or breakwater systems.

RATIONALE FOR RECOMMENDATIONS

Basis for Recommendation 1.

Louisiana should create a governmental agency to deal specifically with Superport (or equivalently, deepwater port) problems as a means of establishing appropriate plans and objectives, such as suitable environmental safeguards and controls.

We believe that some state control is necessary. If port operations are outside the state's jurisdiction, it might be necessary for legal restrictions to apply at the point at which the pipelines enter state jurisdiction. State control ensures that additional Superports or deepwater ports are not established in an unprofitable and random manner, and that meaningful environmental controls are established. (See also the legal section of this report.) Also, state control would, it is hoped, ensure multiple use and rational conservation of the resources of the coastal wetlands.

We do not believe that a Superport designated as an oil terminal is simply another oil platform. For example, the projected flow of oil through one port has been placed at approximately four million barrels per day, or about one and one half billion barrels per year. This volume of oil is of the same order of magnitude as the total 1968 production from both onshore and offshore Louisiana. If we assume accidental spillage during operations at rates between 0.001%* and 0.00004%**, then the respective losses amount to approximately 15,000 or 600 barrels (2100 or 84 long tons) of oil per year. We do not know whether the coastal and estuarine waters off Louisiana can assimilate this oil without degrading the environment, nor do these figures take into account the possibility of a massive spill. The probability of occurrence of a massive spill at any one time is probably quite small, but operations over 10 to 20 years will probably greatly increase the possibility of an accident. We believe that the development of several sites would increase the likelihood of a massive spill and of massive damage to coastal wetlands.

---

*From: Arthur, D. R. (1968), "The biological problems of littoral pollution by oil and emulsifiers." In symposium proceedings of "The Biological Effects of Oil Pollution on Littoral Communities." Editors: J. D. Carthy and D. R. Arthur. Published by the Field Studies Council, 9 Devereux Court Strand, London, W.C. 2.

**From: Dedera, D. (1972), "Port Valdez: Victim of Progress or Model for the Future." Oceans 5(3):33-43.

It is our view that the project would be greatly expedited if the environmental problems are met forthright and "head-on." If the designers of the Superport properly plan for environment protection, criteria will be developed for evaluating the environmental impact and for preserving renewable resources which provide food for man and recycle essential nutrients for all life processes. Once such criteria are developed, they should minimize federal delays because the criteria will be valid as required by federal law. Furthermore, environmental interests should favorably recognize the demonstration of good intent, the identification of and work on environmental unknowns, and the development of techniques for evaluating the environmental impact of future projects.

Basis for Recommendation 2.

> The Superport should be located in waters equal to or greater than 100 feet in depth between Bayou LaFourche and Southwest Pass.

The second recommendation is based on a preliminary critique of what we consider to be the major stresses and constraints of a Superport development at various locations off the Louisiana coast. We define a constraint as "any process or condition which acts as a limiting factor or an encumbrance to the particular project." We define stress as "any effect which the particular project would have on the environment." Constraints can be natural and culturally induced, and both types are considered in our evaluation.

A primary constraint to Superport development is distance from the shoreline to water depths greater than or equal to 100 feet. This requirement is best satisfied in the area between Bayou LaFourche and Southwest Pass. Other areas, such as East Bay and Garden Island Bay, have adequate water depths close to shore but are ruled out because of poor foundation conditions--as indicated by mud lumps, subsurface folds and slumping.

The coastal area west of Bayou LaFourche is considered unsuitable because required water depths do not occur close to shore and the area accounts for only 4% of ocean-going commodity flow in the Central Gulf region. Approximately 78% of ocean-going traffic in the Central Gulf flows on the Mississippi River; hence economic constraints favor an area close to the Mississippi River.

Two major environmental stresses associated with a Superport concern possible oil spill damage and the utilization of coastal wetlands and estuaries as support facility areas. Some of the world's most productive estuaries lie north of the recommended area, but we believe that the surface water circulation here is more favorable than elsewhere because of the prevailing westerly set. We have not, as yet, delineated those specific areas that always, or almost always, have westerly currents so that any potential oil spill will not be carried into the estuaries. We further recommend that the support facilities and activities for the port be confined to narrow zones parallel or close to existing canals, waterways and trans-coastal corridors.

Basis for Recommendation 3.

To obtain maximum economic advantage for Louisiana, the Superport should be constructed as soon as possible.

Our data suggest that Louisiana may have a distinct short-term (10-15 years) advantage over Texas in terms of exporting crude oil by water. For example, Louisiana currently sends more than twice as much crude to the East Coast by water than does Texas; but, because of declining reserves, it is probable that an increasing proportion of this export oil will be allocated to Louisiana and Texas refineries. This prediction implies that outbound shipments of Louisiana-produced crude oil, now a major export from the Gulf, will eventually decline and the area will become a net importer.

Basis for Recommendation 4.

The Superport should be, initially, only an oil-receiving terminal, and only one such terminal should be developed off Louisiana.

If the projected petroleum needs for the United States are correct and must be met by increasing the importation of foreign oil by means of superships, then it is logical to assume that the first U. S. Superport will necessarily be an oil-receiving terminal. Also, crude oil is presently the predominant commodity utilizing superships for transport. In addition, preliminary analyses of wave data suggest that a breakwater system will be necessary for port operations involving off-loading of commodities other than oil. Since an oil terminal, such as single-point mooring system, does not require a breakwater, the costs for such a terminal would be considerably less than for a multi-commodity facility.

Any Superport or deepwater terminal developed to handle a particular commodity will tend to become the predominant economic activity in that area, thus creating a situation not of multiple use but of exclusive use. For example, such a port would require extensive safety and anchorage fairways which would take precedence over other activities in the area. Environmental controls and safeguards will probably require significant expenditures, and it is our belief that such controls will be more effective and cumulatively less expensive if only one terminal is developed. In summary, because of possible environmental impacts and effects on other activities, the number of such facilities should be highly restricted.

Basis for Recommendation 5.

> The environmental and engineering design of the Superport should be adequate to incorporate the flow of all types of commodities at a later time. Crude oil might be better handled at a (initially constructed) separate and distinct terminal, but this terminal should be contiguous to future terminals receiving other commodities.

The bases supporting recommendations 1 and 4 are applicable here. We assume that the deepwater port will initially be an oil terminal, but we also assume that other commodities, such as slurried ores and dry bulk, will eventually be shipped by means of superships. This assumption means that the deepwater port should ultimately handle all types of cargo. Consequently, it is logical from both an economic and an environmental viewpoint to plan for this in the initial stages. In addition, our economic analysis indicates that the present commodity flows outbound from the Port of New Orleans are amenable to transport by superships. For example, 72% of outbound commodities are made up of crude petroleum, farm products, and petroleum products and the major imports are metallic ores. All of these could easily be transported by superships.

Basis for Recommendation 6.

Work must begin immediately in the following areas:

a) Formulation of an Environmental Protection Plan as specified according to Louisiana Revised Statute 34:3101-3114.

b) Clarification of the legal aspects of port operations on the high seas and seabeds beyond the state's jurisdiction.

c) Acquisition of accurate petroleum-flow data and study of these under varying assumptions.

d) Acquisition of other commodity-flow data.

e) Determination of comparative costs of port construction, operation, maintenance, and finances.

f) Determination of potential impact of a Superport on future state revenues and economic development within Louisiana.

g) Initiation of field investigation of various environmental factors such as currents, meteorology, and soil foundations.

h) Initiation of computer model studies of types of Superport structures (such as semisubmerged platforms) or breakwater systems.

It is essential that the continuity of research effort be maintained.

We estimate that work required for the development of a deepwater port can be accomplished within the time frame and costs presented below:

STUDY AREA	TOTAL COST*	COST PER FISCAL YEAR F 73	F 74	F 75
Legal	30	30	--	--
Economic	100	40	40	20
Engineering Design Evaluation**	150	50	50	50
Environmental	450	200	150	100
	730	320	240	170

*In thousands of dollars

**Evaluation of structural design at proposed ports, pumping stations, pipelines, anchoring facilities. Funds required for the actual preparation of these designs are not included.

LEGAL ASPECTS OF A SUPERPORT OFF LOUISIANA'S COAST

by:

Marc J. Hershman
H. Gary Knight
Armin J. Moeller, Jr.

Sea Grant Legal Program
Louisiana State University
Baton Rouge

LEGAL ASPECTS OF A SUPERPORT OFF LOUISIANA'S COAST

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I. Legal Recommendations

Legal recommendations are given in four categories: A. State, B. Environmental, C. Federal and D. International. Each category begins with a general statement of the problem, followed by recommendations for its legal solution.

A. State

If a superport facility is constructed within three miles of the Louisiana coastline, Louisiana's jurisdiction would be nearly absolute since the Submerged Lands Act granted the coastal states of the United States title to the submerged lands lying within three miles of the coastline. The only significant state-federal legal problem in this area is the need for compliance with the navigational rules and procedures promulgated by the Coast Guard and the necessity to obtain a permit from the U.S. Army Corps of Engineers to erect a structure in the navigable waters of the United States. These and related matters will be discussed in Section C.

Present state law relative to port, harbor and terminal operations is typical of that found in most other states. Authority over individual port operations is decentralized at the parish (county) level. Members of the board of commissioners, the governing authority of the individual ports, vary from representatives of port-related businesses in the largest port, New Orleans, to members of town councils and police juries in the less significant districts. Almost without exception commissioners are either appointed or nominated by local interests.

Article 14, Section 31 of the Constitution of the State of Louisiana has provided a relatively simple procedure for the creation of new port districts. Only a majority vote of the Legislature is required. The decade of the sixties saw a proliferation of these politically popular entities until there are now approximately thirty-six in Louisiana. Many, however, can be more realistically referred to as "paper ports." The concept of a unified Department of Transportation encompassing a Division of State Ports has not yet been seriously considered in Louisiana.

It is clear that the state has title to all submerged lands within three miles of the coastline. However, it is possible to interpret Article 14, Section 31 as delegating jurisdiction over the use of submerged lands to present or future port districts. La. R.S. 49:6 provides that the jurisdiction of a coastal parish extends gulfward to the limit of the state's jurisdiction and in at least two statutes a port district's jurisdiction has been made coextensive with the jurisdiction of the coastal parish. This situation could result in multiple superport developments both economically unsound and destructive of the state's delicate coastal and marshland ecosystem.

Recommendations

1. Louisiana should create a statewide authority with exclusive jurisdiction to promote, plan, develop, construct, operate, maintain, and disassemble a Superport consisting of a structure, series of structures, or any facility necessary or useful to superport operations.

2. The goals of the Superport Authority should be:

a. To promote, in addition to port operations, scientific, recreational, and all other uses of a Superport which would be in the public interest;

b. To accommodate and plan for the technological innovations occurring in the worldwide and domestic shipping industry to increase Superport efficiency and the flow of commerce through it;

c. To protect environmental values and Louisiana's unique coastal marshland ecosystem through the adoption of an Environmental Protection Plan;

d. To assert and protect Louisiana's economic, social, environmental, and political interests in any Superport development in proximity to the Louisiana coastline.

3. The minimum legal requirements necessary for successful Superport Authority development and operation are:

a. Protection of the state's existing investment in deepwater ports;

b. The smallest Board of Commissioners politically acceptable which adequately provides for effective statewide representation;

c. Recognition of the policy-making role of the Board of Commissioners;

d. Gubernatorial appointment of Commissioners to assure that Superport development reflects current state policy;

1) Flexibility in appointment procedures in order that the Governor has the power to choose those candidates with the highest personal qualifications;

2) Short terms not in excess of five years to infuse the Board with fresh ideas and leadership in accordance with evolving state policy;

e. The need for a qualified Executive Director to be the highest executive officer within the Authority;

1) The Executive Director should be selected by the Board of Commissioners and serve at their pleasure;

2) In the initial stages of Superport development, the Executive Director should be experienced to handle the promotional effort; later, a professional executive director will be necessary to direct operations;

f. An annual report to the Governor showing the scope of activities and financial condition of the Authority;

g. A procedure for the acquisition of state-owned submerged lands by the Authority under long-term lease for development of Superport facilities;

h. A general grant of authority to do all things necessary or useful for Superport development including the powers delegated by Article 14, Section 31 of the Constitution of the State of Louisiana to port, harbor and terminal districts;

i. Dedication of all revenues derived from Superport operations to the Authority to assist financing and payment of Authority expenses;

j. Adherence to present Public Contract laws of the state;

k. Transfer of any surplus, after payment of all Authority expenses, to the General Fund;

1. The adoption of an Environmental Protection Plan as integral part of Superport development without which such development cannot proceed.

B. Environmental

The coastal plain and marshlands of Louisiana is one of the most biologically productive areas in the world and encompasses over 7,000,000 acres of wetlands and waterbottoms. The recreational benefits of our state's hunters and fishermen are immeasurable. The direct economic benefits to derivative industries (fishing, shrimping, oyster, trapping, etc.) run into hundreds of millions of dollars annually. These renewable resources are distinguished from extractive resources (oil, gas, sulfur, etc.) by the fact that they are naturally dependent upon Louisiana's delicate coastal and marshland ecosystem. Recent gains in harvests of living resources suggest that Louisiana may not have yet reached its optimum yield.

The legislatures of Delaware and Maine have restricted offshore Superports adjacent to the coasts of those states. In many other locations along U.S. coasts, strong demands are being made for protecting the coastal environment.

Federal and State law provide authority for protection of the environment but controls are not centralized in one agency and standards and criteria are uncertain and changing. The many different regulatory programs must be viewed from the perspective of a coastal Louisiana Superport operation and integrated into a specific environmental protection program. The program could reflect and anticipate new environmental protection procedures specifically suited for Louisiana's coastal environment.

Funds for environmental surveillance, monitoring, and enforcement are insufficient and normally dependent upon yearly appropriations from general funds of state and federal government. Mechanisms are needed to build into the operating costs of the Port costs associated with environmental protection.

To protect Louisiana's unique coastal zone, build in environmental planning and evaluation at the outset, provide a mechanism for integrating the many regulatory programs which anticipate new environmental protection needs, and provide a firm financial base for the protection of the environment, a specific Environmental Protection Plan should be in existence at all times which will insure protection of the coastal environment.

<u>Recommendations</u>

1. It shall be the mandatory duty of the Superport Authority to promulgate an Environmental Protection Plan (hereinafter referred to as Plan) which plan shall be created by the Executive Director, Wild Life and Fisheries Director and the Director of the LSU Center for Wetland Resources.

2. The Executive Director shall be charged with the responsibility of following the requirements of the Plan in carrying out all aspects of Superport development.

3. The best talent available in Louisiana shall be charged with creating the Plan. Environmental groups and other interested

parties shall have the opportunity to provide input for the Plan.

4. The Plan shall be promulgated under the rule-making procedures of the Louisiana Administrative Procedure Act (La. R.S. 49: 951-966).

5. The Plan shall provide for amendments at any time to reflect changes in Superport development or operations.

6. All costs in developing and carrying out the Plan shall be considered an internal cost of Superport development and operations.

7. The Plan should consider -

a. An inventory of all stresses on the environment which can be reasonably expected in pursuing Superport development;

b. Environmental data affecting site selection;

c. How facility design might minimize potential environmental damage;

d. What methods of operation would minimize environmental damage;

e. A monitoring program to detect new stresses;

f. Compensating the coastal environment for areas lost to Superport development;

g. Analyzing all ongoing environmental programs to avoid duplication and enhance coordination and cooperation.

C. Federal

In granting to states title to the submerged lands within three miles of the coastline the Federal Government did retain a "navigational servitude," and thus compliance with navigational rules and procedures of the Federal Government including the duty to obtain a permit from the U.S. Army Corps of Engineers to erect a structure in navigable waters is required. As an additional requirement the National Environmental Policy Act of 1969 requires that an environmental impact statement be submitted whenever any major federal action significantly affecting the quality of the human environment is involved.

The Maritime Administration and the Corps of Engineers, except for the above regulatory requirements, are without legal authority to operate ports or develop a comprehensive national ports policy. The United States presently claims only a three mile wide territorial sea. Nevertheless, a twelve mile territorial sea may become international law in the very near future. Should this occur and Congress so wishes, it could delegate to some federal agency the authority to administer a Superport located between 3 and 12 miles from the coastline in a manner similar to the Department of Interior's administration of continental shelf lands for extractive resource use.

Recommendations

1. To assert Louisiana's interest in any Superport development in proximity to the Louisiana coast, the Authority should be empowered to negotiate and enter into contracts with divisions of the Federal Government or other states of the United States concerning Superport development, including jurisdictional aspects of the location of the Superport, sharing of revenues derived from the operation of a Superport, and promulgation and enforcement of regulations governing Superport operations.

D. International

There is no definitive statement of authority as to who, if anyone, has the jurisdiction to construct and operate a Superport beyond the limits of national jurisdiction (presently three miles for the U.S., twelve for most other nations). The Outer Continental Shelf Lands Act has been thought to restrict United States jurisdiction to exploration and extraction of natural resources from the seabed and subsoil. The question of jurisdiction appears to have arisen at this time in few coastal nations. In Belgium, bills introduced in parliament to unilaterally create such jurisdiction were rejected by the Conseil d'Etat which reasoned that installations not used for the exploration or exploitation of natural resources of the continental shelf did not come under Belgian jurisdiction. Serious questions also arise concerning National policy on this issue in view of the pending Third United Nations Conference on the Law of the Sea.

The possibility exists that a specific superport site could be encompassed by the provisions of Article 9 of the Territorial Sea Convention describing roadsteads. Nevertheless, international authority for this approach is lacking.

Recommendations

1. The Louisiana Superport Authority should seek close liaison with the Department of State with a view toward determining the potential effect of current international law of the sea negotiations on the willingness of the State Department to accede to an unprecedented use of the high seas and seabed off the Nation's coast. The Authority should also encourage the United States Government to seek international

agreement authorizing construction of superport-type facilities on the high seas and seabed.

2. The Louisiana Superport Authority should seek close liaison with the Department of the Interior, the Department of Justice, and other interested Federal agencies, with a view toward negotiating suitable legal arrangements for location of the superport on outer continental shelf lands. To this end, the Superport Authority should be empowered to negotiate and enter into agreements with the Federal government concerning jurisdiction, operating regulations, division of revenues, and related matters.

3. The Louisiana Superport Authority should seek issuance of a Presidential Proclamation pursuant to the Outer Continental Shelf Lands Act withdrawing from mineral development an appropriate area surrounding the superport facility. Review of the system of "shipping safety fairways" should also be undertaken with a view toward preserving safety of navigation in the area.

4. The Louisiana Superport Authority should follow closely and study developments at the international level concerning protection of the marine environment and should ensure that the superport facility complies with any international standards adopted for the protection of the marine environment.

II. State, Local and Environmental Aspects of a Gulf of Mexico Superport

A. Introduction

The possibility of developing a Louisiana superport first became evident in August 1971, when an unknown corporation applied for a lease of state waterbottoms as a superport site.[1] Many questions were raised by concerned groups over such an unprecedented use of state waterbottoms.[2] Complicating these questions was the assertion by a local port authority that it had jurisdiction over the proposed superport site and would require any lessee to submit to whatever charges or regulations it might impose.[3] The entry of a second bidder for the site raised new questions as to the potential value of a superport site and whether the best interests of the state required the immediate leasing of state waterbottoms for this purpose. In response to the many unanswered questions and the developing controversy the Governor created an advisory committee to study the problem.[4]

Despite strong objections from the local port authority officials the committee found present state law to be inadequate and new legislation required. The outgrowth of their recommendations and the subsequent efforts of the Louisiana Superport Task Force was the enactment of the Deep Draft Harbor and Terminal Authority Act of 1972.

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[1] See notes 51 and 52, <u>post</u>.

[2] See note 51, Letters from the Port of New Orleans, Gulf South Research Institute, U.S. Corps of Engineers, Plaquemines Parish Commission Council, State Planning Office, Louisiana Wild Life and Fisheries Commission and the Louisiana Intracoastal Seaway Association to Ellen Bryan Moore, Register of State Lands, September 1970-December 1970.

[3] See note 64, <u>post</u>.

[4] See note 54, <u>post</u>.

Several major legal areas which must be understood in considering any proposed Louisiana superport are (1) the present port system of Louisiana; (2) the controversy over state versus local control of a Louisiana superport; (3) critical issues which face Louisiana superport development; (4) the resolution of these critical issues and (5) issues requiring further research and analysis.

B. The Port System of Louisiana

There are thirty-six port commissions or port, harbor and terminal districts in Louisiana. The Board of Commissioners of the Port of New Orleans, which is the oldest, was created by legislative act in 1896.[5] Until 1952 only five additional port authorities had been created including the major deepwater ports of Greater Baton Rouge and Lake Charles. Since 1954 new port authorities have been created at almost every session of the legislature. Invariably, each new port authority established by statute or constitutional amendment provides for (a) a board of commissioners appointed by local interests and (b) jurisdiction analogous to parish, ward, or municipal boundaries.

1. Ports Created by Statute

Most Louisiana port authorities have been created by statute. Article 14, Section 31 gives the legislature, by majority vote, the right to create port, harbor and terminal districts. The section has been amended twice since its creation in 1924 to expand

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[5] La. Acts 1896, No. 70. Act was never codified as part of the Revised Statutes.

the powers which could be delegated by the legislature to such statutorily created ports. It authorizes the legislature to create port, harbor and terminal districts as political subdivisions of the state possessing full corporate powers; to fix their territorial limits; to provide for their organization and government, and to define the duties, powers, and jurisdiction of their governing authorities. Powers which the legislature may delegate to the port, harbor and terminal district include the following: authority to own, construct, operate, and maintain docks, wharves, sheds, elevators, and all other property necessary or useful for port, harbor and terminal purposes; to dredge and maintain shipways, channels, slips, turning basins; to establish, operate, and maintain in cooperation with the federal government, the state and other public bodies navigable waterway systems; to acquire by right of eminent domain, purchase, lease or donation, the land that may be necessary for the business of such district; to acquire by purchase or lease industrial plant sites and necessary appurtenances; to acquire and construct industrial plant buildings within the district; to lease or sub-lease for commercial purposes, lands or buildings owned, acquired or leased; to borrow from any person or corporation using or renting any land, dock, warehouse, or any facility of such district and to construct an improvement thereon, agreeing that the loan shall be liquidated by deducting from the rent, dock, wharf or toll charges payable for such property a stipulated percentage; to collect tolls and fees; to borrow funds for the business of the district; to levy and collect taxes; to mortgage properties constructed or acquired and/or pledge any lease or leases and rent, income and other advantages arising out of any lease or leases granted, assigned or subleased by the district. The legislature can also delegate to port, harbor and terminal districts the power to incur debt and issue bonds for its needs in the manner provided by the Constitution and laws of the state. If the enumerated powers are found insufficient Article 14, Section 31 further authorizes the legislature ". . . to empower the governing authority of said districts to do any and all things necessary or proper for the government, regulation, development and control of the business of such port, harbor and terminal districts . . ."[6]

2. Constitutional Ports

The authority of ten port commissions is found in whole or in part in the state constitution. These are: the Board of Commissioners of the Port of New Orleans,[7] Lake Charles Harbor and Terminal District,[8] Greater Baton Rouge Port Commission,[9] Greater

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[6]The powers mentioned are not a complete listing of the powers found in Article 14, Section 31 of the Louisiana Constitution, as amended in 1968.

[7]La. Constitution 1921, Art VI, Sec. 16.1, 16.2, 17(1954); Art VI-A, Sec. 1, 5; Art XIV, Sec. 30, 31(1956). The Port of New Orleans was first recognized in the 1913 Louisiana Constitution in Article 321. Subsequently, Act No. 69 of 1920 formally recognized the Board as a constitutional board. This recognition was carried forward in the Constitution of 1921 which is still in effect.

[8]La. Constitution 1921, Art XIV, Sec. 30.2, 31(1968).

[9]La. Constitution 1921, Art VI, Sec. 29, 29.1-29.4(1956).

Ouachita Port Commission,[10] Lake Providence Port Commission,[11] South Louisiana Port Commission,[12] Avoyelles Parish Port Commission,[13] Concordia Parish Port Commission,[14] Rapides Parish Port Commission,[15] and Caddo-Bossier Parishes Port Commission.[16]

The powers of such constitutional ports are in most instances similar to those ports created by statute. The chief advantage of constitutional status is insulation from legislative change. Establishing a new port authority in the state Constitution is a formidable task. A constitutional amendment requires the approval of two-thirds of the members of both houses of the legislature and approval by a majority of the voters at the next general election. Since a port proposal normally generates only local interest, statewide voter support in most instances is uncertain.

3. Uncertainties within the Port System

Several critical issues have arisen in recent years concerning the status of constitutional ports. One dispute arose over

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[10] La. Constitution 1921, Art VI, Sec. 31(1968).

[11] La. Constitution 1921, Art VI, Sec. 33(1966).

[12] La. Constitution 1921, Art VI, Sec. 33.1(1960).

[13] La. Constitution 1921, Art VI, Sec. 35(1960).

[14] La. Constitution 1921, Art VI, Sec. 34(1966).

[15] La. Constitution 1921, Art VI, Sec. 39(1966).

[16] La. Constitution 1921, Art VI, Sec. 31(1966).

the question of whether a constitutional amendment[17] which ratified and confirmed the act of the 1924 legislature creating the Lake Charles Harbor and Terminal District, made it a constitutional port. In Joe J. Tritico v. Board of Commissioners of Lake Charles Harbor and Terminal District 134 So. 2d 401 (3rd Cir. 1961), the Court of Appeals held that the terms "ratified" and "confirmed" are not the equivalent of "to make part of" or "to incorporate into."[18] Therefore, the amendment validating and ratifying the statute creating the Lake Charles Harbor and Terminal District[19] did not make the act creating the district a part of the Constitution.

The authority of some constitutional port commissions to exercise the powers granted by the constitutional amendments creating them has been questioned. One writer[20] has suggested that certain constitutional port commissions including the South Louisiana, Rapides, and Caddo-Bossier Port Commissions cannot function completely because no enabling legislation was passed to permit them to perform all of their functions. However, the last sentence of Article VI, Section

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[17] La. Constitution 1921, Art XIV, Sec. 31(1924); La. Acts 1924, No. 55.

[18] See State ex. rel. Saunders v. Kohnke, 109 La. 838, 33 So. 793(1903); Pede v. City of New Orleans, 199 La. 76, 5 So. 2d 508 at 521(1941).

[19] La. R.S. 34:201-212(1924); La. Acts 1924, No. 67.

[20] E. Stiegman, Ports of Louisiana 2(1965) (Available from the Board of Commissioners of the Port of New Orleans).

33.1 of the Louisiana Constitution creating the South Louisiana Port Commission states that the constitutional amendment shall be self-operative, and "no further Legislation shall be required to effect the same." Subsection P of Article VI, Section 39 of the Louisiana Constitution creating the Rapides Parish Port Commission and the same subsection of Article VI, Section 32 creating the Caddo-Bossier Parishes Port Commission provide that all sections of the Constitutional amendment are self-operative and "shall require no further or other legislation" except that authorized in subsection G. Subsection G provides the commission with the power to "regulate the commerce and traffic within the port area in such manner as may, in its judgment, be for the best interests of the state." The subsection enumerates several specific grants of authority[21] and further provides that

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[21] To improve understanding of this point subsection G is reproduced in its entirety:

The commission shall regulate the commerce and traffic within such port area in such a manner as may, in its judgment, be for the best interests of the state. It shall have charge of and administer public wharves, docks, sheds and landings. It shall have authority to construct or acquire and equip wharves and landings and other structures useful for the commerce of the port area and provide mechanical facilities therefor; to erect sheds or other structures on said wharves and landings; to provide light, water, police protection and other services for its facilities as it may deem advisable; to construct or acquire, maintain and operate basins, locks, canals, warehouses and elevators; to charge for the use of all facilities administered by it, and for all services rendered by it; to establish such fees, rates, tariffs or other charges as it may deem fit; to establish harbor lines within the port area by agreement with the United States Corps of Engineers; and to construct, own, and operate and maintain terminal rail facilities and other common carrier rail facilities for the purpose of rendering rail transportation to and from the facilities to be erected, owned and operated by the commission in both intrastate and interstate commerce. The legislature may confer additional powers upon the commission not inconsistent with the provisions hereof; provided, however, that it shall not impair any contracts lawfully entered into by the commission. Title to all property and improvements thereon operated by the commission shall vest in the state of Louisiana.

"the Legislature may confer additional powers upon the commission not inconsistent with the provisions hereof. . ." The correct interpretation of subsection G in light of subsection P would seem to be that (a) the port commission enjoys the authority to regulate the commerce and traffic within the port area in whatever manner it considers to be in the best interests of the state; (b) specific grants of power are delegated to the port commission under subsection G but are not an exclusive listing of the port commission's powers, and (c) the legislature may confer additional powers upon the commission not inconsistent with the constitutional amendment creating the commission. It would appear that port commissions created with language similar to that found in subsection P do not require enabling legislation to exercise any of the extensive powers specifically delegated to them and will require only legislative approval for future grants of additional powers clearly not granted. The scheme of subsections P and G appears to be primarily designed to avoid the necessity of proceeding by constitutional amendment should additional powers be required.

One advantage to being a constitutional port authority is the protection afforded its jurisdiction due to the difficult procedure for amending the state constitution, and the inability of the legislature to encroach upon it by creating overlapping port, harbor and terminal districts. However, the recent establishment of numerous port, harbor and terminal districts appears to have created jurisdictional conflicts between them and older port authorities.

The most critical jurisdictional conflict involves the

Board of Commissioners of the Port of New Orleans, the St. Bernard Port, Harbor and Terminal District and the Greater Jefferson Port Commission. The jurisdiction of the Port of New Orleans was established by Act 70 of 1896 and included the parishes of Orleans, Jefferson, and St. Bernard.[22] Whether or not this statute has been incorporated into the state Constitution to give the port's jurisdiction constitutional status is uncertain. However, the constitutional protection afforded the Board of Commissioners of the Port of New Orleans in Article 14, Section 31 prohibiting any delegation of authority which "shall add to or detract from the provisions of the Constitution of the State of Louisiana relative to the Board of Commissioners of the Port of New Orleans. . ." strengthens its argument in favor of constitutional jurisdiction.

[22] The preamble to the Act recited various ills associated with port activities in the vicinity of New Orleans and the unfavorable effects of competition among the "three parishes" in the area. The preamble declared it to be the purpose of the act to consolidate the three parishes into one port commission. Section 1 indirectly defines the Port of New Orleans jurisdiction by providing for "said Board to consist of five members who shall be citizens of the United States and reside within the Port limits of New Orleans in the parishes of Orleans, Jefferson, or St. Bernard. . ." Louisiana jurisprudence has recognized the Board of Commissioner's three parish jurisdiction in several cases. See State ex. rel. Tallant v. Board of Commissioners of the Port of New Orleans, 161 La. 361, 108 So. 770(1926); Duffy v. City of New Orleans, 49 La. Ann. 114, 21 So. 179(1896).

Louisiana's Attorney-General has acknowledged that Act 70 of 1896 gives the Board of Commissioners of the Port of New Orleans jurisdiction over the parishes of Orleans, Jefferson, and St. Bernard. See La. Op. Atty.-Gen. 1946-48, p. 38.

The challenge posed by the Greater Jefferson Port Comission and the St. Bernard Port, Harbor and Terminal District can be illustrated by using the latter as an example. According to R.S. 34:1701 it ". . . shall have territorial limits coextensive with the Parish of St. Bernard, Louisiana, as presently constituted, less and except that portion of the Parish occupied by the Mississippi River and the Mississippi River batture and levee." Section 1705 further states "Nothing herein contained shall add to or detract from the present provisions of the Constitution and laws of the state relative to the board of commissioners of the port of New Orleans, the rights under all of said provisions being preserved, and in the event of any conflict between the provisions relative to the board of commissioners of the port of New Orleans, the latter shall prevail." The implication of these two sections would seem to be that the territorial jurisdiction of the Port of New Orleans is restricted in St. Bernard Parish to "that portion of the parish occupied by the Mississippi River and the Mississippi River batture and levee." If the territorial jurisdiction provided for the Board of Commissioners of the Port of New Orleans in Act 70 of 1896 has any present day validity, such a geographical division of jurisdiction between the two port authorities is of doubtful legal effect. It can be argued that the reasons given in the preamble for the passage of Act 70 of 1896 and its reference to the "traffic of the Port" could be construed to limit the jurisdiction of the Port of New Orleans within St. Bernard Parish to the only avenue of waterborne commerce existing at the time, i.e., the Mississippi River. Nevertheless, such a view appears to be erroneous for two reasons. The port limits have been equated with that area within which members of the Board of Commissioners of the Port of New Orleans must reside. A member appointed from St. Bernard Parish is certainly not required to reside in "that portion of the parish occupied by the Mississippi River and the Mississippi River batture and levee." Since he clearly can be chosen from anywhere in St. Bernard Parish it would seem that the St. Bernard Port, Harbor and Terminal District is devoid of any authority in St. Bernard Parish if Act 70 of 1896 has any present-day validity.[23] The same arguments apply with equal force against the purported jurisdiction of the Greater Jefferson Port Commission.[24]

Similar jurisdictional problems have arisen between existing inland port authorities. The Red River Waterway Commission was created by statute[25] in 1965 with the object and purpose of establishing, operating, and maintaining a navigable waterway system extending from the vicinity of the confluence of the Red River, the Old River, and

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[23]Article VI, Section 17 of the Louisiana Constitution which presently provides for the selection and qualification of the Board of Commissioners speaks only of prospective members "residing in the parishes in which the Port Area is located. . ." Whether such reference to the "Port Area" is sufficient to incorporate into the Constitution the jurisdiction originally conferred by Act 70 of 1896 is a question insusceptible of determination through existing authority.

[24]La. R.S. 34:2021-2025(1966).

[25]La. R.S. 34:2301-2317(1965).

the Atchafalaya River northwestward in the Red River Valley, encompassing the parishes of Avoyelles, Rapides, Natchitoches, Red River, Grant, Bossier, and Caddo. The Commission also was authorized to acquire, construct, operate, and maintain various port and related facilities. The delegation of such powers seems to place its territorial jurisdiction in direct conflict with the constitutionally created jurisdiction of the Caddo-Bossier Port Commission,[26] the Avoyelles Parish Port Commission,[27] and the Rapides Port Commission.[28] In 1966, Grant Parish established by statute[29] its own port commission. Consequently, it is difficult to perceive any role for the Red River Waterway Commission in light of existing independent port commissions. It is a reasonable assumption that litigation seeking to resolve these conflicts has been avoided thus far because of the inactivity of the affected port commissions.

4. Dominant Features of Louisiana Ports

An analysis of Louisiana's port commissions and port, harbor and terminal districts would be incomplete without a discussion of certain features common to all of the state's port authorities.[30]

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[26] See note 16, <u>supra</u>.

[27] See note 13, <u>supra</u>.

[28] See note 15, <u>supra</u>.

[29] La. R.S. 34:2351-2357(1966); La. Acts 1966, No. 49.

[30] The authors of this work acknowledge the substantial contribution of Mr. Emero S. Stiegman's comparative analysis of the common features of Louisiana ports in his report, "Ports of Louisiana." Mr. Stiegman's approach to this area is generally followed in Section II(B)(4).

Article 14, Section 31 of the Louisiana Constitution authorizes the legislature to create port, harbor and terminal districts as political subdivisions of the state of Louisiana possessing full corporate powers. Many constitutional port authorities have been established as political subdivisions possessing full corporate powers. Litigation has arisen as to whether the benefits and immunities conferred upon a state agency are applicable to an authority which possesses such corporate powers. The jurisprudence indicates that port commissions and districts will be characterized as state agencies entitled to such benefits and immunities.[31] In line with this reasoning the state Supreme Court in Miller, Royal Indemnity Co., Intervener v. Board of Commissioners of the Port of New Orleans, 1942, 199 La. 1071, 7 So. 2d 355, held that the Board of Commissioners of the Port of New Orleans being an "agency of the state" was performing purely administrative functions and was not a "corporation," and consequently denied to an injured employee of a lessee to which the board had leased wharves the right to sue in tort. The court pointed out that the board was not operating for profit or performing a "proprietary function" in leasing wharves.

The number of commissioners composing the governing board

[31] State ex. rel. Tallant v. Board of Commissioners of the Port of New Orleans, 1926, 161 La. 361, 108 So. 770 held the Board of Commissioners of the Port of New Orleans to be a "state agency" administering public property for the benefit of the port.

of a port authority varies, but usually numbers 5, 7 or 9. Three port commissions have eleven members and Greater Baton Rouge has ten. While the Greater Baton Rouge exception is understandable since the port area encompasses four parishes, it is interesting to note that the two newest port, harbor and terminal districts, Union and Morehouse, have eleven member boards.

The commissioners' term of office is generally 5 or 6 years. The Morgan City Harbor and Terminal District members serve for 9 years. Since the Plaquemines Port, Harbor and Terminal District governing body is the Plaquemines Parish Commission Council, the length of their terms and number of Commissioners is determined by the laws relating to the Plaquemines Parish Commission Council. With only two exceptions the law provides that the members shall serve without compensation and will receive only a reasonable travel allowance.[32]

The power of the Governor to appoint members to existing port commissions has been severely restricted. This is the result of the "Jones Committee" formed by the legislature in 1965 for the purpose of formulating a policy to reduce the powers of the Governor in order to permit legislation to be introduced in the 1966 Legislative Session to allow the Governor to succeed himself for a second term. Its

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[32]The exceptions are the members of the Plaquemines Port, Harbor and Terminal District (La. R.S. 34:1351-1365[1970]) who receive compensation as parish commission council members and members of the Greater Lafourche Port Commission (La. R.S. 1651-1660[1968]) who receive $10.00 per diem with reasonable travel allowance.

recommendations to remove from the Governor the power to make numerous appointments to port commissions and districts were subsequently enacted into law by statute and constitutional amendment.[33] The Governor still has the right to appoint one or more members to the following port commissions: The Board of Commissioners of the Port of New Orleans, the Lake Charles Harbor and Terminal District, the Greater Baton Rouge Port Commission, the Morgan City Harbor and Terminal District, the South Louisiana Port Commission, the Greater Lafourche Port Commission, Red River Waterway Commission, and the Grant Parish Port Commission. Even this right is more apparent than real. The Ports of New Orleans, Lake Charles, and Greater Baton Rouge actually select their members through nominating organizations. These nominating organizations recommend a limited number of nominees. In the case of the Port of New Orleans, the Governor could consistently bypass the nominees of a disfavored nominating organization. However, under the procedure employed by the Lake Charles Harbor and Terminal District, vacancies are rotated among the nominating organizations with only one organization submitting

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[33] La. Acts 1966, No. 446; La. Acts 1966, No. 543. Port authorities affected by the reduction of the governor's power to appoint port authority members were: New Iberia Port District; Jennings Navigation District; Greater Ouachita Port Commission; Greater Krotz Springs Port Commission; Lake Providence Port Commission; Delcambre Port Commission; St. Bernard Port, Harbor and Terminal District; Avoyelles Parish Port Commission; Columbia Port Commission; Livingston-Tangipahoa Parishes Port Commission; St. Tammany Parish Port Commission; Greater Jefferson Port Commission; Jonesville Port Commission; Caddo-Bossier Parishes Port Commission and Rapides Parish Port Commission.

nominees for each vacancy. The Governor must fill the vacancy from among the nominees submitted. Consequently, it is impossible for the Governor in such instances to avoid appointing a nominee of the special interest group represented by the nominating organization.

With respect to taxation practically all port commissions have the authority to levy an ad valorem tax ranging in amount from 2 1/2 mills, 3 mills, 5 mills, to 10 mills. In addition, Act 43 of 1969 gave authority to all port, harbor and terminal districts to levy a special ad valorem tax not in excess of ten mills on the dollar of assessed valuation, provided the levy of the tax and issuance of the bonds are approved at an election in the district. In four cases the law specifically prohibits the levying of any ad valorem tax. In at least two cases the law is silent as to the right of taxation. Of those commissions authorized to tax, 10 may do so only by an election in the district, and 11 may levy the tax without any form of election.[34]

The right to issue bonds exists in all except one instance. In some cases issuance must be approved by the Board of Liquidation of State Debt. Applicable law requires some port commissions to seek approval by an election before issuing any bonds. Other cases require the approval of the State Bond and Tax Board.

The right to issue bonds is often accompanied by a limit on the bonded indebtedness that the port authority can assume. This appears to be especially true of the larger port commissions. The Board

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[34] E. Stiegman, Ports of Louisiana 3(1965).

of Commissioners of the Port of New Orleans is limited to $95 million.[35] The Greater Lafourche Port Commission, one of the newest and most active port authorities, is limited to $25 million. Others restricted by law are limited to smaller amounts.

Only three port authorities are required by law to file an annual report with the Governor. In seven other cases the law required that a report be filled with the governing authority of the parish.[36]

5. Characteristics of Selected Port Systems

The authority to construct works of internal improvement and promote, develop, construct, maintain, and operate all harbors and seaports within the state of Alabama has been delegated to the Alabama State Docks Department (hereinafter referred to as Department).[37] The Department consists of a director of state docks and a state docks advisory committee. The advisory committee can "act only in an advisory capacity with reference to any matters coming before or concerning the department."[38] The director of state docks is the chief executive officer of the department. A general manager appointed by the director is responsible for the management of the facilities under the control of the department. In addition there is a general manager for operations

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[35] La. Constitution 1921, Art VI, Sec. 16.5(1958).

[36] E. Stiegman, Ports of Louisiana 4(1965).

[37] Code of Ala. Tit. 38, Sec. 1(2526) and (9) (1955).

[38] Code of Ala. Tit. 38, Sec. 1(9) (1955).

appointed by the director who performs such duties as may be assigned to him by the director in connection with the administration, operation, management, construction, and maintenance of the facilities under the jurisdiction of the state docks department.

The state docks advisory committee consists of one member from Mobile County and one member from each of the congressional districts in the state. All are appointed by the governor with the advice and consent of the state senate for four year terms. To qualify for such a position the law requires that the prospective appointee be of good character and be possessed of ability and experience which would qualify him to advise in the operation of the facilities and activities coming under the jurisdiction of the department.

Alabama's state-wide port authority illustrates the strong influence of politics and geography in fashioning a state legal regime to handle port activities. With its limited coastline the only commercially important port in Alabama is the port of Mobile. The geography of the coastline in conjunction with the shallow coastal waters makes the development of other coastal ports impractical. This combination of factors has resulted in a state-wide authority which permits the predominant non-coastal area of the state to share in the control and prosperity of the port of Mobile.

North Carolina has established a state ports authority "to develop and improve the harbors or seaports at Wilmington, Morehead City and Southport, North Carolina, and such other places, including inland ports and facilities, as may be deemed feasible for a more expeditious and efficient handling of water-borne commerce...."[39] It has been given extensive powers similar to those delegated to Louisiana ports. The North Carolina Port Authority is governed by a board of nine members. The Governor appoints all members for six year terms which "membership thereof shall be selected from the state at large.... so as to fairly represent each section of the state and all of the business, agricultural, and industrial interests of the state."[40] The members of the Authority are not entitled to compensation "but shall be reimbursed for their actual expenses necessarily incurred in the performance of their duties."[41] The Authority is empowered to issue negotiable revenue bonds but such bonds cannot "constitute a debt of the State of North Carolina or a pledge of the faith and credit of the state."[42]

North Carolina has gone one step further than Alabama in operating a state-wide authority by transferring the state port authority in 1971 to the Department of Transportation and Highway Safety.[43] However, the state port authority continues to exercise all its prescribed statutory powers independently of the head of the principal department except that management functions are performed under the direction and supervision of the head of the Department of Transportation and Highway Safety.

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[39] Gen. Stat. of N.C. Ch. 143-216(1961).

[40] Gen. Stat. of N.C. Ch. 143-216(1961).

[41] Gen. Stat. of N.C. Ch. 143-216(1961).

[42] Gen. Stat. of N.C. Ch. 143-219(1945).

[43] Gen. Stat. of N.C. Ch. 143A-107(1971).

The operation of the Port of Boston by the state of Massachusetts differs significantly from the above two instances. State law provides for the Port of Boston Commission (hereinafter known as Commission) to consist of five members appointed by the Governor with the advice and consent of an advisory council.[44] The governor designates one commission member as chairman. The commissioners serve five year terms. The Commission is in administrative charge of the port of Boston and is responsible for making all necessary plans for its development. The members serve without compensation but are reimbursed for their necessary expenses incurred in connection with travel in the discharge of their official duties. They may appoint and remove a director at their pleasure.

Each vacancy on the commission is filled in the following manner:[45] Shortly before the expiration of the term of a member or within ten days after any other vacancy occurs, the chairman of the commission addresses a communication to each of the organizations represented on the advisory council calling upon each organization to submit within fifteen days the names of not more than three persons to fill such vacancy. The Commission then certifies the names submitted and the governor selects a candidate to fill the vacancy.

The advisory council,[46] which plays a critical role in the

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[44] Anno. Laws of Mass. C.6, Sec. 53(1953).

[45] Anno. Laws of Mass. C.6, Sec. 53(1953).

[46] Anno. Laws of Mass. C.6, Sec. 53A(1953).

nominating process for commission members, is composed of the mayor of the city of Boston and twenty other members, each of which represents an organization with an economic interest in the port. Each organization appoints its own representative. All appointments are for a term of four years.

The advisory council is charged with reviewing the activities of the Port of Boston Commission and interesting itself in ways and means of advancing the interest of the port of Boston.[47] It is empowered to require the appearance at its meetings of the director of the port or other commission officials and has access to the records of the Commission. It is required to make an annual report to the governor of its activities and accomplishments.

The advisory council approach of Massachusetts resembles the nominating council procedure of the Board of Commissioners of the Port of New Orleans. At least one generalization may be drawn from the similarity. The port areas of both cities account for the dominant share of water-borne commerce of their respective states. These well-established ports have the backing of established commercial interest groups with a tradition of involvement in maritime affairs. Such interest groups were available in the two cities to take an active role in port development. Furthermore, the utilization of these interest groups in a policy-making role has apparently thwarted the development

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[47] Anno. Laws of Mass. C.6, Sec. 53A(1953).

of unwanted state-wide authorities which local interests fear would subordinate them to broader state-wide interests. Hence, the advisory council and/or nominating organization procedure appears to be an effective instrument for (a) instilling professional business management into port operations and (b) preventing state takeover of local port operations.

The Alabama, North Carolina, and Massachusetts examples provide some insight into the varying legal arrangements under which the different port authorities operate. Unfortunately, the examples offer only a very limited view of the existing arrangements under which United States ports operate. Appropriate comparative studies of existing legal arrangements for United States and foreign port systems must be done in order to assess the strengths and weaknesses of Louisiana's approach to superport development.

C. The Superport Concept: State versus Local Interest

1. History

In the late 1960's local officials of Plaquemines Parish were the first to recognize the potential for a superport located in the vicinity of the mouth of the Mississippi River.[48] In 1970 Plaquemines Parish officials were successful in having the state legislature amend the statute governing the Plaquemines Port, Harbor and

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[48]Times-Picayune (New Orleans), April 20, 1972, at sec. 1, p. 2, col. 4; Morning Advocate (Baton Rouge), December 1, 1971, at 9-B, col. 3.

Terminal District to give it "territorial limits coextensive with the parish of Plaquemines, Louisiana."[49] Innocuous as the amendment may have appeared, it had the effect through another statute[50] of extending the boundaries of such coastal, parish-wide port authorities to the gulfward limit of the state's boundary. Consequently, the jurisdiction of the Plaquemines Port, Harbor and Terminal District had been extended to the gulfward limit of the state's boundary off of Plaquemines Parish which includes the area around the mouth of the Mississippi River.

Following this undiscovered coup by Plaquemines officials, Deep Water Sites, Inc., a mysterious corporation whose ownership has been the subject of controversy,[51] submitted an application[52] to the Register of State Lands to lease several 640 acre tracts of state waterbottoms for use as superport sites. They finally narrowed their choice to one tract in Garden Island Bay near the mouth of the Mississippi

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[49] La. R.S. 34:1351(1970).

[50] La. R.S. 49:6(1964).

[51] Morning Advocate, December 3, 1971, at 21-A, col. 1; Morning Advocate, December 1, 1971, at 9-B, col. 2.

[52] The records of the State Land Office indicate that William J. Kihneman, attorney for Deep Water Sites, Inc., originally requested applications for nine tracts covering 5,760 acres of waterbottoms on August 17, 1970. The second application for the single tract in Garden Island Bay was made on October 5, 1970.

River. After bids were opened for the Garden Island Bay site another corporation[53] submitted a surprise offer. This triggered a controversy between the Register of State Lands and officials of Plaquemines Parish relative to each party's rights concerning state waterbottoms off of Plaquemines Parish. The resulting publicity and questions raised by interested parties resulted in the Governor issuing an executive order[54] creating an advisory committee to study leasing procedures and the superport concept. Out of the advisory committee's recommendations and the continuing controversy between the Register of State Lands and Plaquemines Parish developed two legal issues on which the positions of the parties were irreconcilable: (1) the authority under Act 59 of 1970[55] to lease state waterbottoms for superport purposes; (2) the jurisdiction of the Plaquemines Port, Harbor and Terminal District over state waterbottoms.

2. Legal Issues

Local officials of Plaquemines parish have claimed that Act 59 of 1970 provides an adequate legal basis for the lease

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[53] International Tank Terminal, Ltd. See Morning Advocate, December 1, 1971, at 9-B, col. 3.

[54] Executive Order No. 86, May 24, 1971. The executive order specifically appoints an advisory committee "to study leasing procedures and make recommendations to the Register of State Lands. . ."

[55] La. R.S. 41:1262-1270(1970).

of state waterbottoms to public or private groups for the construction and operation of a superport. The statute authorizes the Register of State Lands to lease "the bodies of any lakes, bays or coves or other navigable waters and beds thereof for the purpose of granting to the lessee the right to erect and use on the leased premises tanks and facilities for the receipt, storage, transportation and shipment of oil, goods, wares and merchandise. . ."[56] Assuming one complies with the procedural formalities required by the act its broad language could be construed as a means to lease waterbottoms for a superport facility. Nevertheless, the statute raises three critical issues which make its usefulness for superport purposes doubtful: (1) disputes concerning its original sponsorship and intent; (2) the omission of any reference to port operations in the statute; (3) the discretion reserved to the Register of State Lands to accept or reject any or all lease applications.

It is unclear who the primary sponsors of Act 59 of 1970 were. For this reason it is unclear what the original intent of the Act was. How one resolves this question depends upon the credibility one attributes to the parties involved. The Register of State Lands and her assistants contend that the Act was a State Land Office bill introduced at their request. Since the State Land Office

[56] La. R.S. 41:1262(1970).

does not employ a full-time attorney the actual drafter of the legislation is unknown. The State Land Office asserts that the legislation was intended to assist the offshore oil and gas industry in acquiring sites for such things as compressor stations and temporary storage facilities. They argue that the broad language of the legislation was designed to avoid the need for subsequent amendment as technological changes requires the oil and gas industry to lease offshore sites for requirements unforeseen at the time of its passage. The State Land Office further points out that the Attorney-General's Office warned them on several occasions prior to 1970 that the lease of offshore sites to the oil and gas industry was without legal basis under Act 73 of 1944 (La. R.S. 41:1262 prior to its amendment by Act 59 of 1970) and suggested remedial legislation.[57] This view is supported by the language of Act 73 of 1944 since it authorized only the lease of lands. Only leases for support facility sites in aid of the oil and gas industry have been granted under either act. A State Lands Office memorandum dated April 28, 1970 seems to reflect their motive to assist the offshore oil and gas industry in amending La. R.S. 41:1262 et seq., since it indicated that any future discussions with the Attorney-General of Louisiana should cover the need for "further utilization" of state waterbottoms through La. R.S. 41:1262, in light

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[57]Conversations with Mr. Ory Poret, Assistant Register of State Lands, March, 1972.

of the fact that on several occasions the State Land Office had already used the original statute to grant pumping station and compressor station leases on state waterbottoms.[58]

Local officials of Plaquemines Parish contend that they assisted in drafting the legislation and are therefore privy to its intent, one aspect of which was to permit the leasing of state water-bottoms for superport development.[59] They dispute the Register's assertion that it was solely State Land Office legislation, it could never be determined to the point of legal certainty and consequently the broad language of the statute should control.

Opponents of the lease admit that the broad language of La. R.S. 41:1262 encompasses many of the activities incidental to the operation of a superport. In the absence of convincing proof as to the intent of the act, the broad language should control. However, they point out that this overlooks the <u>purpose</u> for which certain interests now desire to lease state waterbottoms. The purpose for which the lease is sought is to operate a superport. The broad language of the statute permits the leasing of state waterbottoms for many incidents of port operations and various piecemeal port activities. The statute, however, does not intimate in any of its sections that it

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[58]The records of the State Land Office confirm the granting of such unauthorized leases in line with its prior utilization of La. R.S. 41:1262-1270(1944).

[59]See note 53, <u>supra</u>.

authorizes private or public groups to lease state-owned waterbottoms for the purpose would seem to be in direct conflict with the existing legal regime governing Louisiana ports as the Register of State Lands would, in effect, be creating new port authorities with the acceptance of each lease bid. Those opposing the lease assert that the legislature did not intend through Act 59 of 1970 to delegate its authority to create ports to the State Land Office.

Irrespective of the conflicting claims of the adversary parties, the Register of State Lands is vested with the discretionary authority to accept or reject all bids. Section 1262 provides that the Register of State Land Office may lease state waterbottoms. The use of the term "may" confers upon the Register discretionary power to lease or not to lease. If the legislature had intended for the Register to be under an affirmative duty to lease, the term "shall" would have been used. In addition, section 1265 states that the Register of State Lands "shall have the right to reject all bids."

The state Attorney-General's position throughout the controversy appears to be uncertain. In reply to the question posed by the Register of the State Land Office as to whether a surface lease could legally be granted on state waterbottoms in Garden Island Bay pursuant to Act 59 of 1970, the Attorney-General's office replied affirmatively.[60] When the Governor issued an executive order appointing

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[60] Letter from Melvin L. Bellar, Assistant Attorney-General, to Ellen Bryan Moore, Register of State Lands, February 3, 1971.

an advisory committee to study the problem in light of the questions raised by the proposed lease, a legal committee was formed and included the same Assistant Attorney-General[61] who had written the opinion affirming the Register's right to grant a surface lease under Act 59 of 1970. After numerous meetings with interested parties the Assistant Attorney General and other members of the committee concluded on November 23, 1971 that present Louisiana laws were not sufficient to authorize the leasing of state waterbottoms for deepwater ports.

Irrespective of the merits of Act 59 of 1970 as a procedure to lease state waterbottoms for superport development Louisiana has unwittingly surrendered its territorial jurisdiction over some proposed superport sites to certain coastal port authorities. The Plaquemines Port, Harbor and Terminal District is only an example.[62] Any coastal port authority which has jurisdiction coextensive with the limits of a coastal parish or any coastal port authority which can persuade the legislature to grant it such jurisdiction, can take advantage of La. R.S. 49:6 which extends the jurisdiction of coastal parishes to the

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[61] Melvin L. Bellar; Report of the Legal Committee of the Governor's Superport Advisory Committee, November 23, 1971. (Available from the Office of the Secretary of State.)

[62] There are at least two other coastal port authorities which have parish-wide jurisdiction: Terrebonne Port Commission (La. R.S. 34:2201-2205) and St. Bernard Port, Harbor and Terminal District (La. R.S. 34:1701-1715).

outer gulfward boundary of the state. Therefore, by relating the jurisdiction of the port authority to parish boundaries the jurisdiction of such coastal port authorities is extended to the gulfward limit of the state's boundary.

3. Policy Issues

The attitude of the Plaquemines Port, Harbor and Terminal District and the broader legal questions mentioned above raise several policy issues concerning superport development such as: (1) the ability of the state to receive fair value for the lease of state waterbottoms as a superport site; (2) the question of whether state or local control can most effectively advance the interests of Louisiana in superport development.

The present conflict between the authority of the Register of State Lands to lease state waterbottoms and the power of certain port authorities to exercise control over the lessee's activities makes it questionable whether the state can realize the potential value of the waterbottoms. The state's ownership of waterbottoms having depths greater than sixty-five feet near the vicinity of the mouth of the Mississippi River can be analogized to the discovery of a valuable natural resource in limited supply. Bathgraphic maps of the Gulf of Mexico indicate that Louisiana is the only state having deep waterbottoms within the limits of the state's jurisdiction. It is difficult to speculate upon the actual value[63] of the lease interest in such waterbottoms to a private lessee interested in developing a superport facility or the potential revenues from a state operated superport. Nevertheless, it is improbable that the state could realize the actual market value of its lease interest if the prospective lessee must figure into his lease bid the uncertainties of dealing with a local port authority possessing the power to impose unlimited onerous conditions. The Plaquemines Port, Harbor and Terminal District has indicated to the Register of State Lands[64] that they would require any lessee to submit plans and specifications of the proposed facility for their approval, to secure a permit from the parish for construction, and to comply with whatever regulations they may establish. In addition, they reiterate their right under the statute creating the district to charge fees to each vessel arriving in ballast or carrying cargo of any kind. They further suggest that

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[63] Deep Water Sites, Inc.'s bid for the Garden Island Bay tract was five dollars per acre and one and one eight cents per ton of cargo handled. International Tank Terminal, Ltd.'s bid was three dollars and thirty cents per acre and five cents per ton. The five cents per ton bid is significant when one considers that super tankers and other bulk cargo carriers would be discharging 100,000 or more tons of liquid or dry bulk energy cargoes at a time. Each such discharge would provide $5,000 in revenue to the state's general fund. The willingness of a bidder to offer such terms in the face of the obvious legal obstacles to superport development existing at that time would seem to indicate that the value of state waterbottoms as superport sites has not yet been fully recognized by public officials.

[64] Letter from Chalin O. Perez, President, Plaquemines Parish Commission Council, to Ellen Bryan Moore, Register of State Lands, March 19, 1971.

it would be "highly inappropriate" for the state to grant a lease subject to its jurisdiction without its "concurrence and consent" to such a facility.[65]

Local officials of Plaquemines Parish have argued that the Plaquemines Port, Harbor and Terminal District could develop a superport at an earlier date and more efficiently than any state agency.[66] They cite frequent examples of bureaucratic inertia in state government and the state capital's distance from the coastal area (over 100 miles in places) as reasons in favor of the local approach. However, those who argue in favor of the state approach point out that many coastal port authorities are nothing more than "paper ports."[67] In their judgment, local port authorities clearly do not possess the expertise to do even preliminary superport planning nor do they have the financial resources necessary to build their own superport. They further point out that the present situation could lead to disastrous competition between numerous inadequate superport developments sponsored by the different coastal port authorities which would be economically unsound, environmentally unsafe, and possibly hazardous to navigation.

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[65] See note 63, supra.

[66] Times-Picayune, April 20, 1972, at sec. 1, p. 2, col. 4; States-Item (New Orleans), April 17, 1972, at 1, col. 3.

[67] The Plaquemines Port, Harbor and Terminal District for example, does not have any port facilities in operation at this time.

D. Critical Issues Facing Superport Development

The question of state versus local control is perhaps the most critical issue facing superport development in Louisiana. Regardless of how it is resolved some agency will be authorized to pursue Louisiana's superport interests. Numerous issues have arisen with respect to the needs of such an agency in order to pursue Louisiana's superport interests effectively.

1. Operational Flexibility

A critical issue is the need for flexibility in the legal framework of the agency designated to advance Louisiana's superport interests. We are faced with an area of rapidly changing technology. Superships are altering traditional world-wide shipping patterns. These changes will require the state agency to frequently alter its staff requirements in order to acquire the expertise necessary to exploit new developments to Louisiana's advantage. Emphasis must be placed on providing the agency with the flexibility to hire a professional director of the highest order of competence and a professional staff of his choosing to direct Louisiana's superport efforts. This will require that managerial powers and organizational structure more closely resemble that of a large corporation than a typical state agency. The pay scale for the director and his staff must also be flexible in order that the agency can bargain for the best talent available.

2. Extent of Authority

A critical issue that Louisiana must face is the extent of authority to be delegated to the state agency. It is known that any offshore superport development will require certain onshore support facilities such as tank farms, compressor stations, depots, pipelines, etc. The agency must be authorized to negotiate with municipalities, parishes, and all other local political subdivisions to acquire the necessary facilities and enter agreements with such bodies to supply necessary services. Similarly the agency must be empowered to negotiate agreements with other state agencies which have interests in the coastal zone in order to effectively coordinate their efforts.

3. Federal-State Relations

At the federal level it is critical that Louisiana designate a state agency to negotiate and enter agreements with the federal government or any of its agencies relative to superport development, operation, and control. The Corps of Engineers has jurisdiction over all navigable waters for certain purposes;[68] the Coast Guard has the power to promulgate regulations necessary for the safety of navigation;[69] the National Environmental Protection Act of 1969[70] requires an environmental impact statement for any action significantly affecting the

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[68] 33 U.S.C. 403(1964) [originally enacted as Act of March 3, 1899, ch. 425, 30 Stat. 1152].

[69] 14 U.S.C. 2 (originally enacted as Act of August 4, 1949, ch. 393, 63 Stat. 496).

[70] 42 U.S.C. 4321 (originally enacted as Act of January 1, 1970, 83 Stat. 852).

quality of the human environment. It is evident from these few examples that for Louisiana to protect and advance its interests in a Louisiana superport the agency must be empowered to negotiate and enter into agreements with the federal government and its agencies. The need for such authority is especially critical in light of the fact that present data suggests that it is likely the initial superport facility will be located between 8 and 12 miles[71] off the Louisiana coast, clearly beyond state jurisdiction. Consequently, the state may literally have to "negotiate" its way into superport development, operation, and control as no other basis for state authority exists beyond three nautical miles from Louisiana's coastline.

The critical federal-state relationship for Louisiana superport development demands that the state agency must have exclusive authority to manage Louisiana's superport interests. The coastal port authorities referred to above were established as political subdivisions of the state. At present each would be a state agency authorized to negotiate any agreements with the federal government relating to port activities within their jurisdiction. Such fragmentation of authority would make it impossible to advance the overall state interest in superport development, operation and control. This will permit Louisiana

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[71]Morning Advocate, May 2, 1972 at 1-A, col. 5.

to speak with one unified voice and avoid the pitfalls of subdivisions of the state competing against each other.

The state agency must also be empowered to negotiate any agreements with international agencies regarding superport development and undertake an active role in any international organization which may be established to further international understanding relative to the development and operation of superports and superships. The United States is presently bound by international agreements regulating the pollution of the sea.[72] The recent worldwide environmental conference in Stockholm[73] indicates that international regulation and restriction of various uses of the high seas will increase. Such regulations will affect any Louisiana superport either because of stresses in international waters created by its operation in coastal waters or because its location will be beyond the territorial sea and within the juris- of the international community. Consequently, the importance of empowering the agency to undertake an appropriate role in the international community concerned with superport affairs cannot be overestimated.

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[72] International Convention for the Prevention of Pollution of the Sea by Oil, (done May 12, 1954, 12 UST 2989; TIAS 4900; 327 UNTS3 in force December 8, 1961); Convention on the High Seas (done April 29, 1958, 13 UST 2312; TIAS 5200; 450 UNTS 82 in force Sept. 30, 1962). There are at least two recent treaties to which the U.S. is a party, but they are not yet in force.

[73] United Nations Conference on the Human Environment, June 12-25, 1972, Stockholm, Sweden.

4. Economic Protection for Existing Deepwater Ports

A critical issue which could present serious political, economic, and legal difficulties is the need for economic protection of the state's existing deepwater ports. The three deepwater ports of New Orleans, Baton Rouge and Lake Charles rank first, fourth, and tenth in the Mississippi River Valley and the Gulf Region in the dollar value of cargo handled.[74] The bonds of the Ports of New Orleans and Baton Rouge are backed by the full faith and credit of the state.[75] The Port of New Orleans has approximately 95 million dollars in bonds outstanding (principal and interest to maturity), and the Port of Greater Baton Rouge has approximately 43 million dollars in bonded indebtedness outstanding.[76] If a Louisiana superport were to divert significant amounts of cargo presently handled by the three deepwater ports, the loss of revenues could jeopardize the payment of existing port bonds. Since the bonds carry the full faith and credit of the state, the state would have to assume the unanticipated burden. The state further assists the Port of New Orleans with $500,000 annually from the state gasoline tax;[77] the Lake Charles Harbor and Terminal District receives 1/20 of

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[74] "Waterborne Commerce of the United States," 1969, Dept. of the Army, Corps of Engineers.

[75] La. Constitution 1921, Art.VI, Sec. 16.5(1958); Op. Atty. Gen. 1932-1934, p. 677. La. Constitution 1921, Art.VI, Sec. 29(1952), secs. 29.1 and 29.4(1956).

[76] Figures supplied by the State Treasurer's office, April 1, 1972.

[77] La. Constitution 1921, Art.VI-A, Sec. 5(1952).

one cent from the same source. The value of this assistance would be to some degree negated by the state's establishment of a strong rival.

The need is to identify those cargoes which could be handled most efficiently by a superport; those cargoes that can be handled most efficiently at existing deepwater ports; those cargoes critical to the continued prosperity of existing deepwater ports, and those cargoes critical to the economic health of a Louisiana superport. Policies will have to be developed for overlapping areas with the twin aims of preserving the economic integrity of existing deepwater ports and providing a sound economic base for superport development. Obviously, there are no simple solutions to what might develop into a complex commodity-by-commodity analysis and bargaining between two adversary interests.

5. Environmental Protection

Perhaps the most critical issue of all is the question of whether a legal regime can be established to protect Louisiana's coastal environment while superport development proceeds. There are at least four predictable stresses on the coastal environment flowing from superport development. Recent history has shown that there is a risk of some catastrophic event occurring such as a major oil spill caused by shipwreck or collision, major explosion or fire, etc.[78]

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[78] Notable examples of such events are the Torrey Canyon oil spill off the coast of Great Britain and the Ocean Eagle spill in San Juan harbor.

Another stress is that which results from day-to-day operations causing pollution of varying degrees of seriousness. Negligent or careless operational procedures, faulty equipment, improper personnel training invariably result in continuing stresses on the environment immediately surrounding the facility. A third and serious stress on the coastal environment results when the facility itself is emplaced in the near shore environment. This could result in a direct elimination of habitats for living resources. It eliminates the area for traditional commercial and recreational purposes in exchange for its exclusive use for port and harbor purposes. Each addition or expansion to the port facility continues the encroachment upon the natural coastal environment. A fourth stress and perhaps the most serious relates to the stresses imposed by onshore ancillary facilities serving the superport. These include pipelines, barge loading and offloading points, compressor and pumping stations, oil and other liquid cargo tank farms and other storage facilities. In addition, industrial, commercial, and residential development will be generated by superport activities--all of which create considerable stress on Louisiana's coastal environment. This environment, mostly marsh and low-lying plains, is subject to flooding, subsidence, and hurricane damage. Great expenditures of funds will be needed to provide minimal protection against these risks.

When the superport issue was raised in other states, the major concern was potential environmental damage. Delaware recently passed a coastal zoning law[79] which declared that offshore bulk product transfer facilities represent a significant danger of pollution to the coastal zone and generate pressure for the construction of industrial plants in the coastal zone, which construction is declared to be against public policy. For these reasons, Delaware prohibited bulk product transfer facilities in their coastal zone. Because of the proximity of deepwater bays to the coast of Maine, numerous disputes have arisen regarding the placement of superports in coastal waters which would serve refineries to be located on Maine's scenic coast.[80] To avoid such disputes as have

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[79]Vol. 58, Ch. 175, Laws of Delaware, Approved June 28, 1971. Approval of this law met with considerable attention in the press and government and industrial circles throughout the country. At a time when most coastal states were doing considerable planning, inventorying of coastal resources, and holding many meetings and conferences, Delaware took a bold step to implement one of the recommendations of the Governor's Task Force on Marine and Coastal Affairs. That report recommended against approval at the present time of any deepwater port facility or offshore island in the lower Delaware Bay. See "Coastal Zone Management for Delaware," Governor's Task Force on Marine and Coastal Affairs, 40 p., February 18, 1971, at p.3-1. It was recently stressed by a key Delaware state official that the issue of whether the state would consider a Superport facility was receiving further study. "Remarks of Austin H. Heller, Secretary, Department of Natural Resources and Environmental Control, State of Delaware, to Sea Grant Association, University of Wisconsin, October 12, 1971 at p. 6.

[80]The Maine Site Selection Law, 38 Maine Stat. Sec. 481(1970), was recently used to deny a construction permit to an industrial developer, Maine Clean Fuels, Inc., who applied for a permit to construct a $150,000,000 refinery on tiny, uninhabited Sears Island in Penobscot Bay, Maine. Supertankers were to supply the refinery with 150,000 barrels of oil daily. See "Environmental Agency in Maine Completes Hearings on Refinery," New York Times April 18, 1971, p. 66, col. 3. The Coastal Conveyance of Petroleum Act (Act 572 of 1970) mandated the Maine Environmental Improvement Commission to establish regulations for the transfer of oil and other petroleum products between vessels and onshore facilities and between different vessels within the jurisdiction of the state.

arisen in Delaware and Maine, a wise course for Louisiana would be the full consideration of environmental matters at the outset of superport planning.

All levels of government have laws and regulations for environmental protection. Many of these deal with similar environmental issues and occur at varying times during the development program. To the Louisiana citizen concerned with general environmental protection from the port operation, there is little opportunity for effective participation, and the morass of individual, special purpose regulations makes it difficult for one to see the overall environmental protection program. Similarly, for the port authority itself, there is a need to integrate the varying governmental requirements so that duplications in data-gathering and monitoring can be avoided and a long term environmental protection program formulated. For these reasons the authority needs to disclose at an early date in its operation its blueprint for environmental protection. This should be done at the same time as its blueprint for port development.

One critical issue relates to paying the costs of environmental protection associated with a superport. Often, environmental protection programs suffer from inadequate financing because they are subjected to an annual battle for appropriations with a legislative body. Whatever the scale of the environmental protection program to be developed, it must be provided with a continuing source of revenue. Unless the people of Louisiana are willing to assume this additional burden, the funds necessary to operate an effective environmental protection program must come from the users of the facility.

Another critical issue relates to the qualification and affiliation of those who develop and control the environmental protection program. The program's leaders bear the burden of establishing the program's credibility. The credibility of the program depends on the role played by recognized environmental scientists and institutions. Their efforts must not be totally controlled by those whose responsibilities are primarily commercial and developmental. The environmental protection program must be pursued in a spirit of coordination and cooperation with other interested public and private groups. The lines of communication must always be open to the acceptance of new ideas from any source. Additionally, the program must be pursued within the overall perspective that environmental protection from stresses imposed by a superport is but one aspect of environmental protection from all stresses which are continually created by development in the coastal zone. Specific consideration should be given to broad-based coastal zone management efforts and state-wide transportation planning programs.

E. Resolving the Critical Issues

The Deep Draft Harbor and Terminal Act* was designed to avoid the shortcomings of the present Louisiana ports system, resolve the

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*Reprinted in its entirety in Section IV of this Chapter.

present conflicts in state law which prevent superport development, and provide a legal regime by which Louisiana could develop, operate, and assert its interest in any superport development in proximity to the Louisiana coast for the benefit of all its citizens. The objects of the statute are set out in section 3101 of La. R.S. 34: 3101-3114. Subsection A states that the purpose of the Act is to create a new political subdivision of the state possessing full corporate powers to "promote, plan, finance, develop, construct, control, operate, manage, maintain, and modify a deep draft harbor and terminal" for ".....the loading and unloading of vessels carrying liquid or dry bulk and energy cargoes." Additional objects provided for in subsection B are to promote the prosperity of existing Louisiana port authorities and interstate, national, and international trade; to promote scientific, recreational, and all other uses of the deep draft harbor and terminal in the public interest; to accomodate and plan for the technological innovations occurring in the worldwide and domestic shipping industry to increase efficiency and the flow of commerce through the deep draft harbor and terminal outside the state of Louisiana.

1. State Control Over Superport Development

The Deep Draft Harbor and Terminal Act resolves the critical issue of state versus local control concerning Louisiana superport development in favor of state level control. Since Louisiana does not have an agency with any supervisory power over the thirty-six local port authorities, the Act provides for the creation of a new state agency to be known as the Deep Draft Harbor and Terminal Authority (hereinafter referred to as Authority). The Authority is established as an Article 14, Section 31 port, harbor and terminal district. This approach was taken because the Authority could be created expeditiously by the legislature as compared to the slower constitutional amendment process.

The problem of the jurisdiction of local port authorities is resolved by Sections 3103 (Jurisdiction; domicile), 3109 (Powers) and 3108 (Acquisition of sites; lease of state-owned waterbottoms). Subsection 3103(A) grants to the Authority "exclusive jurisdiction over the Authority Development Program within the coastal waters of Louisiana." The Authority Development Program is defined in Section 3102(2) to mean all phases of planning, development, and operation through which a deep draft harbor and terminal may proceed. Section 3102(1) defines a deep draft harbor and terminal as the structure emplaced in coastal waters which is designed to accommodate the cargo or passengers of the new generation of deep-draft ships. Coastal waters are defined as those waters extending three nautical miles or beyond to the extent of the state's jurisdiction as measured from the state's coastline. Section 3103 was designed to pre-empt whatever rights local port authorities may have possessed in coastal waters for the limited purpose of superport development. It is noted that no constitutional question arises as the local port authorities with jurisdiction in Louisiana's coastal parishes were all created by statute.

Section 3108 resolves the problem of the separation of the state's interest in its waterbottoms from its interest in operating a port by making it the mandatory duty of the Register of State Lands to lease state waterbottoms in the Gulf of Mexico which are selected by the Authority as sites for the deep draft harbor and terminal. Section 3108 (B) provides that the selected tracts shall be leased by the register of state lands for five dollars per acre per annum. The proceeds arising from such leases become part of the state's general fund. The Authority is thereby placed in a position to realize the maximum value of the waterbottoms to be leased for superport purposes. If the Authority develops and operates its own superport, Section 3108 guarantees it the capacity to acquire the necessary sites at a nominal price. If the Authority believes that it is in the best interests of Louisiana to sublease such waterbottoms to private groups for superport purposes, it is empowered to negotiate a sublease for the best possible price. The lease bids offered for the tract in Garden Island Bay are illustrative of what may be the actual market value of such leases.[81]

Section 3108(E) prohibits the Authority from engaging in the exploration or development of oil, gas, or other minerals (as controlled by the State Mineral Board) or the cultivation of living marine resources (regulated by the Louisiana Wild Life and Fisheries

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[81] See note 63, supra.

Commission) on waterbottoms leased as superport sites.

2. Powers of the Superport Authority

The powers delegated to the Authority consolidate its position as Louisiana's exclusive agent for superport development. Section 3109(A) vests the Authority with the "exclusive and plenary authority to do any and all things necessary or proper for the Authority to promote, plan, finance, develop, construct, control, operate, manage, maintain, and modify the Authority Development Program." Section 3109(C) grants the Authority "all powers capable of being delegated by the legislature under Article 14, Section 31" of the state Constitution. Subsection F authorizes the Authority to lease or sublease lands leased from the state and to negotiate and enter into agreements with any public or private individual or corporation for the construction and operation of a petroleum terminal. The power of the Authority to lease or sublease to private groups for the development of other types of superport facilities is implied from Subsections A and C.

The critical authority to negotiate intrastate, interstate, federalstate, and international agreements is provided by Section 3109(B). In order to assert Louisiana's interest "in any Deep Draft Harbor and Terminal development in proximity to the Louisiana coast, the Authority is empowered to negotiate with and enter into contracts, compacts or other agreements with agencies, bureaus or other divisions of the federal government or other states of the United States concerning the Authority Development Program, including jurisdictional aspects of the location of the Deep Draft Harbor and Terminal, sharing of revenues derived from the operation of the Deep Draft Harbor and Terminal and promulgation and enforcement of regulations governing Authority operations." In conjunction with the general authority provided by subsection A, the section is designed to provide sufficient power for the Authority to enter into any forseeable intergovernmental relationship which may arise. In addition, Section 3110 (B) authorizes intrastate agreements to permit the parties to "engage jointly in the exercise of any power, the making of any improvements which each of the participating authorities may exercise or undertake individually under any provision of general or special law."

3. Administrative Structure for Superport Operations

To resolve the critical issue of representation Section 3104 of the Act provides for a nine member board of commissioners, representing all geographic regions of the state. Subsection B provides that two members shall be selected from each of the state's three Public Service Commission districts. One of these must be a recognized environmentalist. One member shall be selected from the state at large. The other two shall be selected from a list of nominees submitted by the three deepwater ports, with each deepwater port recommending two nominees. Once a final determination is reached as to the location of the deep draft harbor and terminal, the first vacancy occurring on the board shall be filled by appointment of one of three nominees submitted by the governing authority of the parish, offshore from which the deep draft harbor and terminal is located. In case of dispute as to whether the superport is located off of more than one parish, both parishes may submit three nominees each, the Governor making the appointment from the two lists of nominees submitted. The qualifications required of members are purposefully general to provide the flexibility to adjust to changing requirements as to the type of individual which might be needed as a board member. Subsection A speaks only of "their demonstrated experience in civic leadership and their stature and ability to act effectively for the best interests of Louisiana." Subsection C provides each member with a five year term except for initial appointees whose terms are correspondingly abbreviated to provide for an average of two vacancies per year. Such frequent vacancies should permit a new governor to put into effect any policy changes that he may desire furing his first term in office.

The critical issue of flexibility for successful Authority operation is resolved by the delineation of the roles of the board of commissioners and the executive director in Sections 3105 and 3107. The board is made the governing body of the Authority "with full power to promulgate rules and regulations for maintenance and operation of said Authority."

Section 3105(B) provides that the Board shall formulate general policy and decide upon all matters relating to the Authority Development Program. It also adopts the annual operating and capital budget. Perhaps the most significant subsection in explaining the board's powers is subsection F which provides that the board shall meet at least once every sixty days "or upon the written request of the president." While the board of commissioners is vested with ultimate authority, the experience of similar boards indicates that the infrequency of meetings will provide the board with no more than an opportunity to formulate general policy and oversee obvious deficiencies in operation.

Section 3107 provides for a strong executive director to resolve the shortcomings incidental to the part-time nature of the board's role. The board of commissioners shall select the executive director. The statute places no restrictions on the salary or other terms of employment that the board may offer an applicant. The executive director shall exercise all control over the executive functions and the general operation of the Authority. All employees shall be responsible to the executive director "who shall organize them in the most efficient manner to accomplish the purposes of the Authority...." Clearly, the executive director will be responsible to the board for the <u>results</u> of Authority operations as he is provided with the means to achieve the purposes for which the Authority was created. Because he is responsible for the overall performance of the Authority he serves at the pleasure of the board.

Section 3106(B) resolves the critical issue of Authority financing. Since Authority operation more closely resembles the operation of a large private corporation than most state agencies, reliable sources of revenues are required. In order for the Authority to take advantage of new opportunities and bind itself to future obligations, all revenues generated by the Authority are dedicated to it to be used to further the purpose of the Act. However, any revenues remaining at the end of a fiscal year after the satisfaction of all Authority obligations and expenses and the creation of adequate reserves for contingencies shall be considered surplus, to be transferred to the state's general fund. To assist in the initial planning work of the Authority, an appropriation of $350,000 from the state's general fund has been provided for 1972-73 fiscal year.

4. Protecting Existing Deepwater Ports

Section 3110 was designed to ameliorate the potential conflict between existing deepwater ports and the Authority and provide mechanisms for the resolution of future problems in the area. Subsection A recognizes the need to prevent impairment of port bonds and the existing Authority and functions performed by established Louisiana ports. Acknowledging these facts subsection A further provides that the "power and authority of the various existing port authorities established pursuant to Article 14, Section 31 of the Louisiana Constitution, and others, established by specific constitutional provision are not to be diminished by the jurisdiction and powers exercised by the Deep Draft Harbor and Terminal Authority except as provided in this Act." Subsection B permits the Authority to enter into contract agreements with existing port authorities and engage jointly in the exercise of any power which either authority may have exercised individually.

Subsections C and D indicate that the Authority is primarily empowered to develop a deep draft harbor and terminal to handle bulk cargoes. This is supported by Section 3101(A) which explains the object of the Act as "to provide the necessary facilities for docking, loading and unloading of vessels carrying liquid or dry bulk and energy cargoes." Subsection D prohibits the Authority from handling break-bulk or general cargo "without the prior written agreement of the Three Deepwater Ports, which agreement, among other provisions, may provide for use of existing port facilities, rates, wharfage fees and other matters of mutual interest." Subsection C requires that the Authority consider the economic impact on the deep-water ports in enacting its rates and charges for bulk cargo. It further requires that such charges and rates be compensatory, i.e. cover the costs of the services rendered.

5. The Environmental Protection Plan

Section 3113 resolves the critical issue of environmental protection by creating an Environmental Protection Plan (known hereinafter as Plan). The Plan is defined in Section 3102 to mean "a written document prepared in conformity with this law, which shall be a regulation of the Deep Draft Harbor and Terminal Authority which establishes those steps to be followed to insure the protection of the environment whroughout all phases of the Authority Development Program." Section 3113 spells out the details of the Plan and requires the executive director to follow the Plan "in all respects" in carrying out any aspect of the Authority Development Program.

The Plan shall be formulated by the Director of the Louisiana Wild Life and Fisheries Commission, the Director of the Louisiana State University Center for Wetland Resources, and the Executive Director of the Authority. The Plan must be promulgated within a reasonable time after the appointment of the executive director but no later than eighteen months after the effective date of the Act. It is to be promulgated by the executive director under the rule-making procedures of the Louisiana Administrative Procedure Act.[82] It may be amended at any time in accordance with the provisions of the Administrative Procedure Act to reflect changes in the Authority Development Program. The three directors who formulate the Plan or any interested person can initiate changes.

The three directors in formulating the Plan are charged with the duty to make every effort to reach a consensus. In case of disagreement each shall proffer his proposed Plan or amendment to the board of commissioners for its consideration. After receiving and studying the recommendations submitted, the board of commissioners shall decide which plan or combination of plans shall be adopted and promulgated. To assure that environmental interests do have a voice on the board of directors, Section 3104(B) provides that one of the members selected from the three Public Service Commission Districts "shall be selected for his primary interest in protecting the unique coastal environment of Louisiana."

To resolve the problem of adequate financing for environmental protection, Section 3113(G) makes the Plan an integral

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[82] La. R.S. 49:951-966(1966).

part of the Authority Development Program. Costs incurred to develop the initial Plan or amendments shall be considered an internal cost of the Authority Development Program to the same extent as economic, engineering, and promotional programs are considered costs. The three directors must agree on the appropriate level of funding for the Plan and carry out its requirements.

In order to maximize the effectiveness and credibility of the Plan, Section 3113(H) directs the three directors to seek out the best talent available to perform the studies and surveys necessary to develop the Plan and carry out its requirements. It further provides that to the extent possible, University-based, public, and private researchers in Louisiana shall be utilized. The results of all research done in connection with the Plan shall be available to any interested person.

The actual Plan must contain a series of specific provisions as set out in Section 3113(J). If it is impossible to set forth these provisions due to uncertainties in the Authority Development Program, the Plan must state the uncertainties which do exist at the time the Plan is promulgated and why the uncertainties make the inclusion of such provisions premature. Otherwise, the Plan must consider under a separate chapter each of the following: (1) An inventory of all stresses on the environment which can be reasonably expected in pursuing superport development; (2) environmental factors affecting site location; (3) facility design and how it might minimize potential environmental damage; (4) the methods of operation which would minimize environmental damage; (5) a monitoring program to detect new stresses; (6) compensation to the coastal environment for areas lost to superport development; (7) analysis of all ongoing environmental programs to avoid duplication. Consideration of these factors is essential in order to provide any measure of environmental protection. However, their inclusion in the Act is illustrative only; changes in superport technology and use will bring the need for changes in the regulations and research priorities of the Plan.

F. Issues Requiring Further Research and Analysis

1. Interstate Commerce and Taxation

Louisiana's economic stake in a deep draft harbor and terminal off its coast goes far beyond the possibility of lease or operational revenues, and beyond the superport's economic effects on employment, waterborne commerce, transportation savings; etc. Louisiana must also take into account the social and economic costs to state and local governments associated with such an enterprise. A deep draft harbor and terminal will invariably bring with it demands for additional public works such as improved highways to adjacent coastal areas, new canals to connect the superport with existing inland waterways, and other transportation facilities which will be necessary to move superport bulk cargoes inland. Expenditures will be necessary to protect against the increased risks of flooding, subsidence, and hurricane damage in the coastal zone due to superport related development. Costs associated with environmental stresses can be expected. In light of the necessary support facilities which must be built in the coastal zone and the growth which can be expected to parallel superport development, state and local agencies will be required to increase the services which they supply in the coastal zone of Louisiana.[83] Although an increased tax base can be anticipated for certain localities, it is not clear that increased tax revenues will offset increased public services dollar for dollar. Nor is it clear that the same governmental unit benefiting from the tax increase has the equal burden of providing the services. Inequities abound in the property tax system, as is evident by current court cases.[84] The question ultimately will become who shall bear the burden of the increased costs of governmental services brought on by the deep draft harbor and terminal: the users of the superport or the taxpayers of Louisiana?

The state's options regarding this burden differ with the location of the superport. If the facility is located within the state's territorial jurisdiction, i.e. coastal waters, then the state may take such costs into consideration in negotiating the price for the lease of state waterbottoms. In addition the state has the opportunity

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[83]Foreign Deep Water Port Developments, Volume I, "A Selective Overview of Economics, Engineering, and Environmental Factors," published by Institute for Water Resources (IWR), Department of the Army, Corps of Engineers.

[84]Morning Advocate, June 30, 1972, at 1-A, col. 7.

to impose the traditional variety of taxes suited to such a facility subject to constitutional limitations.

It appears more likely than not that the first superport will be beyond Louisiana's jurisdiction.[85] Without a federal-state agreement designating Louisiana as operator of the superport facility and granting the state a share of the lease and/or operating revenues, Louisiana would be unable to receive any revenues from the facility. Louisiana's responsibilities and financial burden attributable to the superport would not be diminished since the need for onshore support facilities, transportation corridors, and general governmental services in the coastal zone would be unchanged.

The argument of prospective users of the superport located beyond the state's jurisdiction will be that the superport itself is clearly beyond the state's power to tax since it is outside of the state's jurisdiction. Absent a special federal-state agreement as indicated above, this argument is incontrovertible. They will also argue that coastal support facilities and pipelines are exempt from state and local taxation because they are engaged in interstate commerce. The operation of a superport oil terminal would be a typical example. The oil would be discharged from supertankers into undersea pipelines which would transport the oil to an inland tank farm. To maintain the pipeline's operation through Louisiana only compressor and pumping stations would be

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[85] See note 71, <u>supra</u>.

required. As needed, the oil could then be pumped out of the tank farm and into an interstate pipeline to refineries in other states. The petroleum companies can argue that the oil pipeline and support facilities are used exclusively in interstate commerce and are thus subject to the well-settled doctrine that Congress has the exclusive power under the Commerce Clause (Art. 1, Sec. 8, cl. 3) to regulate interstate commerce and even where Congress has failed to act on the subject in the area of taxation, the power granted to it requires that interstate commerce be free from any direct restrictions or impositions by the states.[86] This view is accepted by Louisiana jurisprudence. In a similar situation the First Circuit Court of Appeals held in Colonial Pipeline Co. v. Mouton, 228 So. 2d 718 (1st Cir. 1969) that a pipeline company engaged in picking up petroleum products in Louisiana and discharging products in Louisiana, but never discharging in Louisiana products picked up in Louisiana (which company also was qualified to do business, file suit, appoint agents, and exercise eminent domain in Louisiana) was not subject to Louisiana franchise taxes payable for the privilege of doing business in Louisiana.

This view raises serious questions. Due to its proximity to favorable superport sites, Louisiana's coastal zone could not avoid becoming the location for pipelines and onshore support

[86] Northwestern States Portland Cement Co. v. Minnesota, 358 U.S. 450, 79 S. Ct. 357, 3 L. Ed. 2d 421, 67 A.L.R. 2d 1292(1959).

facilities for any superport constructed off of Louisiana's coast. A rigid interpretation of the Commerce Clause in this instance would have the effect of making Louisiana the insurer and protector of the pipelines and onshore facilities, as well as the responsible guardian against potential environmental damage, without being able to realize anything for the risks undertaken or costs incurred.

Another view of the relationship of state taxation to the Commerce Clause holds that a state tax can be exacted even against a business engaged exclusively in interstate commerce provided the tax is compensation for the protection of local activities. In line with this reasoning, Memphis Natural Gas v. Stone, 335 U.S. 80, 58 S. Ct. 1475 (1948), held that a foreign gas corporation operating a pipeline through Mississippi and engaged exclusively in interstate commerce was liable for a "franchise or excise tax" imposed on every corporation equal to $1.50 for each $1,000 or fraction thereof of the capital used, invested, or employed in the exercise of any power, privilege, or right enjoyed by such corporation. Even the First Circuit Court of Appeals in Colonial Pipeline v. Mouton, 228 So. 2d 718 (1st Cir. 1969), recognized that some taxes against a company engaged exclusively in interstate commerce are valid such as ad valorem taxes (Postal Telegraph Cable Co. v. Adams, 155 U.S. 688, 15 S. Ct. 268, 39 L. Ed. 311); a use tax (Hanneford v. Silas Mason Co., 300 U.S. 577, 57 S. Ct. 524, 81 L. Ed. 814); and an income tax (properly apportioned under Northwestern States Portland Cement Co. v. Minnesota, 358 U.S. 450, 79 S. Ct. 357, 3 L. Ed. 2d 421, 67 A.L.R. 2d 1292). In this complex area of the law where decisions often turn on such fact determinations as whether the activity is actually interstate commerce or whether there are sufficient local activities to justify taxation, no clear cut answers are available. Additional research is required including the education of public officials concerning their options in this area.

2. Coastal Zone Management and Planning

It is probable that a coastal zone management act, or land use management act, will soon be passed by Congress.[87] The Louisiana Advisory Commission on Coastal and Marine Resources, created by Act 35 of 1971, has been charged with the development of a coastal zone management plan for the state. Coordination and cooperation must be sought between those charged with formulating the Superport Authority Development Program and those who will be responsible for coastal zone management as their interests are complementary.

Special attention must be directed to providing a legal framework in which new uses of the coastal zone can be accomodated while the traditional users such as fishermen, oysterman, navigators,

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[87] S. 3507 (National Coastal Zone Management Act) was unanimously passed by the Senate. HR 14146 (companion coastal zone management measure) awaits House floor action (as of July 8, 1972). HR 7211 (National Land Policy, Planning and Management Act) awaits action by the Rules Committee and S 632 (to establish a national land use policy) has been reported by the Senate Interior Committee. S 2401 (the National Resource Lands Management Act) awaits action.

etc., are protected and long-term values of the region sustained. To a certain extent this will involve the ranking of priorities for use when multiple uses are incompatible through an analysis of environmental, economic, social, and political criteria. Where the shared use of available resources is feasible, the Superport Authority Development Program must formulate those regulations which will assure open access to the resources and provide for their most efficient shared use.

In certain instances the Act seeks to assure traditional coastal zone users that the advent of superport development will not result in a net loss to them. Section 3113(K) makes clear that the authority of the Louisiana Wild Life and Fisheries Commission to protect fish and game will not be diminished in any way. Section 3109(C)(4) provides that if state waterbottoms are taken for superport purposes on which there has been granted an oyster lease by the Louisiana Wild Life and Fisheries Commission, the private oyster lessee must be reimbursed by the Authority for the actual market value of the lease.[88]

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[88]This section clarifies the point that the oyster lessee must be compensated for the actual market value of the lease rather than the value of one year's crop of oysters or a similar restrictive standard.

As the outlines of superport development emerge and the user conflicts can be more accurately identified, additional research will be necessary in order to draft new regulations to deal with these complex issues.

Another critical aspect of coastal zone management is planning the growth and inter-relationships of all modes of transportation in Louisiana's coastal zone. Since the Superport development will tend to generate pipelines, additional barge and land traffic, and other spin-off developments, it is essential that the Superport program be an integral part of general transportation planning for the coastal zone, under the overall umbrella of coastal zone management principles. Research needs to be done in determining the specific mechanisms for insuring that such cooperation and coordination comes about.

3. Implementing the Environmental Protection Plan

The Environmental Protection Plan is a regulation of the Authority which can be amended to meet the changes of both the Authority Development Program and the local, state, and federal regulations dealing with environmental protection. Numerous regulations exist dealing with environmental impact statements, construction in navigable waters, oil pollution, safety, and others. As the specifics of the Superport Development Program progress, environmental considerations must be dealt with at each stage. Meeting these requirements for regulations will necessitate research into specific rules to be promulgated for dealing with matters as they arise over the coming years.

4. Comparative Studies

Much can be gained from a systematic review of the experience of other jurisdictions in dealing with major deep water port developments and in the organization of a statewide system for waterborne commerce. Research is needed in the experience of other deep water ports of the world--notably those in Japan, the Netherlands and France. Understanding how other states of the United States have handled port systems may assist Louisiana in developing a more coordinated and comprehensive approach to water transportation--avoiding much of the politics and unnecessary competition found today.

III. International and State-Federal Aspects of a Gulf of Mexico Superport

A. Introduction

Because legal rules applicable to the conduct of activities in the ocean change as one moves seaward from the coastline, it is relevant to a discussion of international legal issues concerning Superport siting whether the location is (1) less than three miles from the coastline, (2) between three and twelve miles from the coastline, or (3) beyond twelve miles from the coast. This will in turn depend upon the location of the baseline from which the breadth of the territorial sea is measured.

If the superport were to be located entirely within the three miles of the coast (the present breadth of the territorial sea claimed by the United States) then there are few international legal issues which arise--certainly none concerning competence of the coastal state to make whatever use of its territorial waters and underlying seabed it sees fit. However, if the location were beyond the three mile limit, the seabed would today be classified as continental shelf and the superjacent waters as high seas. It will thus be necessary to examine the legal regime applicable to those two areas of ocean space.

As will be noted post the United States has proposed an international agreement fixing the breadth of the territorial sea at twelve miles. Even considering that the twelve mile limit might be in effect at the time of completion of any superport, the area beyond twelve miles would still be subject to the regimes of the continental shelf and the high seas.

B. Alternatives

The major problems are whether the construction of such a facility is consistent with the rights appertaining to coastal states either under customary international law or through international agreements and, if such rights exist, the extent to which the coastal state would be able to exercise regulatory jurisdiction over activities conducted thereon.

1. Site Within Three Miles of the Coastline

Within the limit of the territorial sea, the jurisdiction of the coastal state is virtually absolute. The Convention on the Territorial Sea and the Contiguous Zone[89] provides:

> The sovereignty of a State extends, beyond its land territory and its internal waters to a belt of sea adjacent to its coast, described as the territorial sea (Art. 1[1]).
>
> The sovereignty of a coastal State extends to the air space over the territorial sea as well as to its bed and subsoil (Art. 2).

Thus, within the territorial sea, the coastal state may make use of the seabed or water column it desires, subject only to the rights of innocent passage and entry in distress. The construction of a superport facility would clearly fall within the scope of coastal state competence.

Further, there are no significant state-Federal legal problems in this area since pursuant to the Submerged Lands Act[90] coastal states in the United States were granted title to the submerged lands lying within three miles of the coastline.[91] However, the Federal Government did retain a "navigational servitude" in the Submerged

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[89] Convention on the Territorial Sea and the Contiguous Zone (done April 29, 1958, 15 U.S.T. 1606 (1964), T.I.A.S. No. 5639, 516 U.N.T.S. 205, in force September 10, 1964) (Territorial Sea Convention hereinafter). The United States is a party to the Territorial Sea Convention.

[90] 43 U.S.C. Secs. 1301-15(1964) (originally enacted as Act of May 22, 1953, ch. 65, 67 Stat. 29).

[91] This is an oversimplification. In fact, Florida (Gulf Coast) and Texas acquired, pursuant to the Act and subsequent litigation, three marine leagues of submerged lands. All other states, including Louisiana, were limited to three geographical miles, however. On the relation of the state-Federal submerged lands controversy to the superport, see Section C.2, post.

Lands Act and thus, even though the superport might be situated entirely within three miles of Louisiana's coastline, compliance with navigational rules and procedures of the Federal Government, including the duty to obtain a permit from the U.S. Army Corps of Engineers to erect a structure in navigable waters of the United States, will be applicable.

Finally, and as will be discussed in Section C.2, post, the "coastline" of Louisiana, from which the three mile limit is to be measured, has not finally been determined. The outcome of that litigation will, therefore, have an effect on the legal regime applicable to the superport.

2. Site Between Three and Twelve Miles from the Coastline

As if the state-Federal boundary uncertainties were not enough, the question of the breadth of the territorial sea is not subject to an agreed international norm at the present time either. In the traditional Western European and United States view a breadth of three miles was regarded as the maximum permissible under customary rules of international law, but in the light of the large number of claims to six, twelve, and even 200 miles, it can no longer be said that any particular breadth is universally accepted.[92] Evidence does suggest that the distance of twelve miles is emerging as a rule of

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[92] The latest State Department tabulation shows 32% of coastal states claiming three miles, 56% claiming four to twelve miles (42% claiming exactly 12 miles), and 12% claiming in excess of twelve miles.

customary law for the breadth of the territorial sea, and the United States has publically advocated international agreement on that breadth. In a speech delivered in February, 1970, John R. Stevenson, Legal Advisor to the Department of State, noted:

> we believe the time is right for the conclusion of a new international treaty fixing the limitation of the territorial sea at 12 miles, and providing for freedom of transit through and over international straits and carefully defined preferential fishing rights for coastal States on the high seas.[93]

At the July-August, 1971 meeting of the United Nations Seabed Committee,[94] the United States Government submitted "Draft Articles on the Breadth of the Territorial Sea, Straits, and Fisheries," which provide for a twelve mile maximum for territorial sea breadth, "free" (vis-a-vis the present regime of "innocent") passage through international straits, and a system of preferential fishing rights for coastal states.[95] Comments made by delegations of other nations at the July-August, 1971

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[93]Stevenson, International Law and the Oceans," 62 Dept. State Bull. 339, 342(1970). See also, "U.S. Outlines Position on Limit of Territorial Sea," 62 Dept. State Bull. 343(1970).

[94]United Nations Committee on the Peaceful Uses of the Sea-Bed and the Ocean Floor Beyond the Limits of National Jurisdiction (Seabed Committee hereinafter), established by U.N. General Assembly Resolution 2467A (21 December 1968). The Seabed Committee originally had 42 members, but membership was expanded to 86 in December, 1970 (G.A. Res. 2750C [XXV]), and to 91 in December, 1971. The Seabed Committee is acting as a preparatory group for the Third United Nations Conference on the Law of the Sea, scheduled for 1973 (see note 96 post).

[95]U.N. Doc. A/Ac.138/SC.II/L.4 (30 July 1971).

meeting of the Seabed Committee, as well as statistical surveys, show overwhelming support (far above the 2/3 majority needed for adoption of treaty articles at the Third United Nations Conference on the Law of the Sea)[96] for the twelve mile limit. However, the United States offer of acquiesence in a twelve mile limit is coupled to controversial proposals concerning passage through straits and preferential fishing rights which may endanger the prospects for agreement on the maximum breadth for the territorial sea. Even so, it seems likely that by 1980 the twelve mile maximum will be international law, either through development of a customary international law rule on the subject or through international agreement. If such an international law standard establishing 12 miles as a maximum breadth should exist, the United States Government would still have to domestically adopt that limit for it to be applicable to this Nation.

Thus, if the superport were located between the three and twelve mile limits, two possibilities exist:

(1) If the territorial sea of the United States is extended to twelve miles, then the same analysis given in Section B.1, supra, is applicable. In short, no significant international legal

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[96] In December, 1970, the United Nations General Assembly adopted Resolution 2750C calling for a Third United Nations Conference on the Law of the Sea to be held sometime during 1973 unless postponed by the twenty seventh session of the General Assembly in 1972 on grounds of insufficient progress of preparatory work. The issues to be dealt with at the 1973 Conference include "the regimes of .... the territorial sea (including the question of its breadth and the question of international straits) and contiguous zone."

problems will arise. This is not the case, as will be noted later, with respect to state-Federal problems.

(2) If the territorial sea of the United States remains at three miles, then the analysis given in Section B.3, post, will be applicable. As will be noted, substantial international and state-Federal legal questions arise in this situation.

3. Site Beyond the Limit of the Territorial Sea (Whether Three or Twelve Miles)

If the superport facility must utilize the water column (high seas) or the seabed (continental shelf) beyond the territorial sea, then it is necessary to examine the legal regime of these areas to determine legal feasibility.

a. The High Seas

The situation of use of the high seas is governed by the Convention on the High Seas[97] which provides that although "no State may validly purport to subject any part of (the high seas) to its sovereignty,"[98] nonetheless the concept of freedom of the high seas contemplates use of the area for such undertakings as navigation, fishing, the laying of submarine cables and pipelines, overflight, and

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[97] Convention on the High Seas (done April 29, 1958, 15 U.S.T. 2312 (1962) T.I.A.S. No. 5200, 450 U.N.T.S. 82, in force September 30, 1962). The United States is a party to the Convention on the High Seas.

[98] Id., Art. 2

"others which are recognized by the general principles of international law."[99] These uses are conditioned on the principle that they shall "be exercised by all States with reasonable regard to the interests of other States in their exercise of the freedom of the high seas."[100]

Two sub-issues are thus presented: (1) is the construction of a superport facility a permitted use within the concept of freedom of the high seas; and (2) can such a facility exist consistent with the "interests of other States in their exercise of the freedom of the high seas?" The equally relevant and significant issue of whether the coastal state would have the power to regulate activities taking place on a superport located outside the limit of the territorial sea (assuming it had the power to locate it there in the first instance) will be discussed in Section B.3.b., post, relating to jurisdictional aspects of the continental shelf.

As to the first issue, the matter is made difficult by the absence of precedent. Certainly uses other than the four enumerated in the Convention on the High Seas have been made, particularly the construction of offshore oil platforms. However, the latter practice is

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[99] Id.

[100] Id.

specifically authorized by the Convention on the Continental Shelf.[101] No solace can be derived from the existence of giant petroleum storage tanks located beyond the territorial sea, such as those in the Persian Gulf and elsewhere, for they are directly related to the exploitation of petroleum resources from the adjacent submerged lands and thus fall within the structures permitted under the Continental Shelf Convention as "necessary for (continental shelf) exploration and the exploitation of its natural resources."[102] The superport envisioned for the coast of Louisiana would be essentially an "import" device and would not be a necessary concomitant of petroleum, natural gas, or sulphur production from the continental shelf underlying the Gulf of Mexico.

Since we are here dealing with an entirely new phenomenon, the catch phrase "other (uses) which are recognized by the general principles of international law" is also of little help. A well established ocean space use such as scientific research may come

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[101] Convention on the Continental Shelf (done April 29, 1958, 15 U.S.T. 471 (1964), T.I.A.S. No. 5578, 499 U.N.T.S. 311, in force June 10, 1964 ("Continental Shelf Convention" hereinafter). The United States is a party to the Continental Shelf Convention. Article 5 provides that subject to certain conditions "the coastal State is entitled to construct and maintain or operate on the continental shelf installations and other devices necessary for its exploration and the exploitation of its natural resources." (Emphasis added.)

[102] See note 101 *supra*.

under this category, but there is no history of usage concerning superports which would qualify them under the quoted provision.

International law, however, is and always has consisted of an evolving set of norms. As new technological advances are made, especially in the oceans, new norms emerge and are subsequently codified. Many of the initial moves toward new legal regimes were accomplished by "unilateral action," and this is a recognized form of initiation of a customary rule of international law. The doctrine of the continental shelf itself stemmed in part from a unilateral declaration by the United States--the Truman Proclamation.[103] Thus, it is not hard to argue that, given justifications as compelling

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[103]Pres. Proc. No. 2667, 3 C.F.R. 1943-1948 Comp., at 67 (1945); 13 Dept. State Bull. 485 (September 30, 1945):

> The Government of the United States regards the natural resources of the subsoil and sea bed of the continental shelf beneath the high seas but contiguous to the coasts of the United States as appertaining to the United States, subject to its jurisdiction and control.

as those outlined in the Truman Proclamation,[104] the United States would be as justified today as it was in 1945 in unilaterally declaring that superport facility construction is a reasonable use of the high seas. If no protests were forthcoming from other nations, and this relates to the second sub-issue, the rule would be well on its way to international acceptance. In the unlikely event of

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[104]The justification for the Proclamation is contained in perambulatory paragraphs as follows:

> WHEREAS the Government of the United States of America, aware of the long range world-wide need for new sources of petroleum and other minerals, holds the view that efforts to discover and made available new supplies of these resources should be encouraged; and
>
> WHEREAS its competent experts are of the opinion that such resources underlie many parts of the continental shelf off the coasts of the United States of America, and that with modern technological progress their utilization is already practicable or will become so at an early date; and
>
> WHEREAS recognized jurisdiction over these is required in the interest of their conservation and prudent utilization when and as development is undertaken; and
>
> WHEREAS it is the view of the Government of the United States that the exercise of jurisdiction over the natural resources of the subsoil and sea bed of the continental shelf by the contiguous nation is reasonable and just, since the effectiveness of measures to utilize or conserve these resources would be contingent upon cooperation and protection from the shore, since the continental shelf may be regarded as an extension of the land-mass of the coastal nation and thus naturally appurtenant to it, since these resources frequently form a seaward extension of a pool or deposit lying within the territory, and since self-protection compels the coastal nation to keep close watch over activities off its shores which are of the nature necessary for utilization of these resources; . . .

protest, modifications in the regime might have to be made.[105]

The basis for such an argument is obvious--since navigation is one of the oldest recognized freedoms of the high seas; since technological development in ship construction now requires drafts only found in deeper offshore waters; and since port facilities are a sine qua non to the exercise of the freedom of navigation; therefore, port facilities constructed on the high seas are an acceptable use of that area. The argument should be developed in more detail, but these are the essential elements of the case.

One negative factor must be considered in this regard. The International Law Commission ("I.L.C.") which acted as the preparatory body for the 1958 United Nations Conference on the Law of the Sea from which the Continental Shelf Convention emerged, stated in its commentary to the draft article permitting structures for the purpose of exploiting the natural resources of the continental shelf:

> To lay down... that the exploration and exploitation of the continental shelf must never result in any interference whatsoever with navigation and fishing might result in many cases in rendering somewhat nominal both the sovereign rights of exploration and exploitation and the very purpose of the articles as adopted. The case is clearly one of assessment of the relative importance of the interest involved.

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[105] In this regard, one might suggest that if, as required by Article 9 of the Territorial Sea Convention for roadsteads and by Article 5 of the Continental Shelf Convention for mineral resource exploitation structures, appropriate notice is given, safety regulations adopted and enforced, and operations conducted with due regard to navigation in the area, there would be little if any ground for objection by other nations.

> Interference, even if substantial, with navigation and fishing might, in some cases, be justified. On the other hand, interference even on an insignificant scale would be unjustified if unrelated to reasonably conceived requirements of exploration and exploitation of the continental shelf.[106] (Emphasis added.)

One view is that a well reasoned and cogent set of justifications for unilateral action would outweigh the pronouncements of the I.L.C. made some sixteen years ago without benefit of knowledge of the tremendous developments in the construction of ocean-going tankers which was to come.[107]

b. The Continental Shelf

There are two principal issues to be raised and discussed in connection with the use of the continental shelf for superport purposes. First, does the coastal nation have the jurisdiction to construct the facility (an issue considered in the last section in terms of the high seas)? Second, if it does, and if such a facility is constructed, does the coastal nation have jurisdiction to regulate activities thereon (i.e., to apply its civil and criminal law, special regulations, etc.)?

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[106] "Report of the International Law Commission to the General Assembly, "Yearbook of the International Law Commission, Vol. II (1956), at 299 (U.N. Doc. A/3159).

[107] The only significant potential interference with other nations' use of the area would be in the realm of fishing. However, in view of the lack of factual complaints about offshore oil exploitation structures in the area (juridical protests are, of course, non-existent because of the permissive language of Article 5 of the Continental Shelf Convention), it seems unlikely that a single installation would generate any concern among foreign fishing nations about interference with their fishing activities.

Preliminarily it should be noted that some observers feel the jurisdictional questions surrounding superport location are entirely related to the high seas. They consider the use of the seabed to be so incidental that no jurisdictional question arises in regard thereto. Were the facility simply a floating structure, temporarily anchored to the ocean floor, one might agree. That would, of course, present all the problems of classifying the facility as a "vessel" and its workers as "seamen." Our view, however, in light of the fact that such a superport is more likely to be permanently affixed to the seabed and that the area of submerged land will thereby be permanently excluded from other possible uses, is that this consists in a use of the continental shelf. Accordingly, it is believed appropriate to analyze the issues involved in utilizing the continental shelf for purposes of a superport.

1) Jurisdiction to Construct

Internationally, the use of the continental shelf is governed by the customary international law doctrine of the continental shelf and, for states party thereto, by the Continental Shelf Convention.[108] The latter is quite explicit in terms of the uses of the seabed covered. Articles 2 and 5 confer on coastal states parties thereto exclusive sovereign rights "for the purpose of exploring it and exploiting its natural resources," including the right "to

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[108] Note 101, supra.

construct and maintain or operate on the continental shelf installations and other devices necessary for its exploration and the exploitation of its natural resources."[109] A logical interpretation of these provisions utilizing the maxim inclusio unius est exclusio alterius would lead to the conclusion that only natural resource extractive activities are within the exclusive purview of the coastal state since these are the only rights conferred by the Continental Shelf Convention, and that other used (if permitted at all) are therefore open to all nations on an inclusive basis under the traditional doctrine of the freedom of the high seas. Indeed, the representative of Belgium in a letter to the Secretary General of the United Nations raising this very issue before the United Nations Seabed Committee observed:

> It follows clearly from these provisions that an installation which is not used for the exploration or exploitation of the natural resources of the continental shelf does not come under the jurisdiction of the coastal State. This would apply to an artificial structure the only purpose of which is to serve as a port. . .
>
> In the event that structures of this kind were to be built, they could not be included within any jurisdiction under the existing international law.[110]

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[109] Note 101 supra Arts. 2(1, 2) and 5(2).

[110] U.N. Doc. A/Ac.138/35 (3 May 1971). The letter requested inclusion on the agenda of the United Nations Seabed Committee of an item concerning the question of "jurisdiction over artificial islands, or artificial installations on the high seas." The letter stated:

> The Belgian Government received a proposal from a private source for the offshore construction, more than twenty-seven kilometres from the Belgian coast, of an artificial port for the unloading of heavy tankers. The proposed site is on the Belgian continental shelf.

The question dealt with in the Belgian situation is more pertinent to the issue of jurisdiction to regulate than to jurisdiction to construct and, accordingly, further discussion thereof is postponed until Section B.3.b.2, dealing with regulatory jurisdiction.

The interpretation of the customary international law rules relating to the continental shelf presents a somewhat more difficult problem of analysis for those rules are less well defined than the rights conferred by the Convention. The most precise formulation of the doctrine was given by the International Court of Justice in 1969 in its decision in the North Sea Continental Shelf Cases[111] as follows:

> the most fundamental of all the rules of law relating to the continental shelf, enshrined in Article 2 of the 1958 Geneva Convention, though quite independent of it, (is) . . . that the rights of the coastal State in respect of the area of continental shelf that constitutes a natural prolongation of its land territory into and under the sea exists ipso facto and ab initio, by virtue of its sovereignty over the land, and as an extension of it in an exercise of sovereign rights for the purpose of exploring the seabed and exploiting its natural resources . . . (This right) is "exclusive" in the sense that if the coastal State does not choose to explore or exploit the areas of shelf appertaining to it, that is its own affair, but no one else may do so without its express consent.[112]

If the Court's pronouncement is authoritative (and it must be remembered that the issue before the Court was neither

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[111] North Sea Continental Shelf Cases, (1969) I.C.J. 3.

[112] Id., para. 19 of the majority opinion.

the seaward extent of the continental shelf nor the nature of coastal states' rights therein, but rather the delimitation of lateral shelf boundaries between adjacent countries) then one can also logically conclude that the rights of the coastal state apply only with respect to the exploration for and exploitation of the natural resources of the area and that other uses must be made on an inclusive basis.

The argument may be advanced that the term "natural resources" should be liberally interpreted to include virtually any use of the seabed and subsoil, for the seabed itself is a resource of value in the economic sense if any commercial or governmental enterprise depends upon the use, either permanently or temporarily, of some portion thereof. It is believed that this approach is inconsistent with the intent of the framers of the Continental Shelf Convention (as well as the practice with respect to the continental shelf which has evolved into the rules of customary international law concerning it), for states up until recently--and most particularly in 1958 when the Convention was drafted--have been concerned exclusively with the extraction of petroleum, natural gas, sulphur, some hard minerals, and certain species of sedentary fishes, and not with any of the newer uses of the seabed which are now gaining public attention. Further, the Continental Shelf Convention specifically defines "natural resources" as consisting of:

> the mineral and other non-living resources
> of the seabed and subsoil together with

> living organisms belonging to sedentary species . . .[113]

It is unknown at present whether the Belgian delegate's suggestion for international resolution of the issue will be acted upon favorably. However, at least one formal proposal submitted to the United Nations Seabed Committee envisions giving coastal states the authority needed to make such "other" uses of their continental shelves. Dr. Arvid Pardo, in his "Draft Ocean Space Treaty" which was submitted to the United Nations Seabed Committee meeting on 23 August 1971,[114] proposes inclusion of the following provision:

> Art. 62. Subject to the provisions of this Convention, the coastal state may construct, on or under the seabed of national ocean space [from the coastline to 200 miles seaward thereof] habitats, installations, equipment and devices for peaceful purposes provided that . . . .
> Art. 63. The coastal state may construct, and maintain or operate in national ocean space artificial islands, floating harbours or other installations for peaceful purposes, anchored to the seabed, provided that . . . .

The provisos relate to the establishment of safety zones and the like. Should a provision such as Dr. Pardo's be adopted at the 1973 Conference, the matter would be clear.

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[113] Convention on the Continental Shelf, note 101 <u>supra</u>, Art. 2(4).

[114] "Draft Ocean Space Treaty: Working Paper Submitted by Malta," U.N. Doc. A/AC.138/53 (23 August 1971).

Domestically, there are a number of factors bearing on the question of jurisdiction to construct, all turning more or less on the feasibility and basis for unilateral action. This route seems to be required in view of the unanimity of opinion on the question of expressly permitted uses of the continental shelf.

First, there is the judicial pronouncement in the case of United States v. Ray.[115] In this decision, the United States Court of Appeals upheld an injunction requested by the United States Government to prevent certain entrepreneurs from constructing an artificial island attached to coral reefs on the continental shelf off the coast of Florida and outside the limits of territorial waters. Although the Government had framed its request for injunctive relief in the form of a trespass allegation, the Court suggested that the allegation was inaccurately framed and that what was in fact sought was "restraint from interference with rights to an area which appertains to the United States and which under national and international law is subject not only to its jurisdiction but its control as well.[116] The Court coupled these "rights," and the "vital interests" of the United States in preventing infringement of those rights, and found the result sufficient to warrant injunctive relief. It must be conceded,

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[115] United States v. Ray, 423 F. 2d 16 (5 Cir. 1970). Lower court opinion 294 F. Supp. 532 (S.D. Fla. 1969).

[116] United States v. Ray, 423 F. 2d 16, 22 (5 Cir. 1970).

however, that the case is not of definitive import on the issue of non-extractive uses of the seabed since the affected seabed area was coral, a living resource within the definition in the Convention on the Continental Shelf,[117] and thus did not hold that the coastal state had exclusive rights with respect to non-extractive uses.[118] However, the classification of the interest of the coastal state in terms of "rights," and the utilization of the "vital interests" doctrine compels one to believe that executive and legislative, as well as judicial organs of government are likely to respond in the same fashion. In view, however, of the adversary litigative process which accompanied it, and the request of the Department of Justice

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[117] Article 2(4) of the Continental Shelf Conventions provides:

> The natural resources referred to in these articles consist of the mineral and other non-living resources of the sea-bed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the sea-bed or are unable to move except in constant physical contact with the sea-bed or the subsoil.

[118] In fact, the Court specifically states

> (The evidence) fully establishes that the structures herein involved interfere with the exclusive rights of the United States under the Convention to explore the Continental Shelf and exploit its natural resources. Under the circumstances we do not decide what the result would be if the structures did not interfere with the rights of the United States as recognized by the Convention, our decision being limited to the particular facts of this case. (Emphasis added.) This language was modified from that of the slip opinion at the specific request of the Department of Justice in order that United States' rights in its continental shelf not be overstated.

for revision of the original slip opinion which, in the opinion of Justice, overstated the nature of United States rights in its continental shelf area, it can hardly be said that Ray represents any definitive view of the United States Government on the question of non-extractive uses of the continental shelf. There is only one other decision which discusses the issue, viz., Ministre de'Etat chargé de la Défense nationale et Ministre de l'Equipement et du Longement v. Starr et British Commonwealth Insurance Co., 1970 Revue Generale de Droit International Public 1114 (Conseil D'Etat, December 7, 1970) an analysis of which[119] quotes the French court as holding that "(t)he littoral State enjoys rights over the continental shelf which are exclusive and independent of any occupation, but these rights are limited to the aims fixed by the (Continental Shelf) Convention and defined in France by the Law of December 30, 1968. The continental shelf thus does not form part of the national territory. This ends at the limit of the territorial waters." There has not been an opportunity to review the actual text of the decision, but if the review is accurate there now exists another national court decision to support the Ray analysis, albeit Ray has implicit value for asserting jurisdiction for non-extractive purposes.

One basis for a unilateral declaration or act of the Truman Proclamation variety is found in Section 3(a) of

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[119] See 3 Journal of Maritime Law and Commerce 189 (1971).

the Outer Continental Shelf Lands Act,[120] the vehicle under which the United States administers its outer continental shelf lands. That section provides:

> It is hereby declared to be the policy of the United States that the subsoil and seabed of the outer Continental Shelf appertain to the United States and are subject to its jurisdiction, control, and power of disposition as provided in this Act.

Elsewhere in the Act, as in the Truman Proclamation and the Continental Shelf Convention, jurisdiction is stated in terms of the natural resources of the seabed and subsoil. In the quoted provision, however, it is the seabed and subsoil itself which is said to come under United States "jurisdiction, control, and power of disposition." Granted, the Act speaks only of oil, gas, sulphur, and other minerals in its "disposition" provisions, but one can argue that there is more jurisdiction here than simply control over resource extractive activities.

In the last analysis, however, and barring adoption of a Pardo type proposal, *supra*, the United States would have to be taking unilateral action (or perhaps action in concert with other nations equally situated) just as in the case of the high seas use.

2) Jurisdiction to Regulate

Assuming the superport is constructed,

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[120] 43 U.S.C. Secs. 1331-43 (1964))originally enacted as Act of August 7, 1953, ch. 345, 67 Stat. 462).

the second issue is whether or not the adjacent coastal nation has the requisite jurisdiction to regulate activities undertaken there. This is obviously of some importance, since although the United States retains jurisdiction over its nationals wherever situated, some special basis of jurisdiction would have to be found for non-U.S. nationals working on the facility.

Since, as noted above, the Belgian Government has apparently taken a closer look at this issue than other nations, it is appropriate to return to that source for a moment.

Speaking at the July-August, 1971 meeting of the United Nations Seabed Committee, Alfred van der Essen, the Belgian delegate, emphasized the difficulties involved in using a portion of the continental shelf for construction of a superport:

> In Belgium, bills introduced into parliament were first submitted to the Conseil d'Etat for a legal opinion on their content. The bill, which had become the law of 13 June 1969 on the Belgian continental shelf, had therefore been studied by that authority. The opinion of the Conseil d'Etat was that an installation which was not used for the exploration or exploitation of the natural resources of the continental shelf did not come under Belgian jurisdiction. Belgium could take legal action against its own nationals, who could always be brought before the court of their place of domicile for an offense committed outside the territory. That, however, was not the case for foreigners, who might well be numerous among the staff of an artificial port.[121] (Emphasis added.)

The Belgian Council of State recommended modifying an earlier version of the Belgian law of 13 June 1969 on the

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[121] U.N. Doc. A/AC.138/SC.II/SR.4-23 at 66 et seq.

basis that it asserted more jurisdiction than was permissible under international law. The earlier draft, embodying many of the principles of the Continental Shelf Convention (to which Belgium is not a party), was modified to make it clear that Belgium was only asserting jurisdiction over structures on the continental shelf designed for the exploration or exploitation of its natural resources and not for any broader purpose. This change, which was in accord with what the government stated to be the purpose of the law, and which was in accord with the preliminary article of the law setting forth this purpose, was made in order to delete language which would have literally given Belgium jurisdiction over all permanent installations situated on the high seas on the Belgian continental shelf.

One can readily disagree with this conclusion in view of the provisions of Article 9 of the Territorial Sea Convention dealing with readsteads. There is inferential authority in the Territorial Sea Convention for the use of areas of the high seas for port-like activities:

> Roadsteads which are normally used for the loading, unloading and anchoring of ships, and which would otherwise be situated wholly or partly outside the outer limit of the territorial sea, are included in the territorial sea. (Art. 9)[122]

By giving territorial sea status to such areas, coastal state competence to regulate activities undertaken there would clearly be accorded.

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[122] A roadstead is "(a) sheltered, offshore anchorage area for ships." American Heritage Dictionary of the English Language (1969) at 1122.

However, it can only inferred from this language that the coastal state has the authority to construct a superport facility for it is unknown whether the term "roadsteads" as used in the Territorial Sea Convention includes the modern concept of a superport.

The only relevant comment in the legislative history of the Territorial Sea Convention is that of the United States delegate who stated that "(t)he purpose of (Article 9) was to ensure that the coastal State could exercise police powers and general jurisdiction in its roadsteads . . ."[123] There would appear to be two arguments which might support the use of the water column outside the territorial sea for superport purposes: (1) superports are, in function, identical to roadsteads, and therefore the coastal state has territorial sea jurisdiction following their construction (this begs the question of initial jurisdiction to construct, of course); or (2) although not identical, their functions are sufficiently analogous that the framers of the provision could be considered to have envisioned technological advances which would produce more sophisticated and complex "roadsteads," so long as the same basic purposes were served (such roadsteads have been delimited in the Gulf of Mexico in connection with the delimitation of shipping safety fairways).[124]

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[123]III Official Records, United Nations Conference on the Law of the Sea 143 (1958), U.N. Doc. A/CONF.13/39.

[124]See Knight, "Shipping Safety Fairways: Conflict Amelioration in the Gulf of Mexico," 1 J. Maritime L. & Comm. 1 (1969).

In a personal communication to the authors, Alfred van der Essen disputed this contention, arguing that the French work "rade" as used in Article 9 has a definite and precise meaning of an extent of sea enclosed in part by land, more or less elevated, which offers to cargo vessels shelter and other port facilities.[125] This is at variance with definition quoted above[126] in its requirement of land enclosure. Further, Webster's New World Dictionary[127] and the Oxford Dictionary of English Etymology[128] make reference respectively to "a protected place near shore" and "sheltered water where ships may ride," thus leaving open the possibility of extension of definition through technological advancement without having to tie the area to land enclosure.

We are of the opinion, in view of the legislative history of the Territorial Sea Convention and recent technological advances in port construction, that a superport facility could be validly assimilated to a roadstead and that territorial sea jurisdiction would therefore be applicable under Article 9.

An important ancillary issue relates to the fact that although the State of Louisiana is championing the case

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[125] Letter from Alfred van der Essen to H. Gary Knight, March 30, 1972.

[126] Note 122 supra.

[127] Webster's New World Dictionary of the American Language (1964) at 1259.

[128] The Oxford Dictionary of English Etymology (1966) at 770.

for location of a superport off the mouth of the Mississippi River, if the facility is built beyond the three mile limit it will be on submerged lands subject to Federal jurisdiction.[129] The Outer Continental Shelf Lands Act provides in Section 4(a)(1) that the "(c)onstitution and laws and civil and political jurisdiction of the United States" are to be applicable to the outer continental shelf and to structures erected thereon for resource extractive purposes. Interestingly, Section 4(a)(2), which provides that "(t)o the extent they are applicable and not inconsistent with this Act or with other Federal laws and regulations of the Secretary (of the Interior) . . . the civil and criminal laws of each adjacent State as of the effective date of this Act are hereby declared to be the law" for the seabed and for artificial islands and fixed structures, the latter not being conditioned on relation to resource extractive activities.

Thus an argument can be made for application of Louisiana law to facilities not designed for resource extractive purposes. In view of the overall legislative intent of the Act, however, it is not believed that this gives Louisiana or any other state a particularly strong argument to jurisdiction over continental shelf activities, particularly when the law is limited to that in force as of "the effective date of this Act."

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[129] Even if the United States should adopt a twelve mile limit for its territorial sea, the boundary line between Federal and Louisiana submerged lands will remain at three miles, for the Submerged Lands Act speaks in terms of the fixed distance (three geographical miles), not in terms of the breadth of the territorial sea. See also Section C.2. post.

In light of the above analysis, we are of the opinion that although a strict interpretation of existing international law affords no express authority to either construct or to regulate activities on a superport facility, nonetheless there are no express prohibitions and, accordingly, carefully structured unilateral action to effect such a user of the high seas and the continental shelf should not meet with protest and should afford the United States the jurisdiction it requires to carry out this proposed project.

C. Related Issues

There remain for consideration a number of ancillary, but important, issues.

1. Foreign Policy Interests of the United States

The possible effect of a unilateral use of the seabed and water column for superport purposes on current law of the sea negotiations is not likely to be overlooked by the United States Government. Preliminary inquiries of members of the Executive Branch indicate that such a project would probably be viewed primarily as a new use of the high seas, and not as a use of the seabed in the sense contemplated in the Continental Shelf Convention. Although areas of seabed would be occupied to the exclusion of other uses, nonetheless it does not (in this view) constitute the type of extractive enterprise which was the genesis of the Truman Proclamation of 1945 and, subsequently, the Continental Shelf Convention.

We have some doubts, however, whether the State Department would approve wholeheartedly any such project in view of the delicate nature of the current law of the sea deliberations at the United Nations. By analogy, the State Department has adamantly opposed the construction of straight baselines along areas of the United States coast which are entirely suitable for such treatment on the grounds that to do so would prejudice our international negotiating position on certain questions relating to the delimitation of straight baselines by outlying archipelago nations and the breadth of the territorial sea. Further, the Department of Defense is quite concerned with a loosely defined phenomenon called "creeping jurisdiction" through which a coastal state purportedly acquires steadily increasing jurisdiction or competence over adjacent ocean space areas until such time as that jurisdiction approaches or reaches the level of a territorial sea claim.

The construction of a facility using the seabed and high seas in a manner heretofore not contemplated would seem to be parallel to such unilateral acts or declarations as the delimitation of straight baselines, and also a type of additional jurisdictional claim involved in the "creeping jurisdiction" hypothesis.

Thus, it is possible that when the Corps of Engineers circulates its notice of application for a permit to erect a structure in navigable waters, the State Department or the Department of Defense might file a letter of objection, or suggest imposition of certain conditions with respect to the project.

2. State-Federal Submerged Lands Litigation Issues

The determination of where the seaward limit of the territorial sea is depends on the location of the "baseline." The provisions for delimiting the baseline are contained, for international purposes, in the Territorial Sea Convention. In United States v. California[130] the United States Supreme Court adopted the standards in the Territorial Sea Convention for purposes of delimiting the boundary between the Federal Government and the several coastal states in the submerged lands controversy. The location of the baseline off the Louisiana coast has not yet been finally determined in all places. It is likely that the Special Master now hearing the case will submit his report to the Court in the fall or winter, 1972, and that a final decision can be obtained before mid-1973. Until this decision is available, it will not be possible to know precisely the location of the superport in relation to the territorial sea boundary. Thus it will be necessary to follow closely this domestic litigation, as it is affected by international agreements and standards.

It should be noted that extension of the territorial sea of the United States to a twelve mile breadth will have no effect on the location of the state-Federal boundary, because the Submerged Lands Act specifies "three geographical miles" as the area under state jurisdiction and makes no reference to the breadth of the territorial sea.

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[130] 381 U.S. 139 (1965).

A further aspect of the state-Federal submerged lands controversy is the substantial ill-will generated on both sides over a long period of time. This is particularly pronounced in Louisiana's case. Thus, it is likely that the representatives of the Justice Department, who handle the litigation for the Federal Government, will view dimly any proposals to give Louisiana any form of jurisdiction on outer continental shelf lands, even for superport purposes unrelated to natural resource extraction. There is, of course, no reason why an appropriate agreement could not be negotiated, taking into consideration the economic impact (both beneficial and detrimental) of the facility on Louisiana and the interest of the Federal Government, through its Maritime Administration, in having a deep draft superport in the Gulf of Mexico. Nonetheless, the negotiations will have to be approached from the realities of domestic law, viz., that the Federal government has exclusive jurisdiction over activities conducted beyond the three mile limit and Louisiana has no legal right, title, or interest in this area. On the other hand, both the Federal Government and Louisiana stand to benefit substantially from a superport located off the mouth of the Mississippi River, and appropriate concessions by both parties can bring about realization of those benefits.

Finally, a technical point on the relative positions of Texas and Florida concerning limits of offshore jurisdiction is appropriate. As a result of litigation following enactment of the Submerged Lands Act, Texas and Florida were granted three marine leagues of submerged lands, other states receiving only three goegraphical miles. The issue is whether Texas and Florida have, in the lands granted to them beyond the three mile limit, rights to construct a superport facility. Our opinion is that they do not--that they stand no better in this area than any of the other coastal states of the United States.

The basis for this assertion is as follows:

(1) The United States, through the Submerged Lands Act, could only grant to the several states in 1953 what title or jurisdiction it then had. In 1953, the United States had full sovereignty within three miles; but beyond that had only the right, under the customary international law doctrine of the continental shelf (the Continental Shelf Convention did not enter into force until 1964), to explore for and exploit the natural resources of the seabed and subsoil. In the area between three miles and three leagues, the United States possessed no other rights vis-a-vis other nations.

(2) Thus, although the Submerged Lands Act purported to grant full title (including title to fish and for any other purpose), nothing additional (to continental shelf rights) were granted to Texas and Florida in the three mile to three league area because the United States did not have it to grant.

(3) Accordingly, jurisdiction to construct a superport in the area between three miles and three leagues off the coast of Texas and Florida lies with the United States, not with those states.

This is, of course, only one opinion. The issue is currently being litigated in Original No. 54 before the United States Supreme

Court on the issue of fishing rights in the three mile to three league area. Determination on that issue will be dispositive of the superport issue, however, for the legal basis of the arguments is the same.

3. Withdrawal of Areas Adjacent to the Superport

The continental shelf resources off the coasts of this Nation are administered under the Outer Continental Shelf Lands Act. It is possible that an internal conflict could arise between the desire to utilize a given area for, say, the production of petroleum and natural gas, and the need to use the same area for a superport. The administration of outer continental shelf ("OCS") lands is rife with such conflicts.[131] Certainly the future plans of the Department of the Interior for leasing outer continental shelf lands for the extraction of oil, gas, sulphur, and other minerals should be carefully checked in siting the superport. Although considering that the relatively small area required for a superport would probably permit directional drilling to recover petroleum or natural gas resources beneath it, the desirability of having the fewest possible offshore structures within several miles of the facility would indicate the desirability also of withdrawing the immediate and surrounding area of the site selected from leasing pursuant to the Act which provides:

> The President of the United States may, from time to time, withdraw from disposition any of the unleased lands of the outer Continental Shelf. (Sec. 1341(a)).

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[131] See, e.g., Study of the Outer Continental Shelf Lands of the United States, Sections 4.74-4.78.

one such withdrawal, for the purposes of creating a National Park, has already been effected.[132]

Of course, if the superport is located within three miles of the baseline, jurisdiction over the seabed lies with the State of Louisiana, and appropriate arrangements would have to be made through the leasing agencies of that State.

4. International and Federal Pollution Laws

The United States is party to several international agreements concerning prevention of pollution at sea. Federal statutes on this subject would also be applicable to United States citizens operating a superport, even if situated outside the territorial sea. The activities conducted at any such facility would, therefore, need to be performed in compliance with all international agreements and National laws governing pollution prevention.

5. Navigation Interests

The creation of a superport off the mouth of the Mississippi River will undoubtedly result in increased shipping tonnage utilizing

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[132] Pres. Proc. No. 3339, 3 C.F.R., 1959-1963 Comp., p. 71 (1960); 25 Fed. Reg. 2352. The proclamation withdrew from disposition under the Outer Continental Shelf Lands Act certain submerged lands off the Florida coast in order to create the Key Largo Coral Reef Preserve. It is worthy of note in considering the likelihood of international protest to the construction of a superport that this withdrawal by President Eisenhower came prior to the date upon which the Continental Shelf Convention came into force. Since the customary uses of the shelf were exclusively theretofore for the extraction of oil and gas, a new use was clearly being made. No protests were received to the action.

the Gulf of Mexico. This will serve to exacerbate the existing conflict between navigation interests and the erection of structures for the production of oil and gas in the Gulf.[133] The existing system of shipping safety fairways has not proven particularly effective in preventing accidental collisions.[134] It may, therefore, be necessary to assert some proprietary rights in areas of high seas in order to protect the international community's interest in safe navigation by designating certain corridors as mandatory routes for shipping. The present system does not require navigation in the fairways, but simply uses the technique of advising mariners that the designated lanes do not contain structures. If traffic density increases substantially, this system will probably have to be abandoned in favor of a mandatory routing system. This, of course, runs counter to traditional concepts of freedom of the high seas, but there is substantial support for the creation of "property" rights on the seas where the variety and density of uses of ocean space present conflict situations.[135]

IV. Deep Draft Harbor and Terminal Act of 1972 (La. R.S. Title 34, Chap. 35)

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[133] See Knight, note 124 supra.

[134] Id. at 18-19.

[135] See, e.g., Christy, "Fishery Problems and the U.S. Draft Article," paper presented to the Fourth Annual Sea Grant Conference, October 13, 1971 (mimeographed) 1-9; Christy, "The Ownership of Ocean Resources," paper presented to the Annual Convention of the Izaak Walton League of America, July 8, 1971 (mimeographed).

§3101. Object; purpose of act

A. It is the object and purpose of this Act to provide for the creation of a political subdivision of the state of Louisiana, possessing full corporate powers, known as the Deep Draft Harbor and Terminal Authority, hereinafter referred to as the "Authority," to promote, plan, finance, develop, construct, control, operate, manage, maintain and modify a deep draft harbor and terminal within the jurisdiction of said Authority and in order to provide the necessary facilities for docking, loading and unloading of vessels carrying liquid or dry bulk and energy cargoes. It is hereby declared to be in the public interest that this Deep Draft Harbor and Terminal Authority be created as a political subdivision of the state of Louisiana.

B. It is further the object and purpose of this Act:

1. To promote the economic industrial wellbeing of the existing port authorities of the state of Louisiana and to promote interstate, national and international trade for the state of Louisiana, its subdivisions and the area served by the Mississippi River and its tributaries, and to provide that existing ports take such steps individually and collectively to assure the maintenance of the economic wellbeing of each port authority, as well as the whole;

2. To promote the industrial and petrochemical base of the Mississippi Valley Region of the United States by providing adequate deep draft port facilities for the handling of the cargoes of deep draft vessels;

3. To promote, in addition to port operations, scientific, recreational and all other uses of the Deep Draft Harbor and Terminal which shall be in the public interest;

4. To accommodate and plan for the technological innovations occurring in the worldwide and domestic shipping industry to increase efficiency and the flow of commerce through the Deep Draft Harbor and Terminal;

5. To protect environmental values and Louisiana's unique coastal marshland ecosystem through the adoption of an Environmental Protection Plan;

6. To assert and protect Louisiana's economic, social and environmental interests in the development of any Deep Draft Harbor outside the state of Louisiana where such development may have an impact upon the state of Louisiana;

7. To constitute the authority as a political subdivision of the state of Louisiana and such functions exercised by the board empowered herein shall be deemed to be held as governmental functions of the state of Louisiana, as the exercise of the powers granted herein will, in all respects, be to the benefit of the people of the state, for the increase of their commerce and prosperity and for the improvement of the economic condition;

8. To assure that the Authority shall not be required to pay any taxes or assessments on any property acquired or used by it under the provisions of the Act or upon the income therefrom, and any bonds issued hereunder shall be serviced from the income of said

facility and shall be exempt from taxation by the state of Louisiana, and by any municipal or political subdivision of the state.

§3102. Definitions

For the purposes of this Act, the following definitions shall apply:

(1) "Deep Draft Harbor and Terminal" means a structure, or series of structures or facility of any type emplaced in coastal waters and designed to accommodate the cargo or passengers of deep draft vessels whose draft is greater than the depths of typical inland harbors and waterways commonly used by ocean going traffic during the first half of the twentieth century, including all those structures and favilities functionally related thereto and necessary or useful to the operation thereof whether landward or seaward of the main structure or facility itself.

(2) "Authority Development Program" means all the phases of growth and development through which the concept of a Deep Draft Harbor and Terminal may go, including but not limited to promoting the concept, raising funds to support the program, planning the uses of the facility, selecting a site for the physical facility and support facilities, designing the structures, constructing the facility and the support facilities, operating and maintaining the facility, expanding or renovating the facility, modification and retirement of the facility, and any other phases through wich Authority development may proceed.

(3) "Environmental Protection Plan" means a written document,

prepared in conformity with this law, which shall be a regulation of the Deep Draft Harbor and Terminal Authority which establishes those steps to be followed to insure the protection of the environment throughout all phases of the Authority Development Program.

(4) "Three Deepwater Ports" means the Board of Commissioners of the Port of New Orleans, the Greater Baton Rouge Port Commission and the Lake Charles Harbor and Terminal District.

(5) "Three directors" means the director of the Louisiana Wildlife and Fisheries Commission, the director of the Louisiana State University Center for Wetland Resources and the Executive Director as created herein.

(6) "Facility" means any structure or improvement actively used on a regular basis in waterborne commerce.

(7) "Coastal waters of Louisiana" means those waters extending three nautical miles from the coastline, or beyond to the extent of the jurisdiction of the state of Louisiana.

Nothing contained herein shall be construed to affect Louisiana's claim to it's tidelands or the location of Louisiana's coastline as interpreted by the State of Louisiana.

§3103. Jurisdiction; domicile

A. The Authority shall have exclusive jurisdiction over the Authority Development Program within the coastal waters of Louisiana. The jurisdiction of the Authority shall not include or extend to the taking, control or operation of existing, proposed or future facilities of existing port authorities except by mutual agreement.

B. The Authority shall have the right to acquire by lease or purchase waterbottoms inside and outside of the territorial limits of the state of Louisiana for use in the construction, operation or maintenance of the facilities functionally required, related, necessary or useful to the operation of the Authority.

C. The domicile of the Authority shall be in the city of New Orleans; however, by appropriate act of the board of commissioners the domicile may be relocated to an appropriate location within the structures and facilities constructed or acquired by the Authority.

§3104. Board of commissioners; qualifications; selection; terms; vacancies; compensation

A. The Authority shall be governed by a board of commissioners consisting of nine members chosen on the basis of their demonstrated experience in civic leadership and their stature and ability to act effectively for the best interests of Louisiana.

B. All commissioners shall be appointed by the governor. Two shall be selected from a list of nominees submitted by Louisiana's Three Deepwater Ports, with each Deepwater Port recommending two nominees.

Two shall be selected from each of the three Public Service Commission Districts in the state of Louisiana.

One of the members selected from the three Public Service Commission Districts shall be selected for his primary interest in protecting the unique coastal environment of Louisiana.

One member shall be selected from the State at large.

Once a final determination is made as to the location of the deep draft harbor and terminal, the first vacancy occurring on the board shall be filled by appointment of a resident of a parish in which, or offshore from which, the deep draft harbor and terminal is to be located. This appointment shall be from a list of three names to be submitted by the governing authority of the Parish in which, or offshore from which, the deep draft harbor and terminal is to be located. If the deep draft harbor and terminal is located in, or offshore from, more than one parish, then the governing authority of each such parish shall submit to the Governor a list of three names and from the lists so submitted the Governor shall select said appointee.

C. Each of the nine commissioners shall serve a five year term, except the initial appointees.

A commissioner may not serve more than two consecutive five year terms on the board of commissioners.

The first nine appointments shall be for terms of one member for one year, two for two years, two for three years, two for four years, and two for five years. The governor shall exercise his discretion as to which nominees to appoint to the initial shortened terms. Thereafter, all commissioners appointey as herein provided shall serve five year terms.

D. All vacancies shall be filled for the unexpired term in the same manner as the appointment originally made, except as herein provided. A commissioner may be removed by the governor for just cause.

E. The members of the board of commissioners shall serve without compensation, but shall be reimbursed for travel expenses incurred in attending meetings, at rates and standards as promulgated by the American Automobile Association or a comparable recognized standard.

§3105. Duties of Board; officers; rules; meetings; quorum

A. The board of commissioners shall be the governing body of the Authority with full power to promulgate rules and regulations for the maintenance and operation of said Authority.

B. The board of commissioners shall be a governing body of laymen. It shall formulate general policy. It shall decide upon all matter relating to the Authority Development Program. It shall adopt an annual operating and capital budget.

C. The commissioners shall elect a president annual from among themselves.

D. The executive director, as chosen by the commissioners, shall be the secretary of the board.

E. The board of commissioners shall prescribe its own rules, which shall be adopted and promulgated in accordance with law.

F. The board of commissioners shall meet at least once every sixty days or upon the written request of three members, or upon the written request of the president.

G. All matters to be acted upon by the board of commissioners shall require the affirmative vote of at least five commissioners, with the exception that the affirmative vote of not less than six commissioners shall be required to select the executive director.

§3106. Annual reports; revenues dedicated to Authority; revenue surplus; audit; central listing of employees and investment of idle funds

A. The board of commissioners shall make an annual report to the governor showing all receipts and disbursements of the board; the number of arrivals and departures of vessels and their tonnage; the exports and imports passing through the Authority; the general condition of the Authority and its structures, facilities and other properties; and make such recommendations for its development, welfare and management as may seem advisable.

B. All revenues generated by the Authority are hereby dedicated to the Authority to be used to further the purpose of this Act subject to the limitations stated herein.

Any revenues of the Authority derived from any source whatsoever remaining at the end of each fiscal year, after the payment and satisfaction of all obligations of the Authority under the terms of any resolution or resolutions authorizing the issuance of bonds hereunder, and after paying all expenses of operating and maintaining the Authority, providing for renewal or replacement thereof, providing adequate reserves for continuous operation of the Authority, providing for the acquisition or construction of improvements to such facilities and the purchase of equipment and furnishings therefore, shall be considered as surplus. Said surplus shall be turned over to the general fund of the state of Louisiana for the use and benefit of its citizens.

C. The fiscal affairs of the Authority shall not be subject in any respect, to the authority, control or supervision of any regulating body of the state or any political subdivision thereof, but its books and records shall be subject to audit annually by the legislative auditor and its employees shall be listed on the central listing of state employees and it shall invest its idle funds in accordance with the Investment of Idle Funds Act and it shall be subject to the provisions of the Code of Ethics.

§3107. Executive director; selection; duties; employees; compensation

A. The board of commissioners shall select an executive director who shall exercise all control over all executive functions and the general operation of the Authority. The executive director shall serve at the pleasure of the board. All employees of the Authority shall be responsible to the executive director who shall organize the personnel employed by the Authority in the most efficient manner to accomplish the purposes of the Authority as provided in the Chapter and by regulations established by the Authority's board.

B. The executive director, in addition to his usual functions, shall be secretary to the board of commissioners. The board of commissioners shall fix the compensation of the executive director.

C. Within six months after operation of the Port Authority has commenced, the executive director, with the advice and consent of the Board of Commissioners of the Port Authority, shall submit a plan of Classified Civil Service for all employees of the Authority except the board of commissioners, the executive director, an assistant executive director, an executive secretary to the executive director, and professional employees hired on a contract basis.

§3108. Acquisition of sites; lease of stateowned waterbottoms

A. To enable the Authority to perform the work herein provided, the state of Louisiana, acting by and through the register of state lands, is hereby authorized, empowered and directed to grant to the Authority a lease on stateowned waterbottoms in the Gulf of Mexico which are selected by the Authority as sites for the Deep Draft Harbor and Terminal; provided, however, that the mineral rights on any and all state lands shall be reserved to the state of Louisiana.

Upon receipt of a request from the governing body of the Authority describing the lands to be leased by the Authority, it is hereby made the mandatory duty of the register of state lands to issue a certificate of title evidencing the lease of the land to the Authority as described in the request.

B. The register of state lands shall lease the selected tracts to the Authority for five dollars per acre per annum.

C. All such leases shall be for a term of forty years, but the legislature may reevaluate the rental payments upward or downward to reflect changing economic conditions.

D. All proceeds arising from the sale of such leases of state-owned waterbottoms shall be paid by the Authority to the state treasurer and shall become part of the general fund of the state of Louisiana.

E. Nothing in this Part is intended to authorize the Authority to lease stateowned waterbottoms for the exploration, development and production of oil, gas, sulphur or other minerals or for the cultivation or production of marine resources or detract from the authority of the state mineral board and/or Louisiana Wild Life and Fisheries Commission to lease for such purposes. However, tracts once leased to the Deep Draft Harbor and Terminal Authority may not be leased by the state mineral board or the Louisiana Wild Life and Fisheries Commission without the express consent of the Authority, unless it can be shown by the state mineral board or the Louisiana Wild Life and Fisheries Commission, by clear and convincing evidence, that such lease or leases will not adversely affect present or future Authority operations.

§3109. Powers

A. The Authority shall be vested with exclusive and plenary authority to do any and all things necessary or proper for the Authority to promote, plan, finance, develop, construct, control, operate, manage, maintain and modify the Authority Development Program.

B. To assert Louisiana's interest in any Deep Draft Harbor and Terminal development in proximity to the Louisiana coast, the Authority is empowered to negotiate with and enter into contracts, compacts or other agreements with agencies, bureaus or other divisions of the federal government or other states of the United States concerning the Authority Development Program, including jurisdictional aspects of the location of the Deep Draft Harbor and Terminal, sharing of revenues derived from the operation of the Deep Draft Harbor and Terminal, and promulgation and enforcement of regulations governing Authority operations.

C. The Authority is granted all powers capable of being delegated by the legislature under Article XIV, Section 31 of the Constitution of the state, including but not limited to authority:

1. To own, construct, operate, maintain and lease docks, wharves, sheds, elevators, pipelines, pumping stations and facilities, storage facilities, housing and food facilities, heliport, locks, slips, laterals, basins, warehouses and all other property, structures, equipment and facilities, including belt and connecting lines of railroads and works of public improvement necessary or useful for Deep Draft Harbor and Terminal purposes.

2. To dredge and maintain shipways, channels, slips, basins and turning basins.

3. To establish, operate and maintain in cooperation with the federal government, the state of Louisiana and its various agencies, subdivisions and public bodies, navigable waterway systems.

4. To acquire by expropriation any real property in fee, leaving the ownership of any minerals or mineral rights in the former owners, and the prescription of nonuse shall not run against said minerals or mineral rights. In the event of expropriation, the compensation to be paid shall be the actual market value of the property at the time of taking. In the event of the acquisition of a servitude, or use of any stateowned waterbottoms on which there has been granted

an oyster lease by the Louisiana Wild Life and Fisheries Commission, the private oyster lessee shall be reimbursed by the Authority for the actual market value of said lease.

5. To borrow from any person or corporation using or renting any land or dock or warehouse or any facility of the Authority such sums as shall be necessary to improve the same according to plans and specifications approved by the Authority, and to erect and construct such improvement, and agree that the loan therefore shall be liquidated by deducting from the rent, dock, wharf or toll charges payable for such property, a percentage thereof to be agreed on, subject, however, to any covenants or agreements made with the holders of revenue bonds issued under the authority set forth in Section 3108 of this Chapter.

6. To collect tolls and fees.

7. To borrow funds for the business of the Authority.

8. To select an official journal for the publication of the official acts of the Authority.

9. To mortgage properties constructed or acquired by said Authority and to mortgage and pledge any lease or leases and the rents, income and other advantages arising out of any lease or leases granted, assigned or subleased by the Authority.

D. The Authority is hereby empowered to take all necessary steps to protect Louisiana's unique coastal environment from any short-term or long-term damage or harm which might occur from any aspect of the Authority Development Program.

E. The Authority may contract with any agency, public or private, to provide for public utilities on such terms as are agreed upon by the Authority and the respective utilities for the financing, construction and extension of sewerage, water, drainage, electricity, gas and other necessary public utilities in and through said development.

F. Said authority may lease or sublease lands leased from the State of Louisiana and is authorized to negotiate and enter contracts or agreements with any public or private individual, or corporation, for the construction and operation of a petroleum terminal as an interstate common carrier.

§3110. Protection of deepwater ports

A. To prevent impairment of the bonds of the Three Deepwater Ports which are backed by the full faith and credit of the state, and to recognize the existing authority of and functions performed by the established ports and harbors of Louisiana, it is hereby recognized that the function, power and authority of the various existing port authorities established pursuant to Article 14, Section 31 of the Louisiana Constitution, and others established by specific Constitutional provision are not to be diminished by the jurisdiction and powers exercised by the Deep Draft Harbor and Terminal Authority except as provided in this Act.

B. The Authority may enter into intergovernmental contract agreements with existing port authorities, individually, or with any other parish, city, municipality or subdivision of the state, and may engage jointly in the exercise of any power, the making of any improvements which each of the participating authorities may exercise or undertake individually under any provision of general or special law.

C. The Authority, in establishing or enacting its rates and charges for bulk cargo shall consider the overall economic impact on the economy of the Three Deepwater Ports, and its charges and rates shall be compensatory.

D. The Authority shall not engage in the handling of break bulk or general cargo without the prior written agreement of the Three Deepwater Ports, which agreement, among other provisions, may provide for use of existing port facilities, rates, wharfage fees and other matters of mutual interest.

§3111. Public contracts

A. All public works exceeding the sum of ten thousand dollars, including both labor and materials, to be performed by the Authority shall be governed by Louisiana Revised Statutes 38:2211, et seq. However, this provision shall not apply in cases of extreme public emergency, but in such case notice of such public emergency shall be published in the official journal of the Authority within ten days thereof.

B. Where the Authority deems it advisable and in the public interest to purchase machinery, equipment or vehicles of certain makes, kinds or types, the advertisement may specify the makes, kinds or types and, after the advertising, the Authority may purchase those makes, kinds or types, but they shall not pay more than the actual market price for the machinery, equipment or vehicles.

§3112. Bonds; procedure for issuance

A. The Authority is hereby authorized to incur debt and issue bonds for its needs in the manner herein provided.

B. The Authority is granted the power to incur debt and issue bonds by any of the means authorized by the Constitution and laws of the State of Louisiana, including but without limiting the generality of the foregoing Article XIV, section 31, and Article XIV, section 1, and paragraphs (b.2) and (b.3) of the Louisiana Constitution.

C. Any revenue producing wharf, dock, warehouse, elevator, industrial facility or other structure owned by or to be acquired by the Authority from proceeds of bonds issued by it is hereby declared to be a revenue producing public utility as that term is used and defined by the Constitution and laws of the state in connection with the issuance of revenue bonds of political subdivisions of the state.

D. As an additional grant of authority beyond other provisions of the Constitution, the Authority is authorized, with the approval of the state bond and tax board, to issue negotiable bonds for any purpose within their delegated authority, and to pledge for the payment of the principal and interest of such negotiable bonds the income and revenues derived or to be derived from the properties and facilities maintained and operated by them or received by the Authority from other sources.

E. Such negotiable bonds may be further secured by a conventional mortgage upon any or all of the property constructed or acquired, or to be constructed or acquired by them.

F. To further secure such negotiable bonds the Authority may apply in whole or part any money received by gift, grant, donation or otherwise from the United States, the state of Louisiana, or any political subdivision thereof, unless otherwise provided by terms of the gift, devise, donation or similar grant.

G. Such bonds shall be authorized by a resolution of the board of commissioners of the Authority and shall be of such series, bear such date or dates, mature at such time or times not exceeding forty years from their respective dates, bear interest at such rate or rates per annum, payable at such time or times, be in such denominations, be in such form either coupon or full registered without coupons, carry such registration and exchangeability privilege, be payable in such medium of payment and at such place or places, be subject to such terms of redemption not exceeding 105% of the principal amount thereof, and be entitled to such priority on the revenues of the Authority as such resolution or resolutions may provide. The bonds shall be signed by such officers as the Authority shall determine, and coupon bonds shall have attached thereto interest coupons bearing the facsimile signatures of such officer or officers of the Authority as it shall designate. Any such bonds may be issued and delivered, notwithstanding that one or more of the officers signing such bonds or the officers whose facsimile signature or signatures may be upon the coupons shall have ceased to be such officer or officers at the time such bonds shall actually have been delivered. Said bonds shall be sold for not less than par and accrued interest to the highest bidder at a public sale after advertisement by the Authority at least seven days in advance of the date of sale, in newspapers or financial journals published at such places as the Authority may determine, reserving to the Authority the right to reject any and all bids and to re-advertise for bids. If, after advertisement as hereinabove provided, no bids are received, or if such bids as are received are considered in the discretion of the board of commissioners of the Authority to be unsatisfactory, then and in that event the board of commissioners may publicly negotiate for the sale of such bonds without further advertisement. No proceedings in respect to the issuance of any such bonds shall be necessary except such as are contemplated by this Section.

H. For a period of thirty days from the date of publication of the resolution authorizing the issuance of bonds hereunder, any persons in interest shall have the right to contest the legality of the resolution and the legality of the bond issue for any cause after which time no one shall have any cause or right of action to contest the legality of said resolution or of the bonds authorized thereby for any cause whatsoever. If no suit, action or proceeding is begun contesting the validity of the bond issue within the thirty days herein prescribed, the authority to issue the bonds and to provide for the payment thereof, and the legality thereof and all of the provisions of the resolution authorizing the issuance of bonds shall be conclusively presumed, and no court shall have authority to inquire into such matters.

I. Such bonds shall have all the qualities of negotiable instruments under the law merchant and the Negotiable Instruments Law of the state of Louisiana, and shall be exempt from income and all other taxation of the state of Louisiana.

J. No bonds as herein described shall be authorized, issued or sold except in accordance with specific authorizations hereafter granted by the legislature for each issue.

§3113. Environmental Protection Plan

A. Throughout all aspects of the Authority Development Program there shall be in existence an Environmental Protection Plan, the details of which shall be followed in all respects by the executive director in carrying out any aspect of the Authority Development Program.

B. The Environmental Protection Plan shall be formulated by the three directors, as herein defined, with the advice and consent of the board of commissioners of the Authority.

C. The Environmental Protection Plan shall be promulgated by the executive director under the rule-making procedures of the Louisiana Administrative Procedure Act of La. R.S. 49:951-49:966.

D. The Environmental Protection Plan shall be promulgated within a reasonable time after the appointment of the executive director, but in no event more than eighteen months after the effective date of this Act. An acting executive director or a temporary executive director may fulfill this function if a permanent executive director is not as yet appointed.

E. The Environmental Protection Plan may be amended at any time in accordance with the provisions of the Louisiana Administrative Procedure Act, to reflect changes in the Authority Development Program. Initiation for changes may come from any of the three directors or any interested person.

F. In preparing the Environmental Protection Plan, or any amendment thereto, at any time during the Authority Development Program, the three directors shall make every effort to reach a consensus. If they are unable to agree, each shall proffer his proposed Environmental Protection Plan and present it to the board of commissioners for its consideration. Each of the three directors shall present detailed comments to the board of commissioners, with recommendations as to the best Environmental Protection Plan. After receiving and studying the recommendations, the board of commissioners shall decide which plan or combination of plans shall be adopted and promulgated.

G. The Environmental Protection Plan shall be an integral part of the Authority Development Program. Costs incurred to develop the initial plan, or any amendments to it, shall be considered an internal cost of the Authority Development Program and shall be considered a cost to the same extent that economic, engineering or promotional programs are considered costs. The three directors shall agree on the appropriate level of funding for the developing of the Authority Environmental Protection Plan, prepare any amendments thereto, and carry out the requirements of the Plan. To the extent possible, federal funds shall be sought to assist in this effort.

H. The best talent available shall be sought to perform the studies and surveys necessary to develop an Environmental Protection Plan and carry out its requirements in accordance with this Act. To the extent possible, University-based, public and private researchers in Louisiana shall be utilized. In all cases, the research in support of the Environmental Protection Plan shall be coordinated by agreement of the three directors. The results of all research done in support of the Environmental Protection Plan shall be open to the public and available to any interested person.

I. The Environmental Protection Plan shall contain specific provisions implementing Subsection J below. If specific provisions cannot be set forth due to uncertainties in the Authority Development Program, then the Environmental Protection Plan shall state in specific terms the uncertainties which do exist at the time the plan is promulgated, and why the uncertainties would make the inclusion of specific provisions in the plan premature. The Authority Environmental Protection Plan shall contain a separate chapter for each of the Paragraphs of Subsection J below and any other chapters necessary to meet the requirements of this Act.

J. The Environmental Protection Plan shall:

(1) Summarize the salient feature of an inventory of all potential and actual stresses on the natural and human environment which can be reasonably expected to occur in pursuing the Authority Development Program. Consideration shall be given to stresses which

have occurred in other parts of the country and the world where similar functional operations were being performed. Consideration shall be given to the peculiarities of Louisiana's coastal environment. The inventory of potential and actual stresses shall include a prediction of the stress on the coastal environment of major accidents which could logically be expected to occur throughtout the Authority Development Program, even though all precautions against such accidents have been taken.

(2) Describe the essential features of existing environmental data upon which the selection of a site for a Deep Draft Harbor and Terminal may be based. Indicate how this data has been analyzed and compared with the inventory of potential and actual stresses required in the above Paragraph so that the site selected will result in the least total stress on the environment. Indicate how economic considerations are compared with the assessed total stress on the environment to arrive at the best economic-ecologic formula for determination of a site for the Deep Draft Harbor and Terminal. State the location and availability of the environmental data upon which these determinations are based.

(3) State how the Deep Draft Harbor and Terminal facility design minimizes potential environmental damage, considers environmental factors as a positive part of the design, and controls long-term development so that growth and additions to the Deep Draft Harbor and Terminal do not result in random growth or in gradual environmental deterioration.

(4) Present details of how the operational aspects of the Authority Development Program will be conducted so as to minimize environmental problems, including but not limited to a monitoring program by the Louisiana Wild Life and Fisheries Commission; establishment of constructional and operational guidelines for environmental protection; strong enforcement provisions, and mechanisms to insure cleanup of accidental spills by technical means, with a surety bond to insure performance. The plan shall consider the circumstances which may justify the temporary cessation of the port activities.

(5) Provide procedures for the funding of projects to be paid for by the Authority to the Louisiana Wild Life and Fisheries Commission or any agency designated by the governor which shall compensate the coastal environment for loss that may be sustained through the stresses on the environment created by the Authority Development Program.

(6) Analyze ongoing programs of the federal, state and local governments designed to protect the coastal environment and to insure that there is no unnecessary duplication of effort and to insure that cooperation and coordination of environmental protection measures are achieved. The opinion of all agencies with a responsibility for monitoring the coastal environment shall be sought with regard to this Environmental Protection Plan prior to its promulgation, to determine if there are incompatibilities between specific provisions of this measure and the requirements of other rules and regulations.

K. Nothing in this Section is intended to diminish in any way the authority of the Louisiana Wild Life and Fisheries Commission.

§3114. Coordination and cooperation

A. It is the policy of this Act that the Authority Development Program be pursued so that there is full coordination and cooperation between agencies and groups that have complementing or overlapping interests and the Authority. It is not the policy of the Act that the Authority Development Program be pursued independently and with a view toward narrow, short-term interests.

B. The board of Commissioners shall take affirmative steps to fully coordinate all aspects of the Authority Development Program with the Louisiana Advisory Commission on Coastal and Marine Resources (Act No. 35 of 1971) or its successor group, which is charged with the development of a coastal zone management plan for the state.

C. The board of commissioners shall take affirmative steps to insure that the Authority Development Program is coordinated into the planning programs of other modes of transportation, to include rail, road, waterway, air and pipeline, so that there is a long-term and orderly pursuit of transportation services in the coastal zone which are interrelated and coordinated so as to achieve the most efficient and economical transportation program that is feasible and that will be least destructive of other values in the state.

D. The board of commissioners shall insure that the appropriate federal agencies which are required by federal law to plan or regulate transportation facilities or programs are consulted regularly and are fully involved in the Authority Development Program where appropriate.

Section 2. If any provision or item of this Act or the application thereof is held invalid, such invalidity shall not affect other provisions, items or applications of this Act which can be given effect without the invalid provisions, items or applications, and to this end the provisions of this Act are hereby declared severable.

Section 3. All laws or parts of laws in conflict herewith are hereby repealed.

PRELIMINARY ECONOMIC CONSIDERATIONS OF LOUISIANA SUPERPORT

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PRELIMINARY ECONOMIC CONSIDERATIONS OF A LOUISIANA SUPERPORT

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I. Economic Summary and Recommendations

A. General Statement

While some 50 deep-draft ports are currently in operation, under construction, or in the planning stages, not one is located in the United States. Almost all ocean ports in the U.S. have drafts ranging from 35 to 45 feet, a fact which limits their use by fully loaded vessels to those in the range of 50,000 to 80,000 dwt. Hence, the United States, which in absolute terms is the largest trading nation in the world, is presently unable to take advantage of the economies of scale provided by the superships.

There is an indisputable worldwide trend toward larger oceangoing vessels. The world's largest tanker in 1956 was less than 60,000 dwt; in 1970 the largest tanker was 326,000 dwt; in 1972 the world's largest tanker is 373,000 dwt. Construction is presently underway on a 477,000 dwt tanker, and there are plans for a 1,000,000 dwt ship in 1980. Unless there is some catalectic lessening of international trade, such as that which occurred in the 1930's, one can expect the number of supertankers to increase. Most data, however, seem to indicate that, with few exceptions, the maximum size of vessels constructed during this century will be about 500,000 dwt, which requires a draft of approximately 100-110 feet. Hence, considerable capital should not be invested in constructing a deep-draft port with channel capacity greater than 110 feet.

B. Louisiana Superport Study

This study was completed in less than 12 weeks of one-half time allocation; it is the beginning phase of a more intensive study to be completed within the next year. There were few attempts at data projections since the immediate need was to determine data on existing flows and phenomena. The study contains data on superships, superports, and recent economic and political trends affecting American superport development and utilization. It examines petroleum and crude flows within and among Petroleum Administration Districts as well as the U.S. energy crisis, particularly as it affects Louisiana. Commodity flow data are also presented for the Central Gulf region.

Very few recommendations for a Louisiana superport can be given with an acceptable degree of confidence at this stage in the analysis. Much additional information must be obtained from numerous sources, and the data must be integrated in some meaningful way. Although a brief summary of the study is presented below, the reader is strongly advised to read the entire report since the summary could be misinterpreted if the assumptions, qualifications and extensions are ignored.

C. Central Gulf Exports

While most discussion on superport development seems to have centered around imports, any argument for a complete Louisiana superport must include export considerations. Unlike the East Coast, which is primarily an importer of goods, the Gulf Coast is primarily an exporter. Approximately 73 percent of total commodity flows in 1970 in the Central Gulf area were outbound shipments.

The next important question is: Are these outbound commodity flows amenable to supership transit? A cursory glance at the commodity flows must yield a definite affirmative answer. Superships transport bulk commodities, and the Central Gulf region exports bulk commodities. Crude petroleum, the major outbound commodity, accounts for more than 20 percent of total commodity flows in the Central Gulf region. Next most important are farm products, which account for slightly less than 15 percent of total commodity flows. The third most significant export is petroleum products, which comprise nearly 15 percent of total volume. Together these three commodity classifications account for approximately 50 percent of total volume of shipments (inbound plus outbound) and 72 percent of outbound commodities. All of these are bulk commodities and therefore, it would appear, constitute an excellent base for utilization of a Gulf superport.

A more intensive analysis, however, does restrain some of the initial enthusiasm. First, petroleum products and crude, which constitute 35 percent of total oceangoing volume, are transported to the East Coast. Since there is no deep-draft facility there, it is not possible to transport petroleum in supertankers. Canadian deep-draft facilities are available in the North Atlantic area, but petroleum transshipped through these ports is subject to the vagaries of Canadian taxation and quantity restrictions. Economic realities may eventually prevail, and an East Coast superport may be constructed. In this eventuality, an offshore deep-draft facility in the Gulf might be desirable for shipments of crude and possibly products to the East Coast.

Shipments of Louisiana crude to the East Coast will be limited to the short run, presumably not much longer than 10 years. Because of declining crude reserves and increased environmental constraints in relation to the demand, an increasing proportion of Louisiana and adjacent offshore crude production will be allocated to Louisiana and Texas refineries. Hence outbound shipments of Louisiana-produced crude petroleum, which is currently the major export in the Central Gulf region, can be expected to decline in importance within the next few years and to be negligible within 10 years.

The strategic proximity of the Central Gulf region to the inland waterways has resulted in this region's being the major exporter of farm products. While farm products are generally considered to be bulk commodities, there has been little shipment of farm products in superships. Perhaps this is because the United States is the world's major exporter of farm products and superships cannot enter U.S. ports. If farm products can be shipped economically in large bulk carriers, there is a strong economic argument for constructing a deep-draft dry and liquid bulk terminal near the mouth of the Mississippi River. Combination dry-liquid bulk ships could possibly be used to export farm products or coal to Europe or Asia and to return with crude or ores.

D. Central Gulf Imports

1. General

Although the Central Gulf Coast is primarily an exporter of commodities, the most reliable long-run utilization of a Central Gulf superport may involve its imports. Metallic and non-metallic ores comprise approximately 20 percent of the area's total commodity flows. This flow will be increased considerably if the proposed steel mills are eventually located on the Mississippi River, and a superport capable of transshipping dry or slurried ore would be an effective inducement to mills to locate in this region. Although large ore ships are not nearly so numerous as petroleum tankers, the development of the ore/oil (O/O) ships and the ore/bulk/oil carriers (O/B/O) and the MARCONAFLO method (loading and discharging granular bulk material as slurry but shipping it as solids) should increase the economic potential of superships in this commodity area. A Louisiana superport capable of handling ores should have a significant impact on Louisiana's economy inasmuch as mills will be attracted to this area and mills are generally more labor intensive than petroleum refineries.

Whereas metallic ores are presently the major commodity imported, the most important import commodities in the long run may be crude petroleum and natural gas. The facts that crude petroleum is currently the Central Gulf area's major export and that it is expected to become a major import within 10 years are indicative of the increasing shortage of available domestic crude supplies. It is estimated that more than 50 percent of U.S. crude requirements will be imported by 1985. Presumably, the West Coast will be serviced by the Alaskan fields, the East Coast by Middle East crude imported through its (future) superport, and the Midwest and South by Gulf crude and imports.

Any long projection of future demand for crude oil is fraught with many difficulties. As crude becomes more scarce, its relative price will increase, thus inducing some industries and individuals to shift from crude consumption to other sources of energy such as coal or nuclear power. It is difficult to assess this price-induced effort on future quantity demanded an on induced technological developments in other energy fields. It is correct to state, however, that if Americans do not wish to pay greatly increased prices for petroleum products and thus be forced to significantly curtail their consumption of petroleum-related products, foreign imports will have to be greatly increased within this decade. This is a short and simplistic interpretation of the "energy" crisis.

The effect of this "energy crisis" on the utilization of a Louisiana superport is even more difficult to assess. First, there are problems of forecasting aggregate demand and supply for energy and, in particular, for petroleum and the cross-elasticities of demand (supply) of petroleum substitutes. In addition, there is the difficulty of predicting what other regions are going to do with their port and refining capacity.

At the present time, the East Coast refines less than 30 percent of its total product consumption, and it has not made a substantial increase in its refinery capacity since 1957. If the East Coast were to reverse this trend by increasing its refining capacity, and if it were to couple this with the construction of a superport, the utilization of a Central Gulf superport would be much less. If refining capacity were not increased and an East Coast superport were not constructed, the Gulf area and the Midwest would have to provide refined products to the East Coast. Since the Gulf area could not provide the crude to meet the input demands of the refineries, the strategic location of Louisiana in regard to pipeline and water transportation suggests that a Louisiana liquid bulk superport would be economically attractive. This deep-draft port would function as a substitute for declining Gulf-area crude supplies and could utilize some of the existing pipeline and water related facilities for redistribution to the Midwest and East Coast. A detailed breakdown of existing crude and product flows among PAD districts as well as a Louisiana-Texas comparison is provided in the complete report.

2. Impact of Crude Imports on Louisiana

A reciprocal analysis to the above suggests that the construction of a deep-draft facility is likely to result in a net relative redistribution of refining capacity and industrial consumers of petroleum and petroleum-related products to the Central Gulf area in general and to the state where the superport is located in particular. While other regions have specialized in manufacturing, transportation or services, Louisiana seems to possess a comparative advantage in the refining of crude and the transportation of petroleum products.

Louisiana ranks fourth among states in exporting the burden of state taxation to individuals residing outside the state.[1] This is due primarily to the heavy reliance of the state (approximately 36 percent of state-generated revenues in 1970) upon severance taxes, royalties and bonuses. As the source of this revenue becomes depleted, Louisiana citizens or industries will have to bear a greater tax burden, state expenditures will have to be cut, or both. If the burden is significantly shifted to industry, this will at the margin, negatively affect the location of new firms and industries in the state and curtail the expansion of those presently located in the state. Hence, it is desirable to increase the industrial tax base of Louisiana so that the rates for both individuals and industry may be reasonable.

There are many factors which determine the spatial distribution of industrial plants. Two significant variables are proximity to consumer market and proximity to source of raw materials. Because Louisiana is located a considerable distance from the major consumer markets, its proximity to the source of raw materials-primarily water, crude petroleum and natural gas-has had a significant impact on the economic development of the state. The depletion of Louisiana's crude and natural gas supplies within the next 10 years, therefore, does not present an entirely optimistic forecast for future economic development or, indeed, for retaining that which has been made. From the viewpoint of crude petroleum imports, therefore, the superport offers the advantage of a reasonably close substitute for those domestic crude sources which will be depleted.

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[1] Charles E. McLure, Jr., "The Interstate Exporting of State and Local Taxes: Estimates for 1962," National Tax Journal (March, 1967), pp. 49-77. It was estimated that approximately 32 percent of Louisiana's tax burden was borne by non-residents.

The bulk liquid superport does not assure economic development of the state because the crude or natural gas could be transshipped through Louisiana to other states with relatively little economic impact on Louisiana. The location of refineries and related industries will depend upon such primary factors as conditions in the labor market, financial inducements, taxes, transportation costs, and availability of cooperating resources and upon such secondary factors as quality and safety of educational institutions, quality of government, climate, recreational facilities, etc. Louisiana, however, could obtain some revenue if it levied a small tax on these imports, subject to the constraint that oil companies could shift their imports to facilities in other states. Most importantly, while the superport will not assure economic development, it does provide the potential for such development.

The above analysis assumes that the East Coast will not increase its refining capacity and will not construct a superport. If it does both of these, the potential of a Louisiana superport will be lessened. If Texas and Alabama construct superports, the potential of a Louisiana location will be decreased even more. The East Coast will probably obtain a superport within 10 years, a fact which, by itself, will not be too damaging to Louisiana prospects unless it is coupled with tremendous expansion in refining capacity. If Texas and other Gulf states construct superports, however, the advantages of a Louisiana superport will be reduced considerably. Additional studies must be made, but is is possible, depending upon what happens on the East Coast, that liquid-bulk superports constructed offshore of both Texas and Louisiana would be feasible. Holding other variables constant, however, the major advantages will accrue to the state which is first to have its superport operational.

E. Where Should a Gulf Superport be Located?

A question of paramount importance is: If a superport is to be constructed in the Gulf, where should it be located? Unfortunately, we did not have time to determine commodity flows in the entire Gulf area. However, if only the Central Gulf region (Lake Charles, Louisiana, to Mobile, Alabama) is considered, the superport should be located in close proximity to the Mississippi River because 78 percent of all oceangoing volume in this region travels to the Gulf on the river. Other factors have to be considered, of course, but the predominance of the Mississippi River and its tributaries cannot be overlooked.

Although commodity flow data for the Texas coast have not yet been analyzed, we did present a thorough and unique analysis of the relative waterborne flows of crude and petroleum products for Texas and Louisiana. Texas ships, by coastwise vessels to the East Coast, 60 percent of the Gulf's outbound petroleum, whereas Louisiana ships only 35 percent of the total. Louisiana, however, ships 64 percent of Gulf crude to the East Coast by water, while Texas sends only 31 percent. Louisiana accounts for a larger percentage (57 percent) of oil and oil products shipped to the Midwest and the East by inland waterways than Texas (40 percent). Texas, however, sends more than twice as much crude oil by pipeline to the Midwest as Louisiana and slightly more to the East Coast than Louisiana.

As long as the Gulf area supplies crude to the East Coast, Louisiana has an advantage over Texas if the East Coast constructs a superport to receive large tankers. This is a relatively short-run advantage, however, as the East Coast will become increasingly dependent upon foreign suppliers.

Mixed conclusions are reached if one examines the long run. Louisiana is closer to the mass consumption markets of the Midwest and the East than is Texas; its strategic location on the internal waterway system is a major advantage. Louisiana has a pipeline distribution system to the Midwest and the East, but Texas ships much more by pipeline to both the Midwest and the East Coast than does Louisiana. Texas also has a much larger refining capacity, and it appears to be running out of crude supplies more quickly than Louisiana. While Texas' reserves and production of crude and natural gas are greater than Louisiana's, its rate of decrease in both reserves and production is greater than Louisiana's. Therefore, Texas may make the argument that it "needs" the crude imports more than Louisiana and the superport should be located off its coast. More thorough studies need to be made to reach a more definite conclusion.

F. Location in Louisiana

1. Commodity Service - One of the most difficult decisions concerning the Louisiana superport is related to the type of commodities it would service. It appears that the liquid bulk terminal would be economically viable in itself and would provide the potential for increased economic development in the state. The feasibility of a structure encompassing dry bulk or other commodities is much less certain. One solution is to construct the liquid terminal now and make additions for dry bulk later. This is one possibility, but it partially ignores the problem. The decision as to whether the additions would be made to accomodate dry bulk commodities would probably affect the design of the liquid structure. More importantly, the location of the oil terminal to be constructed now may be dependent upon the question of future commodity additions to the superport. If no commodity additions are planned, the oil terminal may be most efficiently located in one area, say below Grand Isle, whereas if commodity additions are planned, the oil terminal should be located closer to the Mississippi River. Hence, the type of superport which is expected to emerge in the future will be a significant input into the

location decision of the superport today. The discussion below summarizes total commodity flows and their implications for a locational decision. Different conclusions would be reached if the superport were exclusively a liquid bulk terminal.

2. Offshore - In the Central Gulf region, Lake Charles contributes less than 4 percent to the Gulf oceangoing trade, the Gulfport-Pascagoula-Mobile ports contribute 15 percent, Mississippi River-Gulf Outlet (MRGO) traffic constitutes 2 percent, and the Mississippi River contributes 78 percent. Obviously, the commodity flows in the Central Gulf region suggest that the superport should be located near the Mississippi River if it is to service dry bulk as well as liquid commodities. Since the Gulfport, Pascagoula and Mobile ports, as well as the MRGO, are on the east side of the mouth of the Mississippi River, an east side location is slightly preferable. One problem is the relatively low utilization of the MRGO by oceangoing vessels. One would think that its shorter course and straighter channel would encourage oceangoing ships to use it, but less than 2 percent do. This may be caused by the 36-foot depth of the MRGO as compared to the 40-foot controlling depth of the Mississippi, the lockage delays or the reduced vessel speed which is necessary on the MRGO. If the reasons for this low utilization affect oceangoing vessels but not shuttle barges, the argument for an east side superport location is made stronger.

3. Up River - If the technical problems could be solved, the optimal economic location for a complete superport would probably be on the Mississippi River somewhere below New Orleans.

The offshore facility would present some economic problems. First, employee transportation to and from the port would be expensive; second, industrial, financial, and recreational facilities would not be readily available; third, and most significant, port-adjacent industrial development would be impossible. Europeans are discovering that a major advantage of a superport is its attraction of industries which import raw materials and export processed goods. An industrial park comprising such industries, located adjacent to the superport, would have a very beneficial effect on Louisiana's economy.

An offshore location, however, would preclude such adjacent developments and would force these industries to locate where suitable land and labor could be found. This implies transshipment from the land location to the superport which, at the margin, would retard this related industrial development. Thus, there exist some economic arguments for a superport location on the Mississippi River south of New Orleans. Although the costs and technical feasibility have not been studied, this location would provide greater access to the resources of New Orleans and would permit industrial parks to be developed immediately adjacent to the port.

G. Economic Impact

Many individuals think of an economic study of a superport in terms of an economic impact study. Unfortunately, there are no professional tools available to enable one to evaluate the economic impact of any project. If one were to aggregate the results of all economic impact studies conducted in any one year, they would surely total to more than the gross national product of the United States. Hence, economic impact statements must be approached with considerable caution. Certain qualitative remarks were made in this report which indicate the direction, but not the magnitude, of some economic impact variables. It might be worthwhile in the next phase, however, to determine the net amount of primary income generated by the superport; that is, the amount of wages and income paid to workers, technicians, etc., directly employed by the superport, plus those workers employed by new industries which might locate in Louisiana because of the superport. Any attempt to derive secondary income generation is, in large part, pure speculation.

H. Future Research

A considerable amount of additional research is required before any specific recommendations can be made. Recommended areas of research are listed below:

(1) Petroleum Related Research

a. Intensive study and projections of long-term petroleum balance in the Gulf region under varying assumptions.

1) East Coast superport constructed but no significant increases in East Coast refining capacity.

2) East Coast superport constructed and East Coast refining capacity increased significantly.

3) East Coast superport not constructed and East Coast refining capacity not increased significantly.

4) Effects of competing Gulf superports

b. Development of flow data by method of transportation for petroleum crude and products leaving Texas and Louisiana. We simulated these movements in this study, but their accuracy should be verified by survey data, if possible. Projected flow data by transportation mode.

c. Location of trunk pipelines in Texas and Louisiana, their capacity, usage and destination. Costs of integrating this pipeline distribution network with a superport should be determined.

d. Data on optimal loading/discharging rates, pipeline transshipment facilities, storage facilities, etc.

e. Intentions of major oil companies regarding usage of the superport, size of ships they will use, etc.

(2) Commodity Flow Related Research

a. Completion of comparative commodity flow studies for the Gulf region.

b. Projection of comparative commodity flow data for the Gulf region.

c. Feasibility of transporting farm products in large bulk vessels and the required complementary facilities.

d. Destinations of farm products and origins of metallic and non-metallic ores.

e. Superport and its relationship to an international free-trade zone.

f. LASH and SEABEE utilization of superport.

(3). Effect of alternative superport facilities on economic development of state and on other state ports.

(4) Superport Construction, Operation and Maintenance

a. Costs of constructing alternative types of superports.

b. Source of labor and transportation of superport employees.

c. Ship repair facilities on superport.

d. Storage facilities on superport versus onshore storage facilities.

(5) Finances

a. Port tariffs and total revenue generated.

b. State tax revenues generated.

c. Method of financing construction.

II. Introduction

Twenty years ago oceangoing commerce was carried in two basic types of ships: the 16,000 dwt (T-2) tanker and the tramp steamer, primarily World War II Liberty Ships.[2] In 1956, the world's largest tanker was only 56,089 dwt. Then two major world developments occurred which initiated the era of superships:

(1) Increase in International Trade - The phenomenal growth in international trade following World War II increased the size of the market for oceangoing vessels. This, in turn, encouraged ship owners, operators and builders to find ways to take advantage of the economies of scale in construction, operation and maintenance of larger ships.

(2) Closing of Suez Canal - Although there existed a general long-run trend toward larger ships prior to 1956, the closing of the Suez Canal in 1956 provided the impetus for a more rapid rate of growth. The rapid economic development of Europe during the 1960's and the resulting need for oil from the Middle East meant that tankers of 20,000 dwt making the 11,000 mile trip to Europe were simply too costly. If this same trip were

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[2] The initials dwt represent deadweight tonnage--more accurately, gross dead weight tonnage. Basically, the deadweight tonnage of a ship is the most meaningful figure for estimating the amount of cargo tonnage the ship can carry. Since the dwt value is inclusive of crew, provisions, stores, fresh water, fuel oil in tanks, etc., it is estimated that 96 percent-97 percent of the listed deadweight tonnage figure is available for cargo. For example, a 100,000 dwt tanker could carry approximately 96,000-97,000 dwt of crude oil.

made in 100,000 dwt or 200,000 dwt tankers, the costs would be comparable to those on the Suez route.[3]

Hence, post-war increase in world trade, European dependence on oil imports and the closing of the Suez Canal provided the original impetus for the development of large-deep-draft vessels.[4]

III. The Superships[5]

A. Some Statistics

Figure 1 shows comparative sizes of the "world's largest tanker" in different years. The world's largest tanker in 1956 was less than 60,000 dwt; in 1970 the largest tanker was 326,000 dwt; in 1972 the world's largest tanker is the 373,000 dwt Nisseki Maru. Construction is presently underway on a 477,000 dwt tanker, and there are plans for a 1,000,000 dwt ship in 1980. Figure 2 is a distribution over time

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[3] It has been estimated that Middle East-Europe transportation in a 70,000 dwt ship costs 52 cents per barrel, while the same trip in a 200,000 dwt ship costs 40 cents. Even if the Suez Canal were to open today at its present drafts, it would be more efficient to transport petroleum around the Cape in large tankers. ("Gargantuan Tankers: Privileged or Burdened," by Captain Edward Oliver, Proceedings, U.S. Naval Institute, September, 1970.)

[4] Many but not all of the problems pertaining to deep-draft ports would be alleviated if marine technologists could develop shallow-draft supertankers. Supposedly the Dutch are pursuing this concept because of the depth constraints of most of their ports, excluding Rotterdam. Additionally, the marine architects who developed LASH are reported to be working on a new kind of giant ship (250,000 dwt) to carry oil, ore, and coal and are designed so that they will be able to enter the majority of American ports with present draft constraints.

[5] Once "superships" were thought to be those of 80,000 dwt; now this descriptive term is applied by some only to 326,000 ton Bantry Bay class ships. A more reasonable usage includes all ships greater than 200,000 dwt.

Figure 1

Size of World's Largest Tanker
1956-1980

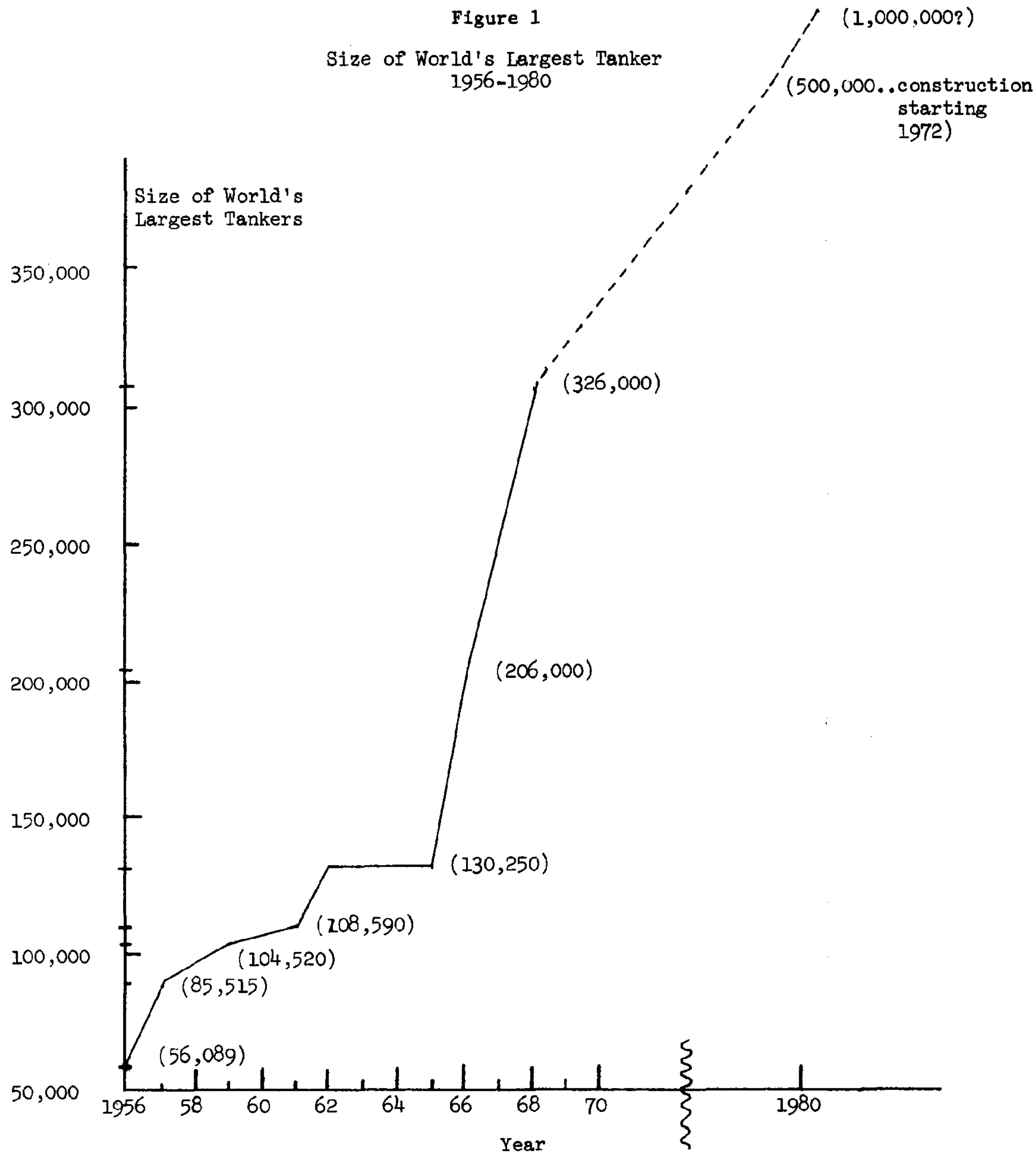
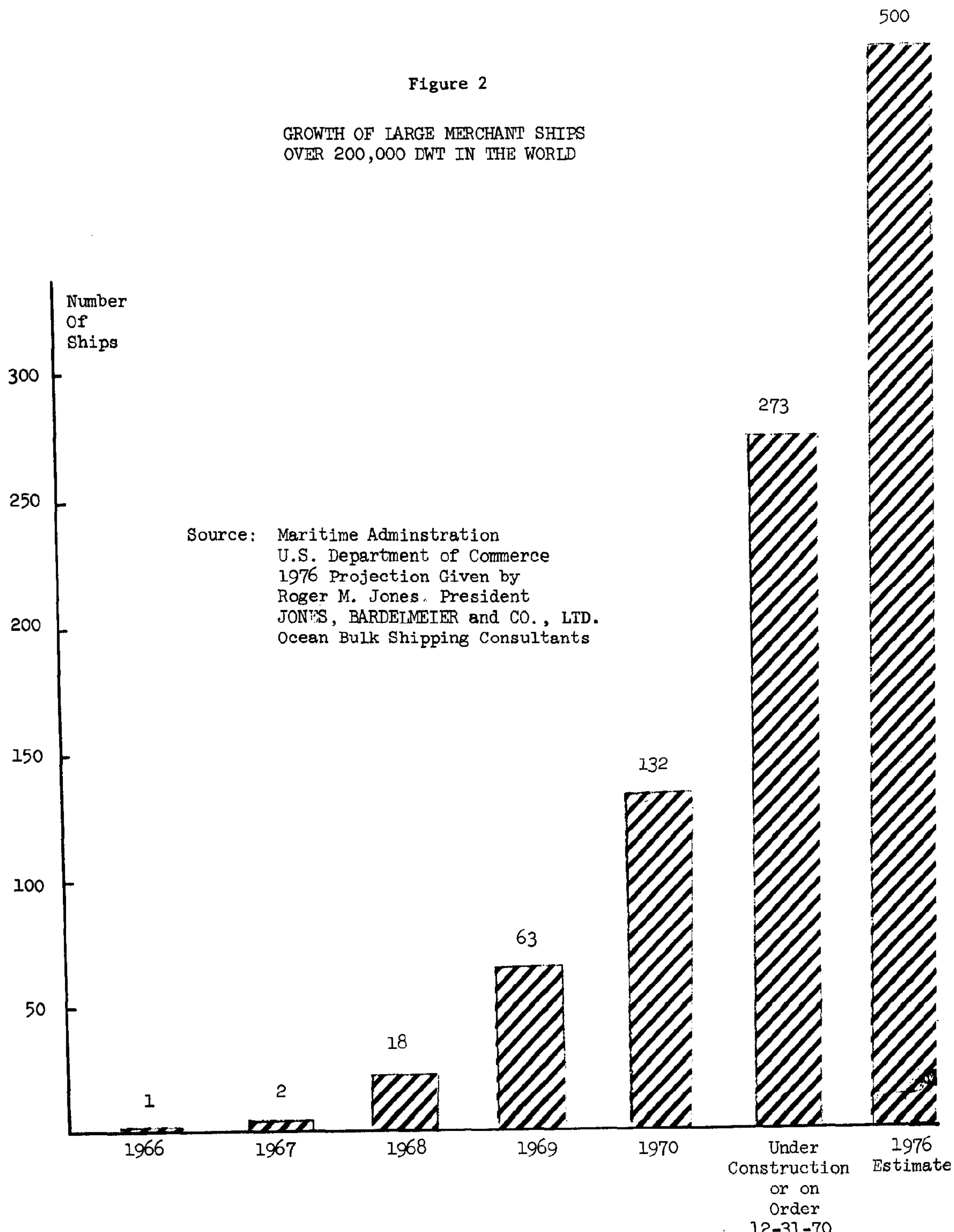


Figure 2

GROWTH OF LARGE MERCHANT SHIPS
OVER 200,000 DWT IN THE WORLD



of ships over 200,000 dwt; the estimate for 1976 is based on ships under construction or on order at the end of 1971. In 1966 there was only one ship of 200,000 dwt or larger, while in 1970 there were 132; in 1972 there are 273; and by 1976 there will be nearly 500 ships greater than 200,000 dwt and 1000 ships 100,000 dwt or larger.

Table 1 summarizes some salient characteristics of tankers. Rows (1) and (2) show the relationship between dwt and cargo dwt, while row (3) relates the approximate draft to ship size.[6] The most interesting characteristics, however, are in rows (4), (5), and (6).

First, speed does not vary with size of ship, and so there is no sacrifice in time en route for large tankers. Second, crew size increases slightly on larger tankers, but a 450,000-ton tanker, which is 2,250 percent larger than a 20,000 dwt tanker, requires a crew only 28 percent larger. Row (6)--construction costs--has been graphed in Figure 3 to show clearly that average construction costs per 20,000 dwt decrease rapidly and then begin to flatten out at about 300,000 dwt. The average construction cost per 20,000 dwt when ship size is also 20,000 dwt is $13 million, while the average construction cost per 20,000 dwt when ship size is 450,000 dwt is $3.19 million.

The power required to propel a vessel does not increase directly with ship size. A 200,000-ton ship requires only 50 percent more power than a 100,000-ton ship, while a 300,000 tonner requires only a doubling in the required power. Because fuel consumption rises in proportion to

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[6]Allowances for squat, freshwater buoyancy loss, motion in the sea and a safety factor requires channel depths 5 to 10 feet greater than the draft.

TABLE 1

SOME COMPARATIVE TANKER CHARACTERISTICS, 1971 ESTIMATES

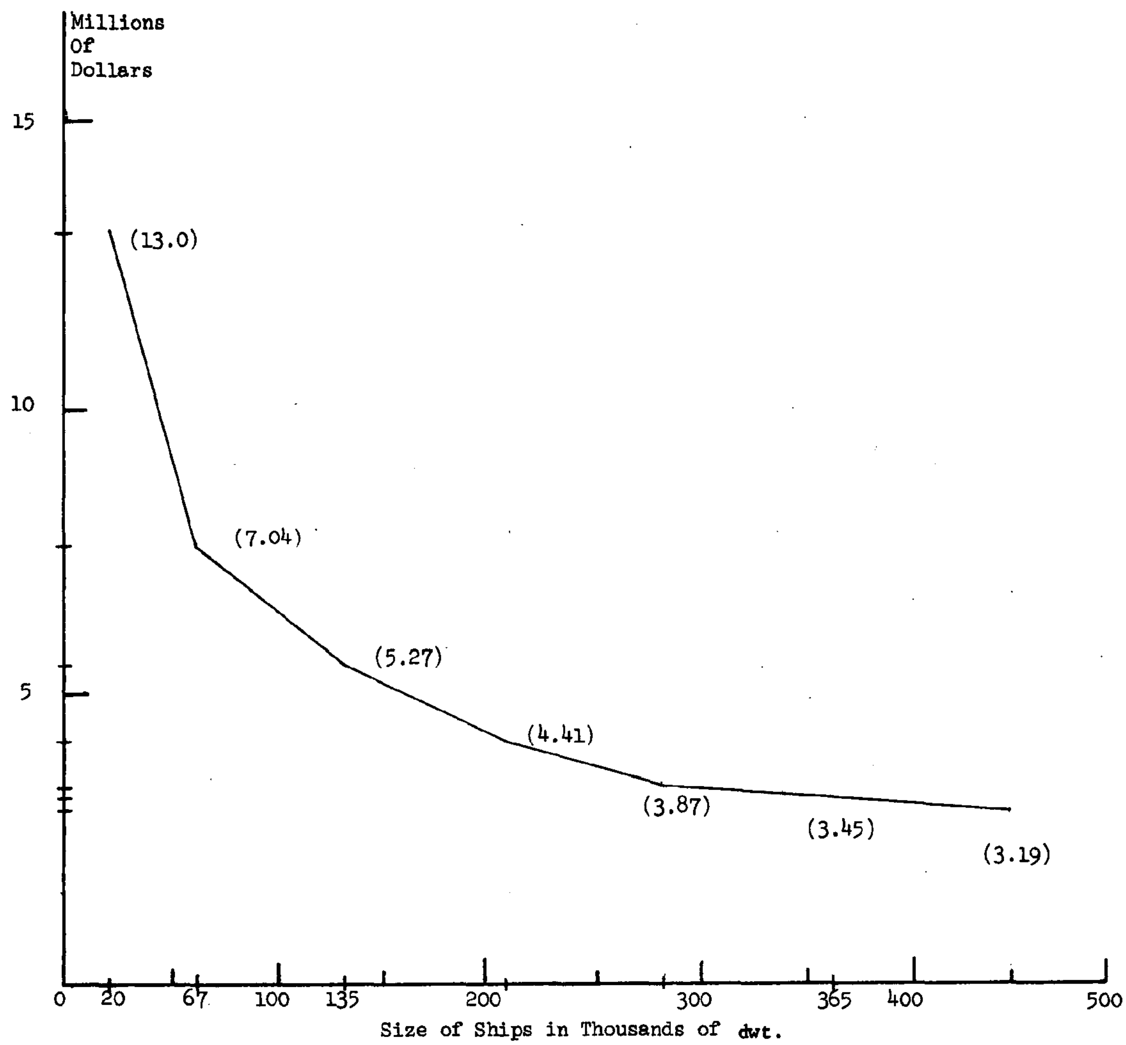
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1) dwt	20,000	67,000	135,000	210,000	285,000	365,000	450,000
2) Cargo dwt	19,200	64,200	129,500	201,400	273,000	350,000	431,500
3) Draft (Feet)	30	40	50	60	70	80	90
4) Speed (Loaded)	16.5	16.5	16.5	16.5	15.5	15.5	15.5
5) Crew Size	25	25	25	30	32	32	32
6) Construction Cost[1]	13.0	23.6	35.6	46.3	55.1	63.0	71.8

[1]Millions of Dollars [Cost estimates per ship are based on construction of three ships in each class]

Source: Personal correspondence with Chief, Division of Ports, U.S. Maritime Administration.

Figure 3

Average Construction Cost Per
20,000 Deadweight Ton by
Size of Ship
1972



Source: Table 1

engine output, which increases less than proportionally to ship size, a 300,000-ton ship at a given speed is more economical than six 50,000 tonners. Obviously, such economies of scale must be reflected in real transportation savings.

The Maritime Administration has calculated the comparative costs of transporting a ton of crude from the Persian Gulf to the U.S. North Atlantic by various sizes of ships as indicated in Table 2.

Table 2

Transportation Costs Per Ton of Crude Oil,
Persian Gulf - U.S. North Atlantic
By Size of Ship
1970

Cost Per Ton	Size of Ship
$17.9	25,000
12.6	47,000
10.5	80,000
5.7	250,000
5.2	500,000

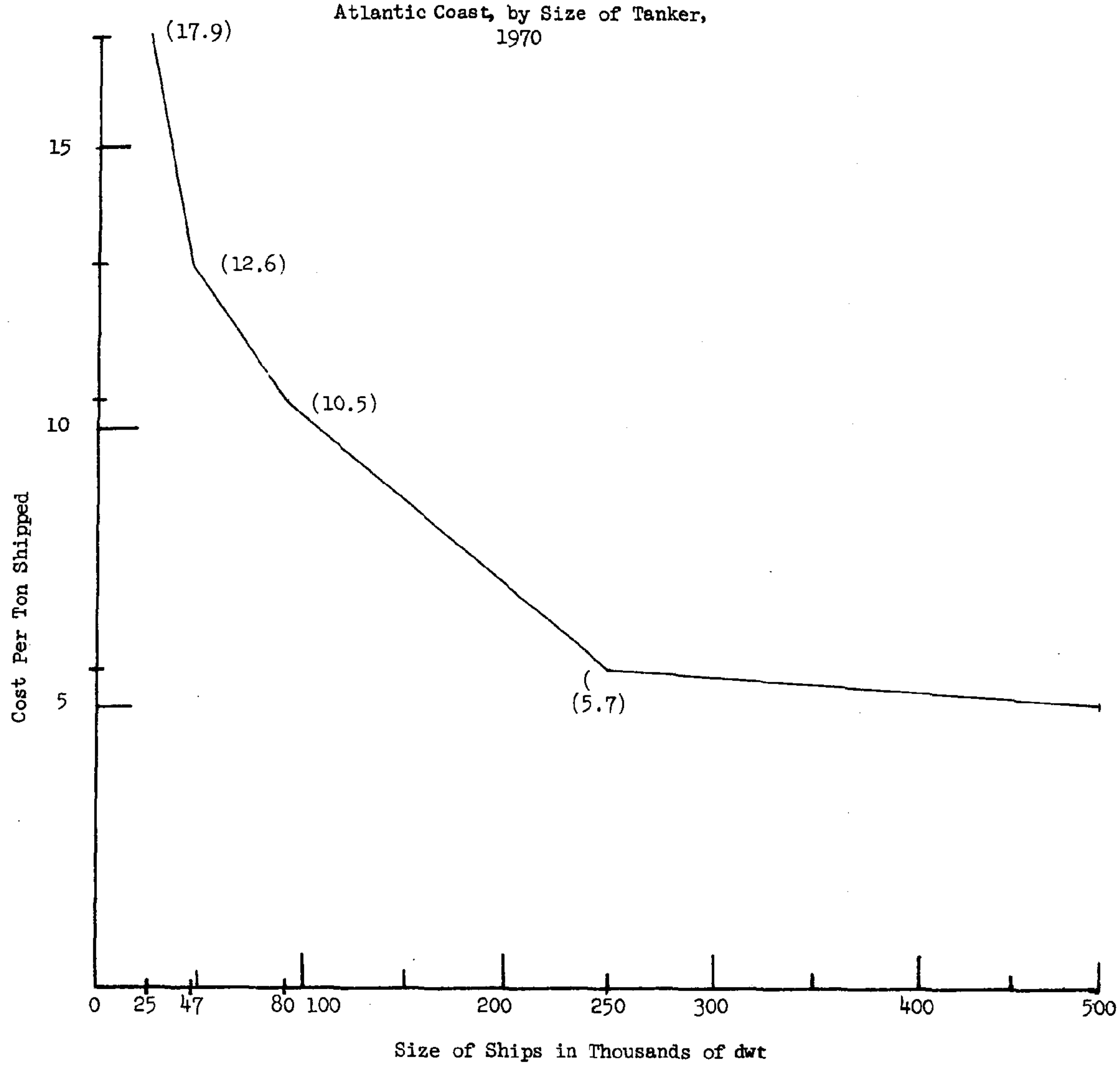
Data in Table 2 are shown graphically in Figure 4. Once again the average cost curve tends to flatten out in the 300,000 dwt-500,000 dwt range.[7]

The most intensive study of superport and supertanker economies was done for an East Coast location. Table 3 shows estimated cost and savings on projected 1980 oil imports from the Persian Gulf and Libya to the Atlantic Coast under various alternatives. Alternatives A and B are variants of developing the Delaware River Harbor. The other alternatives involve superport redistribution terminals. As shown in the last column,

[7]Most marine professionals believe that in the near future few ships will be constructed larger than 500,000 dwt.

Figure 4

Water Transportation Cost Per Ton
from Persian Gulf to U.S. North
Atlantic Coast, by Size of Tanker,
1970



Source: Plotted from Data Provided by U.S. Maritime Administration

Table 3

Estimated Annual Savings on Crude Oil Imports
Alternative Deep-Draft Proposals
North Atlantic Coast, 1980

Alternatives Descriptions/Depth	Liquid Bulk Ship Size dwt	Total Unit Transport Costs for 1980a, b ($/LT) Imported from Persian Gulf		Libya		Projected Annual Savings for 1980 (millions of dollars) Imported from Persian Gulf	Libya	Total
A. Dela. River, Unchanged 40'	35,000	25.98	-	8.67	-	-0-	-0-	-0-
N.Y./N.J., Unchanged 35'	25,000	-	29.26	-	9.86	-0-	-0-	-0-
B. Dela. River Dredged 50'	80,000	16.58	-	5.65	-	94	45	139
N.Y./N.J., Unchanged 45'	65,000	-	18.08	-	6.16	56	19	75
C. 1) Montauk Transfer[c] 75'								
To Dela. River	250,000	10.99	-	4.86	-	242	83	325
To N.Y./N.J.	250,000	-	10.77	-	4.64			
2) Machiasport Transfer: 75'								
To Dela. River	250,000	11.49	-	5.25	-	233	73	306
To N.Y./N.J.	250,000	-	11.71	-	5.44			
3) Lower Dela. Bay Transfer: 75'								
To Dela. River	250,000	10.66	-	4.56	-	246	89	335
To N.Y./N.J.	250,000	-	10.62	-	4.53			
D. Open Sea-Off N.J. Transfer: 85'								
To Dela. River	250,000	14.05	-	7.97	-	195	22	217
To N.Y./N.J.	250,000	-	14.02	-	7.94			
E. Nova Scotia Transfer:[d] 75'								
To Dela. River	250,000	11.25	-	5.02	-	236	79	315
To N.Y./N.J.	250,000	-	11.38	-	5.15			

Notes
a. All ocean freight rates based on U.S. flag bulk carriers including construction subsidy
b. Total transport costs calculated to tidewater oil refineries at Perth Amboy, N.J., and Marcus Hook, Pa.
c. Shuttle voyage rates for all U.S. transshipment locations based on 40,000 dwt U.S. flag oceangoing barges
d. Shuttle voyage rates based on 47,000 dwt foreign-flag tankers

Source: "Deep Draft Vessel Port Capability on the U.S. North Atlantic Coast," Maritime Study, 1971 the transportation savings on the 250,000 dwt ships using these deep-draft facilities range from $217 million to $335 million. Tables 4 and 5 present the alternative dollar savings for iron ore imports from Liberia and Australia and coal exports to Japan and Europe. All cost data were computed on total system costs, including ocean freight rates, transfer and transshipment costs and inland transportation. However, the cost data may have omitted inventory costs, and the Commerce Department's projections of future petroleum imports appear to be somewhat exaggerated. Because of the differential commodity flows in the Gulf Coast region, the annual savings in transportation costs would not be as significant, but these tables do present a relative indication of the economies inherent in supership transportation, and they show the further analysis which must be done for the proposed Gulf Coast superport.

Although superships may appear to be more economical than smaller ships, their operating characteristics may, according to some individuals, make them more dangerous, and thus more costly. Some studies have suggested that a T-2 tanker of 17,000 dwt can come to a "crash stop" within 0.5 mile in 5 minutes but that a 200,000 dwt tanker would take 2.5 miles and 21 minutes; and a 400,000 tonner would take 5 miles and 30 minutes to stop.[8] Experience with the six 326,000 dwt tankers (Bantry Bay class) under long-term charter to Gulf Oil Corporation has suggested

[8]"Gargantuan Tankers: Privileged or Burdened," by Captain Edward F. Oliver, in Proceedings, U.S. Naval Institute, September 1970.

Table 4

Estimated Annual Savings on Iron Ore Imports
Alternative Deep-Draft Proposals
North Atlantic Coast, 1980

Alternatives Descriptions/Depth		Dry Bulk Ship Size dwt	Total Unit Transport Costs for 1980[a] ($/LT) Imported from Liberia		Australia		Projected Annual Savings for 1980 (millions of dollars) Imported from Liberia	Australia	Total
A. Baltimore Unchanged		40,000	8.59	-	22.77	-	-0-	-0-	-0-
Delaware River Unchanged	40'	35,000	-	9.10		24.18	-0-	-0-	-0-
B. Baltimore Dredged	50'	80,000	6.06	-	15.76	-	13	18	31
Delaware River Dredged	50'	80,000	-	6.06	-	15.76	15	21	36
C. 1) Montauk Transfer: 75'									
To Baltimore		250,000	6.27	-	11.68	-	26	59	85
To Dela. River		250,000	-	6.27	-	11.68			
2) Machiasport Transfer: 75'									
To Baltimore		250,000	7.23	-	12.77	-	16	54	70
To Dela. River		250,000	-	7.23	-	12.77			
3) Lower Dela. Bay Transfer: 75'									
To Baltimore		250,000	6.22	-	11.68	-	30	62	92
To Dela. River		250,000	-	5.57	-	11.68			
D. Open Sea-Off Chesapeake Bay: 85'									
To Baltimore		250,000	6.91	-	12.32	-	16	54	70
To Dela. River		250,000	-	7.57	-	12.98			
E. Nova Scotia Transfer[b]: 75'									
To Baltimore		250,00	6.29	-	11.82	-	26	58	84
To Dela. River		250,000	-	6.29	-	11.82			

Notes
a. Total transport costs calculated to tidewater steel plants at Sparrows Point, Md., and Fairless, Pa.
b. Thuttle voyage rates based on 50,000 dwt foreign-flat ore carriers

Source: "Deep Draft Vessel Port Capability on the U.S. North Atlantic Coast," Maritime Study, 1971

Table 5
Estimated Annual Savings on Coal Exports
Alternative Deep-Draft Proposals
North Atlantic Coast, 1980

Alternatives Descriptions/Depth		Dry Bulk Ship Size d.w.t.	Total Unit Transport Costs for 1980[a] ($/LT) Exported to Japan	Europe	Projected Annual Savings for 1980 (millions of dollars) Exported to Japan	Europe	Total
A. Hampton Rds. Unchanged	45'	56,000	23.23[b]	14.18	-0-	-0-	-0-
B. Hampton Rds. Dredged	55'	140,000	22.85	12.67	13	30	43
C. 1) Montauk Transfer: From Hampton Rds.	75'	250,000	18.86	11.25	153	59	212
2) Machiasport Transfer: From Hampton Rds.	75'	250,000	19.74	12.10	122	42	164
3) Lower Delaware Bay Transfer:	75'	250,000	18.21	10.70	176	70	246
D. Open Sea-Off Chesapeake Bay: From Hampton Rds.	85'	250,000	19.20	11.70	141	50	191
E. Nova Scotia Transfer[c]: From Hampton Rds.	75'	250,000	20.02	12.30	112	38	150

Notes
a. Unit costs include inland rail cost through Hampton Roads
b. Via Panama Canal
c. Shuttle voyage rates based on 40,000 d.w.t. U.S. flag barges

Source:
"Deep Draft Vessel Port Capability on the U.S. North Atlantic Coast", Maritime Study, 1971

less drastic differences. This company has found that these tankers, fully laden and moving at top speed, can come to a full stop in 1.75 miles; at half-speed they can come to a full stop in 1 mile. In ballast condition they come to a full stop in 1.6 miles and 12 minutes. The company has also found its ships to be relatively stable during inclement weather. Because of their size and cost it is economically feasible to install such sophisticated navigational aids as radar, Bow Swing Indicator, and Doppler Sonar Device.

These Bantry Bay class tankers provide considerable protection against routine oil pollution because they contain crude/water separators which permit the crude-contaminated ballast to settle to the bottom and to be recovered. Smaller tankers have even been integrated into the supertankers' recovery system, with the result that dirty ballast from the shuttle tankers can be pumped ashore and stored for later removal and separation by the supertankers.[9] Additionally, the movement of a given volume of cargo in a 300,000-ton vessel instead of 50,000 tonners means that shipping lane and channel congestion will be reduced by nearly 600 percent.

B. Capital Costs and Complementary Facilities - whereas smaller tramp steamers can be considered as separate units of oceanic transportation, supertankers are an integral part of a comprehensive land-sea transportation system. They cannot be analyzed apart from their complementary onshore and offshore facilities.

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[9]"Mammoth Tankers Operation," Paper presented by W. C. Brodhead, 15th Annual Tanker Conference, April 29, 1970.

The capital costs of these mammoth ships are great; interest on the capital investment for a 450,000-ton tanker is approximately $20,000 per day.[10] Hence each day these ships lie idle in port costs $20,000 in real capital costs forgone.[11]

Supertankers are not unique in this "time value of capital" concept. For example, four ships of 100,000 dwt entail a greater capital outlay than one 400,000-ton tanker. Hence, the time value costs of the 4 smaller ships lying idle are greater in total than the capital costs of the supertanker's idle time. The important consideration is that the four 100,000-ton tankers need not enter the loading or discharge terminal at the same time, and after 100,000 tons are unloaded from a ship it may leave; the 400,000 tonner, however, is non-divisible, and the entire 400,000 dwt capacity must remain idle while the last 100,000 tons are being unloaded. This non-divisibility of the supertanker presents some rather specific economic problems and important economic tradeoffs.

The large amount of non-divisible capital invested in a supertanker would suggest that port time be minimized. In order to minimize port time, however, very expensive high-rate loading and unloading facilities would have to be constructed; high-capacity and expensive transshipment

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[10] Assuming a 10 percent cost of capital.

[11] Economists and accountants are constantly debating the interpretation of costs; i.e., accountants would calculate the loss on the basis of the recorded costs of constructing that particular ship which is lying idle. The economist, however, would calculate the loss on the basis of capital replacement costs, which, during periods of inflation, would be considerably greater. The cost figures used here are based on 1971 estimates by the Maritime Administration. A more economically meaningful estimate would be based on the total revenue equivalent (less operating cost) forgone by the shipper because of the idle time. This estimate, however, could not be obtained in time for publication.

facilities would have to be provided, etc. For example, the unloading rate at the offshore facility could conceivably be such that a 400,000 dwt ship need spend only 3 hours at the terminal. But the construction and operating costs of this high-rate unloading facility may be considerably greater than the opportunity costs of keeping the supertankers in port for another day. It would not be feasible to construct a high-rate unloading facility costing $100 million annually in order to reduce turnaround time 24 hours for 20 ship calls per year at a capital time saving value of only $400,000.[12] Hence, the objective is to optimize--not minimize--the loading/unloading rate, with the optimal size increasing in relation to size of ships visiting the terminal and the number of ship visits, as well as many other variables.

Once the cargo is discharged, there must be a place to store it or means to transship it. If no storage facilities exist at an offshore facility, the unloading rate is limited by capacity of the transshipment system. In the case of liquid bulks and slurries the transshipment vehicle may be a pipeline. The maximum-size of submarine pipelines (of appreciable length) constructed to date is 48 inches although a 54-inch line is under study for the Persian Gulf. These large pipelines are considerably more costly to construct and to pump than smaller pipelines. This is important for a Louisiana offshore port may lie relatively close to the shoreline but be a considerable distance from an economically viable ground base for storage and related secondary facilities.

The longer the pipeline distance the greater is the economic

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[12] $20,000 per day per ship times 20 ship visits.

argument for offshore storage capability, because such storage will permit a continuous rather than surging flow to the onshore facility. This will thus permit the use of a smaller pipeline and also retain an optimal loading/unloading rate. Storage, however, is costly. Not only must the storage facilities be constructed and maintained, but the value of materials stored pending further processing must also be considered. The opportunity costs of storing a product instead of maintaining a steady throughput to more quickly recover embodied costs are known as inventory costs. A recognized problem of supertankers is that they increase inventory costs because they induce sporadic flows requiring storage. Consider a refinery which uses 50,000 tons of crude stock per day. A 50,000 dwt ton tanker could deliver that amount each day, and virtually no inventory would be required. A supertanker, however, might deliver 500,000 dwt every 10 days, which would necessitate an average inventory of 50,000 tons of crude. Most studies we have seen may have omitted these inventory costs but the lack of detailed presentations makes such assessments difficult.

A second, equally important argument for storage facilities at a Louisiana offshore port relates to its comparative advantage for transshipment by barges or oceangoing vessels. Such transshipments necessitate at least temporary storage facilities.

C. Summary - It is evident that large ships exhibit economies of scale without causing insurmountable problems of safety and environmental damage. However, analysis of supership economics must regard these vessels not as isolated units, but as integral parts of an international transportation system extending from shipping points in producing countries to points of consumption in others. The brief discussion of the problems raised by supertankers suggests that storage facilities be constructed on, or in close proximity to, the superport and that further research efforts should be devoted to an analysis of the interrelationships among the most immediate complementary facilities, including loading/unloading rates, storage at the deep-draft port, and the alternative means and costs of transshipment to intermediate onshore locations.

IV. The Superports[13]

A. The U.S. Lag - Some 50 deep-draft ports are currently in operation, under construction or in the planning stages. Not one of these ports, however, is located in the United States which, in absolute volumes, is the largest trading nation in the world. This means that the U.S. is currently unable to take advantage of economies afforded by the larger and more efficient ships. Most ports in the U.S. have drafts ranging from 30 to 45 feet, which limits their use by fully loaded vessels to those in range of 50,000-80,000 dwt. Only the ports of Long Beach, Los Angeles and Puget Sound can accommodate 100,000-ton ships.

Why has the United States lagged behind other countries in developing deep-draft capability? One answer is that international trade of the United States, while large in absolute volume and value, constitutes only 5 percent of U.S. gross national product. Hence, U.S. citizens and their political representatives are not as interested in

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[13]Superport is a misnomer because the most relevant consideration at this point in time is not the size of the port but the maximum-draft vessel which it will accommodate. Hence, a superport may be a large offshore island complex complete with multipurpose storage, repair and unloading facilities, or it may merely be a single point mooring device with a flexible pipeline attached to it.

or as affected by international trade as Europenas. Second, U. S. ports are numerous and each one jealously guards its own interests. If the Corps of Engineers proposed to deepen the channel in one port, say on the upper East Coast, all neighboring ports would demand similar improvements, and they would exert sufficient political pressure to stop any project which would give another port a competitive advantage.

Third, bureaucratic red tape has been a probable deterrent. One group interested in constructing an offshore terminal in Maine found that it had to obtain 27 separate licenses, permits, concurrences and approvals.[14]

Where deep-draft ports have been proposed, such as the transfer terminal in Delaware Bay, they have been successfully opposed by environmental groups. The Commerce Department has estimated that the Delaware Bay port would cost $210 million but would provide transportation savings of $335 million in the first year alone.[15] Deep-draft ports proposed for Machiasport, Maine, and Montauk Point, New York, were estimated to cost $312 million and $278 million, and to realize annual transportation savings of $305 million and $325 million, respectively. Thus each facility would "pay for itself" in one year or less. This means not that port revenues in one year would be sufficient to pay the costs of deep-draft facilities, but that the total savings among all entities--including

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[14] "Offshore Bulk Redistribution Terminals", Roger M. Jones, speech presented at the Propeller Club Meeting, Port of New Orleans, Feb. 22, 1972.

[15] See Tables 3, 4, 5.

consumers--in the entire system, would equal construction costs within one year of operation. Such optimistic predictions must be viewed critically inasmuch as the details have not been provided by the Maritime Administration. Such items as inventory costs seem to have been omitted, and the projections of future petroleum imports are on the high side of the forecasting range. At the very least, however, such estimates do suggest the potential of net real savings. Nevertheless, both the Machiasport and the Montauk projects seemed to be stalled.

At present, Canada has in existence or under development, five ports which will be able to handle ships larger than 200,000 dwt. A recent decision by the Canadian government to tax all crude imports, has temporarily discouraged oil companies from importing crude through Canadian deep-draft ports for transshipment to the United States. However, the eastern U.S. region may soon be confronted by a situation in which a major portion of its crude supplies will be funneled through Canadian ports.

The lethargic development of deep-draft ports in the U.S. has produced some interesting anomalies. As part of its efforts to rebuild the U.S. Merchant Fleet, the Maritime Administration is seriously considering subsidies for construction of ships which will be unable to enter any U.S. port. Also, the Manhattan--once the "largest ship in the world"--was named after a borough whose harbors it cannot enter fully laden.

While the United States' incentives to construct deep-draft ports are less than those of most European countries, the total lack of such ports in this country poses a potentially serious economic problem, particularly since the lag times in planning, design and construction indicate that a port concept which is approved this year would not be operational until about 1980; the exact lag time would depend on the type of port selected. As pointed out below, the increasing reliance of the United States upon foreign sources for certain bulk raw materials and its increasing exports of coal and farm products suggest that deep-draft ports, limited in number, will be economically advantageous.

B. Reasons for Caution - Certain factors argue against the hasty development of such ports. First, the Canadian East Coast deep-draft ports may relieve some of the pressures created by the U.S. northeast corridor's demand for crude imports. Second, owing to the lack of deep-draft ports in the United States, shipping companies have developed new techniques which are currently becoming operational. These new shipping developments <u>may</u> negatively affect future utilization of a superport.

The LASH and SEABEE concepts, in which fully laden lighters or barges may be loaded on a mother ship, are particularly relevant for a potential Gulf superport[16] since these systems have numerous advantages over other more traditional methods of oceanic transportation. They are particularly well-suited for incoming or outgoing foreign trade serviced by the inland waterway system terminating at the Gulf. Barges

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[16]The LASH (Lighter Aboard Ship) pioneered by the Central Gulf and the SEABEE, developed by Lykes, are oceanic transportation systems in which numerous barges can be loaded onto the mother ship. The LASH system is currently operating with 400 barges and two mother ships, each carrying 80 barges; the SEABEE system is currently operating with 246 barges and three mother ships, each carrying 38 barges.

may be loaded and unloaded in open stream or any sheltered water; a port need not be used. The barges serve as warehouses for both the shipper and receiver. Also, both systems possess economies of scale for oceangoing voyage and divisibility for inland water transportation in the United States and Europe. Neither LASH nor SEABEE systems would need to use a superport because their mother ships do not require deep drafts. The extensive development of these systems could negatively affect a Gulf superport unless (a) the shipping companies decide that the superport is a convenient barge loading/unloading terminal for their mother ships or (b) the mother ships grow in size sufficiently to require the channel depths or shelter of a deep-draft port.

An additional factor that could negatively affect future superport utilization is development of seagoing barges which may divert much of the Gulf-Atlantic coastwise traffic from a superport.

The major negative factors, however, are due not to technological changes but to social, political and economic changes occurring in this country. The environmental movement is likely to discourage further major improvements in the inland waterway system, thus slowing the growth in foreign-bound inland waterway shipments to Gulf Coast ports.[17] One such example is the currently stalemated Tombigbee project.

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[17]The U.S. Environmental Protection Agency has subsidized a forthcoming "citizens' guide" on "How to Stop Army Corps of Engineers' Water Development Projects."

Many economists have argued that the Corps of Engineers has used an artificially low discount rate in evaluating water resource projects, thus making them seem more beneficial than they would be if a more realistic (i.e. higher) discount rate were employed. The argument is based on the contention that private corporations will discount future revenues (representing future benefits to the public) by their cost of capital, say 10 percent, in examining the feasibility of a capital project, and the project will be approved only if this discounted income (benefit) stream is greater than capital costs. The Corps, on the other hand, uses a lower rate, say 5 percent, in discounting the estimated benefits from its projects. This implies that the nation's resources which yield a 10 percent rate of return (or an even higher rate, if corporate taxes are considered) are being sacrificed for projects in which the rate of return is 5 percent. Economists have charged that this constitutes a misallocation of resources into excess water-related projects and away from investments in more beneficial private projects. The U.S. Water Resources Council has recommended to Congress the establishment of a 7 percent discount rate and a projected increase to 10 percent. While Congress may not adopt this recommendation in the current session, the basic analytical arguments, as distinct from the occasional emotional arguments used in support of it, are economically sound.

Related to, but separate from, the discount rate debate is the initiation of waterway user charges. It is alleged that waterway users have received an implicit subsidy from government construction and maintenance of waterway facilities which makes inland waterway transportation appear to be cheaper than it really is. Waterway rates are artificially low because of this subsidy, and thus traffic is diverted from railroads and trucking companies, where the subsidy is much less. Hence, the proposal is to employ user charges which would aid the market in efficiently dividing the traffic among modes of transportation. The National Water Commission will make its recommendations on user charges in May.

Any decision-making process relating to the construction of a superport in the Gulf region, particularly one located near the Mississippi River, must consider the future effects of these three developments. While there is cause for concern about the environment, the current "crisis attitude" may diminish when the public becomes aware of the costs, in terms of forgone goods and services, of attempting to maintain an environmental status quo. Hence, the environmental proposals for curtailing water development projects may have short-run but not long-run political success. Despite the damages which will be suffered by some groups, the basic economic arguments pertaining to discount rate evaluation and to user charges are valid and can be expected to prevail in the long run.

Since a major advantage of a superport off the coast of Louisiana is its connection with the inland waterway system, factors resulting in diversion of traffic away from the inland waterways justify the closest scrutiny. If recommendations for increased user charges, and possibly the discount rate, are adopted, a shipper of bulk farm products in Illinois or Ohio might find it more economical to ship via rail to East Coast ports rather than to use the inland waterways to a Gulf port.

Another extremely important variable in the superport analysis is the number of deep-draft ports which will be developed elsewhere in the United States. If superports were constructed on both the West and East Coasts, their net effect on the Louisiana superport might be either trade creation or trade diversion. A West Coast superport will have little immediate effect in either direction, although realization of the land bridge concept discussed below could change that. An East Coast superport (superports?), however, would have marked effects on the volume and direction of commodity flows on the Gulf Coast as well as on the East and Midwest sections of the country.

Despite the relatively short distances between the North Atlantic and the Gulf Coast, superships would be more efficient in these coastwise movements than conventional shallow-draft vessels and considerably more efficient than land surface transportation.[18,19]

Since the Gulf region exports large quantities of crude petroleum products to the East Coast, the construction of an East Coast as well as a Gulf superport may increase the short-run volume of coastwise shipments from the Gulf superport.

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[18]According to one qualified maritime expert, a 130,000 dwt bulk carrier can transport one ton of cargo 6,500 miles for $2.00, whereas the railroad can haul the same ton 200 miles. R. P. Holubowicz, "The Other Revolution," Proceedings, U.S. Naval Institute, October, 1970.

[19]These savings in transportation costs are reduced greatly by the requirement set forth by the Jones Act (1936), in which cargo moving between U.S. ports must be carried in U.S.-built ships. If this uneconomical law is not repealed, exceptions may be made for inter-superport traffic. One exception already has been made for a Norwegian tanker to transport cargo from Alaska to Seattle.

On the other hand, there would be some trade diversion. The East coast is closer to Europe and the Middle East than is the Gulf and, more significantly, the populous East Coast is the major consumption center in the United States. Hence, bulk commodities destined for the East Coast or the Midwest would be funneled through the East Coast rather than a Gulf Coast superport. This will also affect the flow of petroleum crude oil and products. While an East Coast superport would increase the volume of petroleum shipped through a Gulf superport in the short run, the long-run decline in crude production in the Gulf region and the increased demand for petroleum products imply that it will be more economical for new refineries to be constructed in the East. These could be supplied with crude from the Middle East transshipped through the East Coast superport. This redistribution of refinery capacity not only would have a detrimental effect on revenues of a Louisiana superport, but would also have a significant negative impact on the State's economy.

While an East Coast superport would probably have net negative effects on a Louisiana superport, some trade-creating effects would result from increased coastwise traffic. The establishment of competing superports in the Gulf, however, could result only in trade diversion. Every state on the Gulf Coast is presently studying the feasibility of locating a superport off its shores, and there is a distinct possibility that an interstate poker game is in the offing. If only one other superport is built in the Gulf, even a single point mooring device, it would have a significant impact on the potentials of the Louisiana superport. Although a regional commission of representatives from all

Gulf Coast states may produce more problems for Louisiana than it would solve, a strong argument in its favor is that coordinated effort may avoid the construction of two, three or four superports in the Gulf region.

While there appears to be considerable economic potential for a superport in the Gulf, a number of general constraints must be considered. Unfortunately, resources were not available for a thorough investigation of each of these. More detailed evaluations of petroleum crude and product flows as well as general commodity flows in the immediate region of a Louisiana superport are presented below.

V. Petroleum and Superports

A. Introduction - Among industrialized nations the United States has been fortunate in that it has been able to supply the bulk of its petroleum energy requirements from domestic production. Because neither population nor oil production is evenly distributed within the U.S., considerable quantities of crude oil and petroleum products are shipped relatively long distrances between points of production, refining and consumption. The country has been divided into five geographical areas, called Petroleum Administration for Defense (PAD) districts for the purpose of locating refining operations. Some of these are further subdivided into Bureau of Mines Refining districts. These districts are shown in Figure 5.

The East Coast and the Midwest, PAD Districts 1 and 2, respectively, are the most populous and have the greatest demand for petroleum products.[20]

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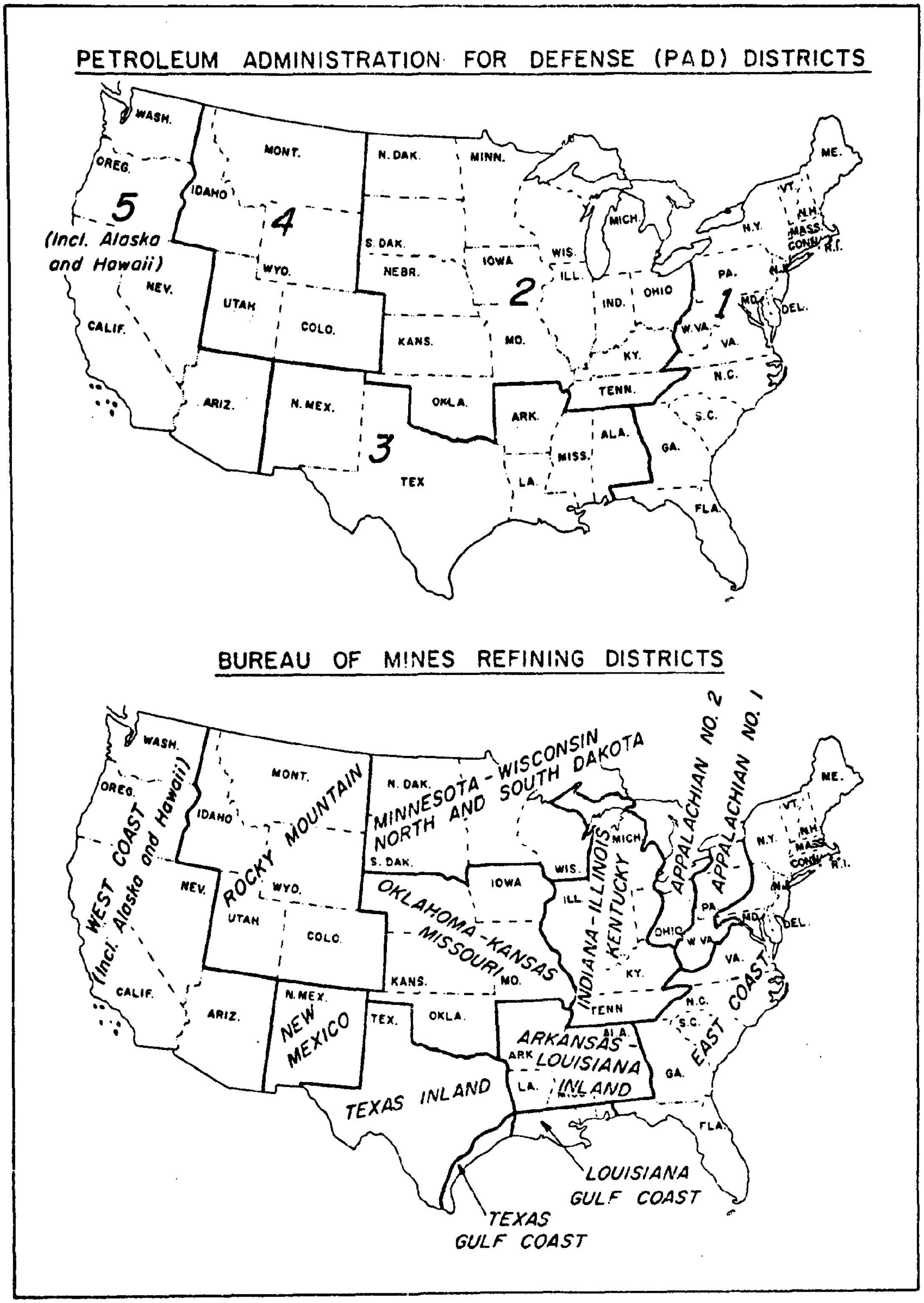
[20] Approximately 40 percent of national consumption of petroleum is in District 1.

Figure 5.


PETROLEUM ADMINISTRATION FOR DEFENSE (PAD) DISTRICTS
WASH.
OREG.
5
(Incl. Alaska and Hawaii)
NEV.
CALIF.
IDAHO
MONT.
4
WYO.
UTAH
COLO.
ARIZ.
N. MEX.
N. DAK.
MINN.
S. DAK.
NEBR.
IOWA
WIS.
MICH.
ILL.
IND.
OHIO
2
KANS.
MO.
KY.
TENN.
OKLA.
3
TEX
ARK.
MISS.
ALA.
LA.
GA.
FLA.
S.C.
N.C.
VA.
W.VA.
PA.
1
N.Y.
ME.
VT.
N.H.
MASS.
CONN.
R.I.
N.J.
MD.
DEL.
BUREAU OF MINES REFINING DISTRICTS
WEST COAST
(Incl. Alaska and Hawaii)
ROCKY MOUNTAIN
MINNESOTA - WISCONSIN NORTH AND SOUTH DAKOTA
OKLAHOMA-KANSAS-MISSOURI
INDIANA-ILLINOIS-KENTUCKY
APPALACHIAN NO. 2
APPALACHIAN NO. 1
EAST COAST
NEW MEXICO
TEXAS INLAND
ARKANSAS-LOUISIANA INLAND
LOUISIANA GULF COAST
TEXAS GULF COAST

District 3, which includes New Mexico, Texas, Louisiana, Arkansas, Mississippi and Alabama, contains the largest share of crude oil production. Because of this, large amounts of crude oil are shipped from District 3 to both Districts 1 and 2, and large amounts of products are shipped from District 3 to District 1. These large movements of crude oil and petroleum products constitute a production and distribution system into which additional shipments of imported oil must be integrated.

Each of the major flows is discussed below.

B. Inter-PAD District Flows

1. Crude Oil. Crude oil is the basic raw material for petroleum products, and its movement to refineries marks the first stage in the conversion to finished consumer products.

a. Production and Refining. Table 6 shows the 1970 crude oil balance for each PAD District and for the United States as a whole. The surpluses and deficits are accommodated by transport to or from other districts or foreign countries. The total production and the oil received at refineries differ slightly because of variations in stocks on hand.

The total refinery receipts of crude oil in the U.S. in 1970 were 3,973,255,000 barrels (42-gallon size). Of this, 3,492,414,000 barrels (87.9 percent) were from domestic production and 480,841,000 barrels (12.1 percent) were imported.

As can be seen, District 3 is a major source of crude oil for refineries in other areas, while Districts 1, 2, and 5 are crude deficit areas.

District 1 (the East Coast) has very little production of crude oil. Because demand for petroleum products is very high in this

Table 6

Crude Oil Balance for the United States, 1970

	Crude Oil (1000 42 Gal. Barrels)					
	PAD DISTRICT					
	1	2	3	4	5	Total
Total Crude Oil Produced (Inc. Lease Condensate)	11,411	426,777	2,735,205	246,317	457,740	3,517,450
Crude Oil Prod. and Received at U.S. Refineries[a]	13,083	414,407	2,361,067	243,985	459,872	3,492,414
Crude Oil Rec. at Refineries in District	472,022	1,151,948	1,593,737	143,661	611,887	3,973,255
District Deficit	458,939	737,541			152,015	1,348,495
District Surplus			767,330	100,324		867,654
Foreign Imports	211,403	113,559	0	17,175	138,704	480,841
From Other Dist.	247,548	630,880	3,980	135	13,750	896,293
To Other Dist.	12	6,898	771,310	117,634	439	896,293
Net Input	458,939	737,541			152,015	1,348,495
Net Output			767,330	100,324		867,654
Net Balance	Even	Even	Even	Even	Even	Even

[a]These totals differ slightly from the production totals because of changes in stocks of crude on hand.

Source: Mineral Industry Surveys, Bureau of Mines, Crude Oil, Refined Products, and Natural-Gas Liquids, 1970. Final Summary district, refinery production, in absolute but not relative terms, is quite high. Slightly over one-half of the crude oil required for refining comes from District 3, and most of the balance is imported.

District 2 (Midwest) has a fairly large amount of production, but the refining industry is even larger and so this district has the largest crude oil deficit. The inland location precludes direct imports by tanker except through Great Lakes ports. Hence, imports are fairly low and the deficit is filled from District 3.

District 3 (South-Southwest) has both the largest production and the largest refining industry, but production exceeds refining substantially, and so this district is a major supplier of crude oil to Districts 1 and 2.

District 4 (Mountain States) has moderate production and a small refining industry so that it has a small net surplus of crude.

District 5 (West Coast) has a substantial crude deficit even though production is fairly high. Imports are used to fill the deficit.

b. Transportation of Crude Oil.

1) General. Crude oil balances of production and refining and total crude movements among PAD Districts are set forth in Table 7 and Figure 6. Figure 7 shows a comparison of District 3 states as suppliers of crude to Districts 1 and 2.[21]

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[21] The basic data were obtained from Mineral Industry Surveys, but all tables and figures were compiled by author.

Table 7

Major Oil-Producing States as Suppliers of Crude Oil To Refineries
Intrastate, Interstate-IntraDistrict and Interstate-InterDistrict, 1970
(1000 Barrel Units)

Location of Refinery	IntSt Rec.of Crude	PAD Dist. 1	Ill. Mich.	Kansas	Okla.	Dist. 2 Total	Ala-Ark Miss	La.	N. Mex.	Texas	Dist. 3 Total	Wyoming	Dist. 4 Total	Dist. 5 Total	U.S. Tot InterSt. To
		Interstate Receipts From													
District 1	6,373	6,698	363	0	976	6,056	14,980	128,219	544	93,842	237,585	0	3,555	352	254,246
District 2	256,006	12	35,053	20,860	82,767	151,503	11,716	169,532	54,301	295,324	530,873	78,905	99,995	0	782,383
District 3 Total	1,194,118	0	1	2	833	836	25,819	247,615	54,653	67,552	395,639	0	3,144	0	399,619
Ala.	1,342	0	0	0	0	0	3,975	1,092	0	0	5,067	0	0	0	5,067
Ark.	15,865	0	0	0	0	0	0	2,730	0	13,784	16,514	0	0	0	16,514
La.	355,361	0	0	0	29	29	21,804	0	0	53,768	75,572	0	0	0	75,601
Miss.	12,353	0	0	0	0	0	0	55,749	0	0	55,749	0	0	0	55,749
N. Mex.	14,790	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Tex.	794,407	0	1	2	804	807	40	188,044	54,653	0	242,737	0	3,143	0	246,687
District 4	69,159	0	0	0	0	6	0	0	42	0	42	39,889	57,192	87	57,327
District 5	390,138	0	0	0	0	0	0	0	2,810	0	2,810	0	10,940	69,295	83,045
Calif.	378,771	0	0	0	0	0	0	0	2,810	0	2,810	0	10,940	60,814	74,564
U.S. TOT.	1,915,794	6,710	35,417	20,862	84,576	158,401	52,515	545,366	112,350	456,718	1,166,949	118,794	174,826	69,734	1,576,620
Intrastate Receipts		6,373	29,261	76,161	118,560	256,006	29,560	355,361	14,790	794,407	1,194,118	45,579	69,159	390,138	1,915,794
Total U.S. Receipts From U.S. Production		13,083	64,678	97,023	203,136	414,407	82,075	900,727	127,140	1,251,125	2,361,067	164,373	243,985	459,872	3,492,414

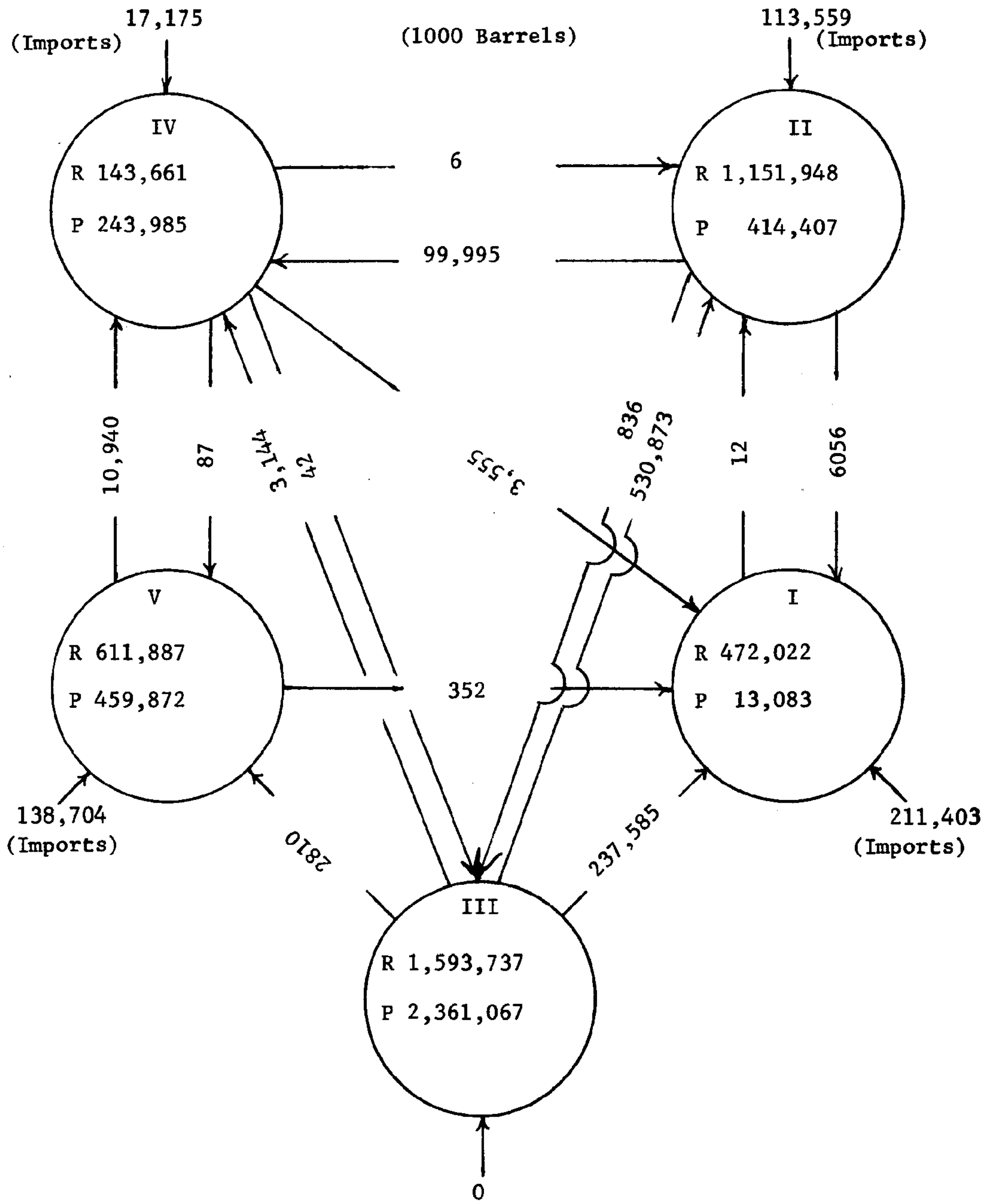
Source: Mineral Industry Survey, Bureau of Mines.

Figure 6

Movements of Crude Oil to Refineries

Across PAD District Borders 1970

(1000 Barrels)



Source: Mineral Industry Surveys, Crude Petroleum; Petroleum Products and Natural Gas Liquids: 1970 (Final Summary), Bureau of Mines.

R = Received at Refineries

P = Received at Refineries in the U.S. from production in the District

Imports - Table 6 and Figure 6 show the flows of crude oil imports into the various PAD districts. All except District 3 import some crude oil. District 1 imports as much as 40 percent of its total crude requirements, or 211,403,000 barrels. District 5 is the second largest importer, with imports of 138,704,000 barrels or approximately 23 percent of total.

Internal Flows - Figure 6 and Table 7 show that the major internal flows of crude oil within the United States are from District 3 to District 1 and that even larger flows are from District 3 to District 2. Table 7 shows the amounts of crude oil sent interstate from each of the major producing states to each of the PAD districts. It also shows the oil refined in the state of origin for each District and for certain states within Districts. As graphically shown in Figure 7, Texas and Louisiana are the two largest oil producing states. Louisiana sent 128.2 million barrels to District 1, while Texas sent 93.8 million barrels to District 1; Louisiana sent 169.5 million barrels to District 2, while Texas sent 295.3 million barrels. In aggregate amounts, Texas surpasses all other states as a supplier of crude to other districts, but does so by receiving substantial amounts of crude from Louisiana[22] and New Mexico to replace the production sent north and east.

Louisiana surpasses Texas as a supplier of crude oil to other states when all interstate shipments are considered. Louisiana was a net exporter of 432 million barrels to other states, while

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[22]As can be seen in Figure 7, Louisiana exported 188 million barrels to Texas, while Texas exported 53.7 million to Louisiana. Hence, Louisiana was a net exporter of crude to Texas of 134.3 million barrels.

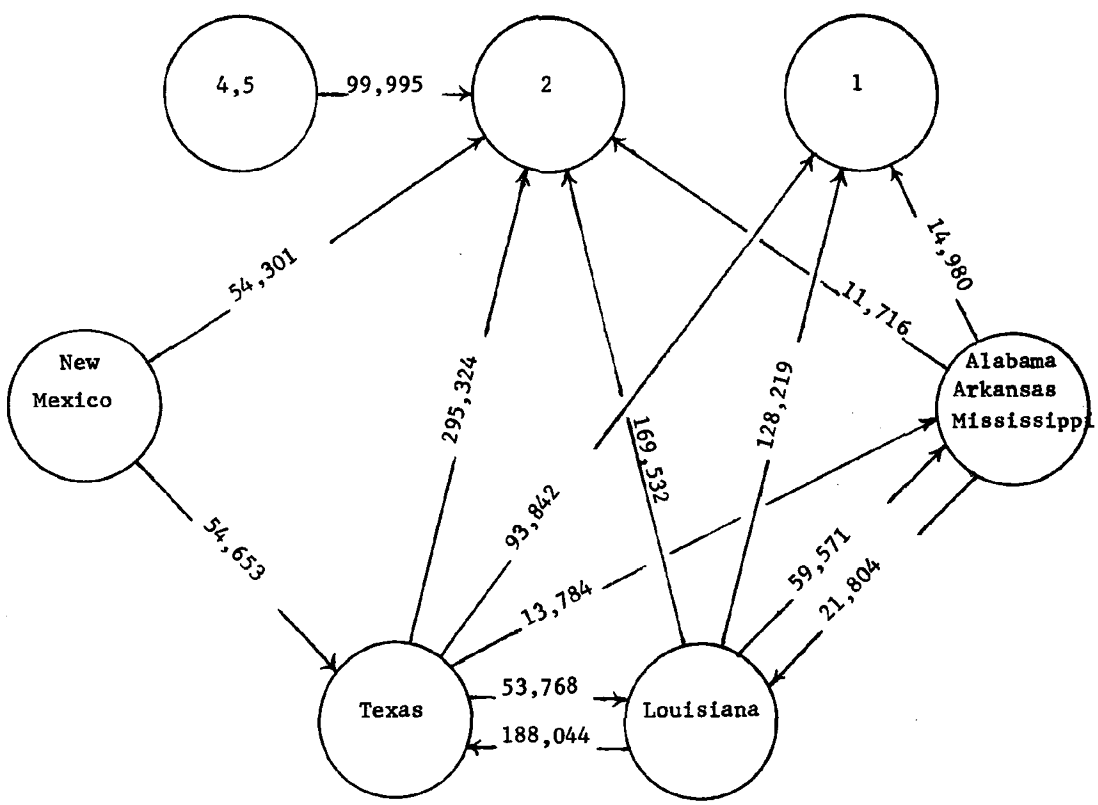
Figure 7

Comparison of District 3 States

And Districts 1, 2, and 4 & 5 as

Suppliers of Crude Oil to Refineries

in Other Areas. 1970



In thousands of 42-gal. barrels
All movements under 10,000 units omitted

Source: Mineral Industry Surveys, Bureau of Mines

Texas was a net exporter of 214 million barrels. Even though crude production is larger in Texas than in Louisiana, Louisiana ships out a larger share of its somewhat smaller production, whereas Texas refines a substantial amount of its own crude production and that which it receives from other states.

2) Movement of Crude by Water. Figure 8 shows the flows of crude oil by water transportation into and among the PAD districts. Where coastal water shipment is available (Gulf Coast to East Coast), it dominates as the prime transportation method. Mississippi River barges are a minor means of transporting crude oil to Districts 1 and 2. They cannot compete with pipelines for this service, but some crude enters District 1 from District 2 on the Ohio River. Imports arriving in District 5 are divided almost equally between pipelines and water transport, but almost all those arriving in District 1 are carried by water.

3) Movement of Crude by Pipeline. Figure 9 shows approximate flows of crude oil into the United States and among PAD districts by pipeline. These figures are derived by substracting the flows moving by water in Figure 8 from the total flows of Figure 6 and rounding to the nearest million barrels. This procedure assumes that movements by other means are minor and seem to be supported by data published by the Bureau of Mines.[23]

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[23] Mineral Industry Surveys, Bureau of Mines, Crude Petroleum, Petroleum Products, and Natural Gas Liquids, 1970, Final Summary.

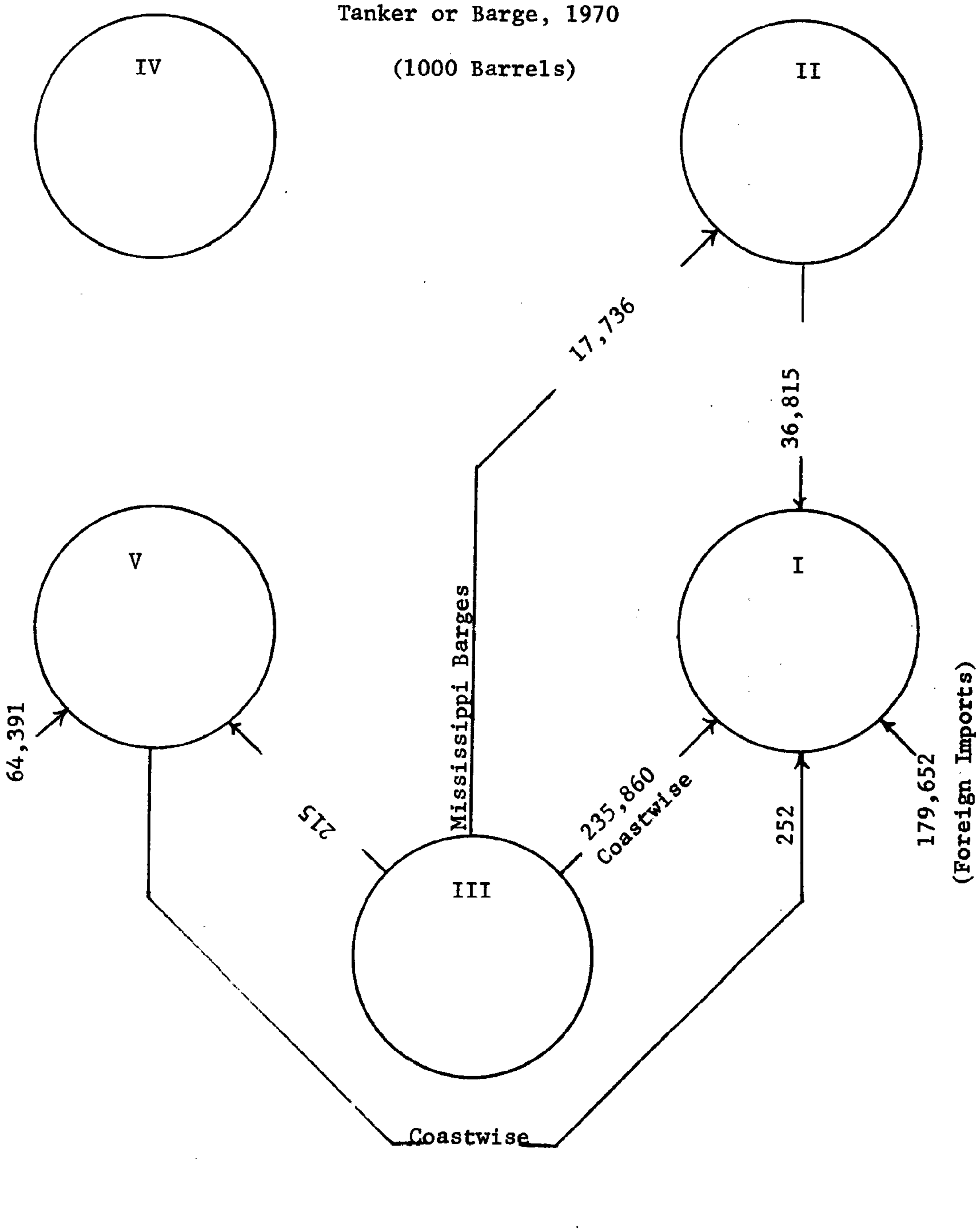
Figure 8

Movement of Crude Oil

Across PAD District Borders by

Tanker or Barge, 1970

(1000 Barrels)



Source: Mineral Industry Surveys, Bureau of Mines.

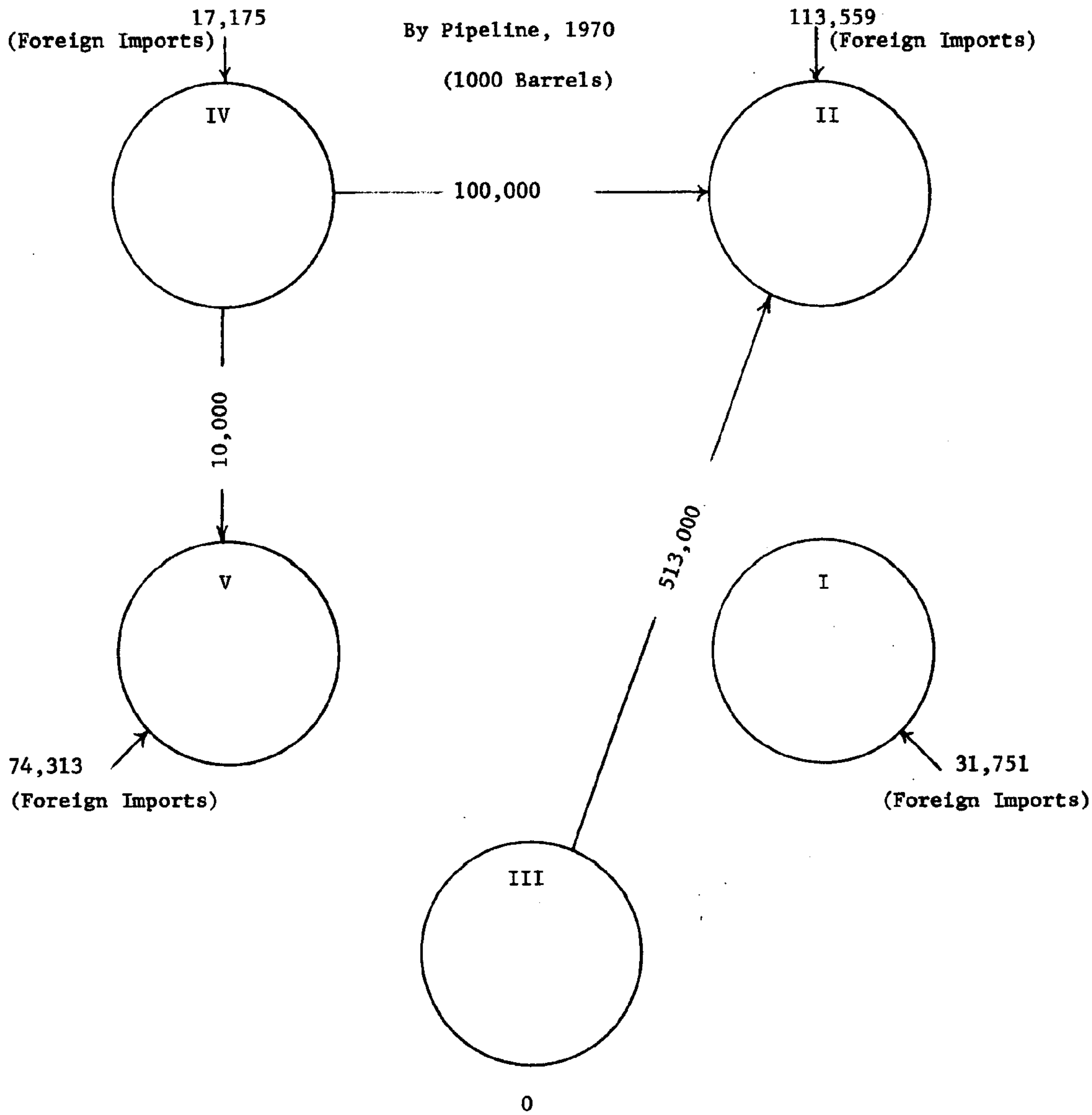
Figure 9

Crude Oil Movement Across PAD District

Borders

By Pipeline, 1970

(1000 Barrels)



Approximate data derived by subtracting the movements by water from total movements to refineries. In general,other movements are negligible.

Figures for imports by pipeline are exact.

The major flows by pipeline are the massive movements of crude into District 2 from Districts 3 and 4. Together these represent over one-half of all crude oil refined in District 2.

The foreign import data, which are exact, show inland imports by pipeline to Districts 2 and 4. Additionally, about half of all District 5 imports are by pipeline. This is the only substantial exception to the rule that crude oil shipments by pipeline are minimal where coastal water transport is available.

2. Petroleum Products. The United States imports large amounts of petroleum products because its refineries do not produce enough to meet its internal demands.

Considerable quantities of the petroleum products consumed in the United States are produced at some distance from consumption centers. This causes much movement of petroleum products among the various PAD districts.

Figure 10 and Table 8 show the pattern of shipments into and out of the various PAD districts in 1970.[24] District 3 had a substantial surplus of petroleum products and shipped large amounts to Districts 1 and 2 to balance their very large deficits.

a. Foreign Imports and Exports. Table 8 and Figure 10 show that the East Coast and the West Coast are the two districts accounting for most of the petroleum product imports. The largest single product imported is 509.9 million barrels of residual fuel oil into District 1. This is over 70 percent of all product imports into the U.S. Total U.S. exports of petroleum products were 89,467,000 barrels.

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[24]These values are the sum of water and pipeline movements from Bureau of Mines Statistics.

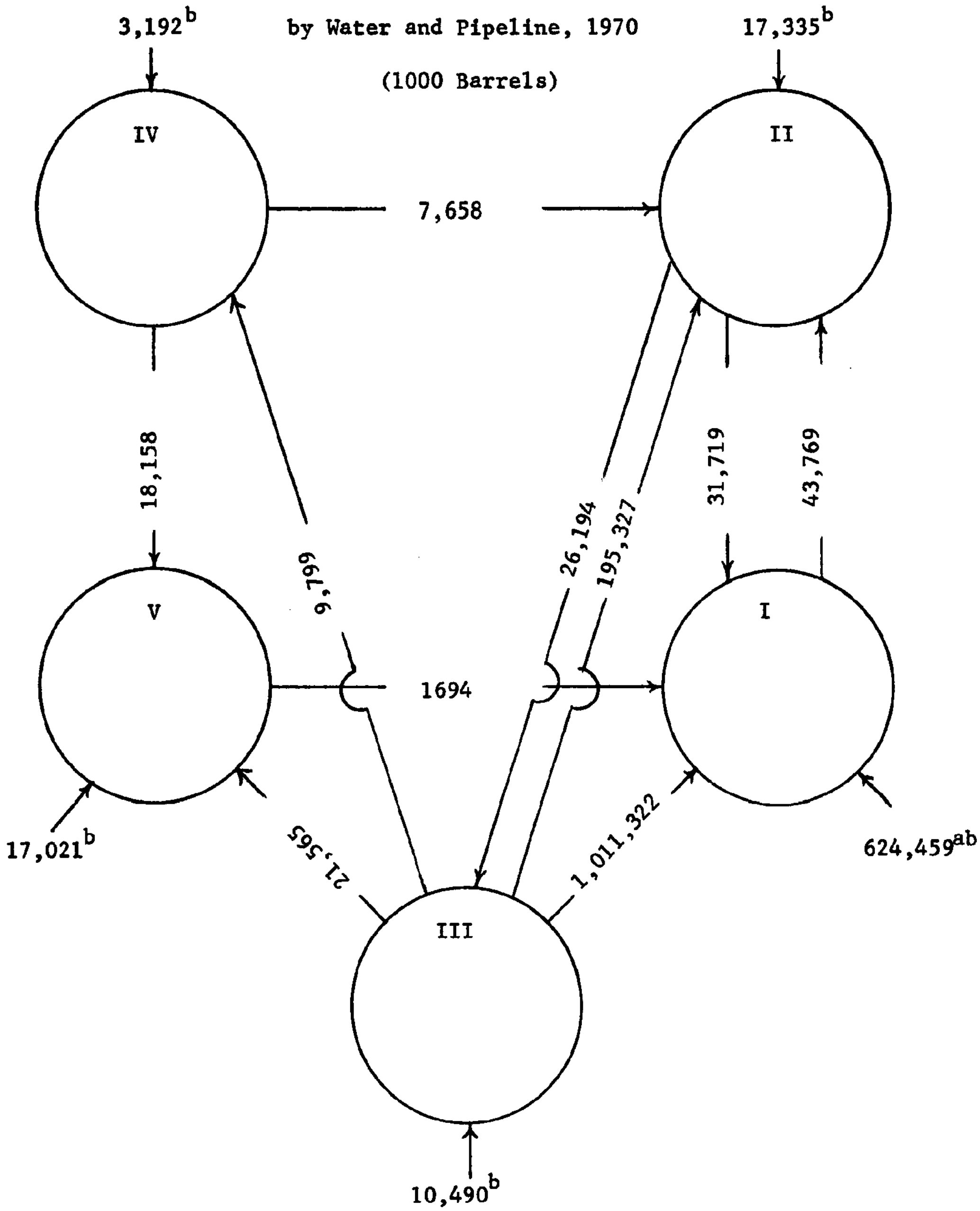
Figure 10

Movement of Petroleum Products

Into the United States and Among PAD Districts

by Water and Pipeline, 1970

(1000 Barrels)



Source: Mineral Industry Surveys.

Notes

[a]Includes 509,916,000 barrels of residual fuel oil.

[b]All import figures exclude bonded fuels.

Table 8

Total Movement of Petroleum Products Into the United States and Among PAD DISTRICTS by Pipeline and Water, 1970

(1000 Barrel Units)

Sending District	Receiving District I	II	III	IV	V	Totals
I	-	43,769	0	0	0	43,769
II	31,719	-	26,194	0	0	57,913
III	1,011,322	195,327	-	9,799	21,565	1,238,013
IV	0	7,658	0	-	18,158	25,816
V	1,694	0	0	0	-	1,694
Sub-Total	1,044,735	246,754	26,194	9,799	39,723	1,367,205
Imports[a]	624,459[b]	17,335	10,490	3,192	17,021	672,497
TOTAL	1,669,194	264,089	36,684	12,991	56,744	2,039,702

Notes

[a] Import figures exclude bonded fuels.

[b] Includes 509,916,000 barrels of residual fuel oil.

Source: Mineral Industry Survey, Bureau of Mines

The Bureau of Mines does not break these down by districts.

b. Petroleum Product Movements Within the United States

1) General. Figure 10 shows that petroleum products are shipped from one district to another in much the same pattern as for crude oil. There are some significant differences, however. District 3 sends most of its interdistrict crude exports to District 2, while it sends most of its interdistrict oil product exports to District 1. This difference is a result of the relatively small refinery capacity in relation to demand existing in District 1, while District 2 has refinery capacity almost equal to product demand. This has important implications for superport location and utilization.

2) Shipments of Products by Water. Figure 11 illustrates the movement of petroleum products from one PAD district to another by tanker or barge in 1970. Most of the flows are fairly small, but considerable amounts of products go up the Mississippi River to both the Midwest and the East Coast from District 3. The only significant flow is the 461,623,000 barrels which moved by coastwise tanker from the Gulf Coast to the East Coast. This is almost one-half of all petroleum products shipped from District 3 to District 1.

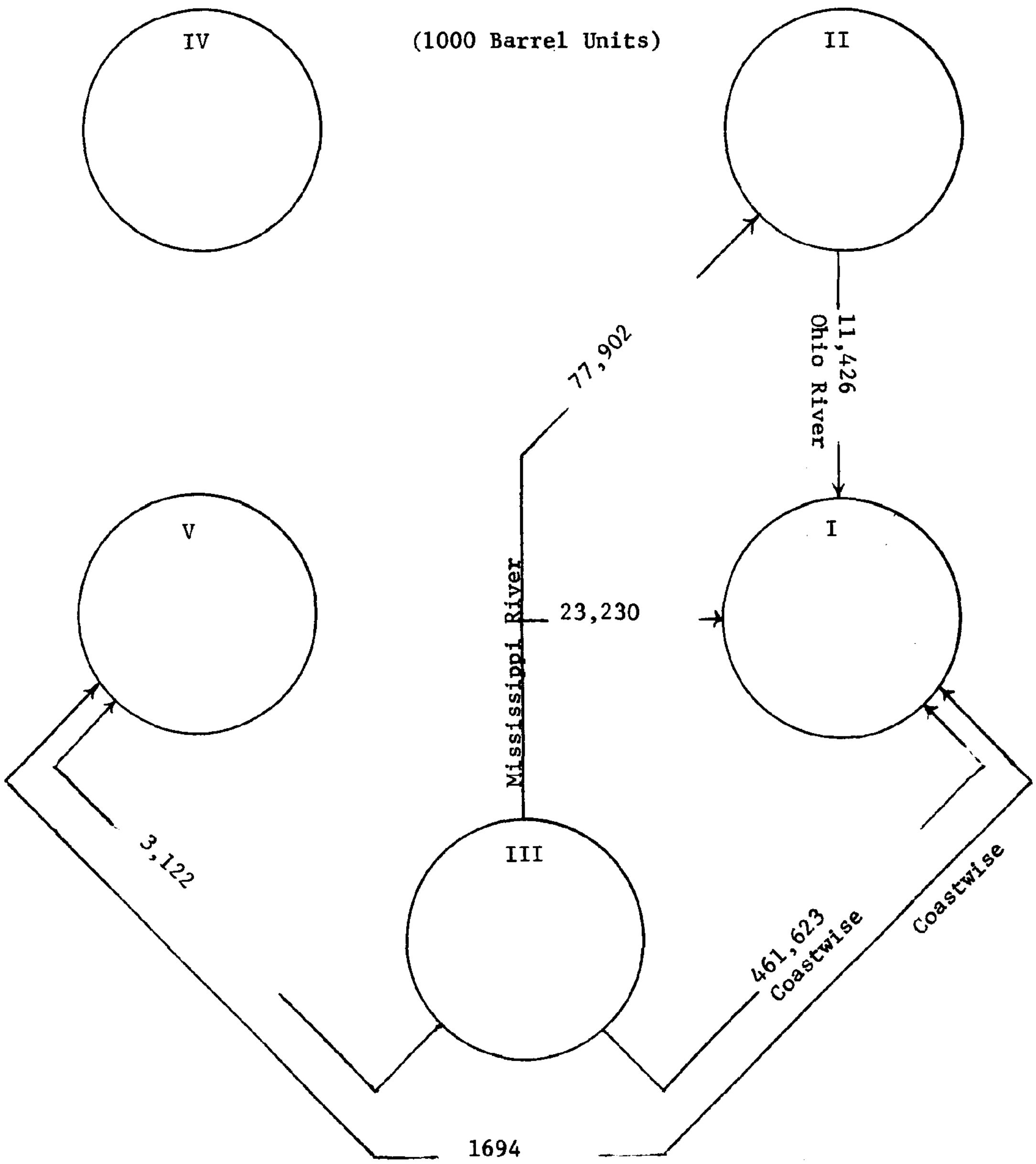
3) Shipments by Pipeline. The second major method for shipping petroleum products is by pipeline. Figure 12 shows these flows among the PAD districts. Once again, most of the flows are relatively minor except for those from District 3 to Districts 1 and 2. Each of these flows is somewhat larger than its corresponding water transport flow, shown in Figure 11. Pipelines seem to compete well with coastal tankers for shipments of products, although they are not important for crude oil.

Figure 11

Movement of Petroleum Products

Among PAD Districts by Water, 1970.

(1000 Barrel Units)



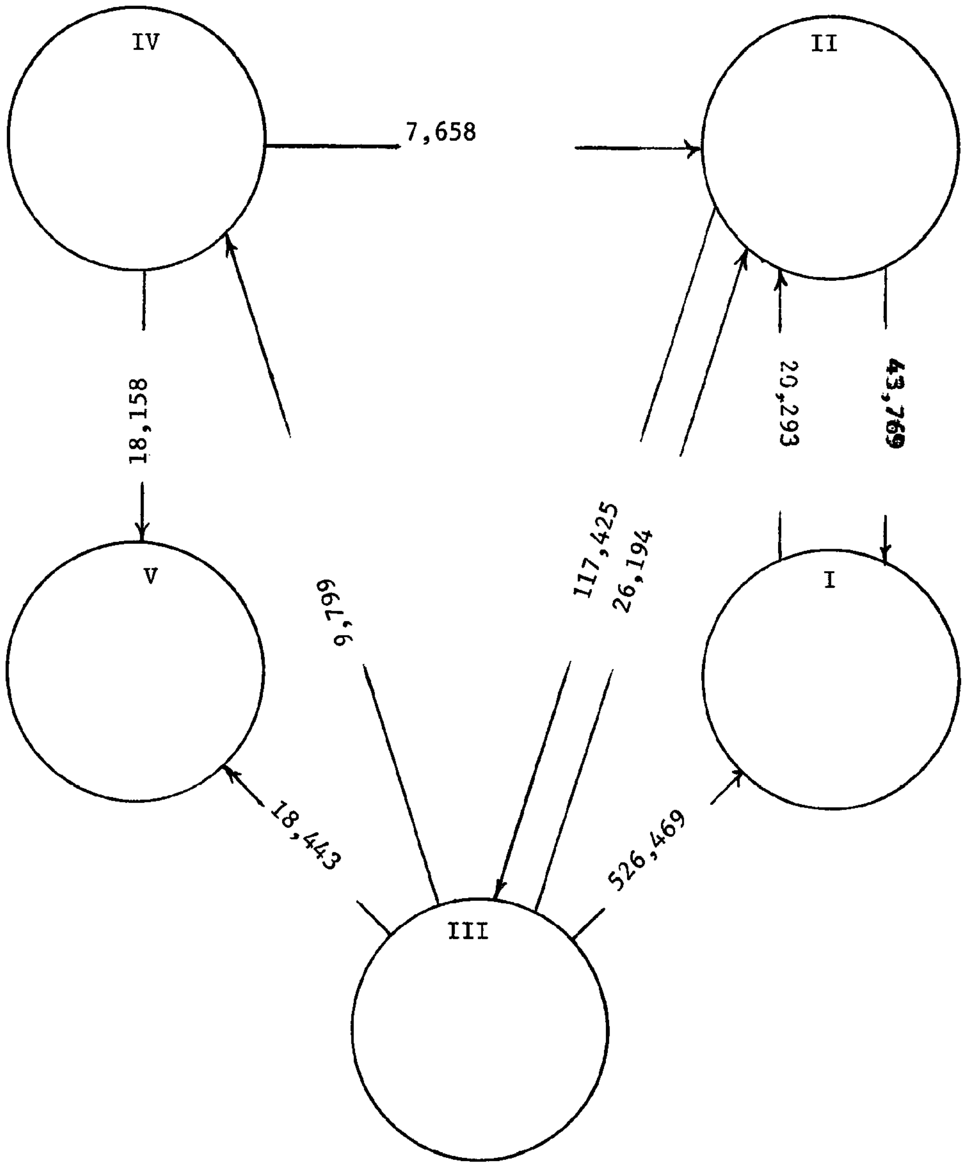
Source: Mineral Industry Surveys: Bureau of Mines

Figure 12

Movement of Petroleum Products

Among PAD Districts by Pipeline,1970

(1000 Barrel Units)



Source: Mineral Industry Surveys, Bureau of Mines

3. Summary of Inter-PAD Movements. The reader should now be acquainted with the inter-district movement of crude oil and oil products. District 3 is a major supplier of both crude and products to Districts 1 and 2. District 3 ships approximately 237.6 million barrels of crude to District 1 almost all of which is shipped in coastwise vessels; it also ships 1,011.3 million barrels of products to District 1, of which 461.6 million barrels are shipped coastwise. The remaining product shipments to District 1 from District 3 are by pipelines. Hence, about 700 million barrels of oil (crude and products) are shipped annually on coastwise vessels from the Gulf region. If a superport were to be located in the Gulf, these 700 million barrels could be shipped more cheaply, provided that a superport were also located on the East Coast. Movements of crude by internal waterways are only 17.7 million barrels and go to District 2, whereas product movements on barges are 77.9 million to District 2 and 23.2 million to District 1. Although these movements are not very significant at the present time, they could increase if District 1 were to begin importing more crude from the Middle East and the Midwest were to receive the Gulf crude. However, it must be recognized that pipelines are more efficient for transporting both crude and products to the Midwest.

Approximately 513.0 million barrels of crude and 117.0 million barrels of products flow in pipelines from District 3 to District 2.

c. Water Transport of Crude Oil and Refined Products by PAD District 3 States

1) General. Whereas the previous sections analyzed the movement of crude and products among PAD districts, it was considered desirable to further segment these movements by states, in order to

establish comparative patterns of transportation to the East and Midwest, (e.g., originating in Texas, as compared to Louisiana). Such an analysis would be an important input into the locational analysis of a superport.

We spent considerable time attempting to gather the necessary statistics. Unfortunately, after much searching, correspondence and personal visits to the Department of Interior, the American Petroleum Institute and the National Petroleum Council, it was determined that such data do not exist. In fact, the Department of Interior had forseen a need for such data and had requested the oil companies to provide them. Because of the complex nature of distribution and redistribution of products, however, the oil companies were unable to comply with this request.

We therefore requested the refineries located in Louisiana to provide us with data on the movement of crude and refined products into and out of Louisiana. Unfortunately, at the time this report was prepared we had received information from only three companies, one of which said that the data sought was proprietary and could not be released. We cannot publish the data we received from the other two companies because (1) they would be seriously incomplete, and (2) with data from only two companies, such publication would violate our pledge of confidentiality.

Hence, we decided to use the less satisfactory alternative of reconstructing data contained in the "Waterborne Commerce Statistics" published by the Army Corps of Engineers to show the water, but not pipeline, movements by states.

2) Movement of Crude Oil and Refined Products by Coastwise Vessels

Figure 13 is a summary of movements of total crude oil among PAD district 3 and between PAD district 3 states and the other PAD districts. This information is useful, but we wanted to know how much was being shipped by water and how much by pipelines. The total movement of crude and products out of PAD district 3 is made up of two basic components. First, there are coastwise shipments by tanker from Texas, Louisiana, Alabama and Mississippi to the East Coast states and, second, there are shipments internally on the Mississippi River and its tributaries, and on the Intracoastal Waterway into Florida.

a. Methodology

Table 9 shows the net coastwise movements of crude oil and the major refined products originating from each of the producing states in PAD district 3[25]. Each state is assumed to have a net contribution to the pool of oils shipped into District 1 (East Coast). Because each state both contributes to and receives from the pool, the net contribution is more relevant for District 1 outbound movements.[26]

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[25]New Mexico and Arkansas, which are located in District 3, are excluded in this analysis because they do not have coastwise shipments.

[26]The following three sections employ unique methodologies to obtain petroleum crude and products flows by states. To our knowledge, these are the only data which exist for origin of state movements for petroleum crude and products. We welcome all criticisms and suggestions.

Figure 13

Comparison of District 3 States

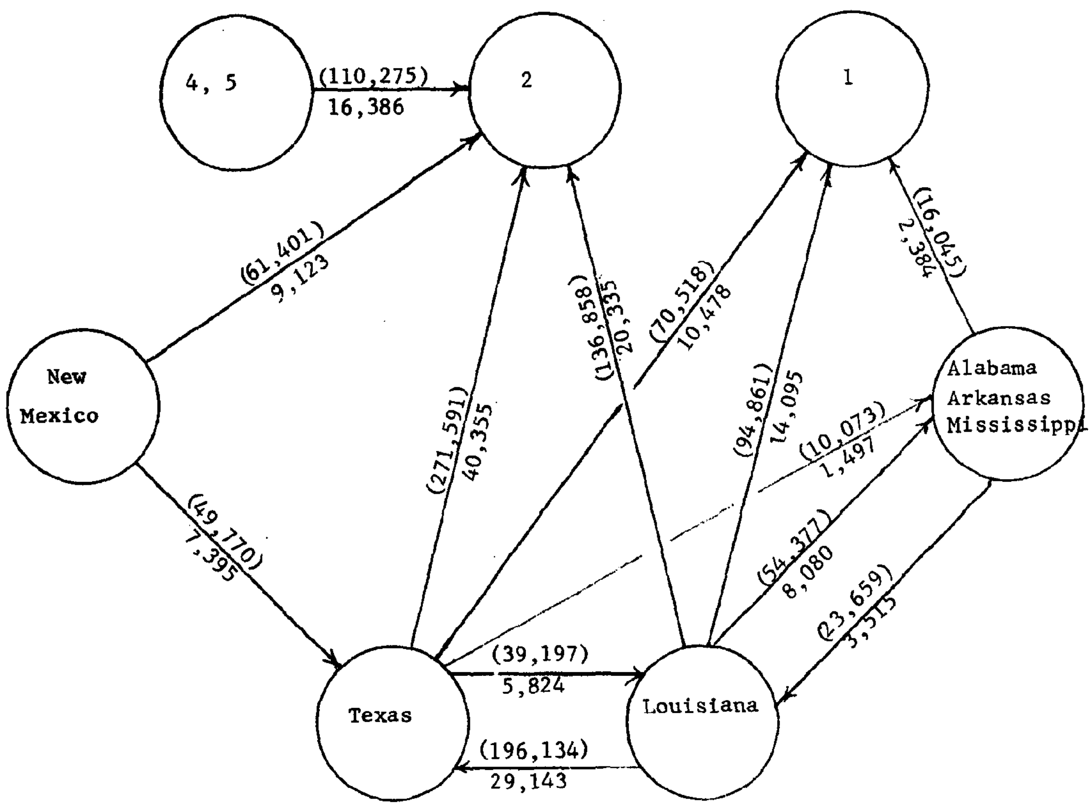
and Districts 1, 2, 4, & 5 as Suppliers

of Total Crude Oil to Refineries in Other

Areas

1969[a,b,c]

Thousands of Short Tons



Source: Minerals Yearbook 1969, Bureau of Mines

Notes

[a]In thousands of short tons, calculated 6.73 barrels/ton

[b]All movements under 10,000 units omitted

[c]Parenthesized figures in thousands of 42-gallon barrels

Table 9

Coastwise Movement from PAD District 3 to the East Coast States
Crude Oil and Oil Products
1969
Short Tons

Area: Commodity	Flow	Texas	Louisiana (short tons)	Ala.-Miss.	Total Net Shipping to East Coast
1311 Crude Petroleum	Shipments	13,322,278	18,842,012	1,635,347	
	Receipts	4,165,829	0	0	
	Net	9,156,449	18,842,012	1,635,347	29,633,808
	%	30.9%	63.6%	5.5%	
2911 Gasoline	Shipments	15,608,178	3,606,471	806,006	
	Receipts	211,376	35.405	28,132	
	Net	15,396,802	3,571,066	777,874	19,745,742
	%	78.0%	18.1%	3.9%	
2912 Jet Fuel	Shipments	2,848,840	1,349,662	272,294	
	Receipts	92,982	0	0	
	Net	2,755,858	1,349,662	272,294	4,337,814
	%	63.0%	30.8%	6.2%	
2913 Kerosene	Shipments	1,036,741	254,472	39,170	
	Receipts	0	0	59,696	
	Net	1,036,741	254,472	-20,526	1,270,687
	%	80.3%	19.7%	-0%	
2914 Distillate Fuel Oil	Shipments	16,948,349	5,736,875	777,570	
	Receipts	0	0	74,608	
	Net	16,948,349	5,736,875	702,962	23,388,186
	%	72.5%	24.5%	3.0%	
2915 Residual Fuel Oil	Shipments	4,657,740	102,788	171,808	
	Receipts	214,750	104,640	185,835	
	Net	4,442,990	-1,852	-14,027	4,427,111
	%	100.0%	0%	0%	
2916 Lubricate Oils	Shipments	1,631,849	450,400	796	
	Receipts	125,248	43,244	80	
	Net	1,506,601	407,156	716	1,914,473
	%	78.7%	21.3%	0%	
2917 Naphtha	Shipments	894,137	38,383	1,753	
	Receipts	186,073	14,523	0	
	Net	708,064	23,860	1,753	733,677
	%	96.5%	3.3%	0.2%	
2918 Asphalt	Shipments	678,960	359,940	113,580	
	Receipts	40,482	0	0	
	Net	638,478	359,940	113,580	1,111,998
	%	57.4%	32.4%	10.2%	
2920 Coke (Oil & Coal)	Shipments	0	21	341	
	Receipts	18	0	0	
	Net	-18	21	341	344
	%	0%	5.8%	94.2%	
2921 Liquid Gases	Shipments	75,389	85,551	6	
	Receipts	13,062	0	0	
	Net	62,327	85,551	6	147,884
	%	42.1%	57.9%	0.0%	
2951 Asphalt Bldg. Mater.	Shipments	93	233	0	
	Receipts	0	0	0	
	Net	93	233	0	326
	%	28.5%	71.5%	0.0%	
2991 Petroleum Products n.e.c.	Shipments	87,785	93,652	702	
	Receipts	12,521	45,269	0	
	Net	75,264	48,383	702	124,349
	%	60.5%	38.9%	0.6%	
TOTALS		52,727,998	30,677,379	3,471,022	86,876,399
Total %		60.7%	35.3%	4.0%	

Source: Computed from basic data contained in Waterborne Commerce of the U.S. - 1969, U.S. Army Corps of Engineers.

Perhaps an example will clarify this rather complicated procedure. Take commodity 1311, crude petroleum. Texas shipped, by coastwise vessels, 13,322,278 short tons but received 4,165,829 short tons, resulting in a net contribution of crude to District 1 of 9,156,449 tons or 30.9 percent of total District 3 crude shipped to District 1. Louisiana, on the other hand, shipped 18,842,012 tons by coastwise vessels and received no incoming shipments, and so it is concluded that Louisiana contributed 63.6 percent of District 3 movements to District 1.

In a few cases, e.g., kerosene movements from Alabama and Mississippi, a state's net contribution is negative. In such instances, the total pool is considered to be contributed by the other states (Texas and Louisiana). All withdrawls from the total pool are assumed to be derived from the contributing states in proportion to their contributions to the other pool. In the case of kerosene, Alabama and Mississippi were net consumers of -20,526 tons, and it was assumed that of this amount 80 percent came from Texas and 19.7 percent from Louisiana; so the net relative contributions of these two states to shipments to the East Coast are not distorted. In the far right-hand column are the total net shipments from the Gulf Coast to the East Coast for each commodity.

b) Results

The grand total of coastwise shipments of petroleum crude and products from District 3 Gulf Coast states to the East Coast states was 86,876,399 short tons. Texas shipped 52,727,998 or 60.7 percent of the total, whereas Louisiana shipped 30,677,379 tons or 35.3 percent of the total. Alabama and Mississippi shipped 3,471,022 tons or 4.0 percent of the total. Louisiana shipped a greater percentage of crude (63.6 percent) than Texas (30.9 percent), but Texas shipped a greater amount of all petroleum products, except liquid gases and asphalt materials, than Louisiana.

3) Movement of Crude Oil and Refined Products by Internal Waterways

a. Methodology

Inasmuch as the methodology of generating these data is unique and affects the quality of Table 11, the reader should familiarize himself with our procedures so that he may exercise proper discretion in interpreting the results. However, the reader who wishes a cursory overview may skip this section since it contains no substantial remarks or conclusions.

Table 10 shows the movement of crude oil and refined products in 1969 by barge on the Gulf Intracoastal Waterway and on the Mississippi River. The data were calculated from Waterborne Commerce of the United States, 1969 by taking the net flows of crude oil and refined products at the points where state borders or divisions of waterways are crosses. For example, the flows up the Mississippi River were calculated by adding together the inbound/upbound traffic and the upbound/through traffic and subtracting therefrom the sum of the downbound/outbound traffic and the downbound/through traffic in the segment of the river from Baton Rouge to the mouth of the Ohio River. This calculation yields the net northbound river traffic passing Baton Rouge on the Mississippi and the traffic entering the Mississippi at the upper end of the Atchafalaya River and the Morgan City-Port Allen routes. This procedure yields the closest possible approximation to the net flow entering the midwestern PAD district 2 from PAD district 3.

Flows across state borders were calculated for the Gulf Intracoastal Waterway in a similar manner. The data were used to give net

Table 10

Oil and Oil Products From PAD District 3 States by Internal Water Transportation to PAD Districts 1 and 2, 1969

Area		Texas	Louisiana	Ala-Miss	Total
Commodity	Flow	(Short Tons)	(Short Tons)	(Short Tons)	(Short Tons)
1311 Crude Petroleum	To River[a]	0	2,066,481	64,351	2,130,832
	To Fla.[b]	0	0	204,524	204,524
	Total	0	2,066,481	268,875	2,335,356
	%	0%	96.98%	3.02%	100.0%
2911 Gasoline	To River	2,338,191	4,666,574	0	7,004,765
	To Fla.	471,897	941,814	0	1,413,711
	Total	2,810,088	5,608,388	0	8,418,476
	%	33.38%	66.62%	0%	100.0%
2912 Jet Fuel	To River	198,933	334,829	0	533,762
	To Fla.	86,060	144,850	244,723	475,633
	Total	284,993	479,679	244,723	1,009,395
	%	28.2%	47.5%	24.2%	99.9%
2913 Kerosene	To River	335,133	286,519	0	621,652
	To Fla.	7,049	6,026	0	13,075
	Total	342,182	292,545	0	634,727
	%	53.91%	46.09%	0%	100.0%
2914 Distillate Fuel Oil	To River	544,597	213,894	0	758,491
	To Fla.	90,513	35,550	0	126,063
	Total	635,110	249,444	0	884,554
	%	71.80%	28.20%	0%	100.0%
2915 Residual Fuel Oil	To River	1,065,141	0	0	1,065,141
	To Fla.	130,404	0	0	130,404
	Total	1,195,545	0	0	1,195,545
	%	100.0%	0%	0%	100.0%
2916 Lubricating Oils	To River	582,862	9,959	0	592,821
	To Fla.	61,823	1,056	0	62,879
	Total	644,685	11,015	0	655,700
	%	98.32%	1.68%	0	100.0%
2917 Naphtha Petroleum Solvents	To River	651,457	122,613	0	774,070
	To Fla.	35,440	6,670	0	42,110
	Total	686,897	129,283	0	816,180
	%	84.16%	15.84%	0%	100.0%
2918 Asphalt Tar and Pitch	To River	224,492	407,168	0	631,660
	To Fla.	14,608	26,495	0	41,103
	Total	239,100	433,663	0	672,763
	%	35.54%	64.46%	0%	100.0%
2920 Coke (oil & coal)	To River	0	0	0	0
	To Fla.	0	0	0	0
	Total	0	0	0	0
	%	0%	0%	0%	0%
2921 Liquefied Gases	To River	2,789	484,633	0	487,422
	To Fla.	470	81,636	0	82,106
	Total	3,259	566,269	0	569,528
	%	0.57%	99.43%	0%	100.0%
2951 Asphalt Building Materials	To River	0	0	0	0
	To Fla.	0	0	0	0
	Total	0	0	0	0
	%	0%	0%	0%	0%
2991 Pet. Prod n.e.c.	To River	33,031	43,081	0	76,112
	To Fla.	0	0	0	0
	Total	33,031	43,081	0	76,112
	%	43.40%	56.60%	0%	100.0%
	River TOT.	5,976,626	8,635,751	64,351	14,676,728
	River %	40.72%	58.84%	.44%	100.0%
	Fla. TOT.	898,264	1,244,097	449,247	2,591,608
	Fla. %	34.66%	48.00%	17.33%	99.99%
GRAND TOTALS		6,874,890	9,879,848	513,598	17,268,336
% of GRAND TOTAL		39.8%	57.2%	3.0%	100.0%

Notes

[a] To River: Means net shipments leaving the Gulf Coast PAD District 3 states on the Mississippi River.

[b] To Florida: Means net shipments leaving the Gulf Coast PAD District 3 states on the Intracoastal to Florida.

Source: Waterborne Commerce of the United States 1969 - U. S. Army Corps of Engineers.

eastbound movement between the Sabine River and the Calcasieu River (proxy for movements between Texas and Louisiana), New Orleans and Mobile (proxy for movements between Louisiana and Alabama) and between Mobile and Pensacola (proxy for movements between Alabama and Florida).

In order to determine each state's shipments of crude oil by barge, we added the net barge movements into Texas from Louisiana and the net barge movement up the Mississippi River (Table 10). This gave a net outward movement of crude oil from Louisiana, but we could not determine which originated in Louisiana and which originated in the other states. We could ascertain that Alabama and Mississippi were net contributors to the pool, and the rest was assumed to come from Louisiana since Texas was a net importer. These contributions to the pool moved by barge were then converted to percentages for Louisiana and for Alabama and Mississippi. It was calculated that 96 of 98 percent of the total pool originated in Louisiana and that 3.02 percent came from Alabama and Mississippi. These percentages were applied to the net flow up the Mississippi to determine each state's contribution.

In a few cases, e.g., liquid petroleum gases, both Texas and Louisiana contributed to a pool which was sent to markets in Alabama-Mississippi and further up the Mississippi. Allocation of each of these flows to Texas and Louisiana was made according to each state's contribution to these two flows. If Alabama and Mississippi were a net importer from this pool, the remaining flow into Florida maintained the same allocation as the original larger flow into Alabama-Mississippi from Louisiana, and Alabama and Mississippi were assumed to contribute nothing to the net flow into Florida.

b. Results

As might be expected, Louisiana accounted for a larger percentage of oil and oil products shipped to Districts 1 and 2 via the inland water system (including Intracoastal) than either Texas or Alabama-Mississippi. According to our generated statistics in Table 10, 57.2 percent of oil and products shipped from PAD district 3 on the inland waterways to PAD districts 1 and 2 originated in Louisiana, while Texas shipped 39.8 percent and Alabama-Mississippi shipped 3.0 percent of total flows. This positive differential in favor of Louisiana is particularly impressive for shipment of crude and liquefied gases.

A further breakdown shows that Louisiana shipments on the Mississippi River were 58.8 percent, while Texas shipments accounted for 40.7 percent; 48.0 percent of Intracoastal shipments into Florida originated in Louisiana, 34.7 percent in Texas and 17.3 percent in Alabama and Mississippi.

Hence, one must conclude that Louisiana's surplus of crude and its advantageous location in proximity to the inland waterway system has made it the major inland waterway exporter of oil and oil products to oil-deficient regions on the East Coast and in the Midwest.

4) Total Water Movements of Oil and Oil Products. Table 11 integrates and summarizes the data presented in Tables 9 and 10, and it compares Texas, Louisiana and Alabama-Mississippi as suppliers of crude oil and refined products by water transportation. As can be seen in Table 11, Louisiana is far more important than Texas as a direct supplier, via water, of crude oil to Districts 1 and 2 (Louisiana: 65.4 percent; Texas: 28.6 percent). With the exception of liquefied petroleum and asphalt materials, however, Texas is more significant as a supplier, via

Table 11

Net Movement of Oil and Oil Products from PAD District 3 States to PAD Districts 1 and 2 by Water 1969

Area Commodity	Flow	Texas	Louisiana	Ala-Miss	Total
			(Short Tons)		
1311 Crude Petroleum	River	0	2,066,481	64,351	2,130,832
	Waterway	0	0	204,524	204,524
	Coastwise	9,156,449	18,842,012	1,635,347	29,633,808
	Total	9,156,449	20,908,493	1,904,222	31,969,164
	%	28.6%	65.4%	6.0%	100.0%
2911 Gasoline	River	2,338,191	4,666,574	0	7,004,765
	Waterway	471,897	941,814	0	1,413,711
	Coastwise	15,396,802	3,571,066	777,874	19,745,742
	Total	18,206,890	9,179,454	777,874	28,164,218
	%	64.6%	32.6%	3.0%	100.0%
2912 Jet Fuel	River	198,933	334,829	0	533,762
	Waterway	86,060	144,850	244,723	475,633
	Coastwise	2,755,858	1,349,662	272,294	4,377,814
	Total	3,040,851	1,829,341	517,017	5,387,209
	%	56.45%	33.96%	9.50%	100.01%
2913 Kerosene	River	335,133	286,519	0	621,652
	Waterway	7,049	6,026	0	13,075
	Coastwise	1,020,362	250,325	0	1,270,687
	Total	1,362,544	542,870	0	1,905,414
	%	71.51%	28.49%	0%	100.0%
2914 Distillate Fuel Oil	River	544,597	213,894	0	758,491
	Waterway	90,513	35,550	0	126,063
	Coastwise	16,948,349	5,736,875	702,962	23,388,186
	Total	17,583,459	5,986,319	702,962	24,272,740
	%	72.44%	24.66%	2.90%	100.0%
2915 Residual Fuel Oil	River	1,065,141	0	0	1,065,141
	Waterway	130,404	0	0	130,404
	Coastwise	4,427,111	0	0	4,427,111
	Total	5,622,656	0	0	5,622,656
	%	100%	0%	0%	100%
2916 Lubricating Oils	River	582,862	9,959	0	592,821
	Waterway	61,823	1,056	0	62,879
	Coastwise	1,506,601	407,156	716	1,914,473
	Total	2,151,286	418,171	716	2,570,173
	%	83.70%	16.27%	.03%	100.0%
2917 Naphtha Petroleum Solvents	River	651,457	122,613	0	774,070
	Waterway	35,440	6,670	0	42,110
	Coastwise	708,064	23,860	1,753	733,677
	Total	1,394,961	153,143	1,753	1,549,857
	%	90.01%	9.88%	.11%	100.0%
2918 Asphalt Tar and Pitch	River	224,492	407,168	0	631,660
	Waterway	14,608	26,495	0	41,103
	Coastwise	638,478	359,940	113,580	1,111,998
	Total	877,578	793,603	113,580	1,784,761
	%	49.17%	44.47%	6.36%	100.0%
2920 Coke	River	0	0	0	0
	Waterway	0	0	0	0
	Coastwise	0	20	324	344
	Total	0	20	324	344
	%	0%	5.8%	94.2%	100%
2921 Liquefied Petro. Gases	River	2,789	484,633	0	487,422
	Waterway	470	81,636	0	82,106
	Coastwise	62,327	85,551	6	147,884
	Total	65,586	651,820	6	717,412
	%	9.14%	90.86%	0%	100.0%
2951 Asphalt Bldg Materials	River	0	0	0	0
	Waterway	0	0	0	0
	Coastwise	93	233	0	326
	Total	93	233	0	326
	%	28.53%	71.47%	0%	100.0%
2991 Petroleum Prod. n.e.c.	River	33,031	43,081	0	76,112
	Waterway	0	0	0	0
	Coastwise	75,264	48,383	702	124,349
	Total	108,295	91,464	702	200,461
	%	54.02%	45.62%	.35%	99.99%
Grand Total Coastwise & Int.		59,570,648	40,554,931	4,019,156	104,144,735
State %		57.20%	38.94%	3.86%	100.00%

Source: Waterborne Commerce of the United States 1969 - U.S. Corps of Engineers.

water, of petroleum products.

In total shipments, Texas accounts for approximately 60 million tons of 57 percent of the total, while Louisiana generates 41 million tons of 39 percent of the total. As mentioned above, Louisiana predominates as a supplier via the Mississippi and the Intracoastal Waterway, while Texas dominates the coastwise shipping, which is the larger of the two. A pictorial summary of our generated data is presented in Figure 14.

In a superport evaluation one must consider that Louisiana does predominate as a shipper (by water) of crude oil. This means that in the relatively short run (10 years), a Louisiana location is preferable to a Texas location for the shipment of crude to the East Coast[27]. In the long run, however, as Louisiana's crude supplies become depleted this relative advantage over Texas becomes more tenuous. Of course, within ten years the Gulf area will be importing crude oil from the Middle East if a superport is located here. Louisiana may have a slight edge over Texas because it is located closer to the East Coast which is deficient in crude and refinery capacity, and it is located on the internal waterway system.

In terms of product shipments, the comparative advantages are much less clear. First, Texas shippers of oil products could utilize a Louisiana superport without backhauling, whereas Louisiana shippers would have to backhaul. Second, Texas does dominate product shipments at the current

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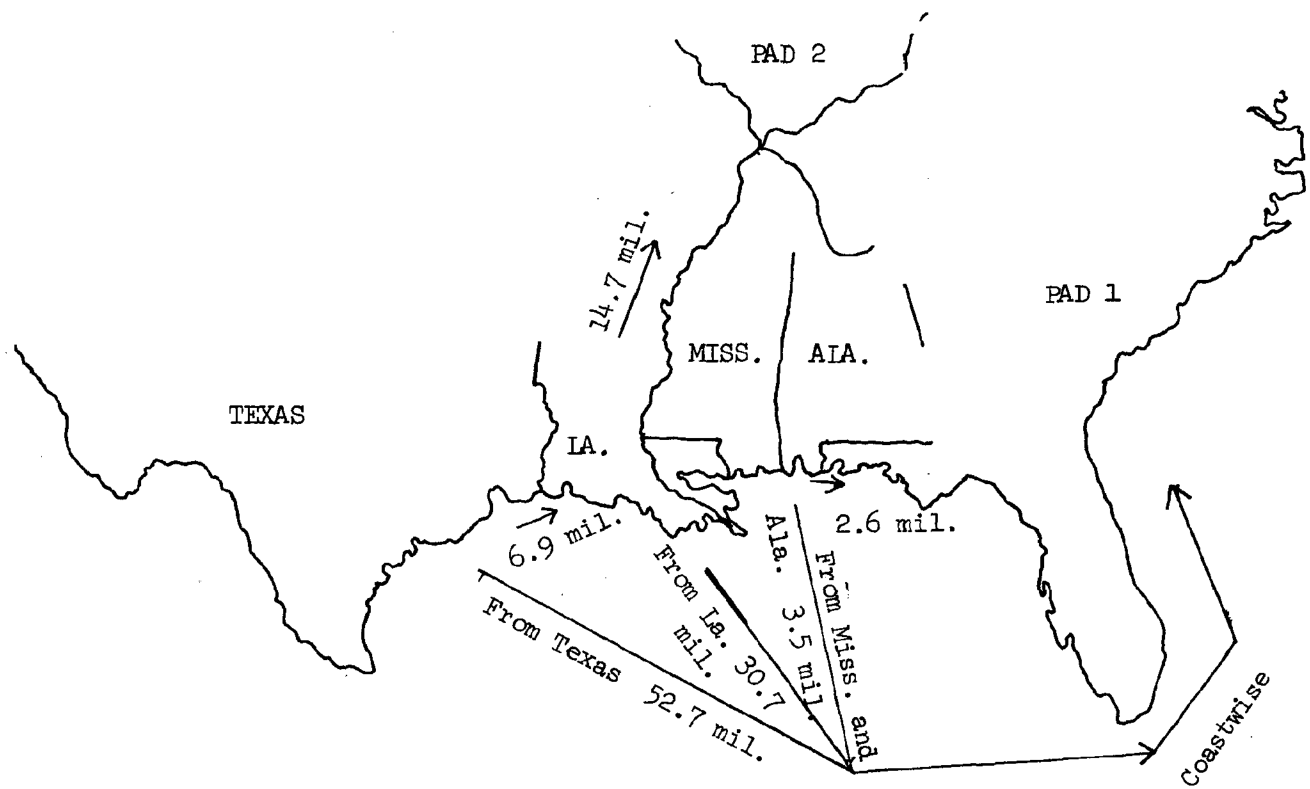
[27]In fact, it is interesting to note the large crude movement by water under present conditions without a superport. This is suggestive of the economics of water shipment of liquid bulks, which would be even greater if superports were located in the Gulf and on the East Coast.

FIGURE 14

Net Water Movement of Crude Oil and Petroleum Products from PAD DISTRICT 3 States to PAD DISTRICTS 1 and 2 by Water in Short Tons 1969



time, but the location of a superport off the coast of Louisiana might alter the relative distribution of refineries in the Gulf region. Third, Louisiana possesses a geographical advantage in relation to the inland waterways which cannot be altered. This would become quite significant if the East Coast were to expand its refining capacity and construct a superport because the Gulf Coast states would then begin to ship to the Midwest, in which case the Mississippi waterways, and consequently Louisiana, would play a more important role.

5) Pipeline Movement of Crude Oil by States.

While paragraph 4 compared the water movements of petroleum crude and products by states, it omitted a discussion of pipeline movements by state. The only data available on state origins of crude shipments were total crude shipments by state, which are shown graphically in Figure 13. The numbers in parenthesis are thousands of 42-gallon barrels as reported in the Bureau of Mines, Mineral Yearbook, 1969.[28] The Bureau of Mines data were reported in barrels and the Waterborne Commerce data were reported in short tons; so we converted all data to tonnage.

As shown in Figure 13 Louisiana shipped 14.1 million tons to District 1 and 20.3 million tons to District 2; Texas sent 10.4 million tons to District 1 and 40.3 million tons to District 2. These data alone are not important since a more recent comparison is provided in Figure 7. They are important, however, inasmuch as they provide the total 1969 movements, from which we can subtract the net water movements to obtain

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[28]The data in Figure 13 vary from the data in Figure 7 in that the former are 1969 data and the latter are 1970 data.

the residual movements which are by pipelines. Figure 15 shows the total water movements, by states, obtained from row 1, Table 12. As indicated in Figure 15, Louisiana sent 18.8 million tons by water to District 1 and 2.1 million to District 2, whereas Texas sent 9.2 million tons to District 1 and nothing by water to District 2. Shipments to District 1 were by coastwise vessels primarily whereas movements to District 2 were on internal waterways.

Taking the water movements shown in Figure 15 and subtracting from the total movements shown in Figure 13 yields net crude movements by pipelines as indicated in Figure 16. All derived pipeline flows, except one, seem reasonable. The questionable figure is the -4.0 million tons between Louisiana and District 1. We know that no such movements occurred for a negative movement means that District 1 sent crude to Louisiana, which is absurd.

There are four possible causes for this discrepancy:

- The basic data on each district's crude receipt were receipts at refineries in that district. Hence, crude might have been shipped by water from Louisiana and then transshipped to District 2.
- The crude was shipped to District 1 and burned directly in power plants. This is the most probable cause of the discrepancy.
- The crude loaded on tankers in Louisiana was shipped by pipeline from Texas.
- Our methodology of generating water movements was incorrect or arithmetic mistakes were made.

Figure 15

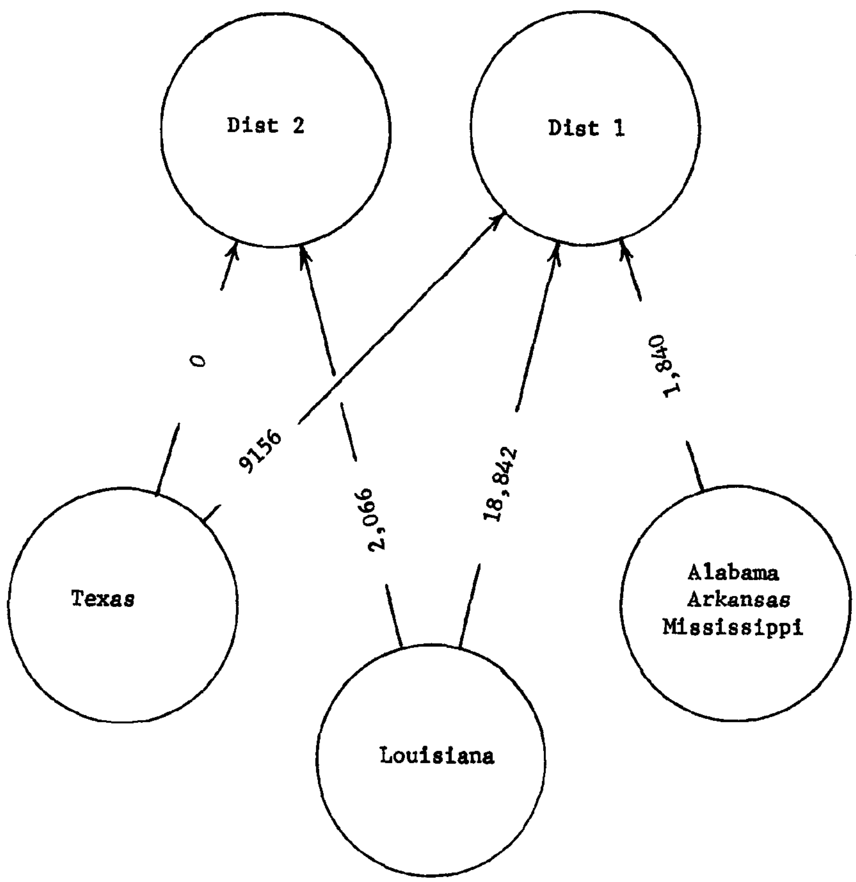
Comparison of District 3 States

as Shippers of Crude Oil by

Water to Districts 1 and 2

1969

Thousands of Short Tons



Source: Manipulation of Data From Waterborne Commerce of the United States, 1969

TABLE 12

CRUDE OIL AND REFINED PRODUCT IMPORTS INTO THE UNITED STATES, 1970

	CANADA			LATIN AMERICA-CARIBBEAN			EUROPE			MIDDLE EAST-AFRICA			FAR EAST			PUERTO RICO VIRGIN ISLANDS			TOTAL
	Thousands of Barrels	Percentage		Thousands of Barrels	Percentage		Thousands of Barrels	Percentage		Thousands of Barrels	Percentage		Thousands of Barrels	Percentage		Thousands of Barrels	Percentage		Thousands of Barrels
		Relative	Overall		Relative	Overall		Relative	Overall		Relative	Overall		Relative	Overall		Relative	Overall	
I FOREIGN CRUDE OIL																			
District 1	31,751	12.95	6.55	97,643	92.02	20.20	--	--	--	82,009	77.18	16.97	--	--	--	--	--	--	211,403
District 2	115,613	47.14	23.92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	115,613
District 3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
District 4	17,573	7.16	3.64	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17,573
District 5	80,321	32.75	16.62	8,465	7.98	1.76	--	--	--	24,248	22.82	5.02	25,670	100.00	5.31	--	--	--	138,704
TOTAL	245,258	100.00	50.75	106,108	100.00	21.96	--	--	--	106,257	100.00	21.99	25,670	100.00	5.31	--	--	--	483,293
II REFINED PRODUCTS																			
District 1	8,587	24.91	1.12	509,232	91.55	66.64	64,219	99.46	8.40	2,671	37.07	.34	133	14.29	.02	96,873	96.20	12.68	681,716
District 2	17,364	50.37	2.27	1,959	.35	.26	--	--	--	--	--	--	--	--	--	--	--	--	19,323
District 3	--	--	--	17,471	3.14	2.29	347	.54	.05	121	1.68	.02	--	--	--	3,822	3.80	.50	21,761
District 4	3,192	9.26	.42	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,192
District 5	5,329	15.46	.70	27,567	4.96	3.61	--	--	--	4,413	61.25	.58	798	85.71	.10	--	--	--	38,107
TOTAL	34,472	100.00	4.51	556,229	100.00	72.80	64,566	100.00	8.45	7,205	100.00	.94	931	100.00	.12	100,695	100.00	13.18	764,099
III CRUDE AND REFINED (I + II)																			
District 1	40,338	14.42	3.23	606,875	91.62	48.65	64,219	99.46	5.15	84,680	74.63	6.79	133	.50	.01	96,873	96.20	7.77	893,119
District 2	132,977	47.54	10.66	1,959	.30	.16	--	--	--	--	--	--	--	--	--	--	--	--	134,936
District 3	--	--	--	17,471	2.64	1.40	347	.54	.03	121	.11	.01	--	--	--	3,822	3.80	.31	21,761
District 4	20,765	7.42	1.66	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20,765
District 5	85,650	30.62	6.87	36,032	5.44	2.89	--	--	--	28,661	25.26	2.30	26,468	99.50	2.12	--	--	--	176,811
TOTAL	279,700	100.00	22.42	662,337	100.00	53.10	64,566	100.00	5.18	113,462	100.00	9.10	26,601	100.00	2.13	100,695	100.00	8.08	1,247,392

Taken From: U.S. Deepwater Port Study "Annex I-B Crude Petroleum and Petroleum Products," Robert R. Nathan Associates, Inc., Washington, D. C., February, 1972.

Source: Foreign Crude Oil: U.S. Department of the Interior, Bureau of Mines, Mineral Industry Surveys, "Monthly Petroleum Statement" December, 1970, prepared by the Division of Fossil Fuels, March 23, 1970, table 15.
Refined Products: American Petroleum Institute, Division of Statistics and Economics, Weekly Statistical Bulletin, March 26, 1971.

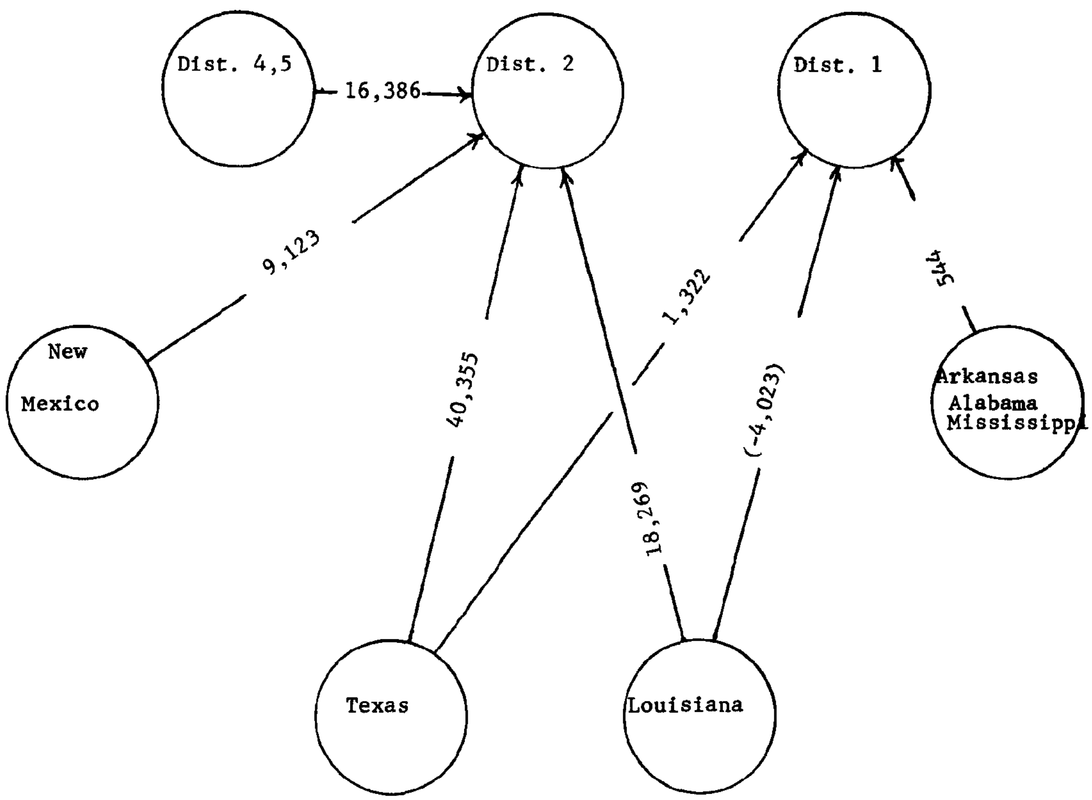
Note: Data on Foreign Crude Oil for 1971 are now available from March 21, 1972, Mineral Industry Surveys
Data on Refined Products will be published in April, 1972, by the American Petroleum Institute.

Figure 16

Comparison of District 3 States and Districts 4 & 5 as Suppliers of Crude Oil to Districts 1 and 2 by Pipeline

1969

Thousands of Short Tons



Source: Data derived by subtracting shipments by water from "Waterborne Commerce of the United States"from Bureau of Mines Data on Refinery Recipts.

In any case, the conclusion we must reach is that Louisiana transmits relatively little crude to District 1 by pipeline, while it sends 18.3 million tons to District 2 by pipeline. Texas sends approximately 1.3 million tons of crude to District 1 by pipeline and 40.3 million tons of crude to District 2 by pipeline. Hence, while District 3 ships relatively small amounts of crude to District 1 by pipeline, Texas ships by pipeline more than Louisiana. Second, Texas sends twice as much by pipeline to District 2 as Louisiana does.

The importance of these data is that they present the existing comparative transportation modes of shipping crude and petroleum product from the Gulf Coast to the East and the Midwest. The location of the superport can be expected to alter these transportation modes and the location of superports in other parts of the country such as the East Coast can be expected to alter the demand patterns. Knowledge of the present transportation modes are important, however, for two reasons. First, during the initial years the port may be utilized as an export facility for outbound liquids. Second, the superport will have to be integrated into the existing patterns of transportation. That state or area which possesses the most rational modes of transportation to the most deficient areas will be enabled to present the more convincing arguments to government officials and investors. A relevant point is that Texas ships considerably more crude and products to the East Coast and the Midwest than does Louisiana, even though Louisiana supplies Texas with a considerable amount of crude. Further research must be conducted to determine the underlying reasons for the seemingly overwhelming advantage possessed by Texas. Perhaps the reason is that Louisiana's advantage is coastwise and internal waterway transportation. If so, the cost trends of these two modes must be investigated further.

d. An Overview of U.S. Petroleum Sources and Demand

1) General. The future supply and demand of petroleum in the United States will have an impact on any superport located in the Gulf. Therefore, a discussion of the supply and demand conditions in the United States and Louisiana is pertinent.

U.S. energy consumption is expected to increase at about 4.2 percent per year between 1972 and 1985, assuming that no major changes are made in government policies in respect to leasing of federal lands, environmental controls, tax rates and regulations. In 1970 domestic energy supplies satisfied 88 percent of U.S. energy consumption. Because domestic supplies of energy are projected to increase approximately 2.6 percent per year during the 1972-1985 period, which is a lower rate of increase than for consumption demand, the nation will become increasingly dependent on imported supplies.[29]

In 1970 domestic supplies of petroleum liquids, consisting of crude oil, condensate and natural gas liquids, totaled 11.3 million barrels a day (BD), which was 31 percent of total energy consumption.

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[29] One problem with all projections such as these is that they cannot adequately consider the effect which price changes will have on quantity demanded. Presumably, relative decreases in supply would result in higher prices, which would decrease the quantity demanded in the future.

Despite the addition of the North Slope discovery and the new discoveries expected during 1971-1985, total U.S. production in 1985 is estimated to be only 11.1 million BD. Since domestic sources of petroleum liquids will remain relatively constant while consumption demand will be increasing, it is estimated that by 1985 imports will account for 57 percent of total petroleum consumption. This would mean that approximately 11 million BD is to be imported, requiring 350 tankers, each of 250,000 dwt.[30]

Except for residual fuel oil and uncontrolled products such as fuel for bonded aircraft and vessel bunkers, it is assumed that most of the refined imports would be crude oil requiring processing in domestic refineries. While 4 percent of gas supplies was imported in 1970, about 28 percent is projected to be imported in 1985.[31]

The difficulties of estimating future domestic petroleum demand and supply are fairly well known. Estimation of future imports is even more uncertain. First, the United States has imposed a quota restriction applicable to all PAD districts, except District 5, of 12.2 percent of domestic production, and a tariff of 10.5 cents per barrel. District 5

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[30]The Department of Commerce has estimated that in 1985 foreign imports will account for two-thirds of U.S. petroleum supply, resulting in the importation of 14 million barrels per day, and would require 500 tankers of 250,000 dwt. Source: Prepared release of talk presented by Andrew E. Gibson, Assistant Secretary of Commerce for Maritime Affairs, to the 60th Annual Convention of the American Association of Port Authorities at Portland, Maine, September 29, 1971. No sources or details were given in the news release.

[31]Projections of energy supply and demand are very complicated procedures and cannot be examined in detail. One of the best sources of such projections is the National Petroleum Council, an officially established industry advisory board to the Secretary of the Interior. Also, consult the publications of the Interior Department, including the periodic mineral industry surveys and the annual compendium published by the American Petroleum Institute entitled Petroleum Facts and Figures.

has a more confusing restriction; it is expressed in such a way that imports of crude oil may be increased proportionally to local production. However, many exceptions to these import restrictions have been made and economic realities should eventually force their removal.

Table 12 shows the origin of crude oil and refined products imports into the United States. Absolute volumes and percentage relationships are shown. The percentage column has two components:

- Percentages which indicate the position of each PAD district relative to other PAD districts for each product and each country. For example, District 1 imports 12.95 percent of total U.S. crude oil obtained from Canada.
- Overall percentages, which relate each district's imports from each country to total U.S. imports of that product. For example, District 1 imports from Canada are 6.55 percent of total U.S. crude imports.

Table 12 indicates that more than 50 percent of current crude imports come from Canada and are mainly sent to Districts 2 and 5. Imports of crude from Latin America, principally Venezuela, are sent to District 1 and account for approximately 22 percent of total crude imports. District 1 imports almost 40 percent of its crude (17 percent of total U.S. crude imports) from the Middle East. Surprisingly, District 5 imports from the Middle East 17 percent of its imports.

The United States imports more refined products than crude. Total petroleum product imports are 764 million barrels, and total crude imports are 483 million barrels. District 1 imports from Latin America account for 67 percent of total U.S. petroleum product imports.

Approximately 75 percent of U.S. petroleum imports comes from the Western Hemisphere, principally Canada and Venezuela. Supertankers would have no effect on the imports from Canada since they move by pipelines. Whether the imports from Venezuela, which are water shipments, would justify supertanker utilization is unknown.

Production in Canada and Venezuela, however, is not expected to keep pace with the rising U.S., Canadian and Latin American requirements. Hence, most of the increased U.S. imports will probably come from the Eastern Hemisphere.

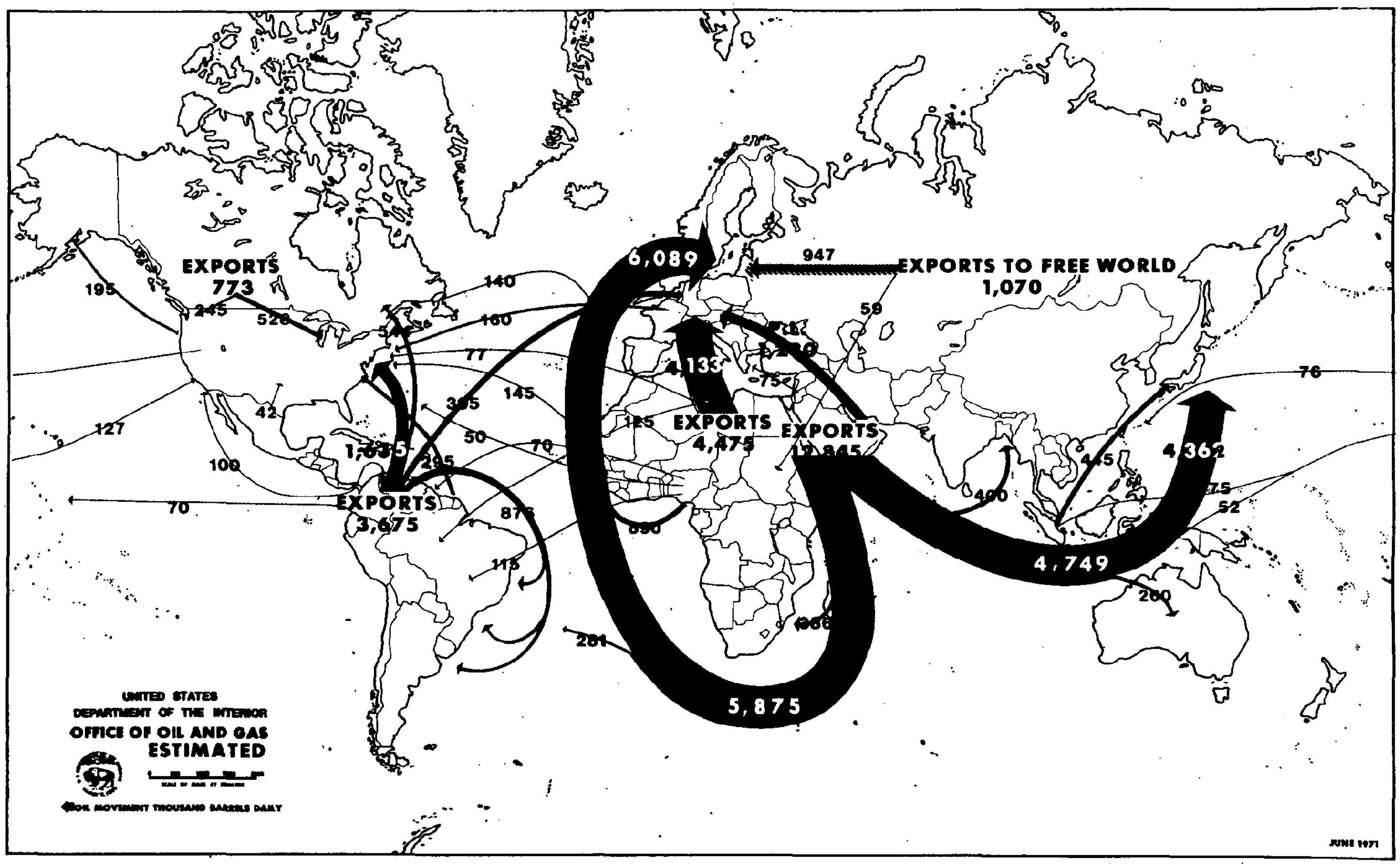
The relative political instability in the Middle East makes future imports from this region uncertain. Another problem arises from the fact that most petroleum-exporting countries have formed an organization known as OPEC (Organization of Petroleum Exporting Countries), which has the maximization of income from oil exports as its primary objective. In 1971 this organization "negotiated" a 50 cents per barrel price increase (to $1.45) which will cost the oil companies, and hence the consumer, nearly $12 billion between 1971 and 1975. In addition, there is some concern that Eastern Hemisphere reserves may not be sufficient to meet European and American requirements much beyond the year 2000.

Figure 17 summarizes the flow of free-world international petroleum in 1970. Note that no international petroleum enters or leaves the Gulf Coast area.

2) Regional Analysis. Although the United States will become increasingly dependent upon foreign imports of crude in the future, the most salient point for this analysis is the existing differential regional balance of crude production and refining capacity. As noted above,

Figure 17

FREE WORLD INTERNATIONAL FLOW OF PETROLEUM 1970 [1]



Reproduced from "Analysis of World Tank Ship Fleet 1970," Sun Oil Company, August, 1971.

District 1, the East Coast, is deficient in both crude production and refining capacity. Approximately 60 percent of the District 1 supply of crude comes from other districts, primarily District 3, and the balance is imported. District 1's refinery output in 1970 represented only 21 percent of its product consumption. In fact, the last new refineries built on the East Coast were completed in 1957, and no substantial additions to these plants have been made within the past 10 years. Hence, these simple observations suggest that the East Coast critically needs a deep-draft port facility and a great increase in refinery capacity, unless the citizens of that area are willing to pay a higher price for petroleum to cover the additional transportation costs. Merely constructing a superport, without increasing the refinery capacity, would not improve the crude import situation of District 1, since the crude oil would have to be shipped to other districts for refining.

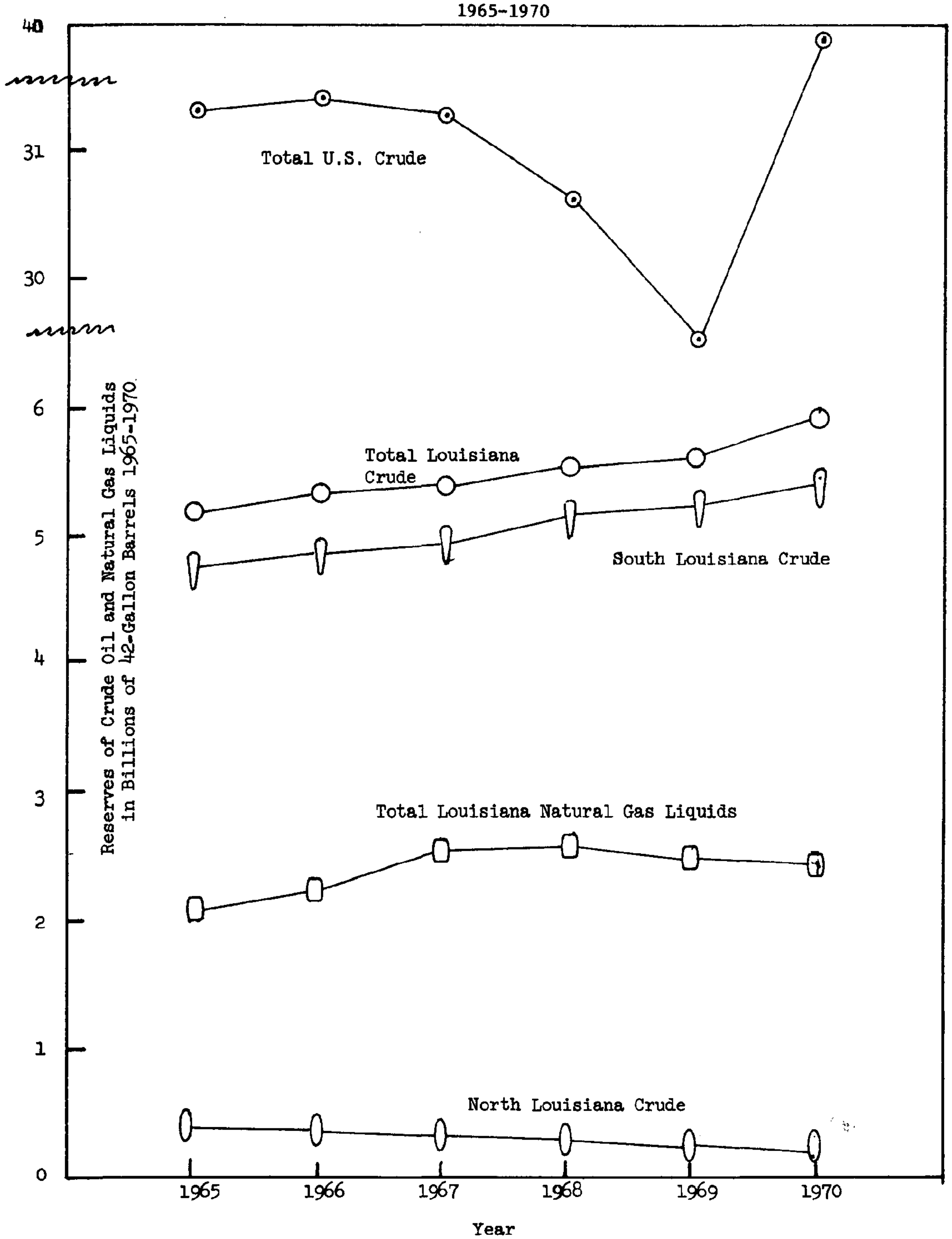
District 5, the West Coast, has been a net oil demander for many years and in 1970 imported approximately 20 percent of its consumption, with one-half of the imports coming overland from Canada. If crude oil production on the Alaskan North Slope is consistent with current estimates, most of that area's annual output could be absorbed by the West Coast within 10 years. This means that Districts 1 and 2 could not rely on the North Slope to supply to meet their demands. They would be forced to rely on Gulf Coast crude or on foreign imports.

District 3 has large surpluses of crude oil, which has been sent primarily to the Midwest, and refined products, which have gone largely to the East Coast. A glance at the Louisiana pattern indicates that Louisiana could become an importer of crude within 10 years or possibly sooner.

Figure 18 shows the reserves of crude oil and natural gas

Figure 18

RESERVES OF CRUDE OIL AND NATURAL GAS LIQUIDS AT END OF YEAR
1965-1970



liquids for the U.S. and Louisiana. U.S. reserves were steadily decreasing until the North Slope discovery was made, which caused a significant increase. Figure 19 shows Louisiana crude oil and condensate production. Most interesting is Figure 20, which shows the ratio of crude oil reserves to crude production in the United States and Louisiana. As can be seen, the reserves/production ratios for both the U.S. and Louisiana have been decreasing, with Louisiana's ratio decreasing faster than that of the U.S. overall. Hence, while Louisiana's crude reserves have been increasing, production has been increasing even more rapidly as a result of the growing demands for petroleum by Districts 1 and 2.

Figure 21 shows the comparative positions, over time, of Texas and Louisiana relative to total United States production and reserves of crude oil. Louisiana's production and reserves, as a percentage of U.S. production and reserves has been increasing, while Texas' production and reserves have been undergoing a relative decline.

Figures 22 and 23 indicate Louisiana's natural gas production and U.S. and Louisiana natural gas reserves. Figure 24 displays the reserve/production ratio for the United States and Louisiana over time. While both ratios are decreasing rapidly, Louisiana's ratio is decreasing most rapidly. A similar conclusion is reached for natural gas liquids, as shown in Figure 25. Figure 26 shows Texas and Louisiana production and reserves, over time, as percentages of U.S. production and reserves. Texas reserves and production, while greater than Louisiana's in relation to U.S. production and reserves, have been decreasing while Louisiana's ratio has been increasing.

Figure 19

LOUISIANA CRUDE OIL AND CONDENSATE PRODUCTION
1965-1970

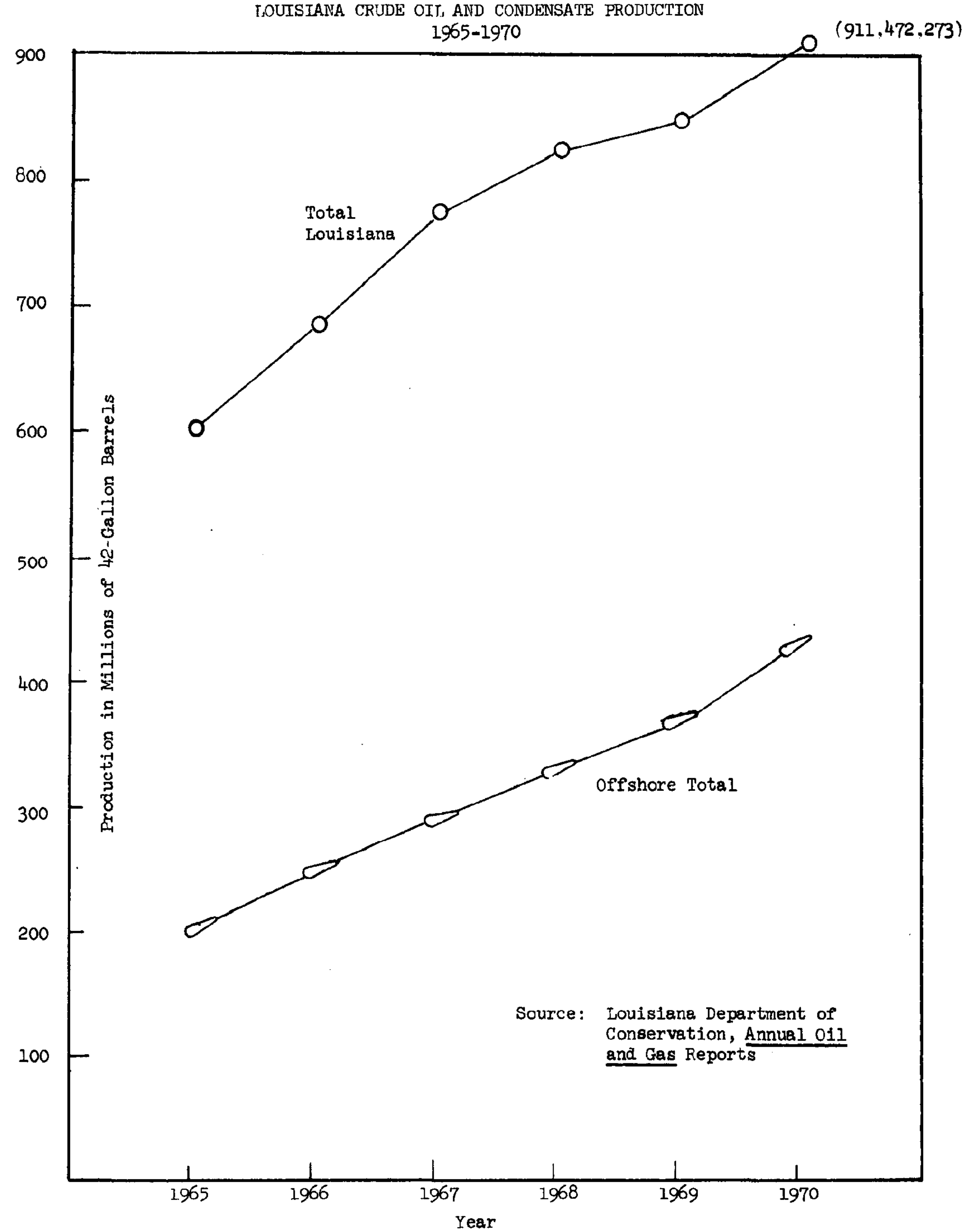
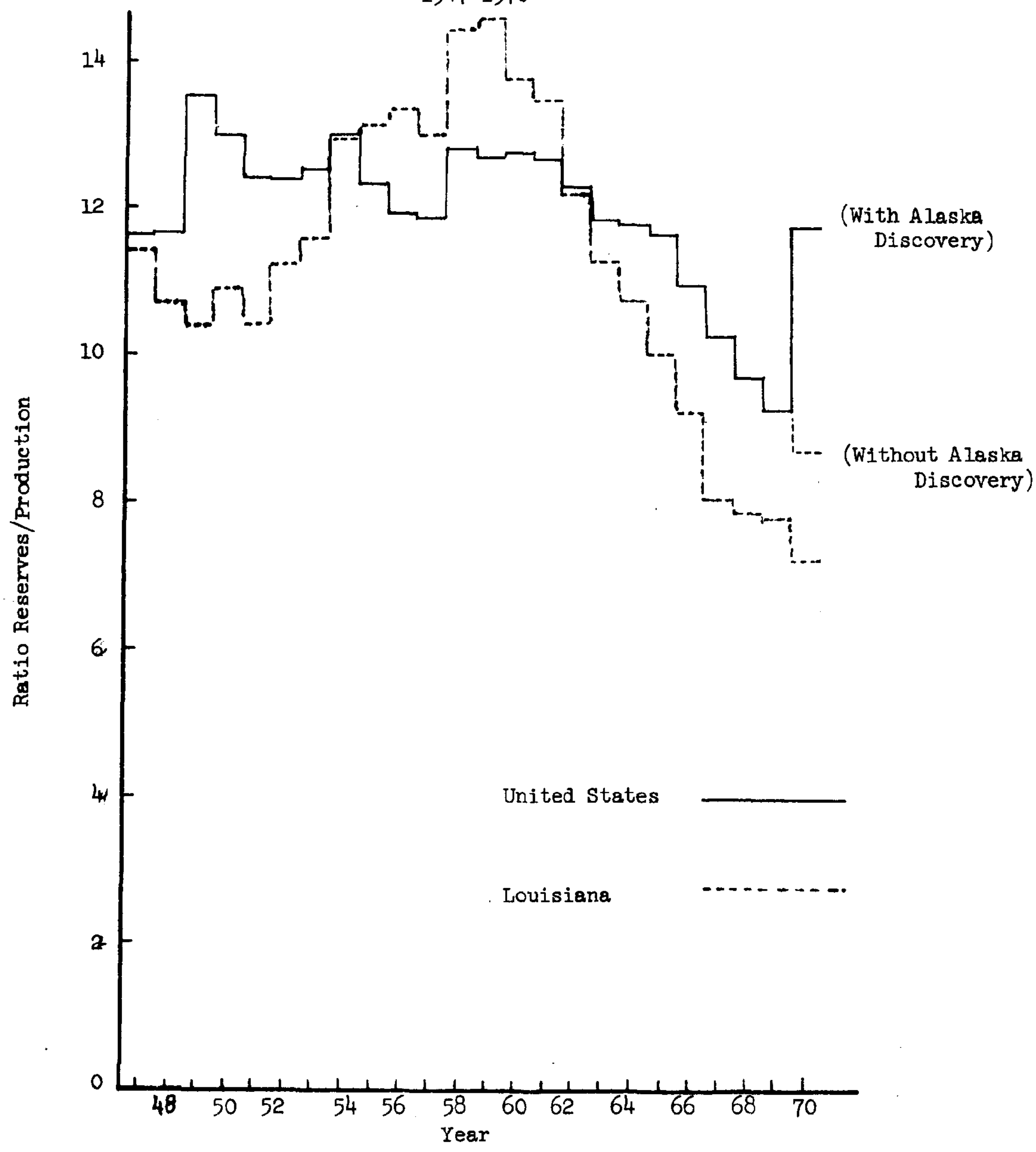


Figure 20

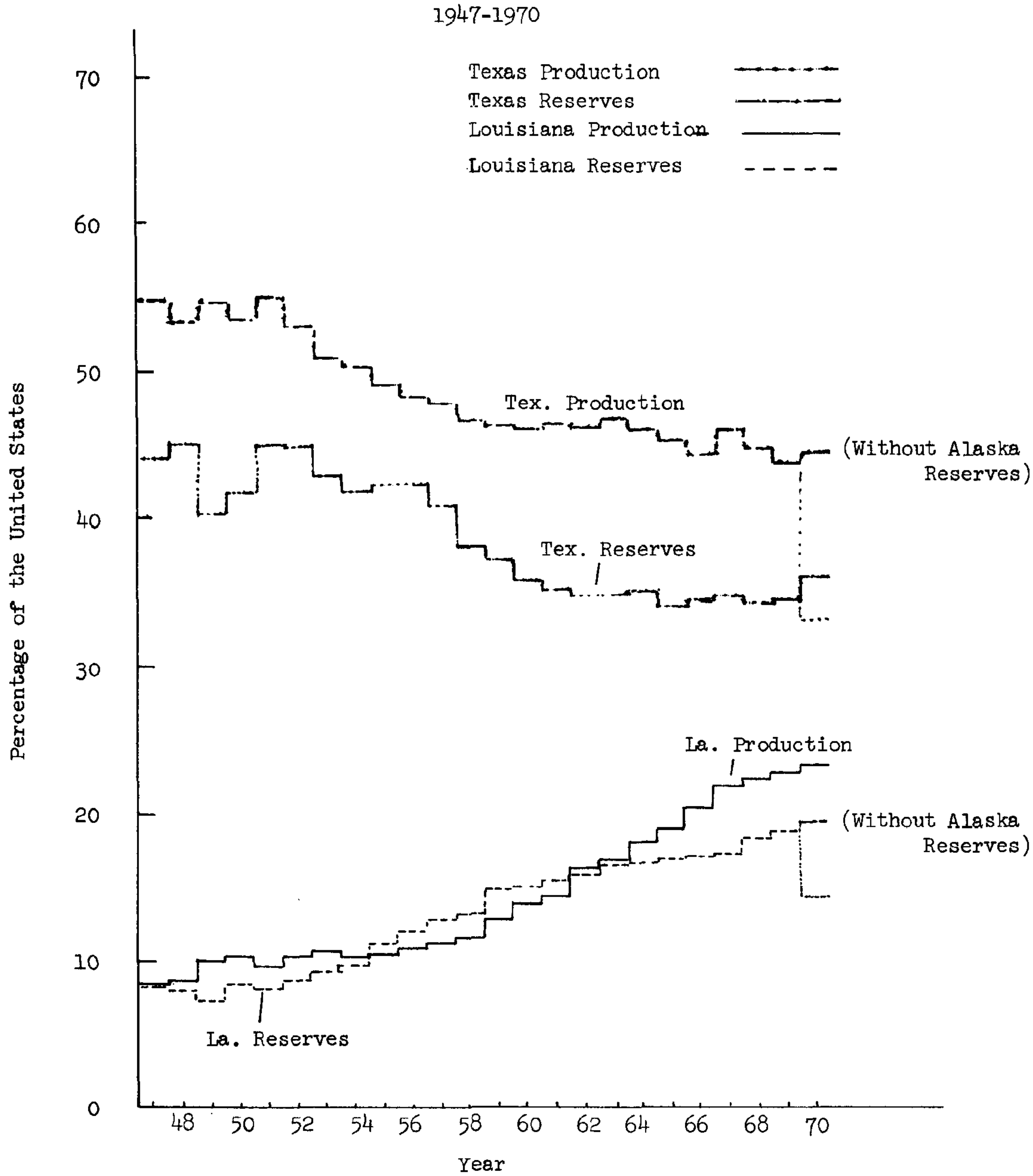
Crude Oil
Reserves/Production
in the
United States and Louisiana
1947-1970



Source: Reserves of Crude Oil, Natural Gas Liquids and Natural Gas in the United States and Canada and United States Production Capacity as of December 31, 1970.
Vol. 25, May 1971
American Gas Association Inc.
American Petroleum Institute
Canadian Petroleum Association

Figure 21

TEXAS AND LOUISIANA
AS A PERCENTAGE OF THE UNITED STATES
IN PRODUCTION AND RESERVES OF CRUDE OIL
1947-1970



Source: Reserves of Crude Oil, Natural Gas Liquids and Natural Gas in the United States and Canada and United States Production Capacity as of December 31, 1970.
Vol. 25, May 1971
American Gas Association Inc.
American Petroleum Institute
Canadian Petroleum Association

Figure 22

LOUISIANA NATURAL AND CASINGHEAD GAS PRODUCTION
1965-1970

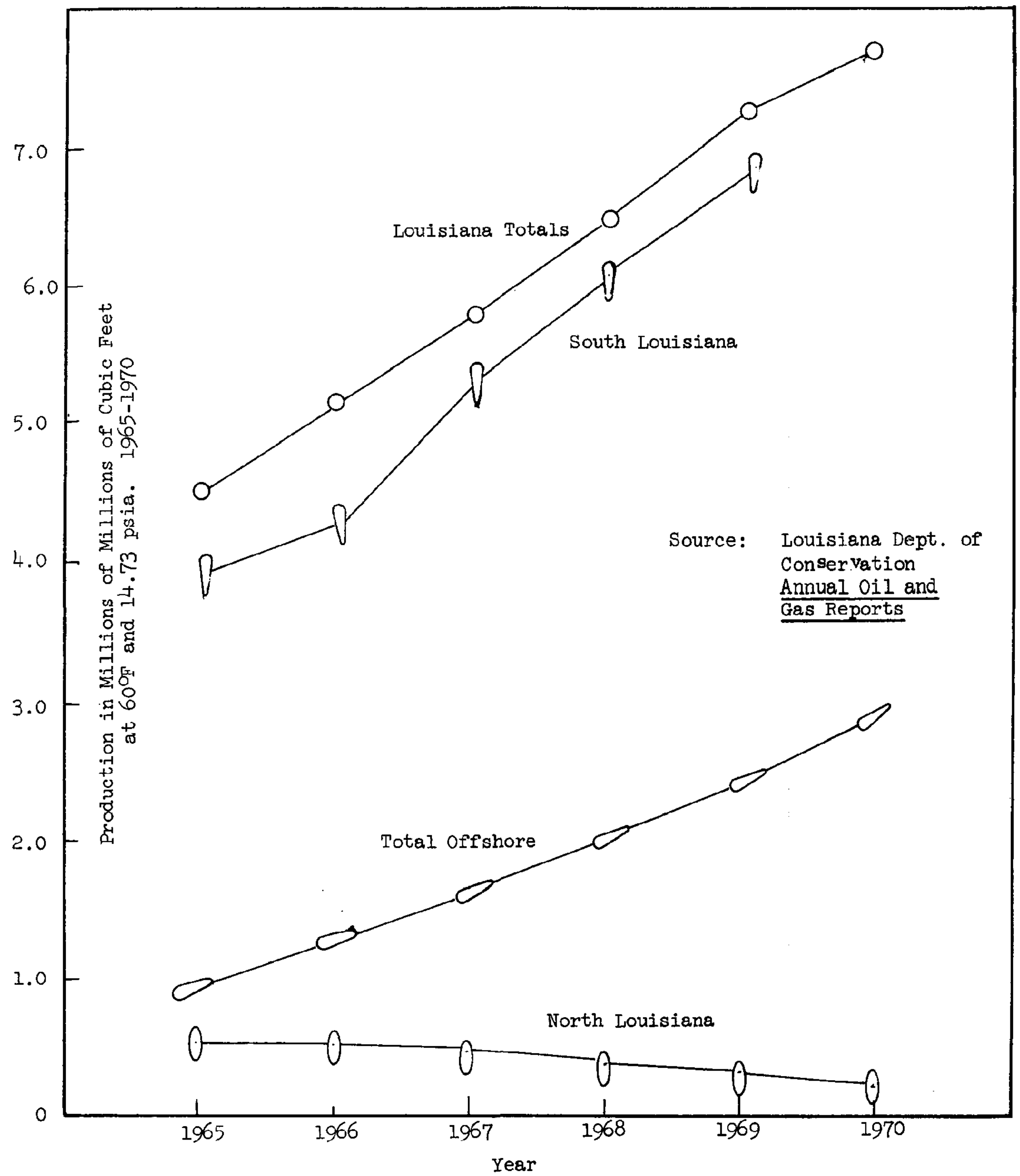


Figure 23

Reserves of Natural Gas at End of Year
1965-1970

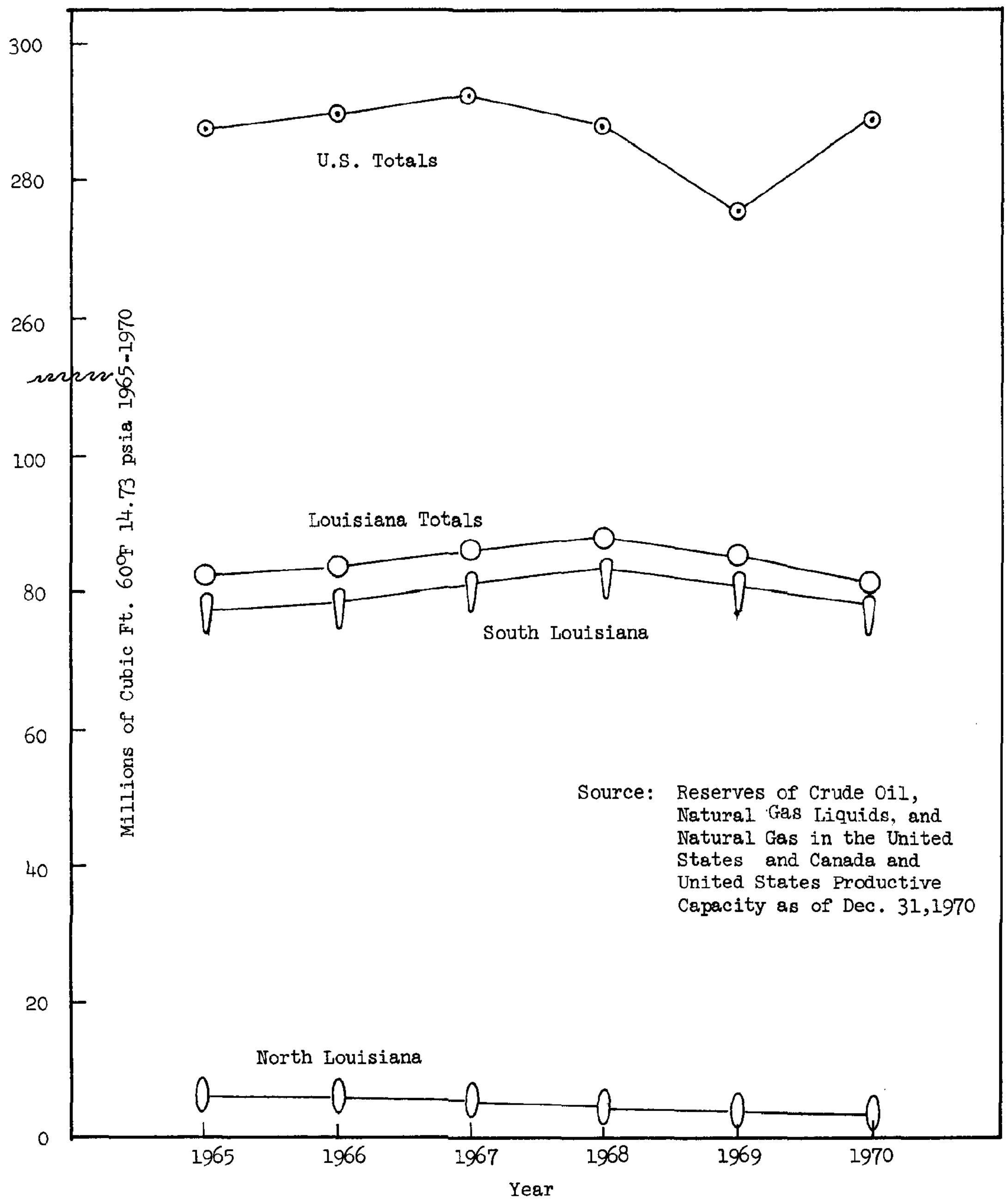
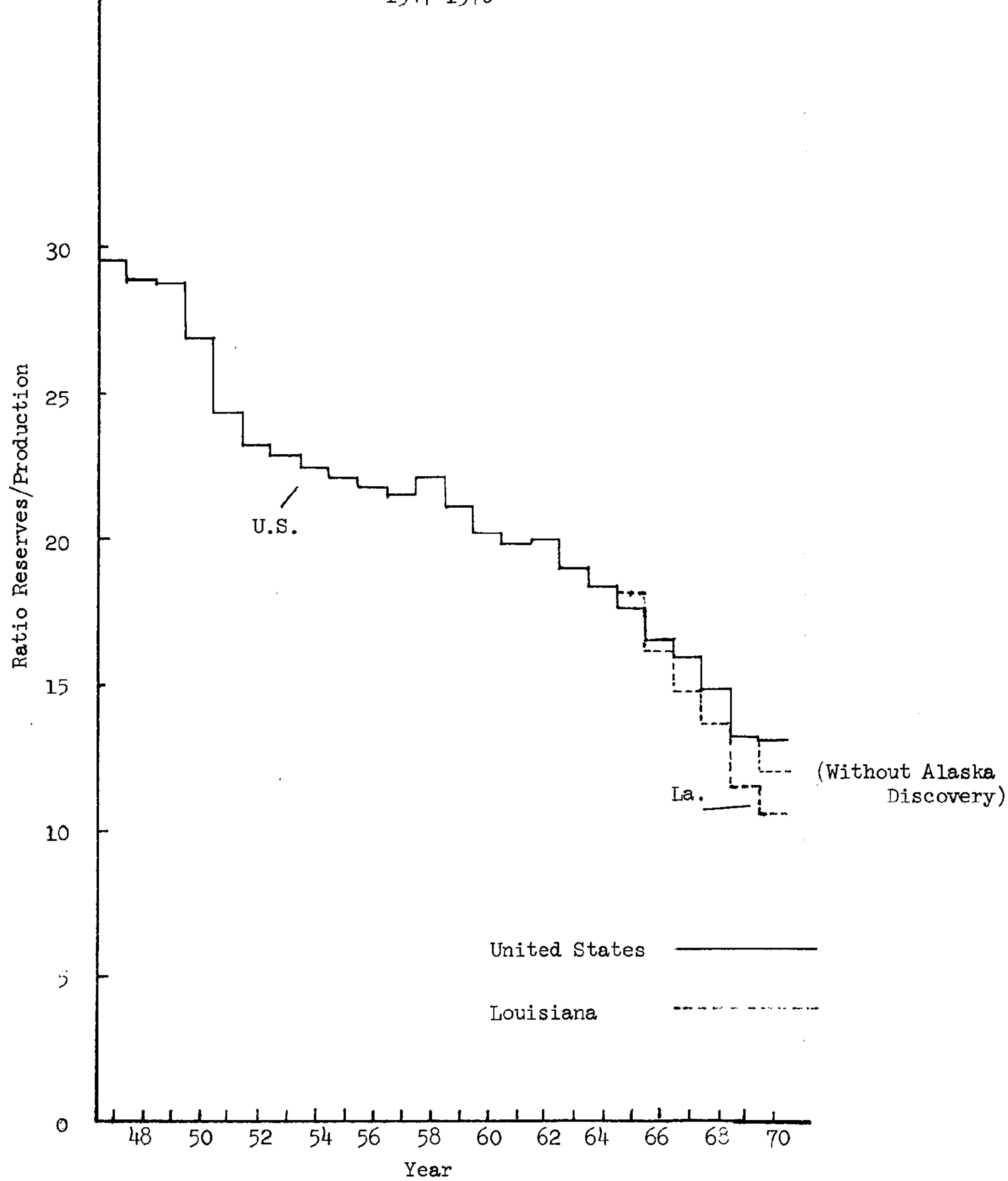


Figure 24

Natural Gas
Reserves/Production
in the
United States and Louisiana
1947-1970



Source: Reserves of Crude Oil, Natural Gas, Gas Liquids, and Natural Gas in the United States and Canada, and United States Production Capacity as of December 31,1970, American Petroleum Institute and American Gas Association

Figure 25

Natural Gas Liquids
Reserves/Production
in the
United States and Louisiana
1947-1970

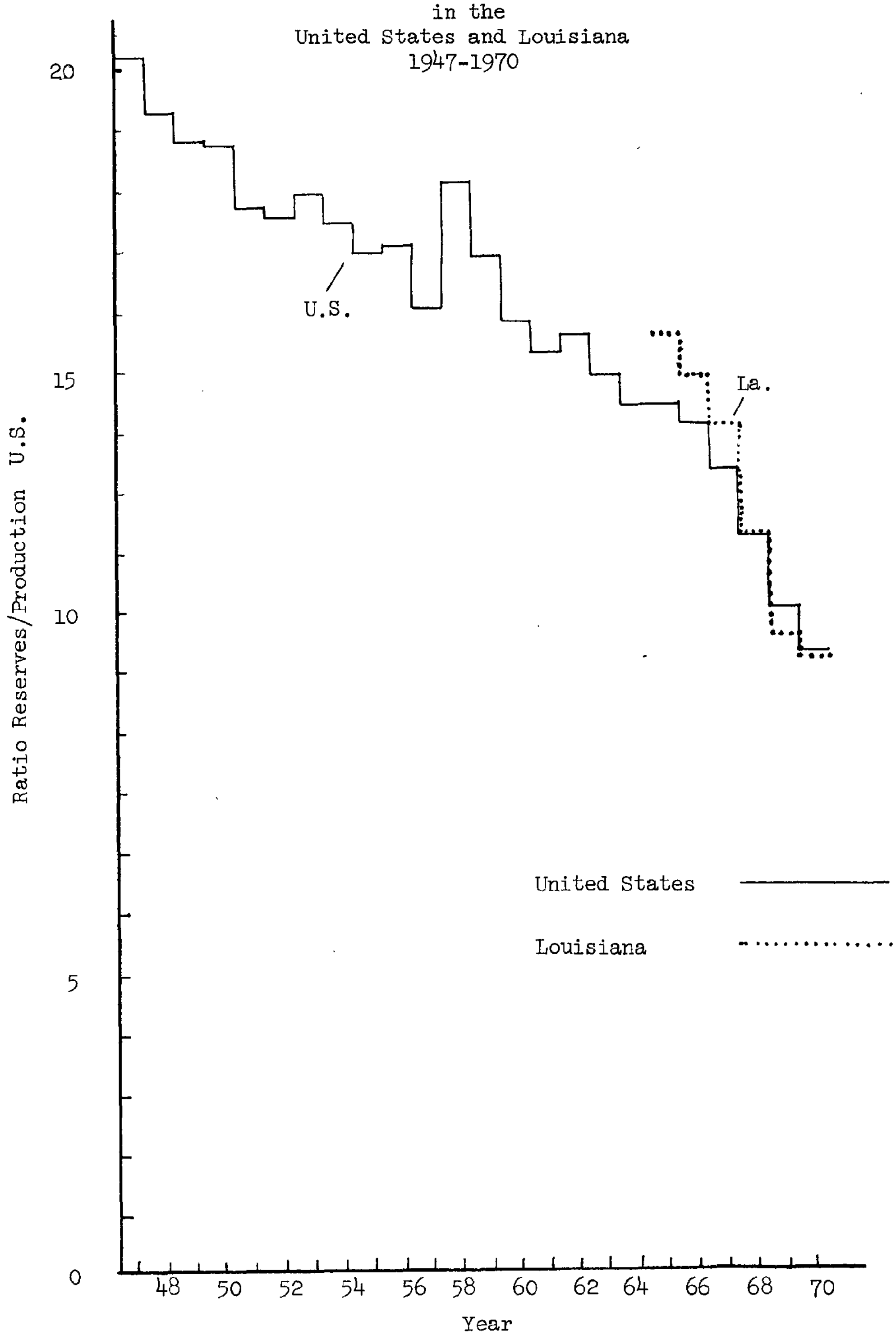
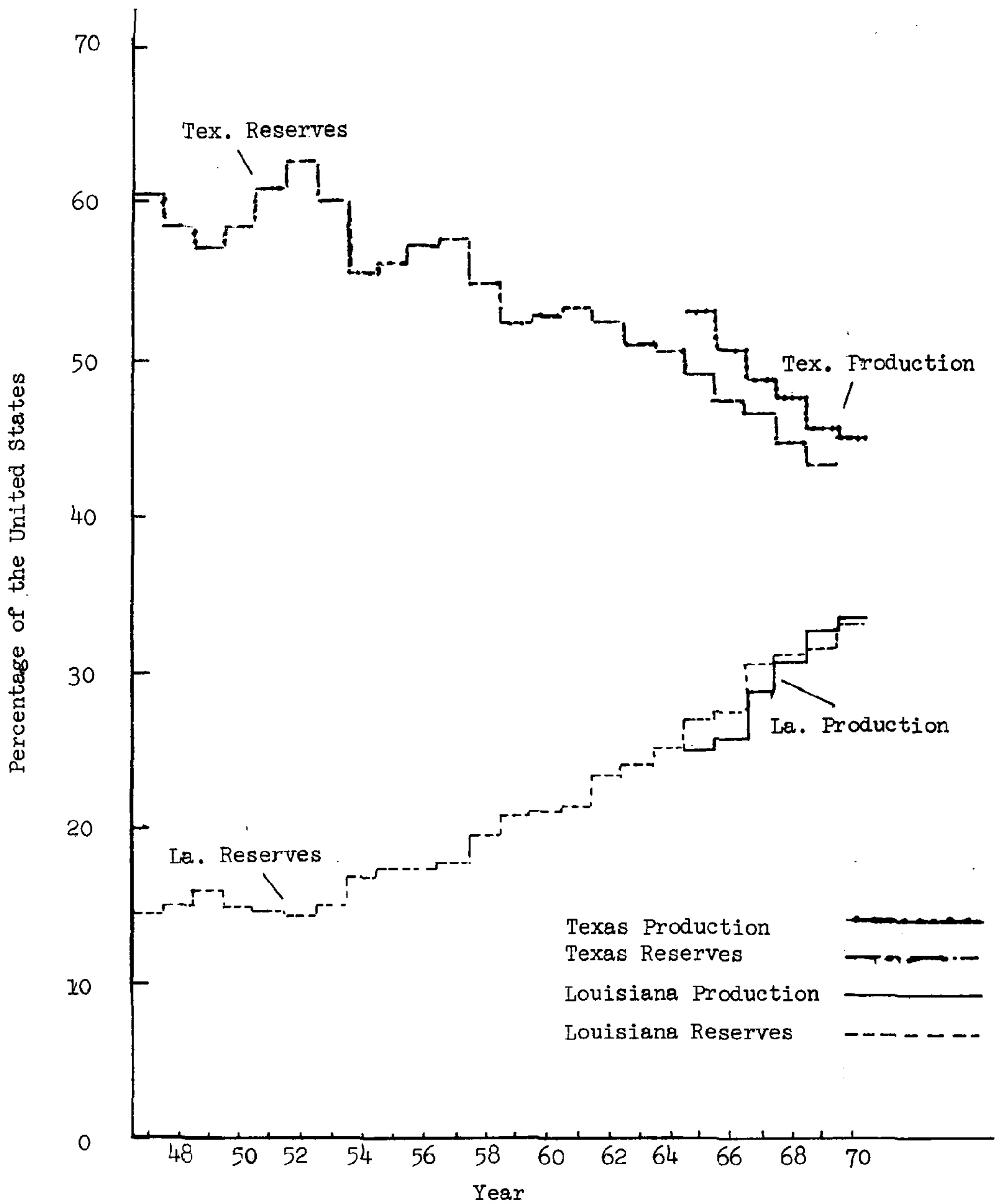


Figure 26

TEXAS AND LOUISIANA
AS A PERCENTAGE OF THE UNITED STATES
IN PRODUCTION AND RESERVES OF NATURAL GAS LIQUIDS
1947-1970



Source: Reserves of Crude Oil, Natural Gas Liquids and Natural Gas in the United States and Canada and United States Production Capacity as of December 31,1970.
Vol. 25, May 1971
American Gas Association Inc.
American Petroleum Institute
Canadian Petroleum Association

3) Summary. Total reserves of crude oil and natural gas liquids in the United States have been decreasing since 1965. The North Slope discovery in Alaska, however, has resulted in a significant increase in such reserves. The reserve/production ratio for the U.S. has been decreasing since 1958, but once again the North Slope discovery has increased this ratio to its 1966 level.

Louisiana's reserves of crude have increased slightly, but its production has increased even faster, so that Louisiana's reserve/production ratio has decreased by approximately 50 percent in the past 12 years. Louisiana's reserve/production ratios of natural gas and natural gas liquids have decreased by an even faster rate. Texas has much greater production and reserves than Louisiana, <u>but in relation to national data</u>, Texas is experiencing a long-term decline, while Louisiana is experiencing a long-term increase. A similar situation exists for natural gas liquids. Hence, the reserve/production ratios of the U.S., Texas and Louisiana are all decreasing, but Texas ratios are decreasing more rapidly than the U.S. ratios, and Louisiana's ratios are decreasing less rapidly. These downward trends could be reversed if dramatic new discoveries of reserves were to occur, or if economic conditions and incentives were to change. However, within the next 10 years the loss of Gulf Coast crude will require importation of crude from the Eastern Hemisphere if the Gulf region is to continue serving Districts 1 and 2. This could occur more quickly if the East Coast does not construct a superport or increase its refinery capacity and Louisiana and Texas refineries are required to meet this deficit.

If the East Coast does not build a superport and increase its refinery capacity, the Gulf area would supply most of the crude and refined products for the United States east of the Rocky Mountains. Since the labor, management, financial and refining resources as well as existing transportation patterns favor the Gulf area, this would be a viable alternative.[32]

For transshipments of crude oil and products to the Midwest and the East, a Louisiana superport location has a comparative advantage over a Texas location for water shipments but if one takes differential volumes in pipeline shipments as indicative of real economies, Texas appears to have an advantage.

If a superport and increased refining capacity are constructed on the East Coast, the feasibility of a Louisiana superport in terms of petroleum usage would be considerably diminished. However, in the short run, crude movements from the Gulf Coast to the East Coast could be made from the Louisiana superport to the East Coast superport. If a superport is established on the East Coast, and one is not constructed on the Gulf Coast, the refining capacity would probably follow, and there would probably be a relative redistribution of refining capacity away from the Gulf region and to the northeast.

VI. Commodity Movements

A. Dry Bulk Supertankers-while petroleum tankers have been the focus of most discussions relating to large ships and deep-draft ports, the utilization of such ships and ports for commodity transportation should not be ignored, particularly in an analysis of a Louisiana superport.

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[32] Another alternative would be to construct refineries at the source of foreign crude, but few officials view this favorably because of the domestic and foreign political repercussions.

Most important of these commodities are the dry bulk cargoes such as iron ore, coal, bauxite, and grains. A composite of two independent projects completed for the Maritime Administration forecasts dry bulk imports to reach 90 million long tons by 1982, representing a 2.5 percent annual increase, and exports to increase at 3 percent per year, reaching 145 million long tons in 1982.[33]

Although very large crude oil tankers have received most of the attention, there have been some dramatic developments among bulk cargo ships as well. During the 1950's ship owners wanted vessels which could transport oil from the Persian Gulf to Europe and then return via the United States with a load of ore. This resulted in the ore/oil ship (O/O), which can be loaded with either oil or ore, (both cargoes cannot be carried simultaneously). In the early 1960's the ore/bulk/oil (O/B/O) carrier was introduced. This is a triple-purpose ship but, again, not all three cargoes can be carried simultaneously. Three years ago the average size of the 90 O/B/O ships on order was 120,000 dwt. In 1972, there were two O/O ships greater than 200,000 dwt in service and approximately 20 on order.

The economies of shipping dry bulk commodities in these large ships are almost as great as those obtained in liquid bulk supertankers. Some examples of savings estimates are cited:

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[33]Two independent forecasts completed for the Maritime Administration are: (1) Forecast of U.S. Oceanborne Foreign Trade in Dry Bulk Commodities, Booz-Allen Applied Research, Inc., MA-4533, March, 1969. (2) Projection of Principle U.S. Dry Bulk Commodity Seaborne Imports and Exports for 1975 and 1982, MA-4534. Composite estimate made by J.A. Higgins and J.J. Garvey, Naval Engineers Journal, December, 1970.

Mining Company Executive - "When you go from a 66,000-ton vessel to a 160,000 tonner, you cut $2 a ton from the cost of shipping ore from Seven Islands, Quebec, to Japan."[34]

"In the trade from Peru to Japan just 16 years ago, iron ore was being handled in Liberty Ships at a cost of approximately $16 a ton. Today, this trade is carried in a 106,500 dwt vessel at slightly less than $3.75 a ton. By next year (1971), the same company will be using three 0/0 carriers of approximately 130,000 dwt, which will reduce the Peru-Japan iron ore transportation cost to approximately $3.25 per ton...Present designs for a 150,000 tonner will further reduce cost to $2.90 per ton."[35] Since the shipping company could pair off oil shipments with ore on the return trip, the actual cost of transporting Peru ore to Japan will be less than a $1.

"The savings in overall operating costs in transporting slurry ore using 250,000 dwt vessels is 50 percent of conventional methods."[36]

B. New Developments - new developments in oceanic shipping and complementary facilities in recent years have greatly increased the feasibility of bulk shipments in large vessels, as illustrated by the following examples:

- A new barge-conveyor belt system has been constructed to transport coal from Union county, Kentucky, on a 10-mile-long single-belt conveyor to the Ohio River where it is loaded onto 15 barge tows to be transported to the Cumberland River. About seven million tons of coal will be transported annually.
- Another development in coal transportation involves the conversion of coal to coal slurry. Peabody Coal Company reduces coal to lumps of 3/8 inch or less, and these lumps are then fed to rod mills, where, after being mixed with water, they are crushed to a fine

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[34] Iron Age, July 31, 1969, p. 81.

[35] R. P. Holobowicz, "The Other Revolution", Proceedings, U.S. Naval Institute, October, 1970.

[36] Surveyor, August, 1970.

powder. The resulting slurry is then moved through an 18-inch pipeline more than 270 miles to a power station on the Colorado River in southern Nevada.

- The San Francisco-based Marcona Corporation has developed a method (called Marconaflo) of loading and discharging granular bulk material as a slurry but shipping it as solids. The slurry is prepared by application of water under high pressure through Marconaflo jets installed in the floors of storage tanks. The resulting slurry is pumped into the vessel's hold, where the solids settle and the water is discharged. The non-shifting cargo contains less than 10 percent water, and when the ship arrives at its destination the cargo is reslurried and pumped ashore. Slurried ore is presently being transported in 42,000 and 52,000 dwt ships. One offshore facility is presently operating at Waipipi, New Zealand, and others are planned or under construction. According to one estimate, the cost of cargo-handling with the slurried method is approximately one-tenth the cost of handling dry cargo. A 200,000 dwt slurry supertanker is being constructed, and there are projections for more.

  The Marconaflo process may encourage the development of regional steel mills because it will provide low-cost transportation of iron ore to coast-based mills. This process has important implications for a Louisiana superport because metallic ores are the third most important oceangoing commodity (by volume) shipped in the middle Gulf area.

C. Commodity Flows in the Central Gulf area -

1. General. One of the most significant inputs to a superport analysis will be oceangoing commodity flow data. These data which will indicate the major commodities in Gulf-oceanic transportation, their volumes and relative importance, are very significant as decision variables in view of Louisiana's strategic location near the entrance to almost 18,000 miles of inland waterways. We originally planned to develop four sets of commodity flow data: one for the middle Gulf Coast area which would be most immediately serviced by a Louisiana superport, one for the west Gulf, primarily the Texas coast, one for the east Gulf or the Florida coast and a general one for the entire Gulf Coast. This would

have enabled decision-makers to view alternative flows through a Louisiana superport, given that Texas or Florida also developed a superport. It would also have enabled decision-makers on the Gulf Coast and in Washington to compare the basic flows which might be attracted to alternative superports located in the west, central or east areas of the Gulf. Unfortunately, within the limited time available to prepare this report we found that the numerous data manipulations could not be accomplished. Hence, we concentrated on presenting commodity flow data for the Central Gulf area comprising the immediate superport service area, extending from Lake Charles, Louisiana, to Mobile Alabama.[37] If a Louisiana superport is constructed, it is expected that it will service a wider area depending, of course, on what the other Gulf Coast states do, and this point must be retained while reading the following analyses.

The commodity flow data are presented as clearly as possible. Classes of commodities having relatively small volumes are grouped together or included as "other commodities." The data are presented in three ways: (1) absolute volumes in short tons are given in tabular form for each major port, river or outlet on the Central Gulf Coast, and an aggregate summary for the entire area is presented in Table 17; (2) a relative distribution of two-digit commodity flows for each port, river or outlet as well as for the entire area (Chart 5), and (3) an integrated outline summary of total volume and percentage ranking for each port, river or outlet, with major two-digit commodity flows to indicate

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[37] We note our original, but unrealized, goals because we believe they should be accomplished in future research.

direction of movement and a brief listing of the most important four-digit commodities under each major two-digit commodity classification.

All basic data were obtained from "Waterborne Commerce Statistics" for 1970. Computations, charts and tables were compiled by the author.

2. Commodity Flow Data for Central Gulf Area

a. Port of Lake Charles

(Refer to: Table 13, Chart 1)

Total Volume: 5,304,591 tons
Percent: 4.0%[38]

Major Commodities

1) Petroleum Products

a) Volume: 2,290,115 tons
b) Percent: 43%[39]
c) Direction of Movement:
Coastwise to East Coast
d) Remarks: Gasoline and distillate fuel oils accounted for two-thirds of petroleum shipments

2) Chemicals

a) Volume: 847,615 tons
b) Percent: 16%
c) Direction of Movement:
Approximately one-third was domestic coastwise and two-thirds foreign. All were outgoing except 14,500 tons of incoming fertilizer.

3) Crude Petroleum

a) Volume: 838,839 tons
b) Percent: 16%
c) Direction of Movement:
Coastwise shipments to East Coast

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[38] This reflects Lake Charles oceangoing volume as a percentage of total oceangoing volume in the immediate superport serviceable area: (Lake Charles to Mobile).

[39] This reflects the ratio of petroleum product movements to all product movements for Lake Charles.

Table 13

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Lake Charles

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign		Domestic Coastwise	
				Imports	Exports	Receipts	Shipments
		Total	5,304,591				
01		FARM PRODUCTS					
	0103	Corn					
	0107	Wheat	13,841		13,841		
	0111	Soybeans					
		Other	541,643	2	502,488		39,153
10		METALLIC ORES					
	1011	Iron Ore & Conc.					
	1051	Aluminum Ores, Conc.					
	1061	Manganese Ores, Conc.					
		Other	3,260	3,260			
11	1121	COAL & LIGNITE					
13	1311	CRUDE PETROLEUM	838,839				838,839
16		NON-METALLIC MIN. EXC. FUELS					
	1471	Phosphate Rock					
	1492	Sulphur, Dry					
	1493	Sulphur, Liq.					
		Other	159,272	156,319	1,185		1,768
20		FOOD & KINDRED PROD.					
	204	GRAIN MILL PROD.	7,089		4,814		2,275
	2061	Sugar					
	2062	Molasses					
		Other	12,894	2,237	3,285	9	7,363
26		PULP & PAPER PROD.					
	2611	Pulp	20,163		20,163		
	2631	Paper & Paperboard	100,806		100,525		281
		Other	4,326		3,666	49	611

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Continuation of

Table 13

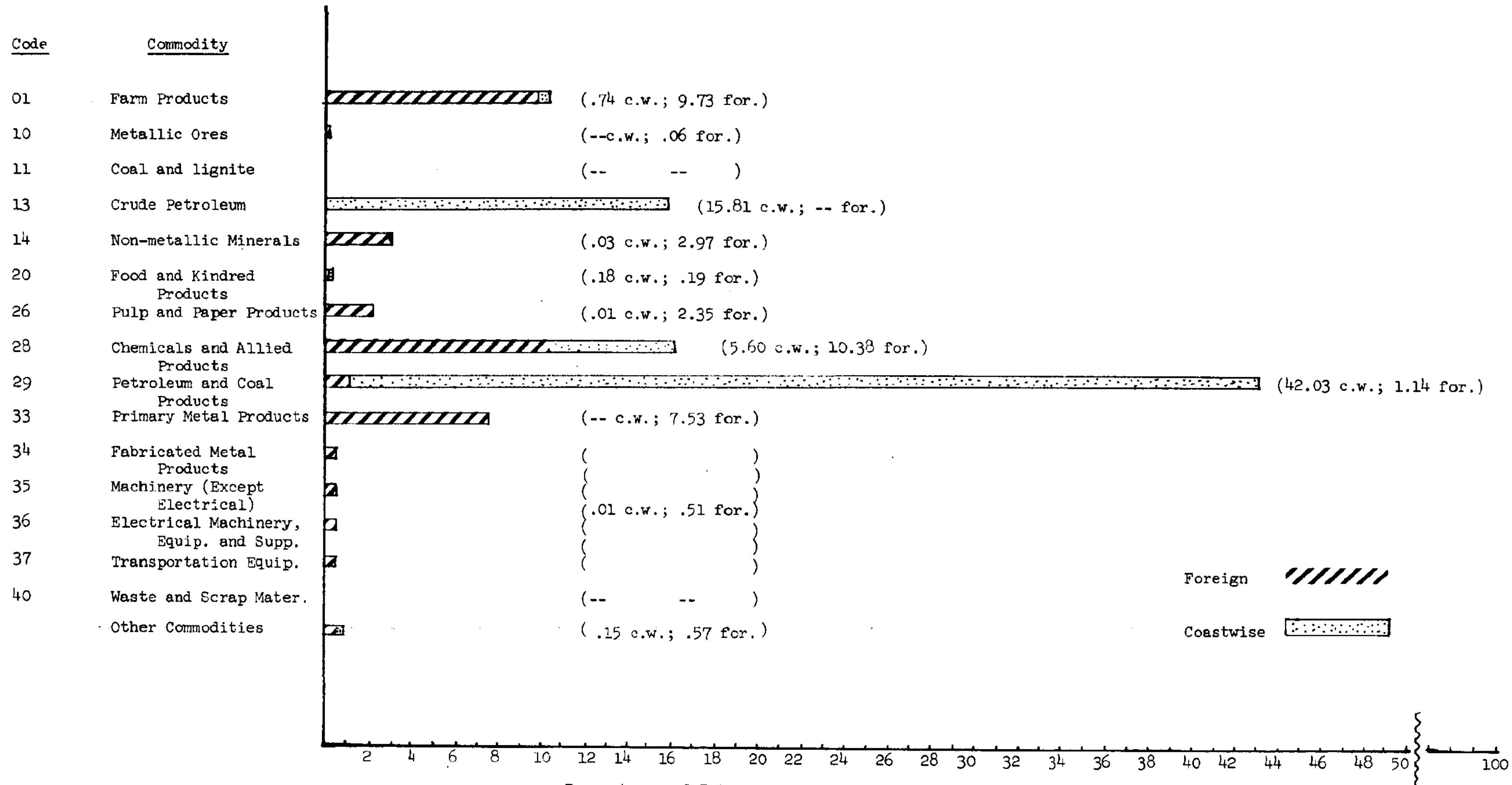
OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Lake Charles

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign Imports	Foreign Exports	Domestic Coastwise Receipts	Domestic Coastwise Shipments
28		CHEMICALS & ALLIED PROD.					
	281	Basic Chemicals	768,055	767	491,389	514	275,385
	287	Fertilizers & Mat.	34,858		13,896	14,500	6,462
		Other	44,702		44,422		280
29		PETROLEUM & COAL PROD.					
	2911	Gasoline	983,814			14,489	969,325
	2912	Jet Fuel	282,867				282,867
	2913	Kerosene	157,851		11		157,840
	2914	Distillate Fuel Oil	465,427				465,427
	2915	Residual Fuel Oil	133,853		14,455		119,398
	2916	Lubricating Oil & Greases	167,815		40,065		127,750
		Other	98,488		5,969	2,672	89,847
33		PRIMARY METAL PROD.					
		Iron & Steel, Prim.					
		Iron & Steel Shapes, Exc. Sheets	824	824			
		Iron & Steel Plates, Sheets					
		Other	398,224	19	398,195		10
34		FABRICATED METAL PROD.)					
35		MACHINERY, EXC. ELEC.)					
36		ELECTRICAL MACH. SUPP.) & EQUIP.)	27,544	27,009	89	252	194
37		TRANSPORTATION EQUIP.)					
40		WASTE & SCRAP MATERIAL					
	4011	Iron & Steel Scrap					
		Other					
		OTHER COMMODITIES	38,136	8,040	22,067		8,029

Chart 1

OCEANGOING COMMODITY FLOWS BY TWO-DIGIT COMMODITY CLASSIFICATIONS, FOREIGN AND COASTWISE, PORT OF LAKE CHARLES--BY PERCENTAGES, 1970



4) Farm Products

   a) Volume: 516,000 tons
   b) Percent: 10%
   c) Direction of Movement:
      Primarily foreign exports

b. Mississippi River: New Orleans to Mouth of Passes

(Refer to: Table 14, Chart 2)

Total Volume: 93,822,477 tons
Percent: 78%

Major Commodities

1) Crude Petroleum

   a) Volume: 22,224,602
   b) Percent: 24%
   c) Direction of Movement:
      Outbound coastwise shipments to East Coast

2) Farm Products

   a) Volume: 21,170,494 tons
   b) Percent: 23%
   c) Direction of Movement:
      Primarily foreign exports of soybeans and corn

3) Petroleum Products

   a) Volume: 17,076,544 tons
   b) Percent: 13%
   c) Direction of Movement:
      Primarily gasoline and kerosene destined for the East Coast

4) Metallic Ores

   a) Volume: 9,411,498 tons
   b) Percent: 10%
   c) Direction of Movement:
      Dominant commodity was foreign imports of aluminum ores (7.2 million tons)

c. Mississippi River-Gulf Outlet

(Refer to: Table 15, Chart 3)

Total Volume: 2,659,173
Percent: 2%

Table 14

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Mississippi River - New Orleans to Mouth of Passes

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign Upbound	Foreign Downbound	Domestic Coastwise Upbound	Domestic Coastwise Downbound
		Total	93,822,028				
01		FARM PRODUCTS	21,170,494				
	0103	Corn	10,495,606	2,944	10,388,190		154,472
	0107	Wheat	1,891,521		1,872,418		19,103
	0111	Soybeans	7,987,572		7,982,351		5,221
		Other	795,795	458,364	280,059	952	56,420
10		METALLIC ORES					
	1011	Iron Ore & Conc.	675,218	675,122	96		3
	1051	Aluminum Ores, Conc.	7,210,121	7,210,055	66		
	1061	Manganese Ores, Conc.	842,732	839,674	2,274		784
		Other	683,427	657,730	25,697		
11	1121	COAL & LIGNITE	4,007,537	361	302,647		3,704,529
13	1311	CRUDE PETROLEUM	22,224,602	182,621	518,547	53,936	21,469,498
14		NON-METALLIC MIN. EXC. FUELS					
	1471	Phosphate Rock	3,455,985	55,295	1,401	3,399,289	
	1492	Sulphur, Dry	809,759		809,754		5
	1493	Sulphur, Liq.	1,539,239				1,539,239
		Other	867,153	320,834	169,288	43,597	333,434
20		FOOD & KINDRED PROD.					
	204	GRAIN MILL PROD.	2,830,786	4,653	2,808,978	9,343	7,812
	2061	Sugar	1,582,361	1,518,544	268	56,978	6,571
	2062	Molasses	805,676	792,370	1,166	11,977	163
		Other	1,372,008	166,213	1,104,560	20,550	80,685
26		PULP & PAPER PROD.					
	2611	Pulp	503,985		503,740	245	5,701
	2631	Paper & Paperboard	367,672	38,352	313,088	40	16,192
		Other	30,547	22,921	4,789	33	2,804

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Continuation of

Table 14

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Mississippi River-New Orleans to Mouth of Passes

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign		Domestic Coastwise	
				Upbound	Downbound	Upbound	Downbound
28		CHEMICALS & ALLIED PROD.					
	281	Basic Chemicals	3,139,627	254,274	2,231,726	115,879	537,748
	287	Fertilizers & Mat.	842,624	39,811	254,227	285,194	263,392
		Other	390,032	37,659	335,682	5,407	11,284
29		PETROLEUM & COAL PROD.					
	2911	Gasoline	3,123,503		153	50,578	3,072,772
	2912	Jet Fuel	455,906				455,906
	2913	Kerosene	806,817	69,399	9,192	14,149	714,077
	2914	Distillate Fuel Oil	5,128,579	135,967	363	45,253	4,946,996
	2915	Residual Fuel Oil	2,011,436	717,473	150,881	206,367	936,715
	2916	Lubricating Oil & Greases	355	145	418,049	68,731	277,430
		Other	549,948	1,081	76,392	122,690	349,785
33		PRIMARY METAL PROD.					
	3314	Iron & Steel, Prim.	1,173,804	6,060	1,167,255		489
	3315	Iron & Steel Shapes, Exc. Sheets	498,738	438,196	40,074	1,222	19,246
	3316	Iron & Steel Plates, Sheets	1,020,150	549,941	465,469		4,740
		Other	1,004,606	582,594	408,432	1,856	11,724
34		FABRICATED METAL PROD.)					
35		MACHINERY, EXC. ELEC.)					
36		ELECTRICAL MACH. SUPP.) & EQUIP.)					
37		TRANSPORTATION EQUIP.)	679,748	329,693	279,123	10,943	59,989
40		WASTE & SCRAP MATERIAL					
	4011	Iron & Steel Scrap	419,114	738	418,159	217	
		Other	76,652	22,674	53,026	387	565
		OTHER COMMODITIES	757,541	494,145	196,129	18,896	48,371

Chart 2

OCEANGOING COMMODITY FLOWS (UPBOUND AND DOWNBOUND) BY TWO-DIGIT COMMODITY CLASSIFICATIONS FOREIGN AND COASTWISE, ON MISSISSIPPI RIVER FROM NEW ORLEANS TO MOUTH OF PASSES, BY PERCENTAGES, 1970

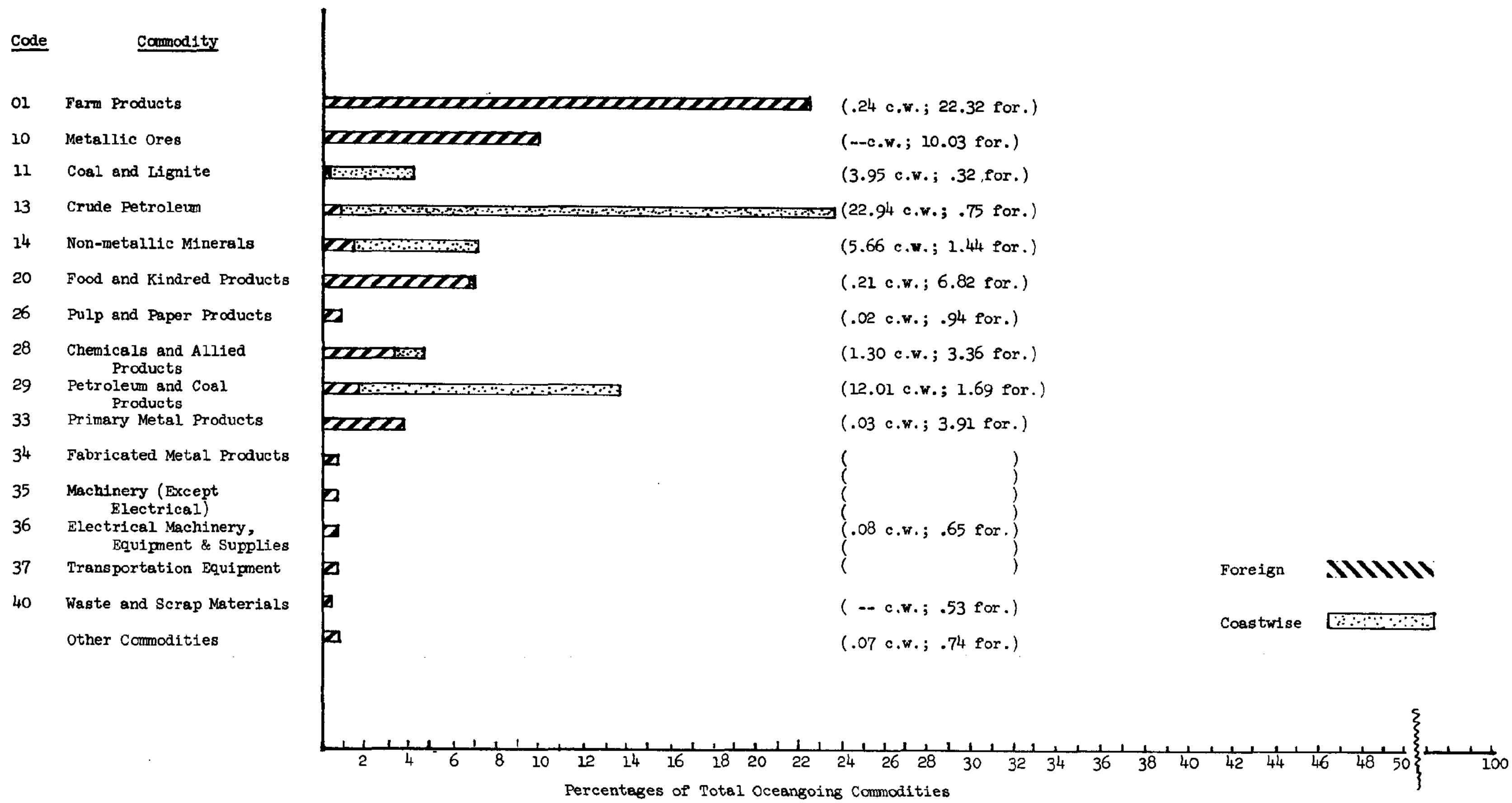

Table 15.

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Mississippi River-Gulf Outlet

2 Digit Code	3 or 4 Digit Code	Commodity	Total	Foreign Upbound	Foreign Downbound	Domestic Coastwise Upbound	Domestic Coastwise Downbound
		Total	2,659,173				
01		FARM PRODUCTS					
	0103	Corn	34,739	23,084	2,378		9,277
	0107	Wheat	5,290		5,290		
	0111	Soybeans	54,115		54,115		
		Other	25,815	20,011	2,945	939	1,920
10		METALLIC ORES					
	1011	Iron Ore & Conc.	3	3			
	1051	Aluminum Ores, Conc.	156,708	140,476		16,232	
	1061	Manganese Ores, Conc.	136,187	134,077	2,110		
		Other	31,428	24,852	6,576		
11	1211	COAL & LIGNITE	202,949		202,943		6
13	1311	CRUDE PETROLEUM					
14		NON-METALLIC MIN. EXC. FUELS					
	1471	Phosphate Rock	34,617	34,617			
	1492	Sulphur, Dry	17		15		2
	1493	Sulphur, Liq.					
		Other	401,433	383,891	5,344	10,864	1,334
20		FOOD & KINDRED PROD.					
	204	GRAIN MILL PROD.	23,373	420	22,697	161	95
	2061	Sugar	238,013	214,414		23,596	3
	2062	Molasses					
		Other	46,919	3,653	17,840	11,273	14,153
26		PULP & PAPER PROD.					
	2611	Pulp	5,701		5,700		1
	2631	Paper & Paperboard	20,527	3,258	17,129	40	100
		Other	971	10	328	7	626

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Table 15

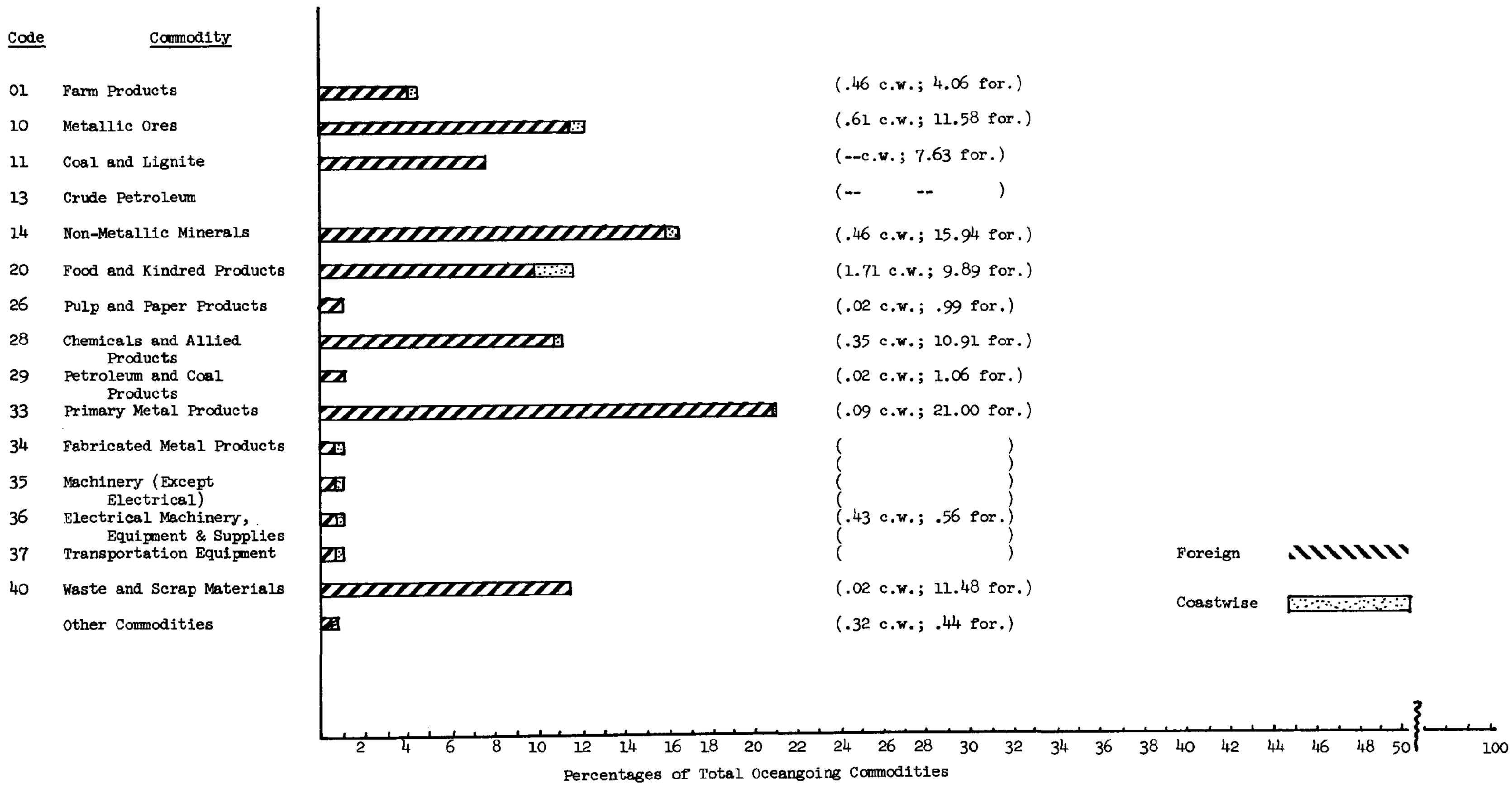
OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Mississippi River-Gulf Outlet

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign Upbound	Foreign Downbound	Domestic Coastwise Upbound	Domestic Coastwise Downbound
28		CHEMICALS & ALLIED PROD.					
	281	Basic Chemicals	187,922	130,185	56,958	683	96
	287	Fertilizers & Mat.	98,041	89,617	2,111	6,223	90
		Other	13,403	1,826	9,453	101	2,023
29		PETROLEUM & COAL PROD.					
	2911	Gasoline	25		25		
	2912	Jet Fuel					
	2913	Kerosene	3		3		
	2914	Distillate Fuel Oil					
	2915	Residual Fuel Oil	20,122	20,122			
	2916	Lubricating Oil & Greases	4,746		4,542	14	190
		Other	3,225	51	2,920	6	248
33		PRIMARY METAL PROD.					
	3314	Iron & Steel, Prim.	54,934	23	54,897		14
	3315	Iron & Steel Shapes, Exc. Sheets	15,692	8,753	6,828		111
	3316	Iron & Steel Plates, Sheets	9,988	5,758	4,230		
		Other	480,065	92,158	385,470	265	2,172
34		FABRICATED METAL PROD.)					
35		MACHINERY, EXC. ELEC.)					
36		ELECTRICAL MACH. SUPP.) & EQUIP.)					
37		TRANSPORTATION EQUIP.)	26,166	3,810	11,033	4,134	7,189
40		WASTE & SCRAP MATERIAL					
	4011	Iron & Steel Scrap	271,195		271,023	172	
		Other	34,599	10,291	24,127	149	32
		OTHER COMMODITIES	20,241	8,853	2,753	4,010	4,625

Chart 3

OCEANGOING COMMODITY FLOWS (UPBOUND AND DOWNBOUND) BY TWO-DIGIT COMMODITY CLASSIFICATIONS, FOREIGN AND COASTWISE, ON MISSISSIPPI RIVER-GULF OUTLET , BY PERCENTAGES, 1970



Major Commodities

1) Primary Metal Products

   a) Volume: 560,769
   b) Percent: 21%
   c) Direction of Movement:
      Foreign exports

2) Non-Metallic Minerals

   a) Volume: 436,067 tons
   b) Percent: 16%
   c) Direction of Movement:
      Foreign imports

3) Metallic Ores

   a) Volume: 324,326 tons
   b) Percent: 12%
   c) Direction of Movement:
      Major components were foreign imports of
      140,476 tons and 134,077 tons of manganese ores

4) Waste and Scrap Materials

   a) Volume: 305,794 tons
   b) Percent: 11%
   c) Direction of Movement:
      More than 271,000 tons of iron and steel scrap
      were exported

d. Mobile, Pascagoula and Gulfport

(Refer to: Table 16, Chart 4)
Total Volume: 17,905,046 tons
Percent: 15%

Major Commodities

1) Metallic Ores

   a) Volume: 7,924,567 tons
   b) Percent: 44%
   c) Direction of Movement:
      Foreign imports of iron ore (5.3 million tons)
      and aluminum ores (2.4 million tons)

2) Petroleum and Coal Products

   a) Volume: 2,365,284 tons
   b) Percent: 13%
   c) Direction of Movement:
      Major flows were coastwise shipments to East Coast
      of gasoline and fuel oil

Table 16

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Mobile, Pascagoula and Gulfport

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign Imports	Foreign Exports	Domestic Coastwise Receipts	Domestic Coastwise Shipments
		Total	17,905,046				
01		FARM PRODUCTS					
	0103	Corn	381,259		279,283		101,976
	0107	Wheat	166,421		64,552		101,869
	0111	Soybeans	816,407		799,313		17,094
		Other	594,069	375,732	205,505	20	12,812
10		METALLIC ORES					
	1011	Iron Ore & Conc.	5,360,306	5,360,306			
	1051	Aluminum Ores, Conc.	2,436,888	2,436,888			
	1061	Manganese Ores, Conc.	60,941	60,941			
		Other	66,432	61,072	5,360		
11	1121	COAL & LIGNITE	343,587	16	343,521		50
13	1311	CRUDE PETROLEUM	1,371,330	57,130		27,422	1,286,778
14		NON-METALLIC MIN. EXC. FUELS					
	1471	Phosphate Rock	307,776			307,776	
	1492	Sulphur, Dry					
	1493	Sulphur, Liq.					
		Other	232,506	17,852	212,962		1,692
20		FOOD & KINDRED PROD.					
	204	GRAIN MILL PROD.	547,956	75,492	441,738	2,852	27,874
	2061	Sugar					
	2062	Molasses	79,578	79,578			
		Other	103,266	30,058	52,756	8,168	12,284
26		PULP & PAPER PROD.					
	2611	Pulp	122,441	74,185	48,256		
	2631	Paper & Paperboard	193,778	7,801	169,903		16,074
		Other	3,461	1,063	775	14	1,609

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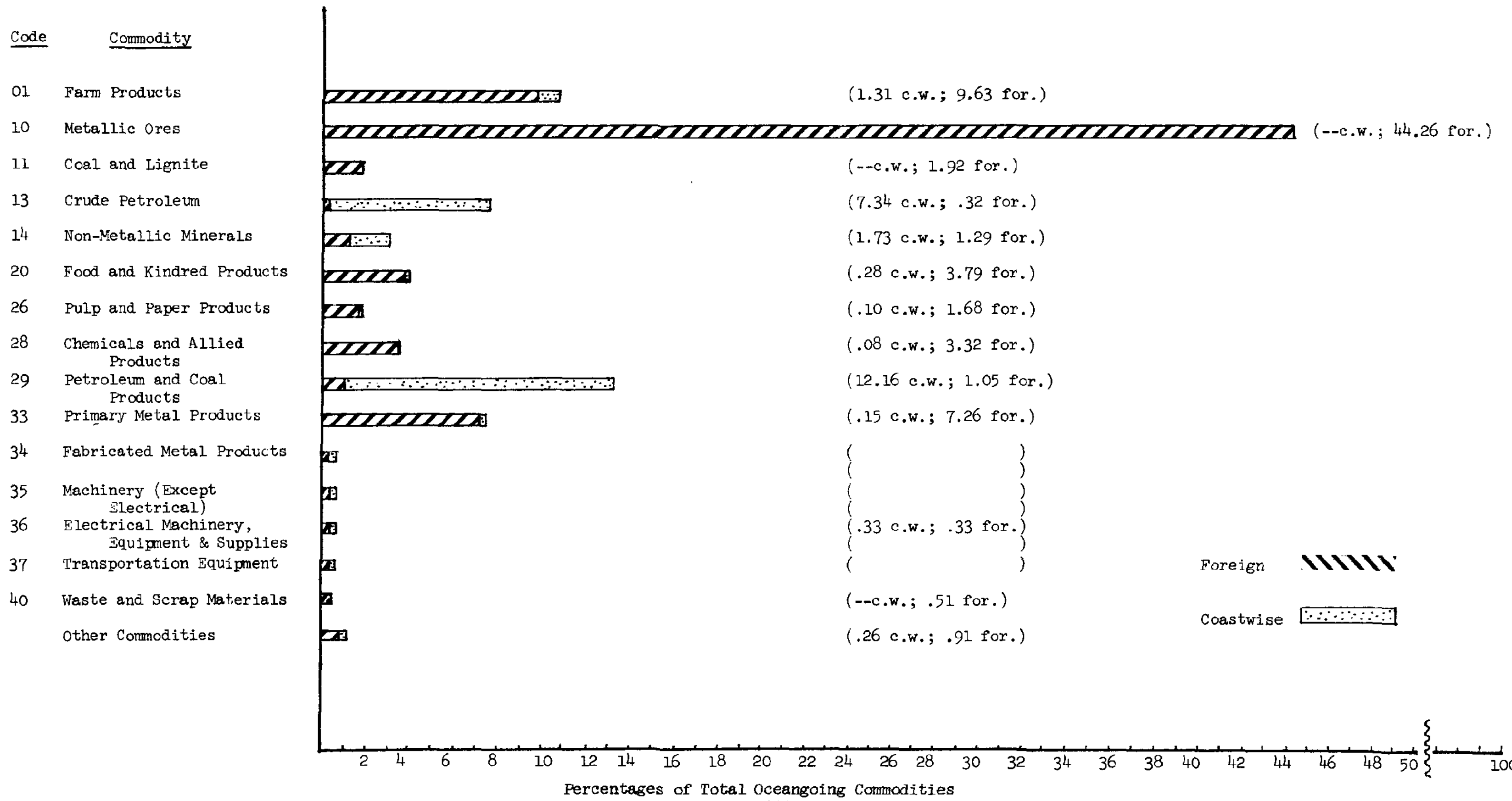
Table 16

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)
Mobile, Pascagoula and Gulfport

2 Digit Code	3or4 Digit Code	Commodity	Total	Foreign Imports	Foreign Exports	Domestic Coastwise Receipts	Domestic Coastwise Shipments
28		CHEMICALS & ALLIED PROD.					
	281	Basic Chemicals	422,330	41,128	369,463	6,836	4,903
	287	Fertilizers & Mat.	153,604	2,029	151,233		342
		Other	32,094	2,443	27,866		1,785
29		PETROLEUM & COAL PROD.					
	2911	Gasoline	637,060				637,060
	2912	Jet Fuel	307,975				307,975
	2913	Kerosene	39,764				39,764
	2914	Distillate Fuel Oil	821,926		23		821,903
	2915	Residual Fuel Oil	436,413	167,242	19,231	9,884	240,056
	2916	Lubricating Oil & Greases	528		502		26
		Other	121,618	384	1,558		119,676
33		PRIMARY METAL PROD.					
		Iron & Steel, Prim.	189,384		189,384		
		Iron & Steel Shapes, Exc. Sheets	49,148	46,310	1,712		1,126
		Iron & Steel Plates, Sheets	133,725	46,357	85,818		1,550
		Other	951,607	114,305	814,837		22,465
34		FABRICATED METAL PROD.)					
35		MACHINERY, EXC. ELEC.)					
36		ELECTRICAL MACH. SUPP.) & EQUIP.)	118,770	39,958	19,268	1,080	58,464
37		TRANSPORTATION EQUIP.)					
40		WASTE & SCRAP MATERIAL					
	4011	Iron & Steel Scrap	77,384	54	77,330		
		Other	13,501	5,910	7,443		148
		OTHER COMMODITIES	209,813	78,655	84,535	692	45,931

Chart 4

OCEANGOING COMMODITY FLOWS BY TWO-DIGIT COMMODITY CLASSIFICATIONS,
FOREIGN AND COASTWISE, FROM PORTS OF MOBILE, PASCAGOULA, AND GULFPORT, BY PERCENTAGES, 1970



3) Farm Products

   a) Volume: 1,958,156 tons
   b) Percent: 11%
   c) Direction of Movement:
      Major movements were exports of corn and soybeans

4) Crude Petroleum

   a) Volume: 1,371,330 tons
   b) Percent: 8%
   c) Direction of Movement:
      Shipments of crude to East Coast

e. Total Central Gulf Area

(Lake Charles, Louisiana to Mobile, Alabama)

(Refer to: Table 17, Chart 5)

Total Volume: 119,691,267 tons
Percent: 100%

Major Commodities

1) Crude Petroleum

   a) Volume: 24,434,771 tons
   b) Percent: 20%
   c) Direction of Movement:
      About all shipments were coastwise deliveries to the East Coast

2) Farm Products

   a) Volume: 23,804,073 tons
   b) Percent: 20%
   c) Direction of Movement:
      Major commodities are exports of corn and soybeans

3) Metallic Ores

   a) Volume: 17,663,651 tons
   b) Percent: 15%
   c) Direction of Movement:
      Imports of manganese, iron ore and aluminum

4) Petroleum and Coal Products

   a) Volume: 17,524,063 tons
   b) Percent: 15%
   c) Direction of Movement:
      Primarily coastwise shipments of fuel oil and gasoline to the East Coast

Table 17

OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Central Gulf Area

2 Digit Code	3 or 4 Digit Code	Commodity	Foreign Upbound	Foreign Downbound	Domestic Coastwise Upbound	Domestic Coastwise Downbound	Total
01		FARM PRODUCTS	880,137	22,402,728	1,911	519,297	23,804,073
	03	Corn	26,028	10,619,851		265,725	10,911,604
	07	Wheat		1,956,101		120,972	2,077,073
	11	Soybeans		8,835,779		22,315	8,858,094
		Other	854,109	990,997	1,911	110,285	1,957,302
10		METALLIC ORES	17,604,456	42,179	16,232	784	17,663,651
	11	Iron Ore & Conc.	6,035,431	96			6,035,527
	51	Aluminum Ores, Conc.	9,787,419	66	16,232		9,803,717
	61	Manganese Ores, Conc.	1,034,692	4,384		784	1,039,860
		Other	746,914	37,633			784,547
11	21	COAL & LIGNITE	377	849,111		3,704,585	4,554,073
13	11	CRUDE PETROLEUM	239,751	518,547	81,358	23,595,115	24,434,771
14		NON-METALLIC MIN. EXC. FUELS	968,808	1,199,949	3,761,526	1,877,474	7,807,757
	71	Phosphate Rock	89,912	1,401	3,707,065		3,798,378
	92	Sulphur, Dry		809,769		7	809,776
	93	Sulphur, Liq.				1,539,239	1,539,239
		Other	878,896	388,779	54,461	338,228	1,660,364
20		FOOD & KINDRED PROD.	2,887,632	4,458,099	144,907	159,278	7,649,916
	4	GRAIN MILL PROD.	80,565	3,278,224	12,356	38,056	3,409,201
	61	Sugar	1,732,958	268	80,574	6,574	1,820,374
	62	Molasses	871,948	1,166	11,977	163	885,254
		Other	202,161	1,178,441	40,000	114,485	1,535,087
26		PULP & PAPER PROD.	147,590	1,188,062	183	38,543	1,374,378
	11	Pulp	74,185	577,859		246	652,290
	31	Paper & Paperboard	49,411	600,645	80	32,647	682,783
		Other	23,994	9,558	103	5,650	39,305

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Table 17

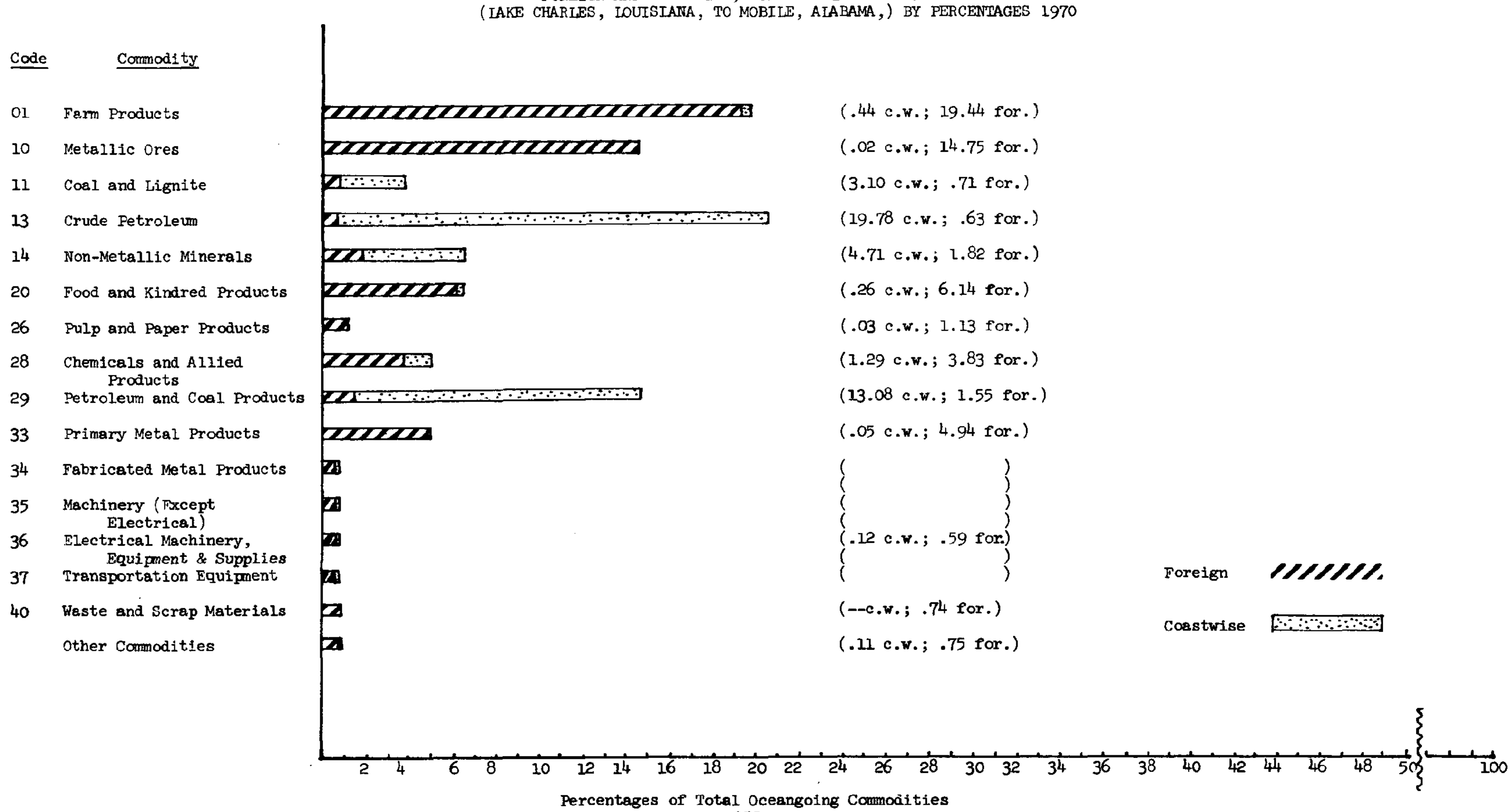
OCEANGOING FREIGHT TRAFFIC, 1970
(Short Tons)

Central Gulf Area

2 Digit Code	3 or 4 Digit Code	Commodity	Foreign Upbound	Foreign Downbound	Domestic Coastwise Upbound	Domestic Coastwise Downbound	Total
28		CHEMICALS & ALLIED PROD.	599,739	3,988,426	435,337	1,103,790	6,127,292
	1	Basic Chemicals	426,354	3,149,536	123,912	181,132	4,517,934
	7	Fertilizers & Mat.	131,457	421,467	305,917	270,286	1,129,127
		Other	41,928	417,423	5,508	15,372	480,231
29		PETROLEUM & COAL PROD.	1,111,864	744,333	534,833	15,133,033	17,524,063
	11	Gasoline		178	65,067	4,679,157	4,744,402
	12	Jet Fuel				1,046,748	1,046,748
	13	Kerosene	69,399	9,206	14,149	911,681	1,004,435
	14	Distillate Fuel Oil	135,967	385	45,253	6,234,326	6,415,931
	15	Residual Fuel Oil	904,837	184,567	216,251	1,296,169	2,601,824
	16	Lubricating Oil & Greases	145	463,158	68,745	405,396	937,444
		Other	1,516	86,839	125,368	559,556	773,279
33		PRIMARY METAL PROD.	1,891,298	4,022,601	3,343	63,647	5,980,889
	14	Iron & Steel, Prim.	6,083	1,411,536		503	1,418,122
	15	Iron & Steel Shapes, Exc. Sheets	494,083	48,614	1,222	20,483	564,402
	16	Iron & Steel Plates, Sheets	602,056	555,517		6,290	1,163,863
		Other	789,076	2,006,934	2,121	36,371	2,834,502
34 35 36 37		FABRICATED METAL PROD.) MACHINERY, EXC. ELEC.) ELECTRICAL MACH. SUPP.) & EQUIP.) TRANSPORTATION EQUIP.)	400,470	309,513	16,409	125,836	852,228
40		WASTE & SCRAP MATERIAL	39,667	851,108	925	745	892,445
	11	Iron & Steel Scrap	792	766,512	389		767,693
		Other	38,875	84,596	536	745	124,752
		OTHER COMMODITIES	589,693	305,484	23,598	106,956	1,025,731
		Total	27,361,482	40,880,140	5,020,562	46,429,083	119,691,267

Chart 5

OCEANGOING COMMODITY FLOWS BY TWO-DIGIT COMMODITY CLASSIFICATIONS, FOREIGN AND COASTWISE, FOR IMMEDIATE SERVICEABLE AREA (LAKE CHARLES, LOUISIANA, TO MOBILE, ALABAMA,) BY PERCENTAGES 1970



5) Non-Metallic Minerals

a) Volume: 7,807,757 tons
b) Percent: 7%
c) Direction of Movement:
Importation of phosphate rock (3.7 million tons) and exportation of liquid sulfur (1.5 million tons)

6) Food and Kindred Products

a) Volume: 7,649,916 tons
b) Percent: 6%
c) Direction of Movement:
Exports of grain mill products (3.2 million tons) and imports of sugar (1.8 million tons)

D. Summary and Conclusions

1. The central Gulf area is primarily a net exporter of commodities to the East Coast and the world. Approximately 73 percent (87.3 million tons) of total commodity flows are outbound shipments whereas 27 percent (32.4 million tons) are inbound. Approximately 57 percent (68.2 million tons) are foreign shipments while 43 percent (51.5 million tons) are domestic coastwise shipments. The major outbound commodities are crude petroleum, which is shipped almost entirely to the U.S. East Coast, and farm products from the Midwest, which are shipped via the Central Gulf ports to Europe and Asia. Outbound commodities of secondary importance are petroleum products, transported primarily to the East Coast, and grain mill products, shipped to Europe and Asia. Together these total approximately 19 percent of total commodity flows. Imports are primarily metallic and non-metallic ores, which together constitute approximately 20 percent of the area's total commodity flows. Hence, the Central Gulf area is "exporting" petroleum crude, petroleum products, grains and other farm products and importing minerals.

This is a desirable commodity mix for a superport since the commodities of greatest volume are liquid and dry bulk. Because the greatest economies are realized in bulk superships and almost all large ships are bulk carriers, the advantages of the Gulf region are obvious. Perhaps even more important is the fact the Central Gulf exports liquid bulks and farm products and imports ores. A detailed study of the destination of farm products not having been completed, it may be possible to use O/B/O or oil/slurry/ore ships to export farm products to Asia and to return with ores from Australia, or to ship farm products to Europe or Africa and return with African crude to the East Coast. The trade routes and technology will have to be examined more thoroughly, but the fact that the major exports and imports in the Central Gulf region are bulk commodities indicates some potential for a Central Gulf superport.

One of the most difficult decisions concerning the Louisiana superport is related to the type of commodities it will service. It appears that the liquid bulk terminal will be economically viable in itself and will provide the potential for increased economic development in the state. The feasibility of a structure encompassing dry bulk or other commodities is much less certain. One answer is that the liquid terminal should be constructed now and additions can be made for dry bulk at a later date. This is one possibility but it partially ignores the problem. If future additions are to be made to accomodate dry bulk commodities, the type of liquid structure will probably be different than if no further additions are planned. More importantly, the location of the oil terminal to be constructed now may be dependent upon the question of future commodity additions to the superport. If no commodity additions are planned, the oil terminal may be most efficiently located in one area, say below Grand Isle, whereas if commodity additions are planned, the oil terminal should be located closer to the Mississippi River. Hence, the type of superport which is expected to emerge in the future will be a significant input into the location decision of the superport today. The discussion below summarizes total commodity flows and their implications for a locational decision. Different conclusions would be reached if the superport were exclusively a liquid bulk terminal.

2. Total volume of Gulf traffic flowing on the Mississippi from New Orleans to the mouth of the passes is 93,822,028 tons (Table 15) while the comparable traffic on the Gulf Outlet is only 2,659,173 tons (Table 16). This is a very considerable difference in volume, especially in view of the fact that the MRGO is 40 miles shorter. It is not immediately clear why so many shippers prefer the river to the MRGO. The controlling depth on the Mississippi River is 40 feet, while that on the MRGO is only 36 feet. Approximately 1000 ships using the Mississippi route had drafts between 36 feet and 40 feet, so this would account for some of the river's differential movements. Also, the lockage delay may have deterred some ships or part of the traffic may have originated or terminated at ports or piers of the Mississippi below New Orleans, in which case the MRGO would have involved some backhauling. But these factors cannot explain a difference of 91 million tons. Further research must uncover the reasons favoring the Mississippi River; if there are long-run economic or transit and piloting problems, they would suggest that the superport should be located close to the mouth of the Mississippi.

3. Location of Superport in Central Gulf Region

a. Considering commodity flows in Central Gulf region.

The flow of oceangoing commodities entering and leaving the Central Gulf area on the Mississippi River constitute more than 78 percent of total oceangoing volume in the Central Gulf area.

Mobile, Pascagoula, and Gulfport account for approximately 15 percent of Central Gulf traffic, of which nearly one-half (or 8 million tons) is receipts of foreign metallic ores. Lake Charles accounts for less than 5 percent of oceangoing Central Gulf traffic. Hence, considering only the Central Gulf area, the superport should be located close to the mouth of the Mississippi to minimize time and distance in transshipments of the predominant commodity flows on the Mississippi River. The existence of the MRGO and the metallic ore trade in the ports of Pascagoula, Gulfport and Mobile might suggest that the superport be located east of the mouth. However, relatively large shuttle vessels, using the Mississippi River would have to travel south and west to enter Southwest Pass, which is the only one capable of handling such ships.

Another area for future research is the type of shuttle vessels which will be employed. If they are river barges, they could use the MRGO or the North or South passes, and this would be an argument for an eastside location. This would place the superport in closer proximity to the Mississippi and Alabama ports and to the Intracoastal Waterway.

If shuttle barges are used primarily, will they find it attractive to use the MRGO? Obviously, the oceangoing vessels have not. If the barges do find it attractive and if the lockage rates and capacity on the MRGO - Industrial Canal permit the increased flows, an east side superport location, from purely a transshipment point of view, looks attractive. However, the reasons for the infrequent utilization of the MRGO by larger vessels will have to be determined before this question can be answered.

b. Considering other factors

1. Texas Superport and Commodity Flows

Since a commodity flow analysis was not completed for other Gulf areas, the volume and type of commodity flows which could be channeled through the Louisiana superport from (to) these areas are unknown. Obviously, petroleum crude and petroleum products constitute a major factor, and some of these flows could be transshipped through the Louisiana superport. If Texas does not construct a superport, this would argue for a superport located west of the mouth.

2. Pipelines

Since petroleum as well as slurried ores can utilize pipelines as a means of transshipments, their present location, capacity, and usage should be determined. The relative costs of transshipments by pipelines and waterways will also have to be determined. While we have some data on the locational patterns of pipelines in Louisiana, they were insufficient to develop a meaningful general pattern. Additional data were being procured as this report was being written.

ENVIRONMENTAL ASPECTS OF A SUPERPORT OFF THE LOUISIANA COAST

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ENVIRONMENTAL ASPECTS OF A SUPERPORT OFF THE LOUISIANA COAST

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ENVIRONMENT

I. Introduction

The location, design, construction, operation, and future development of a proposed Superport facility along the Louisiana coast (Figure 1) depends on the best fit between social, economic, political and environmental considerations. In this preliminary evaluation we are concerned with identifying the most critical factors and organizing them in order to facilitate further planning and analysis. This section of the report emphasizes environmental aspects of the problem. However, related land use and political and economic factors are also examined. Environmental problems must be considered in every phase of development--from site selection to facility operation. All probable stresses on natural and human environments, as well as constraints imposed on the project by environmental factors, must be evaluated.

Environmental stresses are defined as pressures on scenic and historic resources and on biological productivity of existing natural environments (i.e., drainage of a fisheries nursery area, destruction of an archeological site, or water pollution in an oyster growing area).

Environmental constraints are those factors related to existing environments which limit or preclude certain types of land use or development (i.e., flood prone areas or poor foundation conditions). The region also offers certain environmental opportunities. These are unique features of the coastal landscape which make it ideally suited for a specific kind of land use or development (i.e., natural levee ridges as highway right-of-ways, or barrier islands as recreation areas).

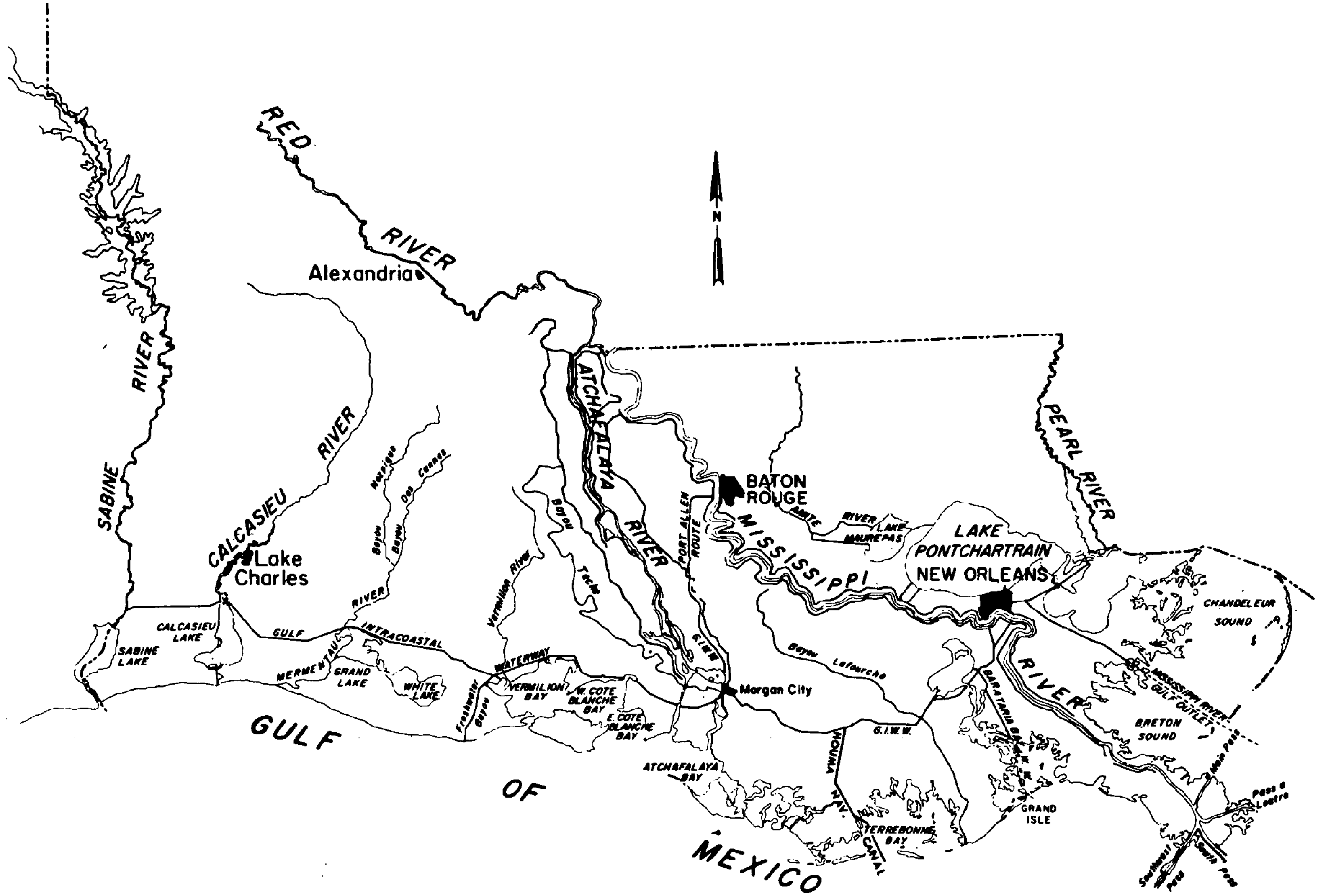

Fig. 1. The Louisiana coastal area.

Our task then is to identify those stresses, constraints and opportunities relating to the proposed Superport and to show their distribution in the study area. In the analysis equal emphasis must also be given to those factors related to onshore support activities and transportation/utility links with onshore facilities.

Natural stresses associated with the offshore structure include: (1) dredging and other site preparation and construction activities, (2) maintenance dredging after the facility is in operation, (3) possible massive spills, and (4) possible operational leakages. Land links involving pipelines, utilities, and possible over-water highways introduce additional environmental problems. Social and cultural stresses associated with the offshore structure itself are probably limited to disruption of fishing activities. Primary constraints which enter into selection of the site are the (1) distance offshore to water depths of 100 feet, (2) sea-bottom foundation problems, and (3) vulnerability to storm generated surges and winds. Secondary constraints critical to facility design, construction and operation are primarily intensity and temporal variation of fog, wind, currents, and waves. Density or spacing of existing offshore structures and the location of primary fishing grounds must also be considered in site selection.

Secondary stresses imposed on onshore areas may well be more important than those associated with the offshore structure itself. For example, it is probable that support activities will require moving large numbers of people into flood-prone areas in the gulfward fringes of the coastal zone. Because land areas well-suited for urban and industrial development are extremely limited in this region, pressure to initiate wetland reclamation projects must be carefully monitored. Such projects encroach into areas of high biological productivity and very poor foundation conditions. Secondary onshore activities may thus produce stresses on the natural environment and social/economic burdens for people moving into the coastal zone. Social burdens include high risk to hurricane storm surge hazards, as well as drainage and foundation problems. Other stresses related to population increase in the gulfward fringes of the coastal zone include problems of sewage treatment, storm runoff removal, solid waste disposal, and a need for additional power-generating stations. Furthermore, the requirements for additional navigation channels to move cargo and supplies in an orderly fashion between the offshore structure and onshore support facilities may result in environmental damage. Routing of pipelines and utilities through estuarine areas between the offshore platform and onshore support facilities may also create major environmental problems.

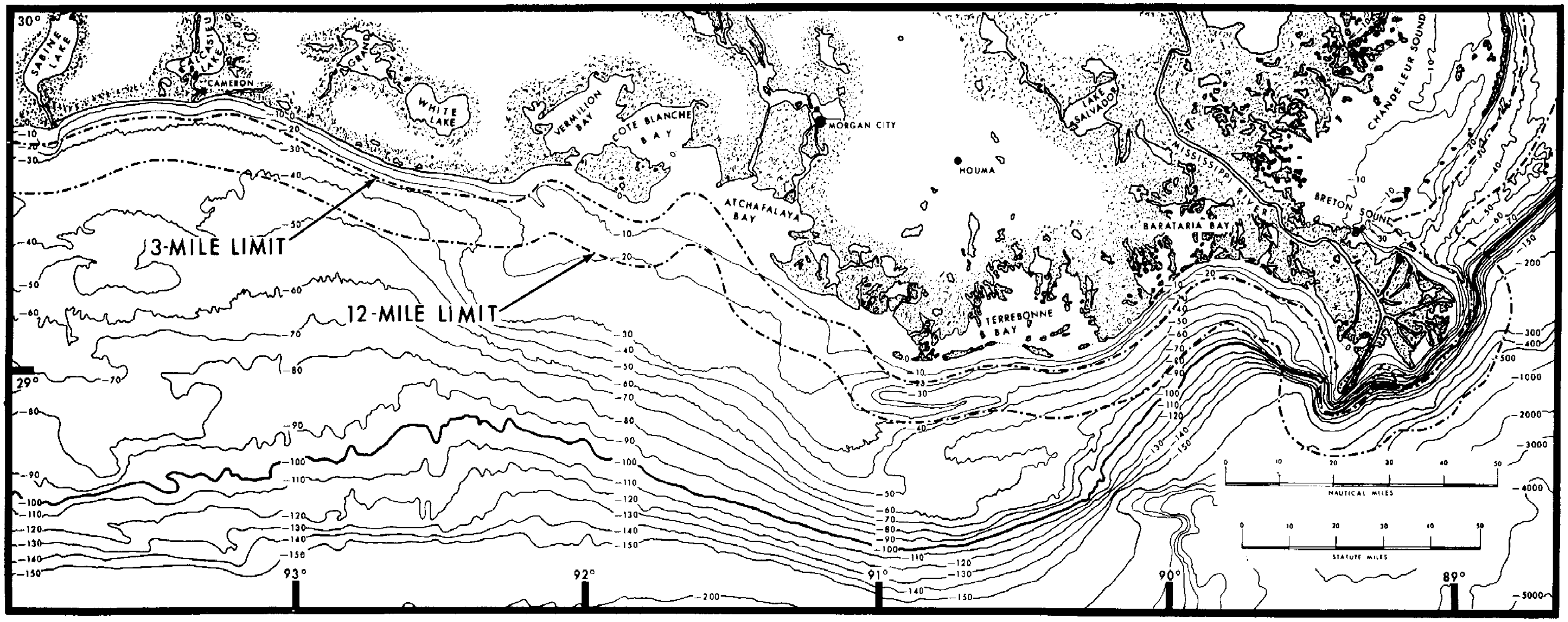

Fig. 2. Bathymetry and lines of legal jurisdiction along the Louisiana continental margin. Contours in feet.

II. Major Factors Related to Site Selection

Bathymetry and Legal Jurisdictions

One of the most important constraints for locating a major offshore structure is the distance to deep water. Figure 2 depicts the bathymetry of the Louisiana continental margin and location of the 3-mile and 12-mile lines, representing aspects of state and federal jurisdictions. From the map it is readily apparent that the most favorable locations for an offshore port are in southeastern Louisiana where deep water is reasonably close to the shore and where it lies within the legal jurisdiction of the United States. For this reason it seems that areas east of about 90° 15' W longitude should receive primary considerations.

Current and Circulation Patterns

Although currents and water circulation in the vicinity of the Louisiana coast are complex and have not been studied in detail, a map of the general pattern has been compiled from various published and unpublished sources. As shown in Figure 3, the circulation pattern presents both opportunities and constraints for various site locations. On the one hand the westward drift of the Mississippi River effluent plume would provide a natural flushing mechanism if a spill were to occur at some location immediately south or west of the delta. On the other hand, there would be a high risk to the Breton Sound seed oyster and estuary areas if the facility were located on the east side of the delta. Conditions would in general be unfavorable in the summer and autumn during coinciding low water stage and prevailing southeast winds.

Slope and Foundation Conditions

From the standpoint of water depth, legal jurisdiction and

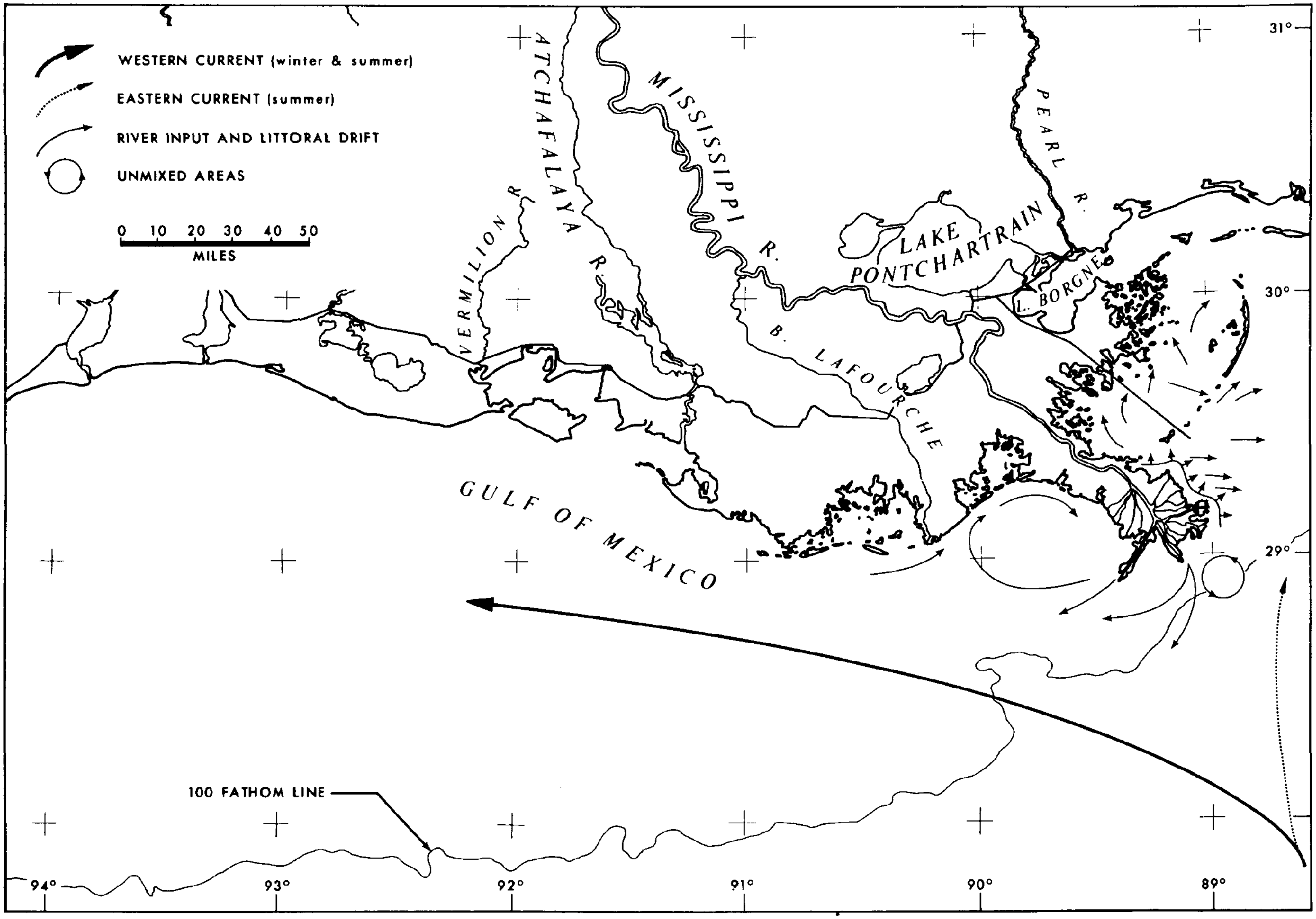

Fig. 3. Dominant current systems along the Louisiana coast.

proximity to inland waterways, the most logical location for the proposed Superport facility is in the lower delta near South or Southwest passes. Unfortunately, relatively steep sea bed slopes and very poor foundation conditions of this area present major engineering problems.

One indication of foundation instability is the occurrence of mudlumps in the vicinity of active Mississippi River distributary mouths (Figure 4). Detailed studies indicated that mudlumps are actually surface expressions of massive subsurface diapiric folds and thrust faults resulting from deposition of thick localized masses of heavier bar sediments directly upon lighter, plastic clays. These mudlumps are found in the immediate vicinity of active distributary mouths where sediment deposition is rapid. Fold amplitudes of 500 feet and vertical displacement in excess of 350 feet have been documented at South Pass (Morgan et al., 1963). Areas of known mudlump occurrence define a 45 mile long arc extending from Pass a Loutre to Southwest Pass (Figure 4).

A second and related type of instability involves massive submarine slumping along the upper slope of the delta platform (Figure 5). Such sea floor slides, occurring in the poorly consolidated delta front and prodelta clays, are believed initiated by wave generated vertical differential pressures acting on the bottom. As a result of this process a number of pipelines have been broken and drilling platforms toppled. The best documented cases occurred in South Pass Block 70 during the passage of Hurricane Camille. Storm waves initiated a massive sea-floor slide and two platforms (in 320 and 325 feet of water) were toppled and displaced (Bea, 1971). A number of similar accidents have been reported in the lower delta. It thus appears that a zone of

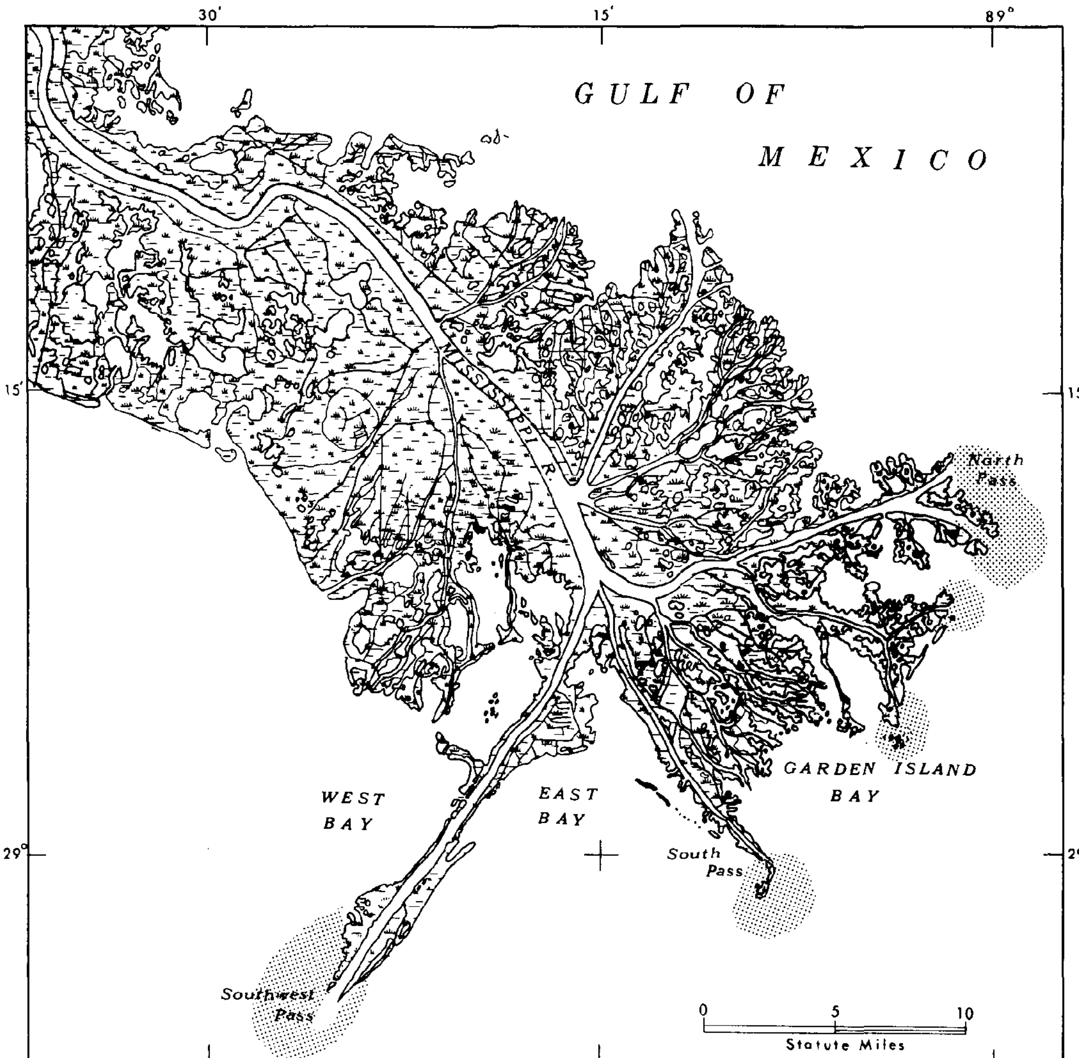

Fig. 4. Areas of mudlump development at major distributary mouths, Mississippi River delta. (After Morgan, Coleman, and Gagliano, 1968).

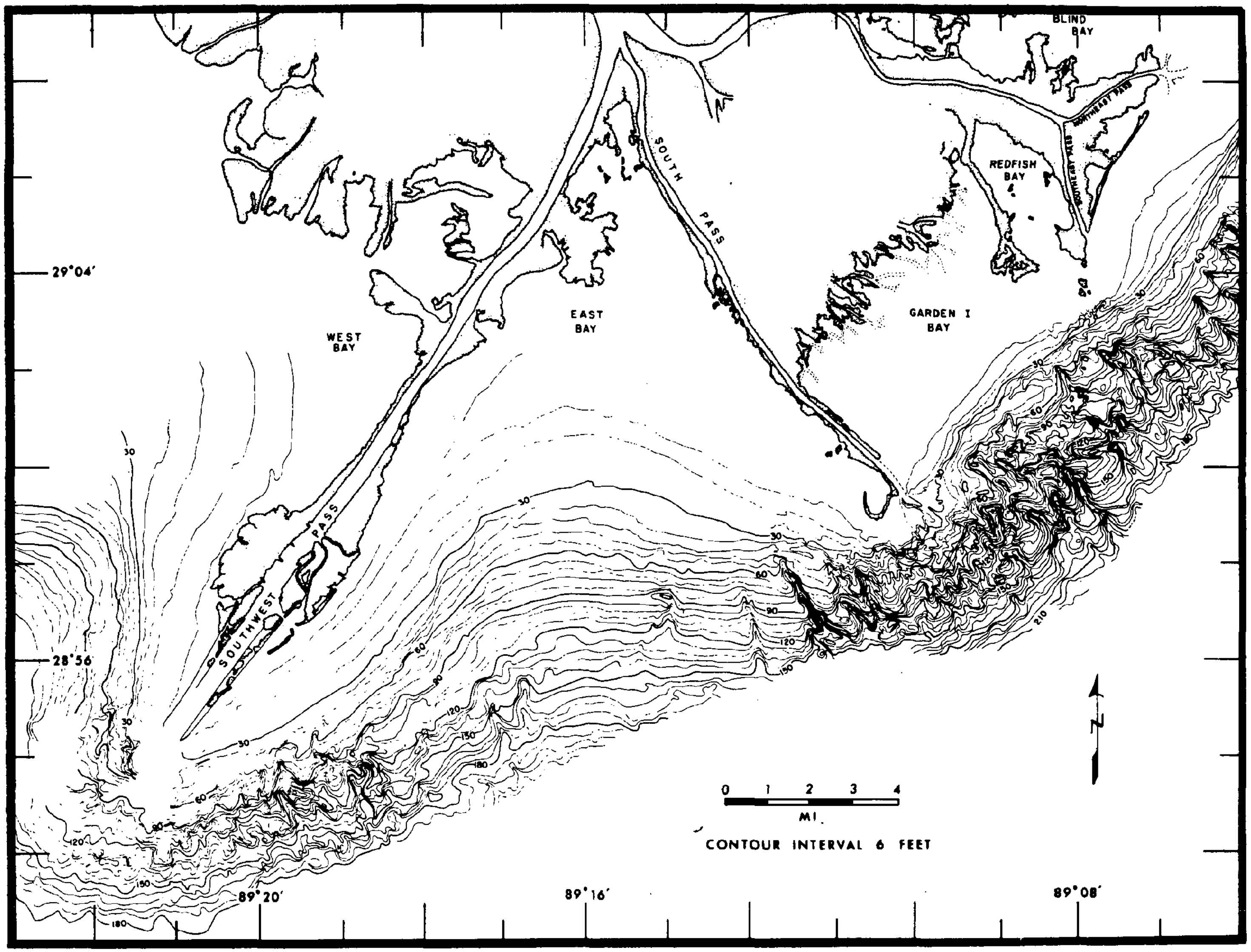

Fig. 5. Submarine topography of upper slope on the Mississippi Delta platform.

instablity and very poor foundation conditions extends outward from the mudlump area to water depths of about 400 feet. This area should not be completely ruled out as a possible port site; however, foundation conditions are generally very poor.

Possible Sites in the Vicinity of the Lower Delta

Although analysis of environmental data has not progressed to the point where a specific site can be recommended, the relative merits of large coastal sectors in the vicinity of the lower delta can be evaluated on the basis of the major factors previously discussed. Four major sectors are identified in Figure 6. A fifth area for consideration, Chandeleur Sound and vicinity, lies beyond the map margin.

The Chandeleur area has a broad shoal shelf and can probably be ruled out because of the great distance to the 100-foot contour. In the Breton and Main Pass areas current patterns are unfavorable. Foundation conditions rule out most, if not all, of the South Pass area. Hence from preliminary analysis, the West Delta seems to have a favorable combination of factors for further consideration.

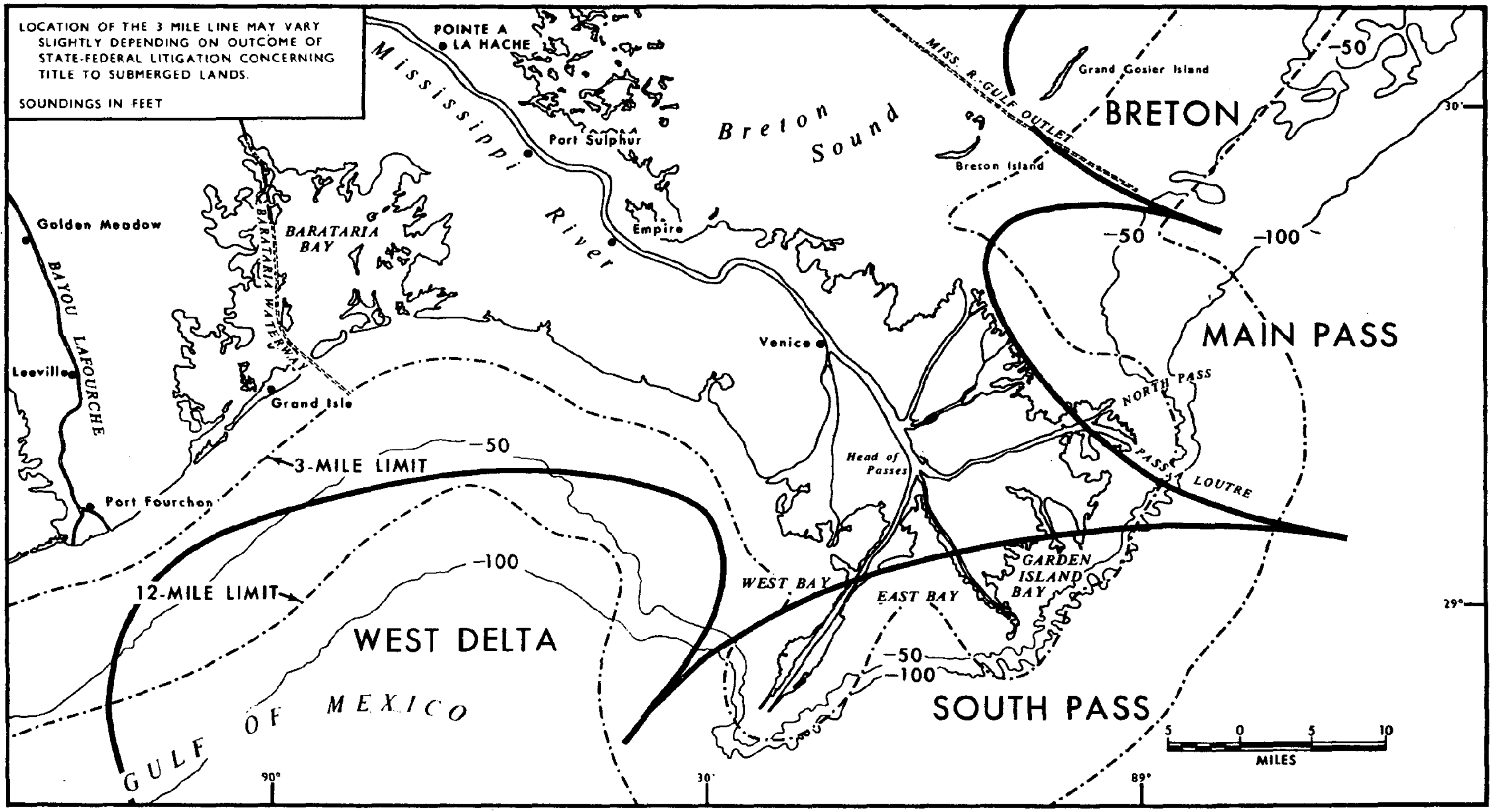

Fig. 6. Major areas of consideration for Superport location in the vacinity of the lower Mississippi River Delta.

III. Relationships to Estuarine Zone

Environmental Management Areas

From the standpoint of renewable resources and scenery or esthetics it is useful to identify the major environmental management units in the Louisiana coastal zone.

As shown in Figure 7, the coastal zone can be segmented into fourteen management areas. Four of these are large, fresh water basins dominated by extensive swamps, shallow, muddy rounded lakes and fresh marsh. Eight major estuarine management regions can also be defined. Salinities, in general, range from brackish to saline. These areas are characterized by extensive stands of transitional and saline marshes, innumerable shallow ponds and lakes, and large shallow bays with irregular shorelines. The Grand-White unit, although classified as estuarine, is dominated by fresh marsh and large freshwater lakes and is managed as a reservoir for southwestern Louisiana's rice farming district. These estuarine management areas are biologically the most productive places in Louisiana and represent the state's most important renewable resource.

Two controlled delta building units are indicated in Figure 7. Under present conditions these are freshwater bays and marshes in close proximity to active distributary outlets of the Mississippi and Atchafalaya rivers. In such places delta building processes are usually the rule. Both areas have tremendous potential for land building and environmental management.

It should be noted that each of the environmental management areas

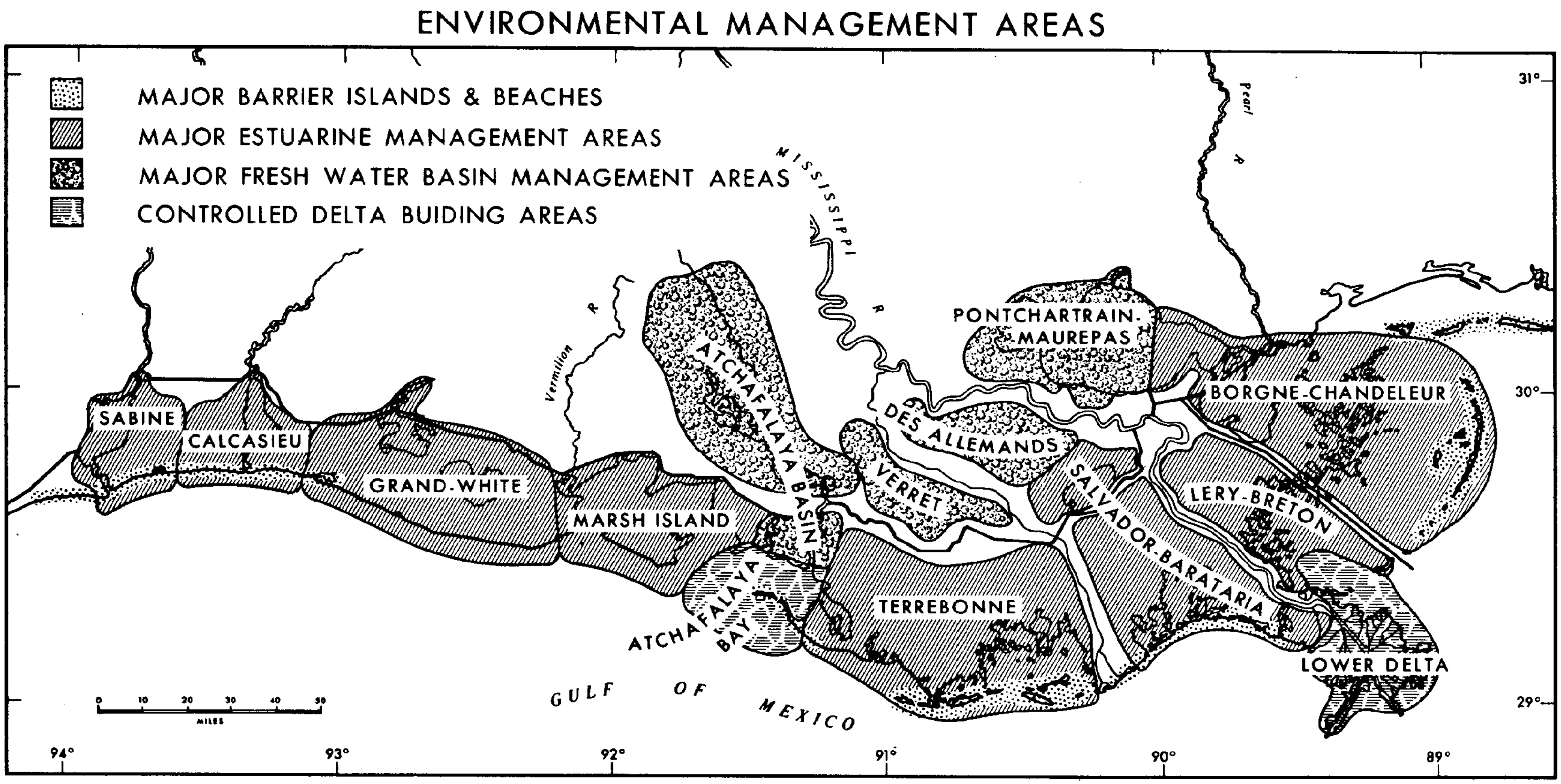

Fig. 7. Environmental management areas of the Louisiana coastal zone.

is a large complex natural system. Each is highly productive and represents a major resource. Historic studies have documented that segmentation of such systems through construction of embankments, canals, or other man-made features is usually detrimental, causing deterioration of the natural elements of the system and a decline in productivity. It should be stated in the strongest possible terms that the integrity of these environmental management areas should not be violated.

Canals, Waterways and Trans-coastal Corridors

One of the most critical problems affecting location of a Superport is the impact of onshore support facilities and connecting links. Obviously, the port cannot exist in isolation but must be tied to its customers and land based support units by elaborate transportation and communication links. Some observers have visualized such links as being contained within a single "umbilical cord," and others view them as nebulous, flexible ties consisting of pipelines and air- and water borne shuttles. The latter view is closer to reality. The environmental problem is further complicated by the fact that Superport customers would be removed from the immediate coast. The markets for crude oil are the refineries bordering the Mississippi between Baton Rouge, and New Orleans and other areas far inland. Existing ports such as New Orleans, Lake Charles and Baton Rouge may serve as transshipment points. The problem, then, is threefold:

1. To provide onshore service facilities in the coastal zone with the least amount of environmental impact
2. To route pipelines through the estuarine management areas without destroying their integrity

3. To provide links to inland navigation channels without destroying the estuarine management areas.

Figure 8 shows the existing web of canals, natural waterways and transcoastal corridors in south Louisiana. Major natural corridors extending through the estuarine zone to the coast are defined by the natural levee ridges and channels of active and abandoned distributaries of the Mississippi River, notably Bayou Teche, Bayous du Large-Calliou-Terrebonne, Bayou Lafourche, and the Mississippi River.

The relatively high, firm land of the natural-levee ridges and proximity to navigation channels resulted in early settlement and development of these corridors, and they still provide the major links between inland areas and the coast. Secondary links have been created by the Mississippi River Gulf Outlet, the Barataria Waterway, the Houma Navigation Channel, the Atchafalaya River outlet, Freshwater Bayou, and the Calcasieu and Sabine river channels. Although these secondary links (canals) are important for shipping, they should not be confused with the natural transcoastal corridors. Foundation conditions are generally very poor in the vicinity of these canals, and there are definite constraints to development. Inasmuch as most of the canals bisect major estuarine management units, development along their banks would result in stresses on important habitats.

Therefore, another principal guideline for Superport development is to <u>confine all support activities and onshore links to narrow zones parallel and in close proximity to existing canals, waterways, and transcoastal corridors</u> (Figure 8). Ultimate limits of corridor development must be defined, and all pipelines, highways, power lines, and

CANALS, WATERWAYS AND TRANS-COASTAL CORRIDORS

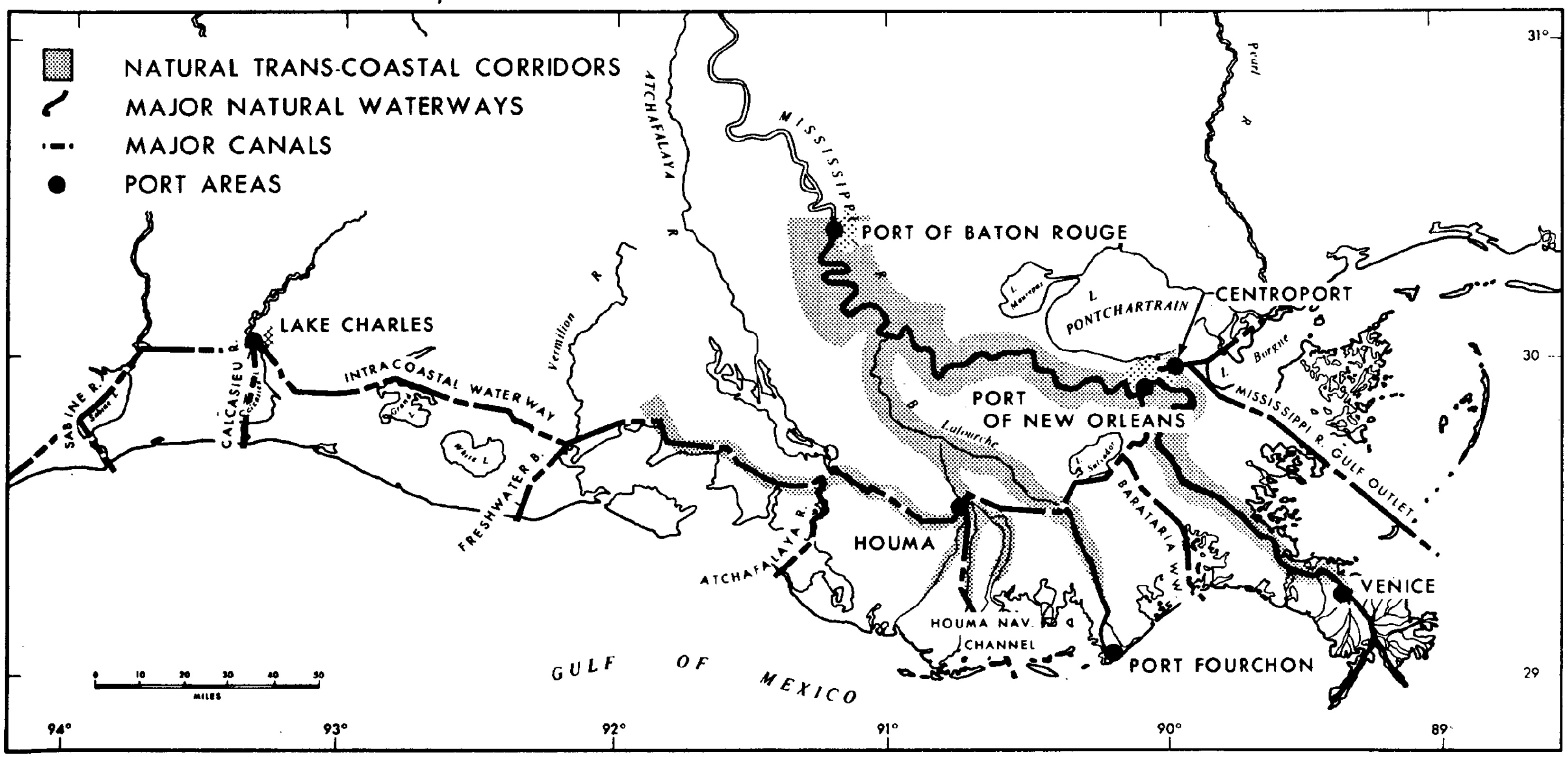

Fig. 8. Canals, waterways and trans-coastal corridors.

land-based facilities must be confined to these corridors.

Biological Productivity

Assuming that the most probable sites for the Superport facility are in the West Delta, we may then consider probable impact on adjacent environmental management areas. A West Delta port location would create numerous stresses on the Salvador-Barataria area. From the standpoint of fauna and flora this is believed to be the single most productive part of the Louisiana coastal zone. One measure of this productivity is the commercial fisheries catch; and, as shown in Table 1, the combined Des Allemands and Salvador-Barataria areas show the greatest yield in pounds per acre of harvest.

Some of the more important physical parameters and biotic components influencing the ecology of this estuarine system and maintaining its high level of productivity include (1) input of solar radiation, which maintains high mean water temperatures; (2) high annual rainfall; (3) high volume of fresh water and nutrients from the Mississippi River discharge via the gulf; (4) daily tidal flushing; and (5) annual variation in mean gulf level. The mild climatic regime allows year-round primary production and longer growing seasons for seasonal organisms. Mississippi River discharge indirectly influences the salinity of the estuary and is the main external source of nutrients. Tidal flushing is very important in all estuaries, for it moves nutrients, detritus, and many small planktonic organisms. The importance of the tide is also evident in the marsh. At the edges of tide-affected streams and ponds, the biomass of both grasses and biological consumers is very high. This biomass decreases with distance from the water.

Table 1: Production and value of major commercial estuarine-dependent fisheries by environmental management areas. Data based on five-year (1963-67) average annual harvests and 1967 exvessel prices. (William N. Lindall et al., 1972)

Environmental Management Areas / Species	Pontchartrain-Maurepas, Breton, Chandeleur & Breton-Lery	Lower Delta	Des Allemands & Salvador-Barataria	Verret & Terrebonne	Atchafalaya Basin & Atchafalaya Bay	Marsh Island	Grand-White	Sabine & Calcasieu	Total
Menhaden									
Production[2]	159.33	30.20	335.83	64.80	28.30	41.10	12.40	41.10	713.06
Value[3]	2.26	0.43	4.77	0.92	0.40	0.58	0.18	0.58	10.12
Shrimp									
Production	18.30	3.70	20.00	22.91	2.00	3.20	0.50	2.90	73.51
Value	6.64	1.34	7.25	8.31	0.73	1.17	0.19	1.05	26.68
Croaker									
Production	4.33	1.20	4.93	7.63	1.10	2.11	0.30	2.11	23.71
Value	0.07	0.02	0.08	0.14	0.02	0.04	0.01	0.04	0.42
Oyster									
Production	4.68	0.00	4.14	0.85	0.00	0.01	0.00	0.29	9.97
Value	2.06	0.00	1.82	0.37	0.00	0.005	0.00	0.13	4.39
Blue Crab									
Production	3.66	0.03	2.46	1.12	0.28	0.06	0.04	0.62	8.27
Value	0.32	0.003	0.22	0.10	0.03	0.005	0.005	0.05	0.73
Spat									
Production	0.57	0.23	0.85	1.58	0.22	0.53	0.11	0.53	4.62
Value	0.01	0.004	0.01	0.03	0.004	0.02	0.002	0.01	0.08
Catfish & Bullheads									
Production	0.16	0.00	1.94	0.41	1.79	0.07	0.22	0.003	4.59
Value	0.03	0.00	0.33	0.07	0.30	0.01	0.04	0.001	0.78
Seatrout									
Production	1.41	0.21	1.08	0.31	0.18	0.42	0.08	0.42	4.11
Value	0.07	0.01	0.05	0.01	0.01	0.02	0.003	0.02	0.19
Red Drum									
Production	0.23	0.02	0.12	0.13	0.005	0.00	0.00	0.02	0.53
Value	0.04	0.003	0.02	0.02	0.001	0.00	0.00	0.003	0.09
Total									
Production[2]	192.68	35.59	371.35	99.74	33.87	47.50	13.65	47.99	842.37
Value[3]	11.50	1.81	14.55	9.97	1.50	1.84	0.43	1.88	43.48
Estuarine Water[4]	1764	163	314	419	153	323	13	134	3283
Production, lbs/acre	109.2	218.3	1182.6	238.0	221.4	147.1	1050.0	358.1	256.6
Value, dollars/acre	6.5	11.1	46.3	23.8	9.8	5.7	33.1	14.0	13.2

1. Management areas grouped because of the nature of the primary fish catch data.
2. Millions of pounds
3. Millions of dollars
4. Thousands of acres

Estuarine salt marsh systems are naturally eutrophic, high net-yield systems. They are very much open systems. A diagram of the major populations and energy flows is shown in Figure 9. Heavy lines in the figure indicate the importance of organic detritus to the system. As indicated in Figure 10 and Table 2, the most important unit of primary production is the marsh grass. Of lesser importance is primary production by benthic plants and phytoplankton. Little marsh grass is consumed alive; most is broken down into detritus by microbial and physical processes. This detritus dominates the lower levels of the estuarine food web, both in the marsh and in open water. Thus the production, movement and consumption of detritus are of extreme importance. Within the estuary, probably the most critical and certainly the most productive area is the boundary zone between tide-affected waters and the marsh (i.e., this excludes areas around isolated marsh ponds). Production of *Spartina alterniflora* in this zone in Barataria Bay is the highest that has ever been measured for a salt marsh (net production = 2800 g dry wt/m^2/yr). This production is about 50 percent higher than that in the interior marsh (Table 2). Detritus levels in the sediments are highest near shore. Standing crops of animals are highest in the marsh and on the water bottoms adjacent to the shore. Tidal flushing and maintenance of the proper amount of marsh-water interface are probably the two most important factors maintaining high productivity in these shore areas.

Another major factor affecting the productivity of salt marshes is the high rate of evapotranspiration. Recent findings indicate that productivity of emergent plants generally increases as their ability

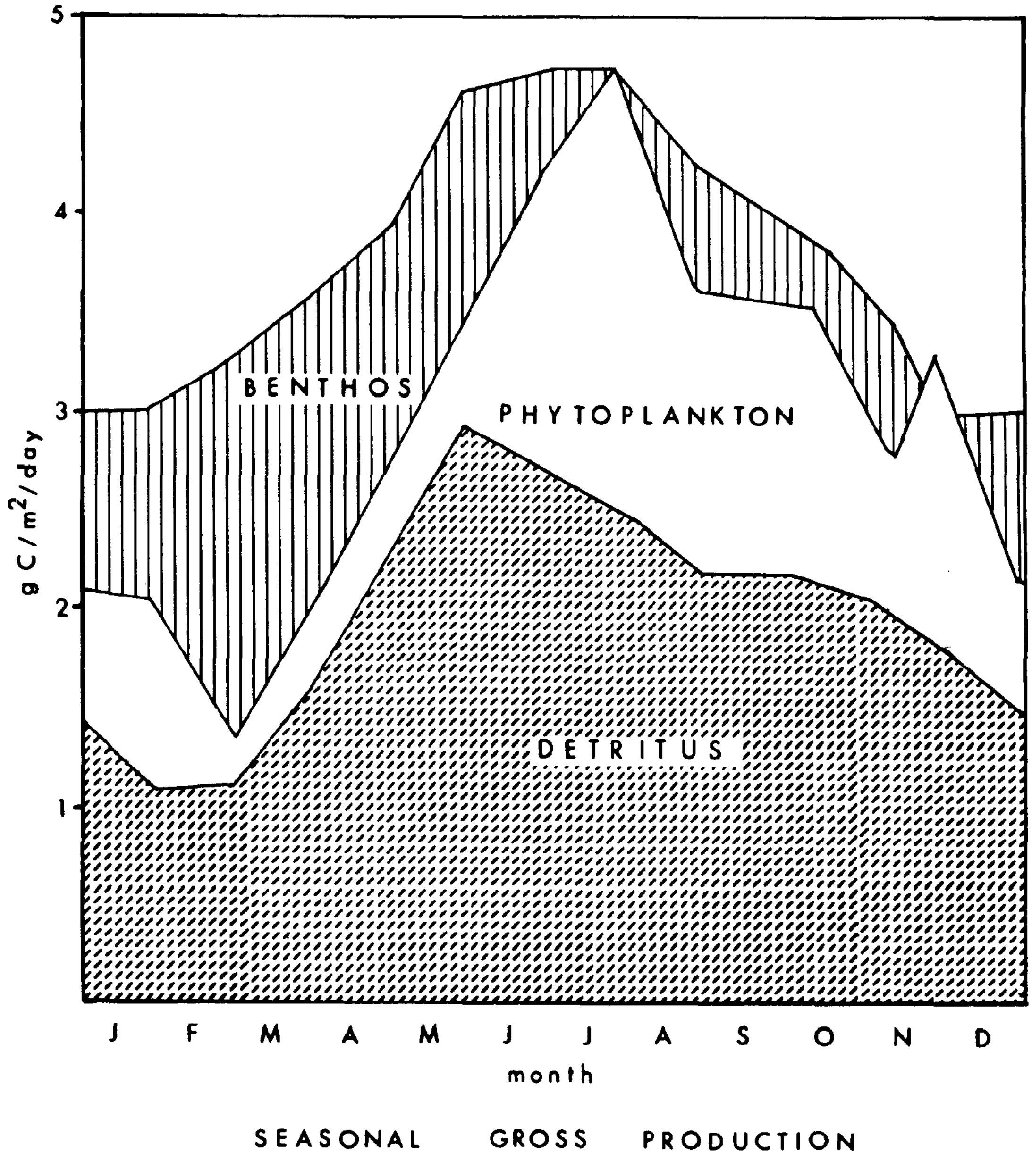

Fig. 9. Comparison of production of benthic plants, phytoplankton, and detritus.

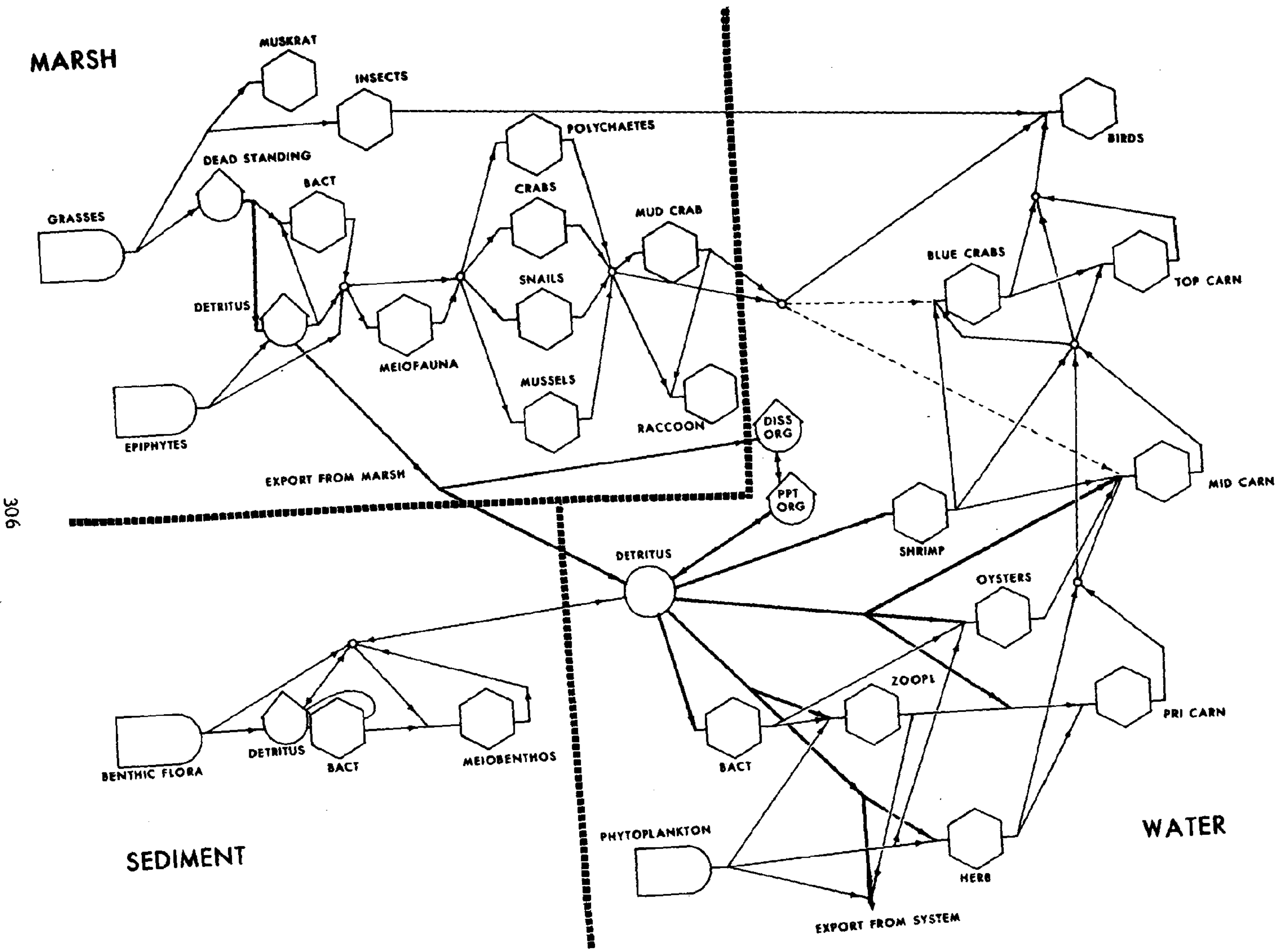

Fig. 10. Diagram of marsh-estuary system showing components and pathways.

Table 2: Primary production in Barataria Bay area of Louisiana in g org/m^2/year

Producer	Gross	Net
Grass		
Streamside	13,171	2,800
Inland	11,628	1,950
Phytoplankton	354.4	188.4
Benthic plants	328.2	149.2

This table of primary production in the Louisiana salt marsh points out the importance of the rooted plants to an estuarine ecosystem. (Preliminary data from Day et al., 1972)

to utilize water increases (Penman, 1970). From this standpoint a salt marsh has the best of two worlds, combining pulsation of tides to bathe its roots with an ever-changing supply of water and nutrients and an emergent foliage to allow free gas exchange. This situation results in loss of water at rates approaching the theoretical evapotranspiration potential for the locality. A complicating factor in more arid regions is lethal buildup of salt derived from seawater, but in humid Louisiana this is not a problem.

There can be high standing crops and productivity of animal populations because of the high percentage of seasonal inhabitants. Organisms such as shrimp, crabs, and fish use the estuary as a nursery area when food is plentiful and when temperature and salinity conditions are optimal. When conditions are suboptimal these forms can move offshore. Also, critical times during the life cycle, such as early larval development, can be spent in areas where conditions are relatively stable.

Birds are another important group of migrants. Carnivorous birds such as egrets and herons normally move south during the winter, when animal populations are low. Herbivores such as ducks migrate into the coastal areas during the winter when growth of benthic vegetation is at a maximum.

Below are listed some of the more important mechanisms maintaining the productivity of the estuarine zone and possible stresses related to construction and operation of a deepwater port facility.

1. Tidal flushing includes movement of water, nutrients, detritus, and organisms. Direct and indirect development poses the most serious threats to water movement. The diking and draining of land or the dredging of new canals can alter water movements, allow intrusion of saline waters into fresher areas, and change tidal coverage of the marshes. Major salinity change associated with the Mississippi River Gulf Outlet is a good example of an adverse environmental effect that can result from such projects.
2. The most important unit of primary production is that of the marsh grasses. Constructing a deepwater port facility poses the most serious and irreversible threat to marsh grasses. Because the facility itself would be located offshore, it would not directly affect the marshes. However, the destruction of marshes caused

by construction of pipeline and navigation channels, and the possible draining of marsh for back-up facilities, could have serious effects on the ecology of the area. When marsh is converted to open water by canal construction, the biological yield per unit area decreases because benthic plants and phytoplankton are less productive than the marsh grasses (Table 2). Yield might be even less in navigation channels as a result of higher turbidity levels created by frequent boat traffic and may be completely lost from "reclaimed" land. There is also the possibility of massive oil spills and chronic, low-level spills, which would have a detrimental effect on the entire marsh community.

3. Possible changes in production, movement, and consumption of detritus should be considered. Because the main source of detritus in estuaries is marsh grass, anything affecting the grasses would alter the production of detritus. Beside destruction of the source of detritus (i.e., marsh grass), the other most serious threat would be the inhibition of the breakdown of marsh grass into detritus. This production is intimately associated with microbial and physical processes. Because this transformation is microbially mediated, any deleterious effect on microbial flora would have important implications. Perhaps the most likely cause of this happening is through a massive oil spill. There is also the

possibility that oil-coated or oil-saturated detrital particles would be less palatable to detritivores. All these possibilities need further investigation.

4. Maintenance of the optimum amount of marsh-water zone is critical. Drainage and current patterns in the marsh zone have developed in response to small differences in elevation. Manmade canals which cut across different drainage units alter these current and drainage patterns, and spoil banks retard flow of water across some marsh areas. If the greater volume of water flow is changed from natural to manmade channels, water exchange along much marsh edge would be lessened. Water exchange seems to be the main factor in enriching the marsh edge. Thus a decrease in water exchange would result in lower productivity. Even in open waters, submerged spoil banks can alter current patterns. Because this most productive area is adjacent to the water's edge, it would also be most affected by a massive oil spill.

5. A Superport facility alone would not affect migrating organisms unless it were very near one of the major passes into the bay systems. It is not known whether a massive oil spill would be more damaging during large migrations than during others. Poorly placed channels or canals where spoil banks cross shallow bays would come nearly or completely to the surface and might affect migration into certain areas.

Massive Oil Spills

Data on the effects of major oil spills or the effects of spilled oil on biological systems are somewhat fragmentary and contradictory. The most intensively studied oil spills are the Tory Canyon wreck and the oil spill in the Santa Barbara Channel. Both of these accidents occurred in areas characterized by rugged coasts with cliffs and pocket beaches. No study has been made of the effects of a major oil spill in a broad, shallow, salt-marsh estuarine system such as the Louisiana coast. In the two major well blowouts off coastal Louisiana (Chevron spill, March 1970, Murray, Smith, and Sonu, 1970; Shell spill, January 1971, Watson, Terry, and Buckmeier, 1971), the greater part of the spilled oil was swept away from the marshes by currents.

Interpretation of data concerning the effects of oil on various components of the biota are varied. Mackin and Hopkins (1962) found no evidence that oil affected oysters in coastal Louisiana waters. Reports indicate that no long-term damage resulted from the Santa Barbara or Tory Canyon incidents (Smith, 1968). Blumer et al. (1970) reported the effects of a spill of No. 2 fuel oil in Buzzards Bay, Massachusetts, an estuary bordered by marsh (see also Blumer and Sass, 1972). They found that the composition and concentration of oil in the sediments remained nearly unchanged for four months after the spill. They found oil in whole oysters and in the adductor muscle of the scallop. Further, they concluded that a presumably biochemical modification leads to a gradual depletion of straight chain, and to a lesser extent branched chain, hydrocarbons. The more toxic aromatic hydrocarbons were retained in the organisms several months after the spill. Mitchell (1972) indicated that the water-soluble fraction of crude oil (10% oil) was not toxic to bluegill or catfish but caused 64% mortality to small crustaceans (Daphnia) and a 50% reduction of the cell division rate of a marine diatom. Many workers have shown that commercial oil emulsifiers are much more toxic than crude oil alone, and that emulsifier-crude oil mixture is more toxic than either alone.

As previously emphasized, one of the most important processes in the estuary is the conversion of marsh grasses to detritus. Microbes and meiobenthic organisms play a major role in this conversion. Any effects of oil on this conversion could be seriously detrimental. It has also been reported that oil will adhere to particulate matter in the water (Mackin and Hopkins, 1962). Most of the detritus exported from the marshes is very small. If these detrital particles were coated with oil, the oil would move very easily into the biota.

Scenic, Historic, and Archeological Resources

The Des Allemands-Barataria estuarine management area is an aesthetically pleasing coastal wetlands area close to the heavily populated greater New Orleans urban center. As such it is a major recreation resource. The center of the estuary provides direct access, through inland waterways, to the Gulf from the New Orleans area. The Grand Isle part of this management area is the only major Gulf shore development in the state. The area is steeped in historic lore and abounds in prehistoric Indian village sites. As a part of the Mississippi deltaic plain, one of the largest delta systems in the world, it is an important and unique natural wonder. The vast areas of shallow lakes and bays, extensive marshes and swamps, oak covered natural levee ridges and sandy gulf barriers, and the abundance of migratory waterfowl and indigenous birds, animals and marine life give the region a unique character and present great opportunities for recreation. Sports fishing and hunting are well known, and the beauty of this area's sinuous waterways and picturesque fishing villages provide other attractions.

IV. Other Environmental Considerations

Final selection of the site must be based on a comprehensive inventory of existing environmental data. The inventory should be the basis for evaluation of stresses imposed on the environment by construction, operation, and future development of the Superport. It is also required for assessing constraints imposed by foundation conditions, storm vulnerability, waves, currents, fog. The site selected should have the least possible number of known stresses and constraints, and the choice should not be based on economic considerations alone.

The total impact of environmental stresses, both primary and secondary, must be evaluated so that adequate compensatory measures can be provided. The traditional cost-benefit analysis is not appropriate. Evaluation should be based on primary biological productivity, or perhaps on acres of specific types of habitat affected by the development.

The facility design must minimize potential environmental damage. Seasonal changes in the intensity of natural phenomena must be considered in the design. However, environmental factors should be utilized in a positive manner wherever possible. For example, prevailing currents may be used as a natural flushing mechanism to move leakage and/or accidental spills away from the coast. Long-term restrictions must be included in the facility development plan. Once established, the Superport cannot be allowed to grow in a random manner. Case studies of existing projects clearly demonstrate that such development can only result in gradual environmental deterioration.

Restrictions on land links, size and location of support facilities, and other constructions that may either directly or indirectly serve the port facility must be included in the original proposal.

Facility operation must be conducted in a manner that will minimize environmental problems. The operation must be monitored by professional scientists. Monitoring should be conducted before, during and after construction in order to establish ecological baseline data necessary for evaluating environmental stresses and impact. It is assumed that these monitoring operations will be conducted by the Louisiana Wild Life and Fisheries Commission and other authorized state and federal agencies. However, the authority and enforcement provisions of these agencies should be reviewed in reference to the Superport and responsibilities should be clearly defined. The enforcement provisions, along with mechanisms to insure cleanup of accidental spills by technical means with a surety bond to guarantee performance, are important environmental considerations. Compensatory provisions should be written into the plan, based on a realistic assessment of primary and secondary stresses created by the Superport development. Measures might include creating marshland preserves--in any portion of the state's coastal zone--designed and managed such that the environment will be enhanced and biological productivity optimized. New marshlands might be built through controlled diversions near the mouth of the river. New land created through deltaic processes in shallow bays near the mouth of the Atchafalaya River might be placed under the control of a publicly owned wetland management trust. Supplementary freshwater injection or delivery systems might be constructed for use in estuarine management programs. Manmade barrier islands might be built along the shores of large lakes and bays to reduce erosion and diversify natural habitats. These and many other proposals should be evaluated and selected projects implemented with funds derived from Superport revenues.

Careful consideration of environmental factors throughout the design, construction and operation phases of the project and the judicious use of compensatory provisions can insure that the Louisiana deepwater port will be of both economic and environmental benefit to the people of this state.

V. Selected References

Bea, R. G., 1971, How Sea Floor Slides Affect Offshore Structures. Oil and Gas Journal, Nov. 1971, pp. 88-92.

Blumer, M., G. Souza, and J. Sass, 1970, Hydrocarbon pollution of edible shellfish by an oil spill. Marine Biology, 5:195-202.

Blumer, M. and J. Sass, 1972, Hydrocarbon pollution of edible shellfish by an oil spill. Science, V. 176(4039):1120-1122.

Day, J., W.J. Smith, P. Wagner and W. Stowe, 1972, Community Structure and Energy Flow in Salt Marsh and Shallow Bay Estuarine System in Louisiana. Department of Marine Science, Center for Wetland Resources, Baton Rouge, Louisiana.

Mackin, J. and S. Hopkins, 1962, Studies on oyster mortality in relation to natural environments and to oil fields in Louisiana. Publ. Inst. Mar. Sci., University of Texas, 7:1-126.

Mitchell, D. M., 1972, "The susceptibility of bluegill sunfish and channel catfish to crude oil and oil emulsifiers," unpublished MS thesis, LSU, Baton Rouge, Louisiana.

Morgan, James P., James M. Coleman and S.M. Gagliano, "Mudlumps: Diapiric Structures in Mississippi Delta Sediments," reprinted from "Diapirism and Diapirs-Memoir No. 8," The Amer. Assoc. Pet. Geol., 1968.

Murray, S. P., W. G. Smith, and C. J. Sonu, 1970, Oceanographic Observations and Theoretical Analysis of Oil Slicks During the Chevron Spill, March 1970, Coastal Studies Institute, LSU, Technical Report No. 87.

Penman, H. L., 1970, The Water Cycle, Scientific American, v. 233(3): 89-108.

Shepard, Francis P., 1955, Delta Front Valleys Bordering the Mississippi Distributaries, Bull. Geol. Soc. Am., V. 66:1489-1498.

Smith, J. E. (Ed.), "Torrey Canyon, Pollution and Marine Life;" A report by the Plymouth Laboratory of the Marine Biological Association of the United Kingdom, Cambridge University Press, 1968.

Watson, J. A., S. A. Terry, and F. J. Buckmeier, Oceanographic and Remote-Sensing Survey in the Vicinity of the Shell Spill, Gulf of Mexico, January 1971, Final Report. Texas Instruments Incorporated, Prepared for Environmental Protection Agency, Contract No. 68-01-0017.

SELECTED ENGINEERING ASPECTS OF A SUPERPORT

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SELECT ENGINEERING ASPECTS OF A SUPERPORT

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Part I. ENGINEERING RECOMMENDATIONS

Floating buoys, articulated columns, and small platforms can handle liquid and slurried cargo only. Because a buoy or column can be installed at a cost of a few million dollars, the lower cost puts these structures in the reach of individual companies when the need for supertanker service arises. For very large quantities, a small platform, costing from $20 to $60 million, would be better suited to state participation.

If the proposed port must also transfer and store bulk solids and liquids, containerized cargo, and general cargo, then a major structure will be required. According to present knowledge, man-made islands or platforms on piers are unacceptable for 100-foot depths and the bottom conditions prevalent along the Louisiana coast. Therefore, extensive investigations of both large semisubmerged platforms and large storage tanks (in the 100- to 200-acre sizes) should be carried out. Once the structure type has been chosen, the feasibility of the additional uses can be evaluated.

The superport structures study group feels that a large semisubmerged platform composed of modules of approximately 1 acre in size should be given serious consideration. The initial port could be a terminal for oil and gas and should be composed of several modules. This first-stage port, which could conceivably be only 2 or 3 acres, should amount to about 10 percent of the final 200-acre superport cost, and yet it would satisfy current and immediate future (3-5 years) needs. The several modules constituting the initial port would provide a means of studying module design and the feasibility of semi-submerged platforms. It should be composed of several modules to permit a study of the joint design. As necessary, modifications can be made to modules used in future additions.

An advantage of modular construction is that the module can be fabricated at a shipyard and towed to the assembly site. This would greatly reduce offshore construction and would hold down costs. As the need arises for the port to handle additional types of cargo, modules can be added to provide more platform areas. Anchor techniques could be changed as the total structure developed.

A platform built on piles would probably prove to be unfeasible for the bottom existing along the coast. A semisubmerged platform is secured to the bottom by mass anchors which are embedded in the bottom. The load-bearing area of these anchors could be made large to reduce any sinking or shifting tendency. The upward force exerted on the anchors by the platform would help in this respect. If the semisubmerged platform cannot be anchored, then a structure such as a large concrete storage platform should be considered. This could also be modular and would have a load-bearing area essentially as large as that of the platform.

At this stage of study, several areas of basic research associated with a superport can be defined. An extensive study of the soils mechanics of the sediment in the construction area should be made. The ability of the bottom to hold and support anchoring systems of various structures must be determined. The type of structure selected will depend heavily on these results.

Another research area is a model study of possible structure types. Scale models of the various structures should be prepared and subjected to sea state and weather conditions which can be expected in the Gulf. Attempts should be made to simulate bottom conditions so that the model tests can include the anchoring systems.

A final study subject is the wave barriers that would be required to protect docked ships and the structure. Possible barrier types would include rigid structures such as piling, floating structures, and new concepts such as a perimeter of air bubbles. The air bubbles in the latter case would be emitted from the bottom along the barrier line. The emerging bubbles would tend to disrupt incoming waves.

Part II. LITERATURE SURVEY OF SUPERPORT STRUCTURE

I. Introduction

This survey of available information on superport structures, made by the LSU Division of Engineering Research, was limited to the classification of offshore ship terminals that could be constructed in Louisiana coastal waters. The structural types listed below and described in the following section are extant, are being designed, or have been proposed:

A. Single-point mooring

   1. Floating buoy
   2. Articulated column

B. Floating platform

   1. Small semisubmerged platform
   2. Large semisubmerged platform
   3. Displacement hull

C. Rigid platform

   1. Small platform on piles
   2. Large platform on piles
   3. Storage tank

D. Manmade island

Besides a general classification and description of the structural types and their appurtenant subsystems, their advantages and disadvantages are compared in Section III. The possibility of a multi-use terminal is broached in Section IV. Some foreseen engineering problems, stemming from the geology of the coast, are mentioned in Section V, and are followed by recommendations for further investigations and a bibliography.

II. Types of Terminal Structures

A. Single-point mooring

A single-point mooring structure is characterized by single-line mooring of a ship to the terminal. The ship heading varies with the wind and the current, the ship seeking a position of least resistance. Such a terminal can serve only one ship at a time. It is also limited to liquid and slurried cargoes. A positive aspect to single-point mooring terminals is the great reduction in danger from ship collisions or other mishaps in crowded channels and harbors, and the correlative minimization of water pollution resulting from such collisions.

1. Floating buoy

A large floating buoy positioned by several flexible lines anchored to fixed points on the bottom is another type of terminal structure. The cargo is transferred through flexible pipelines attached to a 360° swivel head on the buoy to allow complete rotation of the ship about the buoy. Submarine pipelines carry the cargo between the buoy and subsurface, floating, or onshore storage areas. Shore-based pumping stations can also interface the terminal directly with inland customers, or the terminal may serve as a transfer buffer between supertankers and smaller tankers. Some terminals are capable of handling five different cargoes simultaneously (existing terminals are listed in Table 1). A typical installation is shown in Figure 1.

Special characteristics of the floating buoy terminal are as follows:

a. Cargo

The cargoes are limited to liquids, such as crude or refined petroleum, cryogens, asphalt, molasses, wine, and vegetable oils, and slurried solids, such as salt, iron ore, limestone, coal,

TABLE 1

LOCATIONS AND CHARACTERISTICS OF SINGLE POINT MOORING SYSTEMS PRESENTLY IN USE

Year	Country	Location	Owner	Number & Size of Hoses	Size of Tankers dwt
1959	Malaysia	Muri	Shell	2 x 8" + 1 x 6"	32,000
1959	Malaysia	Miri	Shell	2 x 8" + 1 x 6"	32,000
1959	Malaysia	Miri	Shell	2 x 8" + 1 x 6"	32,000
1959	Malaysia	Miri	Shell	2 x 12"	32,000
1962	Malaysia	Port Dickson	Shell	3 x 12"	90,000
1962	Japan	Niigata	Shell	3 x 12"	90,000
1962	Japan	Yokkaichi	Shell	2 x 16"	90,000
1962	Japan	Yokkaichi	Shell	2 x 16"	90,000
1963	Oman	Mina-al-Fahal	Shell	1 x 8" + 1 x 8" reserve	165,000
1965	Libya	Ras-es-Sider	Oasis	3 x 16"	100,000
1965	Qatar	Halul	Shell	2 x 16"	100,000
1965	Gabon	Port Gentil	Shell	2 x 16"	100,000
1966	Spain	Huelva	Gulf	2 x 16"	100,000
1966	Oman	Saih-el-Malih	Shell	2 x 16" + 2 x 8"	165,000
1966	Oman	Saih-el-Malih	Shell	2 x 16" + 2 x 8"	165,000
1967	Gabon	Port Gentil	Shell	2 x 16"	100,000
1968	Egypt	Ras el Shaqiq	Wepco	2 x 16"	100,000
1968	Cabinda	CAB. 702 Area K	Gulf	2 x 16"	100,000
1968	Libya	Zuetina	Occidental	1 x 24"	100,000
1968	Venezuela	Moron	CVP	1 x 16" + 1 x 16" reserve	100,000
1968	Libya	Zuetina	Occidental	1 x 24" + 1 x 24" reserve	150,000
1968	Libya	Zuetina	Occidental	1 x 24" + 1 x 24" reserve	150,000
1968	Nigeria	Forcados	Shell	2 x 20"	200,000
1968	Nigeria	Forcados	Shell	2 x 20"	200,000
1968	Trucial	Fateh Field	Continental	2 x 16"	150,000
1968	Brazil	Tramandei	Petrobras	2 x 16"	105,000
1969	South Africa	Reunion Rocks Duban	Shell-BP-Mobil	2 x 24"	200,000
1969	Canada	Mispec Point	Irving Oil Co	1 x 24" + 1 x 16"	350,000
1969	Libya	Ras Lanuf	Mobil Oil	2 x 24"	255,000
1969	Italy	Taranto	Shell	Auxiliary buoy for floating hoses - convent mooring	300,000
1969	Libya	Ras-es-Sider	Oasis	2 x 24"	255,000
1970	England	Humber River	Continental	1 x 24"	210,000

Table 1--Continued

Year	Country	Location	Owner	Number & Size of Hoses	Size of Tankers dwt
1970	Italy	Porto Torres	Sardoil	2 x 20"	255,000
1970	Iran	Cyrusfield	Ipac	2 x 16" Permanent mooring ror a storage barge capable of storing 900,00C bbl.	
1970	Saudi Arabia	Zuluf	Aramco	2 x 24", 1 x 16" Permanent mooring for a storage tanker of 250,000 dwt	
1970	Saudi Arabia	Zuluf	Aramco	2 x 24"	450,000
1970	Australia	Botany Bay	M.S.B. of N.S.W.	3 x 12"	120,000
1970	Brazil	Tramandai	Petrobras	1 x 24"	200,000
1970	Nigeria	Escravos	Gulf	2 x 24"	300,000
1970	Norway	North Sea in 230 ft water depth	Phillips	Under buoy: 1 x 20" - Floating: initially 1 x 6" hose line	60,000
1970	Norway	North Sea in 230 ft water depth	Phillips	Under buoy: 1 x 20" - Floating: initially 1 x 6" hose line	150,000
1971	Taiwan	Kaohsiung	C.P.C.	2 x 20"	250,000
1971	Borneo	Brunei	Shell	2 x 20"	250,000
1971	Chile	Quintero Bay	Enap	2 x 20"	209,000
1971	Dominican Republic	Santo Domingo	Refineria Dominicana	2 x 16" 1 x 12"	150,000
1971	Ecudor	Esmeraldas	Gulf/Texaco	2 x 20"	100,000
1971	Ecudor	Esmeraldas	Gulf/Texaco	1 x 24", 1 x 20"	100,000
1971	Trinidad	Galeata Port	Amoco	2 x 20"	250,000
1971	Nigeria	Forcados	Shell	2 x 24"	375,000
1971	Nigeria	Boni	Shell	2 x 24"	375,000
1971	Nigeria	Boni	Shell	2 x 24"	375,000
1971	Indonesia	Balikpappan	Union Oil of Calif.	2 x 20", 1 x 16"	250,000

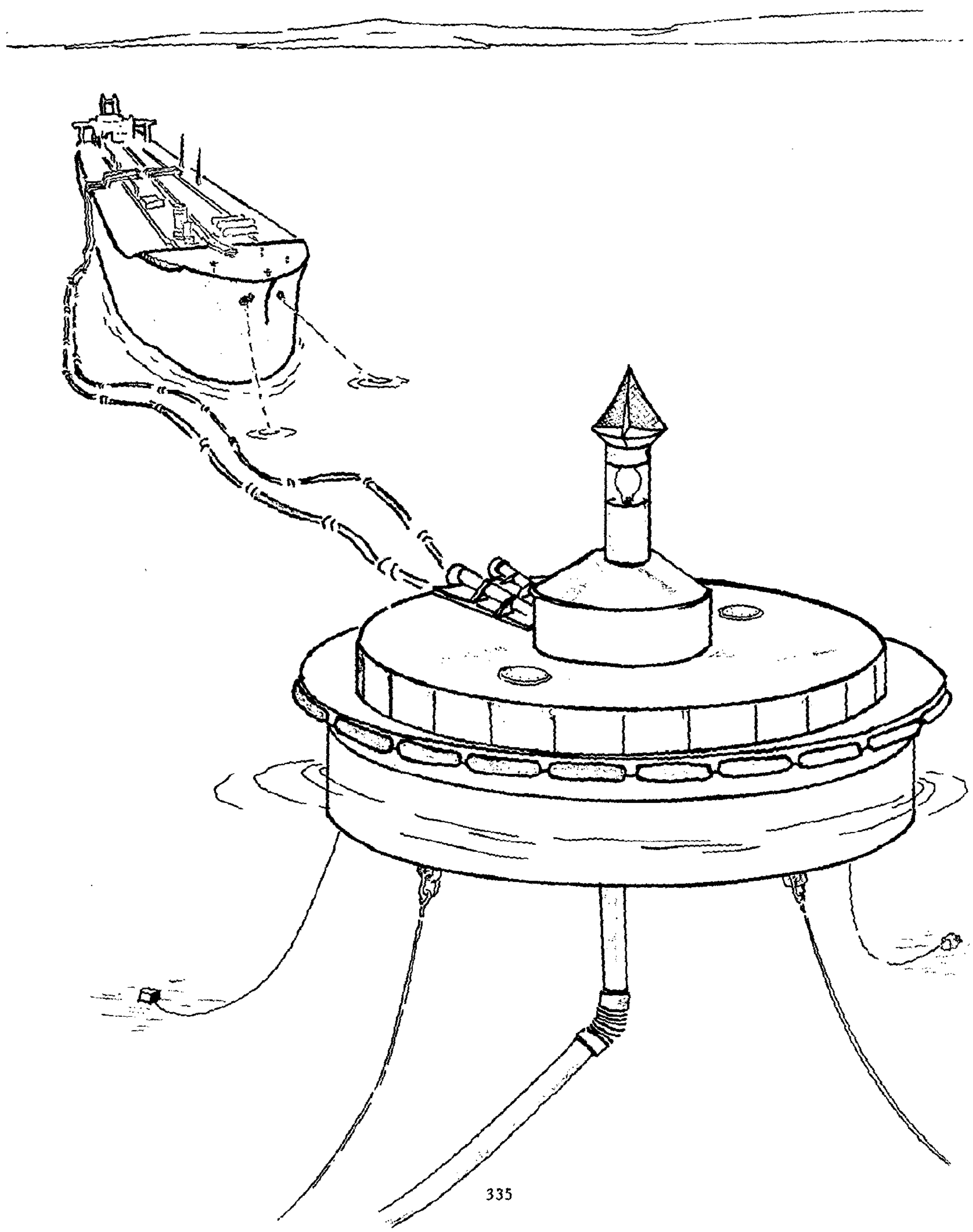
Table 1--Continued

Year	Country	Location	Owner	Number & Size of Hoses	Size of Tankers dwt
1971	Denmark	North Sea in 150 ft waterdepth	Gulf Denmark	Underbuoy: 1 x 12" Floating: 1 x 6"	70,000
1971	U.A.R.	Alexandria	E.G.P.C.	2 x 24"	250,000
1971	U.A.R.	Alexandria	E.G.P.C.	2 x 24"	250,000
1971	U.A.R.	Alexandria	E.G.P.C.	2 x 20"	120,000
1971	U.A.R.	Alexandria	E.G.P.C.	2 x 20"	120,000
1971	U.A.R.	Alexandria	E.G.P.C	2 x 20"	120,000
1971	U.A.R.	Suez	E.G.P.C.	2 x 24"	250,000
1971	U.A.R.	Suez	E.G.P.C.	2 x 24"	250,000
1971	U.A.R.	Suez	E.G.P.C.	2 x 20"	120,000
1971	Tanzania	Dar-Es-Salaam	East African	2 x 24"	100,000
1971	Spain	Tarragona	Shell	2 x 24"	60,000 (fixed mooring)
1961	Spanish Sahara	El Aaiun	C.E.P.S.A.		
1962	West Germany		West German Navy		
1963	Japan	Oita	Kyushu Oil Corp.		
1963	Spanish Guinea	Bata	C.E.P.S.A.		
1964	Korea	Ulsan	Korea Oil Corp.		
1965	Japan	Chiba	Maruzen Oil Corp		
1967	Japan	Koshiba	U.S. Army		
1967	Philippines	Subic Bay	U.S. Navy		
1967	Taiwan	Tai-Chung	U.S. Air Force		
1967	E.Pakistan	Chittagong	Chittagong Port Trust		
1967	Nigeria	Lagos	Nidogas		
1968	Korea	Yosu	Honam Oil Refin.		
1968	Korea	Ulsan	Korea Oil Corp.		
1968	Taiwan	Kaohsiung	Chinese Pet. Corp.		
1968	Japan	Hakozaki	U.S. Army		
1968	Taiwan	Tai-Chung	U.S. Air Force		
1968	Nigeria	Escravos	Gulf Oil		
1968	Japan	Hakodate	Asia Oil Corp.		

Table 1--Continued

Year	Country	Location	Owner	Number & Size of Hoses	Size of Tankers dwt
1969	Japan	Toyama	Japan Sea Oil Co.		
1970	Indonesia	Pangkalan	Pertamina		
1970	Argentina	Puerto Rosales	YPF		
1970	China	Singapore	Esso		
1970	Okinawa	Tengan	U.S. Army		
1970	Persian Gulf	Iman Hasan	SIRIP		
1970	Okinawa		Toyo Gasoline		
1970	Japan	Himeji	Idemitsu Oil		
1970	Morocco	Mohammedia	RAPC		
1971	New Zealand	Waipipi Point	Marcona Corp.		
1971	Nigeria	Oua Iboe	Mobil Oil Corp.		
1971		Java Sea	IIAPCO		
1972	New Zealand	Taharoa	New Zealand Steel Corp.		
1972		Das Island	British Petroleum		
1972		Java Sea	ARCO		
1972		Umm Said	Qatar Petroleum		

FIGURE 1 - SINGLE-POINT MOORING BUOY



alumina, bauxite, laterite ores, and base metal concentrates, or other bulk liquids or slurries.

b. Supporting subsystems

A pumping system (with or without storage) and a small launch to assist in mooring tankers are necessary.

c. Support personnel

A small crew is needed to operate the launch and maintain pumps, lines, and swivel connections.

d. Ship-to-shore/base interface services

None are provided except limited transfer of tanker crewmen to and from shore.

e. Cost

The cost depends on the depth under the terminal. For a depth of 100 feet, the installed cost of the buoy and hoses comes to $1,000,000. The added cost of storage will depend on the volume and storage system.

f. General environmental impact

The bottom area would be minimally disrupted during the installation of the buoy and pipelines. Other impact would depend on the storage or transfer system.

g. Engineering subsystems

No other structures, machinery, or life support systems are required.

h. Site limitations

The bottom must hold the anchor points of the buoy with a tanker moored in rough seas. Loading and unloading are possible also in rough water, while conventional terminals require breakwaters or natural protection against waves.

2. Articulated column

The articulated column is characterized by a cylindrical tower that extends from a universal joint on the ocean floor to a height of about 50 feet above the water surface. Such a terminal would serve as a single-point anchorage for the loading and unloading of liquids and slurries in much the same way as a floating buoy operates. Included, however, are special features, such as living quarters for a small mooring and maintenance crew in the upper section of the column, a heliport on top, and cargo storage in the lower part of the column. The flexible transfer lines and swivel mooring used for floating buoys apply also to the articulated column. A typical installation is shown in Figure 2. The only current example, in the Bay of Biscay, has been used successfully since 1968. It was installed 18 miles offshore in 330 feet of water. It is designed for 65-foot waves with 16-second periods and water velocities of 2.7 feet per second combined with winds up to 135 mph.

Other characteristics of articulated columns are as follows:

a. Cargo

The cargo limitations are the same as for floating buoys (liquids and slurries).

b. Supporting subsystems

Pumping facilities for liquids and slurries are needed, along with a small launch for use in mooring tankers. The storage system may be offshore (submerged or floating) or onshore. To some

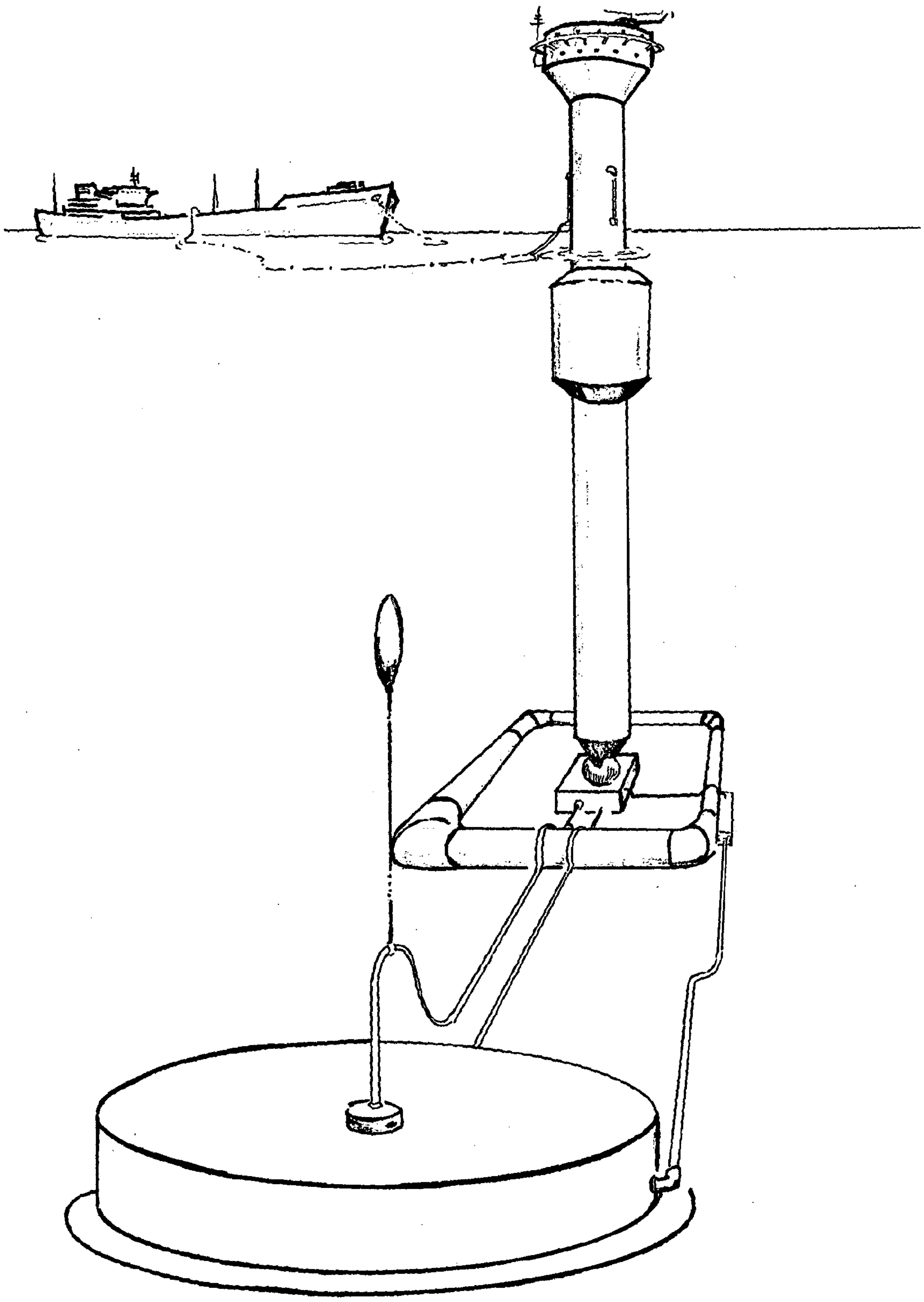


FIGURE 2 - ARTICULATED COLUMN

extent storage may be provided in the column.

c. Support personnel

A small on-site crew is needed to operate the launch and provide maintenance on the terminal.

d. Ship-to-shore/base interface services

Limited tanker crew accommodations and terminal-to-shore transfer may be provided. In addition, ships can take on supplies previously transported to the terminal by small boat and helicopter. Minor loading and unloading equipment would be located on the platform for this purpose.

e. Cost

The cost would depend on the water depth. The terminal in the Bay of Biscay cost about $1,500,000 (330 feet of water). Storage capacity is not included. Such a terminal would be more economical than floating buoys at depths of more than 200 feet.

f. General environmental impact

The base for the tower would occupy about 5,000 square feet of ocean floor. Permanent disruption of this area and any area used for submerged storage would result. However, as with a floating buoy, any disruption at 100 feet or deeper is very minor.

g. Engineering subsystems

Needed are essential life-support systems such as electrical power, fresh water, food storage and preparation, ship-to-terminal and terminal-to-shore communication, evacuation facilities, and living quarters for the tower crew. In addition, systems are required for material handling, equipment and machinery decks, universal joint lubrication, ballasting to maintain stability, instrumentation to monitor the column, etc.

h. Site limitations

These terminals can be designed for nearly any sea state and depths up to 1500 feet. The bottom area must be capable of supporting the base.

B. Floating Platform

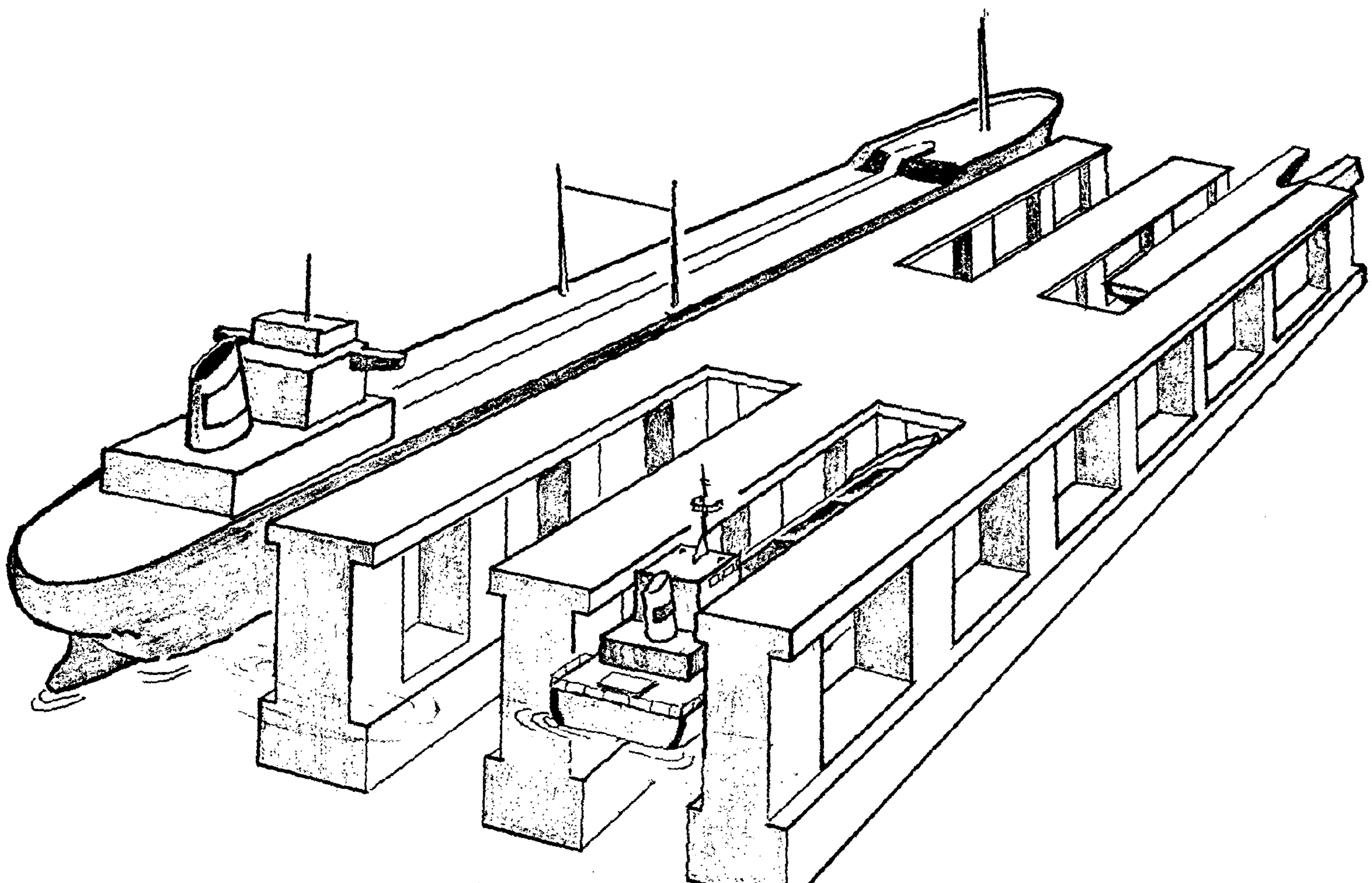
This type of terminal consists of a platform ranging in area from one to several hundred acres. It is supported by buoyant force and is anchored by lines to fixed points on the ocean bottom. Ships are moored with a fixed heading by multiple lines.

1. Small semisubmerged platform

The small semisubmerged terminal is shown schematically in Figure 3. The platform is supported on columns attached to a submerged buoyant member. It is high enough above the surface to avoid wave action under the worst seas and to permit easy cargo transfer. The buoyant member is set below the active depth of the water. The only portions of the structure subject to wave energy are the narrow columns connecting the platform and the buoyant member. This arrangement provides a very stable platform when the buoyant member is anchored to the bottom. Even though the water surface changes with tides and wave motion, the small variations in displacement volume of the columns have little effect. Thus there is very little tendency for the platform to move.

The small semisubmerged platform is characterized as one which has an area on the order of a few acres. Intended to handle

FIGURE 3 - SMALL SEMISUBMERGED PLATFORM



liquid and slurried cargoes only, it would be functionally similar to the articulated column except that ship mooring would be on a fixed heading and cargo transfer could be faster. Structures of this type have been used successfully for mobile, stable drilling rigs where deep water made it unfeasible to use fixed or jack-up platforms.

Other characteristics of small semisubmersible platforms are as follows:

a. Cargo

Same as for single-point mooring terminals.

b. Supporting subsystems

A storage capacity of 1,500,000 barrels is possible, the structure itself is used as a tank. Pumping and pipeline systems are needed in conjunction with loading, unloading, and storage of cargo. Conventional loading arms and service cranes are used on this structure for hose hook-up and loading of ship's supplies, spare parts, etc. A ballast system with pumps and tanks throughout the structure is used to maintain the required draft and shift the center of gravity during loading and unloading. Other needed fluid systems are compressed air, fresh water, oil bunkers, and lubricating oil. The compressed air is used for pneumatic fenders and normal marine service air requirements. A freshwater generation system, such as an evaporator, is needed to supply ships and the platform.

c. Support personnel

Three eight-man shifts are needed for operation and general maintenance of the terminal. One man per shift serves as cook, steward, etc,; two per shift control the ballast and cargo flow, keep the engine-room watch, and handle radio communications; and five per shift dock the tankers and barges, operate the loading arms, load the tankers with fresh water, fuel oil, lubricants, and stores.

d. Ship-to-shore/base interface services

These are generally the same as for articulated columns except that interface services can be carried out more quickly and conveniently. Fresh water, lube oil, bunkering, stores, spares, and minor maintenance services can be easily afforded supertankers.

e. Cost

The cost is estimated at $10 to 50 million. The platform can be designed to hold approximately one million barrels of crude in the structure itself. Therefore, the need for additional storage area is not a factor, as it is with single-point mooring terminals.

f. General environmental impact

Distrubances during construction or from the structure itself would be comparable to single-point mooring terminals. The advantage of this and every other offshore terminal is that any spills or pollution will occur offshore, not in inland waterways and harbors, thus reducing the chance of disrupting the wildlife and fish breeding grounds. If spilling occurs, the pollutant can be contained and cleaned up before it can cause damage. Any offshore port should have a means of cleaning up pollution from spills.

g. Engineering subsystems

Engineering subsystems would be the same as for articulated columns, but they would be more sophisticated in design and output because the needs would be greater.

h. Site limitations

Small floating terminals may be located anywhere as long as the bottom will support and hold the anchor points. The depth is limited by the excessive dead load stresses in long anchor lines. A practical limit would probably be 400 feet. Loading and unloading operations can be carried on in sea states up to 6 feet.

2. Large semisubmerged platform

Schematics of a typical large platform are shown in Figures 4 and 5. The area ranges from 50 to 150 acres. This type of terminal is intended to be comparable to a conventional port, with all its interface services and cargo handling ability. It would have sufficient space for bulk storage of ore, grain, coal, etc., a warehouse area for general and containerized cargo, offices and housing, and possibly an aircraft landing strip. This requires a multideck structure so that warehouses, housing, offices, cafeterias, mechanical equipment, etc., may be located below the top deck. The bulk storage, loading equipment, and runway space would be situated on the top deck.

Terminals of this type and size exist at present. However, airports as large as 1,000 acres (FLAIR Concept) have been proposed and are being considered. Hawaii is considering the possibility of floating an entire exposition or city on platforms similar to the ones proposed for FLAIR. The use of this type structure as a major ship port (expressed in several literature references) appears to be an excellent concept.

Large platforms would probably be composed of modules of

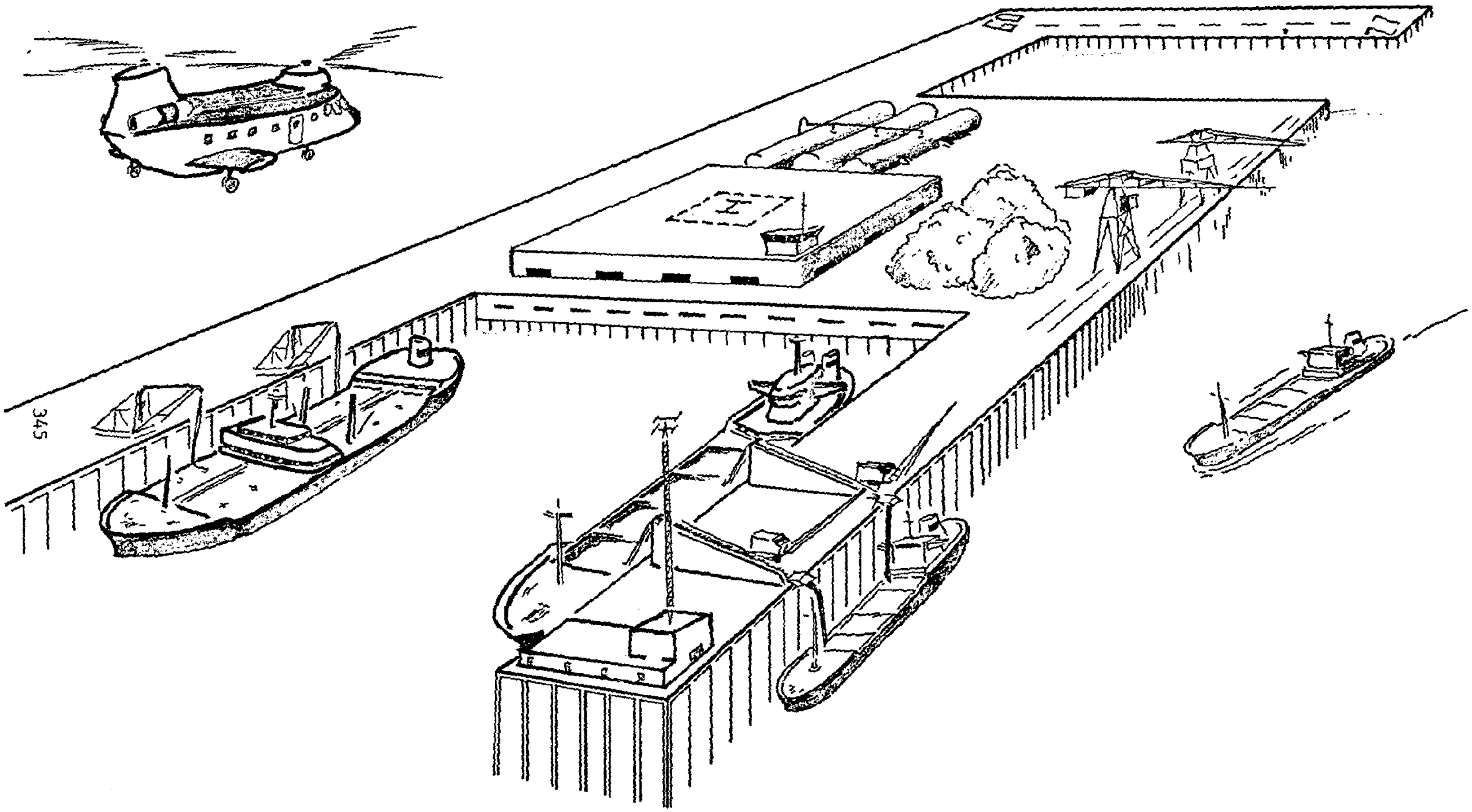
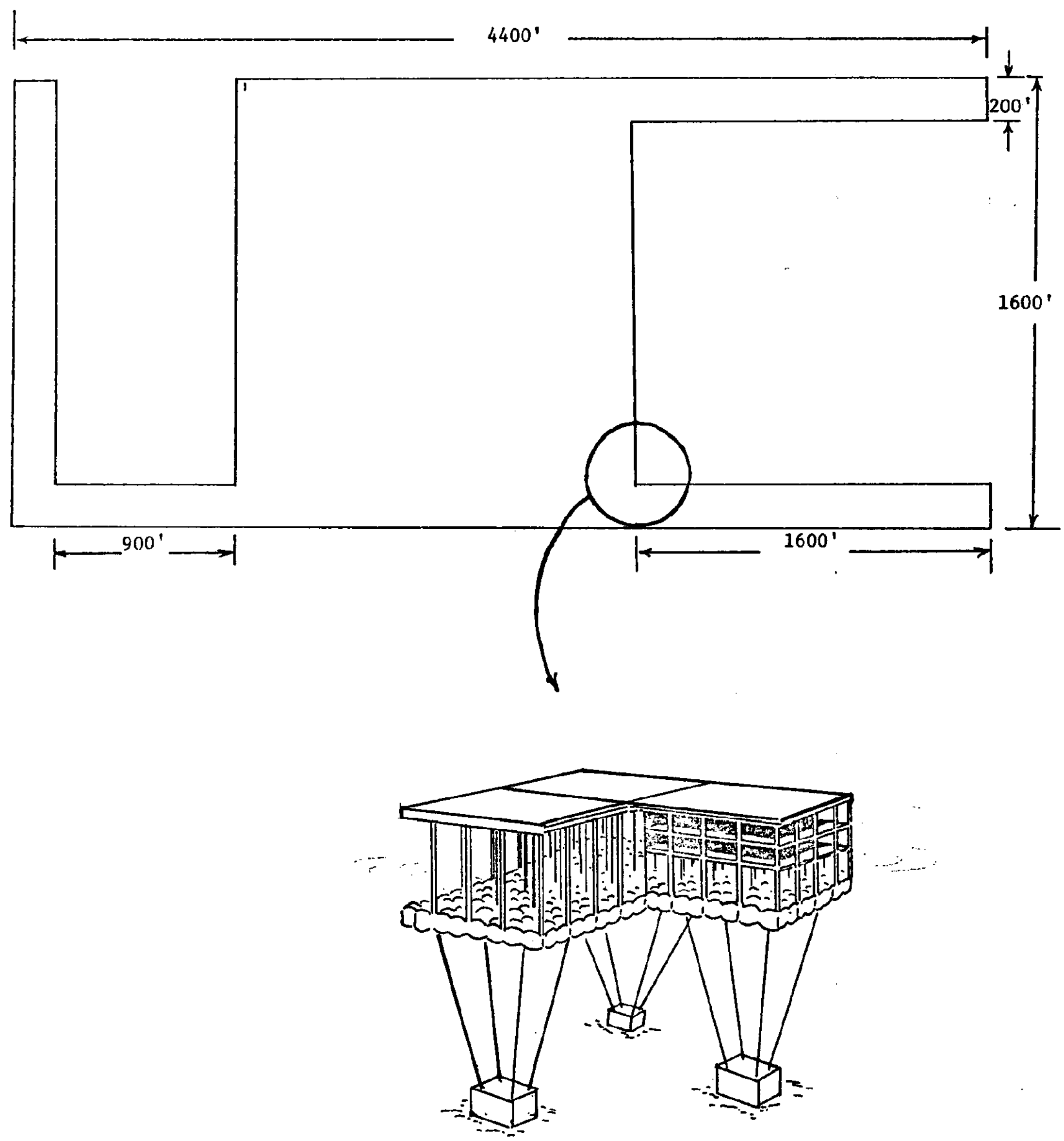


FIGURE 4 - LARGE SEMISUBMERGED PLATFORM

FIGURE 5 - MODULE SECTIONS WHICH COMPRISE SEMISUBMERGED PLATFORMS



about 1 acre that would be constructed at a shipyard, floated to the terminal site, and connected with other modules to form any desired platform size. A schematic of a module for the FLAIR airport concept is shown in Figure 5. Other module designs lend themselves more directly to liquid storage capacity in structural and buoyant members.

Other identifying characteristics are:

a. Cargo

All types of cargo could be handled at a terminal of this type. Additional storage area can be added when it is required.

b. Supporting subsystems

All subsystems required for the support of a shore-based port are also needed for this type of terminal, but unique requirements arise from its offshore location. These include a tugboat fleet, navigation buoys, breakwaters, a shore base, a support community, a weather station, an evacuation system, and a transportation system. The shore base would include businesses and residences that would normally serve the needs of a large port and the families residing in the area. The transportation system would include terminal-to-shore ferrying of people, cargo, and supplies (air and surface), and terminal-to-user distribution and receiving of cargo shipped in bulk. Cargo may be transferred by pipelines, barges, small ships, hovercraft, and aircraft.

c. Support personnel

This terminal would require the same personnel as a shore-based or inland port of the same relative size, with the addition of operations and maintenance people to operate special subsystems unique to offshore ports. These personnel would include a management staff, communication technicians, machine and electrical shop technicians, food service workers, dock workers, tugboat crews, janitors, medical personnel, operation and maintenance technicians, divers for underwater maintenance, mechanics, ship maintenance and service personnel, buoy tenders, secretarial and clerical staffs, public relations representatives, etc.

d. Ship-to-shore/base interface services

Ship unloading and loading systems of the offshore terminal would include derricks and cranes, ore conveyors, liquid and slurry pumps, and equipment for containerized cargo. Storage space would be available for all types of cargo. The transfer to shore and final destinations would be accomplished by barges, small tankers and cargo ships, air-cushion vehicles, aircraft, pipelines, and mechanical, pneumatic, and fluid conveyor systems. The pipelines could possibly occupy one quadrant of a transportation tube or tunnel (as discussed in Reference No. 19), while the conveyors, communication lines, and a rapid transit train (monorail, conventional, or pneumatic) could be located at the other three quadrants.

The terminal-to-ship services would include the supplying of fresh water, fuel and lubricants, spare parts, ship's stores, and maintenance and repair.

e. Costs

In Reference No. 4, the module sections for the FLAIR airport are discussed. A table from this reference is reproduced here as Table 2. It shows that, for each 200-foot x 200-foot platform section, the estimated cost is $1,500,000. A 100-acre platform for

TABLE 2

QUANTITIES AND COSTS OF
200 x 200-ft MODULE IN PLACE

Item	Material	Unit	Quantity	Unit Price $	Total, $
6-in. wearing surface	Reinforced concrete (cast in place)	sq. yd.	4,444	7.00	31,108.00
14-in. deck panels	Prestressed concrete (precast)	sq. yd.	4,444	50.00	222,200.00
Deck framing columns and diagonals	Structural steel	ton	864	400.00	345,600.00
Buoyancy chamber domes	Prestressed concrete (precast)	sq. yd.	10,500	45.00	472,500.00
Buoyancy chamber walls	Reinforced concrete (cast in place)	cu. yd.	3,000	120.00	360,000.00
Mooring cables	Zinc-coated marine cable	lin. ft.	1,020	6.00	6,120.00
Mass anchor "box"	Reinforced concrete (cast in place)	cu. yd.	260	120.00	31,200.00
Miscellaneous	. . . .	. . . .	. . .	. . .	60,000.00
Transportation & assembly	. . . .	. . . .	. . .	. . .	8,800.00
TOTAL	. . . .	. . . .	. . .	. . .	$1,537,528.00

the FLAIR design would cost $165,000,000. (Other designs will probably cost about the same.) The installation of a terminal on the FLAIR platform would cost an additional $150,000,000, for a total cost of $315,000,000.

f. General environmental impact

Disruption resulting from construction and maintenance of a large terminal would cover several hundred acres. However, in 100 feet of water it would probably not be a serious environmental threat. The land area near the terminal required for the construction of the shore base and support community would be a greater problem, depending on the location.

The terminal and shore base should have a pollution control and cleanup system to reduce or eliminate the danger of pollution.

g. Engineering subsystems

All systems needed for life support and operation of conventional shore-based ports are also necessary for large offshore terminals. Additional systems, such as freshwater and power generators, that are unique to the offshore ports are needed. The required engineering subsystems include electrical power generation; freshwater generation; communications; transportation (air and water) for personnel, cargo, and supplies; extensive living quarters; a medical infirmary; rest rooms, showers, and laundry service; waste disposal; a weather station; an office complex; machine, electrical, and carpenter shops; warehouses; cargo handling equipment, such as forklifts and carriers; emergency systems, including fire detection and fighting equipment and personnel evacuation; heating and air conditioning; auxiliary utilities such as compressed air and fuel; food preparation and storage; pumping systems for platform ballasting, cargo handling, and water and air distribution; a small helicopter/airplane terminal for persons and cargo; fender systems for ships and barges; cathodic protection against corrosion; and personal services such as recreation, sundries shops, barber shops, etc.

h. Site limitations

The practical depth limit is about 200 feet. The design sea state will be an extremely important economic factor; therefore, the more sheltered the site, the lower the cost. The local bottom area must be able to support the massive concrete anchors used to moor the modules. (Each anchor would weigh 200-300 tons submerged.)

3. Displacement hull platform

This type of platform is supported by an anchored displacement hull, such as a barge (or barges). The buoyant member floats at the water surface and thus must rise and fall with tides and waves, a condition which makes this type of structure unstable and undesirable as a ship terminal. However, it could be used in conjunction with a single-point floating buoy for the handling of liquids and slurries. In this case, the displacement hull could serve as a storage area. The Pazargod, in the Arabian Gulf, is of this type. With a capacity of 900,000 barrels, it serves as a collection point for crude oil produced in the Cyrus Field. Supertankers are loaded through the mooring buoy, to which the barge is permanently tied.

Other characteristics of displacement hull terminals are similar to those of other platform terminals (depending on size).

C. Rigid Platform

The rigid platform has an area ranging from 1 acre to several hundred acres and is supported by a rigid structure fixed to the ocean floor. This would generally be a platform on pilings but could also involve a huge storage tank extending from the ocean floor to above the water surface. The above-water portion would serve as a platform terminal. As with floating platforms, ship mooring would be multipoint with fixed heading.

1. Small platform on piles

The small platform on piles is similar to the small semi-submerged platform, except that the supports are rigid rather than buoyant. As with other small platforms, the cargo is limited to liquids and slurries. Terminals of this type have been constructed and operated satisfactorily in depths up to 100 feet. However, the problems encountered in driving piles at this depth are extreme. One such terminal was constructed in Bantry Bay, Ireland, in 100 feet of water. The hollow steel piles were 220 feet long and 40 inches in diameter. If the piles were not braced after emplacement, they soon broke off at the mud line. In spite of this problem, the terminal was completed. The entire project cost $25,000,000. A similar terminal is proposed in the North Sea off the island of Helgoland, near the coast of Holstein, West Germany. A slightly larger terminal is planned near New Brunswick, Canada, at a cost of $60,000,000, which includes an onshore 4,500,000-barrel tank farm and a trestle from the platform to shore.

Other characteristics of small platforms on piles are as follows:

a. Cargo

The cargo is limited to liquids and slurries as described for single-point mooring terminals and other small platforms.

b. Supporting subsystems

Same as for small semisubmerged platforms.

c. Support personnel

Same as for small semisubmerged platforms.

d. Ship-to-shore/base interface services

Same as for small semisubmerged platforms.

e. Cost

Estimated at $15 to 60 million in 100 feet of water.

f. General environmental impact

Same as for small semisubmerged platforms.

g. Engineering subsystems

Same as for small semisubmerged platforms and comparable to those of offshore drilling and production rigs.

h. Site limitations

The maximum depth is 100 feet. The bottom must be stable enough to support piles. Better bottom conditions are required for this type of structure than for floating terminals.

2. Large platform on piles

Similar to large semisubmerged platforms, large platforms on piles are intended as major ports for the handling of all types of cargo. The size would probably range from 50 to 200 acres. No existing or proposed structure of this type was found in the literature. It would probably be unfeasible to use this type structure as a major port in water deeper than 100 feet because of the cost of driving piles. Other costs would be comparable to those of large semisubmerged platforms. From the waterline up, the types are comparable.

3. Storage tank

An existing structure of the storage tank type is shown schematically in Figure 6. It is an island, constructed of concrete and steel, which contains liquid storage space. Water fills unused space through the bottom. The stored oil above the water is removed or added to from the top. The intrusion of water into the tank eliminates extremely high hydrodynamic forces that would result if the tank were partially full. A platform area on the top of the tank is used for loading and unloading facilities and other features of small platform terminals.

A structure of this type in 154 feet of water near Dubai has a capacity of 500,000 barrels. This terminal uses a single-point mooring buoy for tankers. Its total cost of $25,000,000 includes the following facilities: flow station, living quarters, pipeline and pumps, storage tank, offloading pumps and pipelines, offloading buoys, meters and provers, design costs, and mobilization and miscellaneous costs.

Another structure, scheduled for completion in 1972 at a cost of $20,000,000, will be a 21-acre artificial island in 164 feet of water in the Norwegian North Sea. It will store 1,000,000 barrels. Included in the cost are an oil and seawater separation system, living quarters, heliport, and tanker loading facilities.

Other characteristics of storage tanks are similar to those

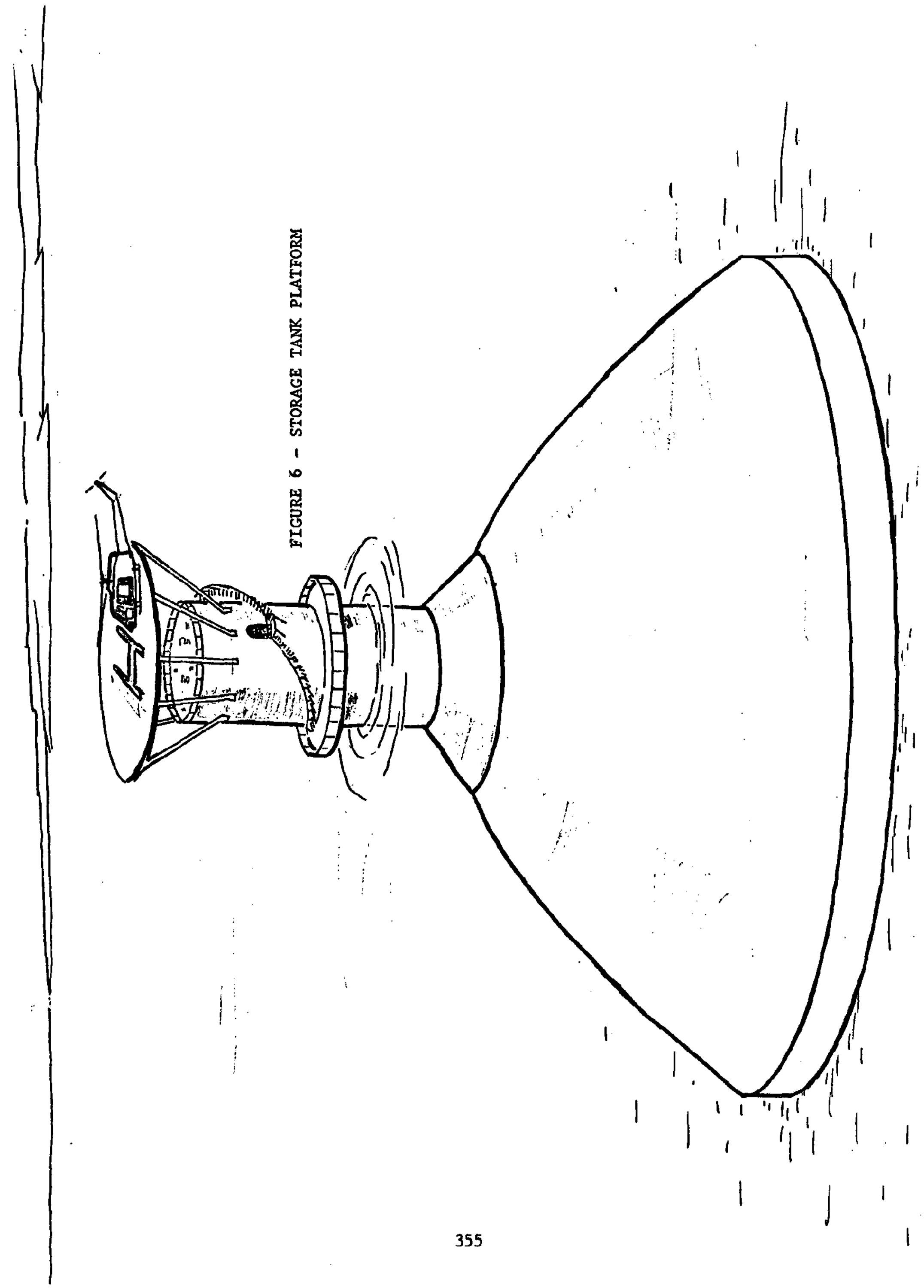


FIGURE 6 - STORAGE TANK PLATFORM

of small platforms and oscillating towers. It is possible, however, that much larger platforms, using this type of structure and comparable to other large platforms, could be designed.

D. Manmade Island

Manmade islands are earth islands, 100 to 300 acres in area, that are composed of dredge material. Conventional piers and dolphins are used for cargo transfer and anchorage. This type of terminal would probably be considered unacceptable for the proposed Louisiana superport because of the enormous amount of dredging and a probable restriction to depths of 50 to 75 feet. A terminal of this type proposed for the Delaware Bay bulk terminal to export coal would have covered 300 acres and cost $160,000,000. Coal was to have been shuttled to the island on barges for storage and transfer to super bulk carriers. The project was rejected by the Delaware legislature for environmental reasons.

III. Comparison of Structural Types

A. Single-Point Mooring

In general, single-point mooring terminals are less costly and can be used in more severe sea states than others. Because ship maneuvering and mooring are much easier, there is less danger of mishaps. However, the types of cargo are limited to liquids and slurries, and ship-to-port interface services and supplies are lacking. The articulated column has advantages over the floating buoy: the column can provide limited interface services, handle larger quantities of cargo, and house a mooring crew. The buoy, however, is less costly and can easily be relocated. An oil company could easily afford one in the Gulf.

B. Floating Platform

A small platform, as compared to a single-point mooring terminal, has a higher transfer rate, built-in storage capacity for liquids, and more and better ship-to-port interface services. The disadvantage is an increase in cost. Small platforms cost less than large platforms, but they are limited in types and quantities of cargo.

Floating platforms, as compared to rigid platforms, have fewer site limitations. Their platform height, size, and storage capacity may be easily varied through modular construction and assembly. At a 100-foot depth, the cost of either a rigid or floating terminal would be the same. However, a floating platform may, with some difficulty, be relocated, module by module. A rigid platform would have to be completely dismantled for moving. Semisubmerged floating platforms and rigid platforms are comparable in stability. Displacement floating platforms have the serious disadvantage of instability.

C. Rigid Platform

In comparison to other alternatives, rigid platforms on piles require better foundations in the ocean floor to support the piles. Rigid platforms built on large storage tanks would possibly have the fewest site limitations, the greatest storage capacity, the best stability, and the lowest cost. However, such advantages are only estimations and will require some basic research, especially on bottom requirements.

D. Manmade Island

Manmade island terminals, compared to others, cause considerable disturbance to the local environment of the construction site and in the areas from which dredge material is obtained. A depth limit of 50 to 75 feet would require cutting of approach channels to deeper water. Because ships would probably be moored to extension piers instead of the island proper, interface services would not be as convenient as with large platforms. The possible advantages of manmade islands are the greater surface areas and complete stability.

IV. Possible Multiuse Structure

Any one of the structures discussed could probably be made more economical if it were designed for more than one purpose. At a relatively small increase in cost, a large platform terminal can also carry a major airport. The platform, in this case, would have two main decks, the top deck serving as landing strips and air terminal, and the lower deck as the ship terminal. Another feasibility would be the inclusion of a large marine science laboratory or educational facility such as the Flower Gardens Ocean Research Center proposed for the Texas coast.

Other purposes that should be studied for inclusion are nuclear power plants and seawater desalting facilities. Along with the enormous supply of domestic electric power, fresh water could be obtained by distillation of seawater used for cooling in the power plant. This "piggyback" arrangement should prove to be economical because the desalting operation would use waste heat from power generation. It would also eliminate the need for smaller, more expensive systems needed to supply the freshwater and electrical needs of the platform, and the Atomic Energy Commission might be considered as a possible source of funds.

V. Engineering Problems

The design and construction of a superport off the mouth of the Mississippi River will involve problems in foundation engineering brought about by the unique geology of the Louisiana coast. This region has been extensively studied and evaluated by geologists and mineralogists. Some engineering interpretations of the foundation conditions have been made by oil companies for construction of drilling rigs. However, most of the information, in its present form, either is unusable by foundation experts or is so unresolved that only difficulties can be predicted.

The extensive deposits of organic silts and soft clays in this area are extremely unstable, from the standpoint of both dimensional stability and strength.

In addition to the problems of settlement prediction, pile length determination, and anchor systems design, there will be the unique phenomenon of Mississippi mudlumps. These small clay islands and submerged mounds apparently are uplifted during slow horizontal slumping and downward pressure of overlying deposits. Historically, they have occurred in conjunction with the more active sediment-laden river passes. Because the times and locations of mudlump building are not predictable (in engineering terms), a thorough study would have to be made to identify the problem, its causes, and its remedies. In addition, methods of predicting horizontal movements would be needed before construction.

VI. Annotated Bibliography of Available References on Offshore Terminals (Ports)

Preamble

This bibliography presents a summary of the literature available to reviewers which appears to have some value to the superport study group. A brief description of the contents of each paper is given. A subject index is presented in the following section for quick reference.

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1. SUPERTANKER LOADS ORE SLURRY AT SEA
no author
(Ocean Industry, August 1971, pp. 7-9)

This article discusses the Marconaflo system, developed by Marcona Corp. of San Francisco, which involves the loading of ship cargoes of bulk minerals in liquid or slurry forms, removal of the water for the voyage, and reslurrying the cargo for unloading at the destination. A single-point mooring buoy is connected to a storage facility by a 12-inch pipeline and a pumping station. System can be used to mine ores of marginal value where a deepwater port is not available. Numerous materials have been tested, including coal, salt, alumina, bauxite, laterite areas, and base metal concentrates.

2. FLOATING NUCLEAR POWER PLANTS NEAR REALITY
no author
(Ocean Industry, September 1971, p. 60)

This article discusses a planned joint venture between Westinghouse and Tenneco corporations in which floating nuclear power plants will be built on an assembly line basis. The floating platforms which will support the plants will be 400 feet square and will have a steel honeycomb structure to assure watertight security. The entire plant will weigh 150,000 tons and will produce 1,200,000 kilowatts. These platforms will be anchored in a stable manmade lagoon and will draw about 30 feet of water. This type of structure could possibly be used in the design of a superport.

3. CONSTRUCTING TANKER TERMINAL IN 100 FEET OF WATER
Fox, Vincent Scott
(Civil Engineering - ASCE, June 1970, pp. 63-65)

The existing supertanker terminal at Bantry Bay, Ireland, constructed in 1967 for the Gulf Oil Company as a crude oil terminal, is discussed. This port can handle tankers of 326,000 tons capacity and more. It is 1100 feet offshore and in 100 feet of water. The platform is on piles of hollow steel 220 feet long and 40 inches in diameter. During construction, the piles would break off at the mud line in 35 to 70 days if they were left unbraced. This was attributed to their length and the wave action. The terminal is connected to shore by a pipeline. During construction, a Bailey bridge was used to connect the platform with the shore. This facility cost approximately $25 million. The article discusses the problems encountered during construction, including sea state.

4. FLOATING AIRPORT
Weidlinger, Paul
(Ocean Industry, May 1970, pp. 47-49)

The platform proposed in this article has an area of 1000 acres and is composed of 200-foot-square modules. The cost per module is about $1 million. Total estimated cost of the airport is $1.1 to $1.4 billion. A typical cross section of the platform is shown on the attached sketch, and a cost breakdown on each module is given. The concept used is that of a platform positioned high enough so that the deck will not be awash under the most severe sea conditions and buoyancy chambers placed deep enough to be below the wave base to minimize the buoyant volume of the structure subjected to wave motion. Includes a good reference section.

5. A $20 MILLION 'ISLAND' FOR EKOFISH
no author
(Ocean Industry, July 1971, p. 21)

Discusses a proposed one million barrel crude oil storage system. This tank will be constructed of prestressed concrete and will cost about $20 million. It will be towed to its location after construction is complete. It will then be submerged slowly until it rests on bottom. The top surface of the artificial island will occupy about 21 acres.

6. HELIGOLAND PREPARES FOR 800,000-TON SUPERTANKERS

(Ocean Industry, August 1969, pp. 46-47, 52)

This article discusses the proposed superport facility at Heligoland, off the coast of West Germany. This port will be a long manmade island of prestressed concrete. The article mainly offers supporting discussion for the building of superports and says little about the actual construction of this facility.

7. DESIGNING HIGHLY STABLE FLOATING PLATFORMS
Carrive and Julien
(Ocean Industry, August 1969, pp. 48-52)

This article discusses a series of tests dealing with the stabilization of rolling and pitching in single and multilegged floating structures. Models were constructed and tested in a swell tank. A free-body diagram showing the pressures exerted on a leg and buoyant body is given. In these studies, platforms of up to 5,000 tons have been stabilized. It is anticipated that in future work platforms as large as 20,000 tons will be stabilized. Some of the pressure analysis used in these studies may be useful in investigations of proposed superport structures.

8. DESIGNING PLATFORMS FOR MINIMUM MOTION
Hooft, Jan P.
(Ocean Industry, December 1970, p. 27)

A new method for calculating vertical motions of semisubmersible platforms is presented. Scientists and engineers at the Netherlands Ship Model Basin, Waningen, Holland, have developed a method of accurately predicting verticle motions of semisubmersible platforms. Results of model studies in wave and current basins have varied the prediction equations presented in the article.

9. BOOM IN TANKERS AHEAD
Tucker, A. J.
(Ocean Industry, January 1970, pp. 35-59)

Trends in tanker size and size distribution of the world fleet are discussed. Facts (such as, "There are only nine ports in the world where the 225 ships of more than 200,000 dwt can enter fully laden") are presented. None of the ports is in the western hemisphere. An artist's conception of a typical single-point mooring buoy terminal is shown. Also shown is an onshore receiving base for an offshore LNG*terminal. Some economic aspects of using larger tankers are presented. *Liquid Natural Gas.

10. ZAPATA PLANS DELAWARE BAY BULK TERMINAL
no author
(Ocean Industry, March 1971)

This article discusses, in general, the proposed deepwater port in Delaware Bay. The port would handle bulk carriers up to 250,000 dwt and would cost about $160 million. Ther terminal would be built on a 300-acre island composed of material dredged from Delaware Bay. The proposed terminal would receive and store coal in bulk quantities until it could be loaded on supercarriers for export to other ports.

11. CONOCO TANKERS BRING FOUR IMPORTANT INNOVATIONS
no author
(Ocean Industry, June 1971, p. 34)

An example of the trends in ship sizes is given, and a brief discussion of the loading and unloading facility Conoco has built in England is presented. This terminal is a single-point mooring system consisting of a 120-ton monobuoy, a 5-mile-long pipeline, and a 1-million-barrel storage tank complex at Tetney, on the Lincolnshire coast. This facility cost $16,800,000.

12. CAN WE DELAY THE NEXT MAJOR TANKER DISASTER"
Ranker, M. B. F.
(Ocean Industry, June 1971, pp. 35-39)

Graphical illustrations are presented which show the trend in tanker size. A tanker of 1 million dwt is predicted for the future. The depths of major existing ports and the typical drafts of various ship sizes are shown. Some problems associated with larger vessels are presented which may be important in the design and location of a superport. An extensive bibliography is given at the end of the article.

13. MODEL BASIN WITH WINDSTORMS
d'Angremond, K.
(Ocean Industry, June 1971, p. 50)

This article briefly discusses the wave generator system used at the Delft Hydraulics Laboratory, Delft, Holland. A schematic of the mechanical wave generator is shown. Waves can be produced by (1) wind only, (2) wind and regular wave train, and (3) a programmed wave generator. A bibliography is given.

14. ELF-ERAP ADDS STORAGE SYSTEM TO OSCILLATING PLATFORM
no author
(Ocean Industry, November 1969, pp. 79-80)

This article describes the proposed 440,350-bbl underwater storage tank to be added to the existing ELF-ERAP offshore tanker terminal system. The mooring platform is attached to the ocean floor through a pivot which allows the platform to oscillate with water motion. The tank will be constructed at a drydock and floated to a site near the platform in the Bay of Biscay. The tank will then be sunk and connected to the platform by pipeline.

15. WIND FORCES ON STRUCTURES, FINAL REPORT OF THE TASK COMMITTEE ON WIND FORCES, COMMITTEE ON LOADS AND STRESSES, STRUCTURAL DIVISION, ASCE, Paper No. 3269, pp. 1124-1198.

This report assembles, correlates, and summarizes existing information on the factors that determine wind forces on structures. It is intended to be a compact source of information in a form that will be of practical use to civil engineers. No new research is presented, but an evaluation of existing data in comprehensive form has probably not been published previously.

16. SYSTEMS APPROACH TO PETROLEUM PORT SITE SELECTION
Gaithan and Sides
(Journal of the Waterways and Harbors Division, Proceedings of the ASCE, August, 1969, pp. 359-412)

This paper examines in successive steps (1) the basic systems engineering approach; (2) the elements of petroleum transportation systems; (3) systems engineering applied to petroleum port site selection; and (4) a mathematical model for choosing one port site from among several candidates.

17. OPTIMUM SIZE SEAPORT
Plumlee, Carl H.
(Journal of the Waterways and Harbors Division, Proceedings of the ASCE, August 1966, pp. 1-24)

The writer examines three principal areas of study that are related to the solution of the problem of sizing seaports. These are:

(a) Investigation of the patterns of ship traffic at seaports;

(b) Determination of a theoretical relationship, in a seaport, between the average number of ships present and the number of berths available that will minimize the combined costs of idle facilities ashore and afloat; and

(c) Determination of a theoretical relationship between the usage of berths of a port and the number of berths that will minimize the combined costs of idle port facilities and of ships waiting for a berth.

18. CONCEPTUAL DESIGN OF THE FLOWER GARDENS RESEARCH CENTER
Howell, John R., et al.
(Report to NASA/ASEE Systems Design Institute by Researchers at the University of Houston, NASA Grant NGT 44-005-114, Sept. 1971, 356 pp.)

This report details the preliminary design of an offshore structure to be used as a research center. The structure is a fixed ridged platform designed to include working areas, living areas, docking areas, waste disposal areas, etc. Also included in this report are discussions of logistics and onshore support facilities.

A systematic design approach is used and each step is discussed in detail.

19. PORT AND HARBOR DEVELOPMENT SYSTEM; PHASE 1 - DESIGN GUIDELINES WORK REPORT
Prepared by the Architecture Research Center, College of Architecture and Environmental Design, Texas A&M University
(August 1971, 140 pp.)

All aspects to be considered in a port analysis, such as types, location, administration, transportation, cargo handling, labor, support industry, safety, and finance, are presented in this report. The design and construction steps are discussed in detail. In addition, there are sections devoted to trends in ships and harbors, existing and new port concepts, and an in-depth bibliography. New ideas are given, such as a floating airport-ship port combination where the upper of two decks is an airport and the lower is devoted to shipping. Another idea is a transportation tunnel concept where a tube houses a monorail train, pipelines, and container conveyor lines.

20. SELECTION OF HOSE SYSTEMS FOR SPM TANKER TERMINALS
Ziccardi, John J.
(Paper #OTC-1152, Offshore Technology Conference, April 22-24, 1970)

Proper selection of surface and subsurface hose types can assume dependable terminal utilization. Improper selection can result in unnecessary tanker delay, drowning or starving storage capacity, and decreases in production.

Operational and environmental conditions must be studied and all available hose designs considered before an SPM hose system can be finalized. This paper reviews these factors by following simplified calculations for a hypothetical SPM terminal. It shows how to select and combine individual hose designs into an efficient, effective, and economical SPM hose system.

21. ANALYSIS OF PEAK MOORING FORCE CAUSED BY SLOW VESSEL DRIFT OSCILLATION IN RANDOM SEAS
Hsu and Blankarn
(Paper #OTC-1159, Offshore Technology Conference, April 22-24, 1970)

Results of investigations into offshore mooring problems offer conflicting indications of the relative merits of various mooring systems. Little attention has been devoted to the effects of slow vessel drift oscillation in random or irregular seas. It is this phenomenon which is the prime subject of the present paper.

22. WAVE-EXCITING FORCES AND MOMENTS ON AN OCEAN PLATFORM
Kim and Chou
(Paper #OTC-1180, Offshore Technology Conference, April 22-24, 1970)

This article describes a new method of predicting the wave-exciting forces and moments acting on an ocean platform restrained in oblique seas. Procedures are based on strip theory. In this study, the two-dimensional method developed by Frank is extended to the calculation of wave forces and moments, and the strip method devised by Grim is applied to obtain the three-dimensional forces and moments.

A bibliography of seven references is given.

23. COASTAL REGION LAW: A PRELIMINARY ANALYSIS
O'Connor, Dennis M.
(Paper #OTC-1183, Offshore Technology Conference, April 22-24, 1970)

This article presents a legal definition of coastal regions and discusses a coastal region law study which was conducted at the University of Miami. A systematic and comprehenisve outline to be followed in a study of coastal region law is given. A bibliography of ten references is included.

24. KHAZZAN DUBAI I: DESIGN, CONSTRUCTION AND INSTALLATION
Chamberlin, R. S.
(Paper #OTC-1192, Offshore Technology Conference, April 22-24, 1970)

The Khazzan Dubai #1 is a 500,000-gallon underwater oil storage tank placed in service in December 1969. This paper discusses the research and development programs which were carried out before this innovation could be effected. These include tests of crude and salt water, handling of sludge, model test work, and development of construction and installation techniques. Some operational considerations are also discussed.

25. DUBAI KHAZZAN -- PIONEER OF LARGE UNDERSEA STORAGE SYSTEMS
Curtis and Shepler
(Paper #OTC-1193, Offshore Technology Conference, April 22-24, 1970)

This article discusses the studies undertaken in the design and construction of the revolutionary Dubai Khazzan storage system. Economic comparison charts and other illustrations are given. The studies discussed include the feasibility study, tank description, oceanographic and weather environment, site location, piling systems, soil analysis, installation, and operational studies. A schematic of the tank is included in the illustrations.

26. ADMIRALTY LAW AND ITS EFFECT ON OFFSHORE DEVELOPMENT
Bluestein, Ed, Jr.
(Paper #OTC-1212, Offshore Technology Conference, April 22-24, 1970)

An introduction to selected phases of the law of admiralty as it relates to offshore technological development is presented for the technologist.

27. LIMITED MOTION OFFSHORE PLATFORMS
Mironer, Levine, and Orthlieb
(Paper #OTC-1217, Offshore Technology Conference, April 22-24, 1970)

After a brief introductory review of the applicability of one degree of freedom oscillation theory to ocean-wave-excited systems, this paper develops simple equations for the heave and pitch natural frequencies of the platform in terms of its physical properties and hydrodynamic mass coefficients. The equations are then nondimensionalized using appropriate dimensionless scaling coefficients which generalize all results to a family of dynamically similar platforms. The concluding portion of this paper presents the results of model tank tests of a 12.5-inch-diameter jack-up platform to determine its hydrodynamic mass coefficients, which are then used to calculate the pitch and heave natural frequencies of a specific family of platforms as a function of separation distance.

28. APPLICATION AND RESEARCH IN AMMI HARBOR, DOCKING, AND FLOATING FACILITIES
Amirkian, Toproe, and Erzurumly
(Paper #OTC-1232, Offshore Technology Conference, April 22-24, 1970)

This paper describes the uses of the AMMI framing system in barges and floating craft, pontoons, deepwater port facilities, and offshore installations. The general features of framing, fabrication, assembly, transportation, and installation of these various structures are discussed. Typical results obtained from recent laboratory research regarding the static and fatigue behavior of steel decks with biserrated ribs are also reported. It is shown that the static response of these structures can be adequately predicted analytically, and that their fatigue behavior is satisfactory.

29. EXPERIMENTAL STUDY OF BREAKING WAVE PRESSURES
Weggel and Maxwell
(Paper #OTC-1244, Offshore Technology Conference, April 22-24, 1970)

The results of a laboratory investigation of the impact pressures that often result when waves break against coastal structures are presented. Pressure measurements were taken to obtain the instantaneous spatial pressure distribution. These data were compared to presently used distributions and were found to have a different shape. A bibliography of fifteen references is given.

30. FORCE DUE TO WAVES ON SUBMERGED STRUCTURES, THEORY AND EXPERIMENT
Herbich and Shank
(Paper #OTC-1245, Offshore Technology Conference, April 22-24, 1970)

The existing theories on wave forces on large submerged structures are briefly reviewed and their inadequacy for design purposes is discussed.

Several models of simple geometric structures were installed in a two-dimensional wave tank. The magnitude of the vertical and horizontal loads on the structure (such as undersea oil storage tanks) by wave action was determined experimentally.

A comparison between forces caused by regular and irregular waves was made. It is concluded that forces resulting from waves are highly variable, but the results presented may be sufficient for preliminary designs.

31. A SEMISUBMERGED STABLE PLATFORM AS AN OFFSHORE PORT
Hooper and Frankel
(Paper #OTC-1331, Offshore Technology Conference, April 19-21, 1971)

Although the concept of the floating stable platform originated as a means to lighten supertankers for the eastern seaboard refineries, its application as a transshipment point for offshore crude is worth considerable attention in the industry. Competing systems include island terminals, monomoors, and telescoping support platforms. Report presents results of comparative analysis which was performed to determine the most effective system; considerations included socio-political acceptability as well as economic feasibility. In most tests the stable platform emerged as the most desirable alternative. This artificial harbor can be attractive for bulk oil; but also, with very little imagination, one can envision it as a material storage platform for the offshore industry, the upper deck (of approximately 4 acres) warehousing pipe, stores, and supplies for a whole offshore field. Furthermore, it would be possible for this platform to serve similarly as a transfer station for dry bulk cargoes or containers feeding into a secondary distribution system to the mainline. The functional advantages of the stable platform are apparent, but the operational characteristics and overall economics make it noteworthy.

32. LIFE AND DRAG FORCES ON A SUBMERGED CIRCULAR CYLINDER
Beattie, Brown, and Webb
(Paper #OTC-1358, Offshore Technology Conference, April 19-21, 1971)

In the design of pipelines which traverse the bed of a flowing stream, hydrodynamic lift and drag forces must be considered. Insufficient strength can result in pipeline rupture owing to drag. Insufficient weighting can lead to oscillation and fatigue caused by lift forces.

Accordingly, an experimental study was undertaken to measure and correlate lift and drag forces. The study was conducted in a water tunnel using pipes ranging in diameter from 6 to 30 inches. Pipes were tested in an "as received" condition and in an artificially roughened condition intended to simulate a concrete jacket.

33. COMPUTER SIMULATION AS A TOOL FOR EVALUATING OFFSHORE CONSTRUCTION ALTERNATIVE
McCarron
(Paper #OTC-1359, Offshore Technology Conference, April 19-21, 1971)

This article discussed the use of a Monte Carlo procedure to predict weather conditions. This program has been used to evaluate bids on pipeline projects in the Gulf of Mexico, and results compared favorably with actual costs.

Time and cost required for offshore operations are often influenced by the weather. Whenever comparisons are made between alternate construction bids, weather effects must be considered. There is no simple, deterministic method which will provide accurate answers to such problems. However, by use of historical weather data it is possible to obtain a probabilistic solution. Based on this, a rational evaluation of alternatives can be made.

34. OFFSHORE BERTHS WITH MULTIPLE ORIENTATION
Soros and Koman
(Paper #OTC-1366, Offshore Technology Conference, April 19-21, 1971)

Offshore berths of various types for loading and unloading minerals, constructed in recent years or now under construction, are reviewed. Designs developed to cope with unsatisfactory fixed orientation berths are illustrated with two breast-off type berths (one for loading, one for unloading) requiring warping of the vessel and a breast-on type offshore berth for the vessel stationary during loading.

35. CONCEPTUAL DESIGN OF A MANMADE ISLAND FOR A SEAWATER DESALTING AND POWER PLANT
Spriggs, _______
(Paper #OTC-1369, Offshore Technology Conference, April 19-21, 1971)

This paper is a review of the Bolsa Island Project, which was a feasibility and economic study for a large seawater desalination and power facility. This study was divided into four phases and included considerable analysis, field work, model testing, and conceptual design.

The island was designed as a free-standing structure situated in 5 fathoms of water; usuable surface area amounted to 36 acres.

This paper summarizes the efforts in site selection, design concepts, plant facilities, wave analysis model studies, criteria, stability analysis, filter blanket, compaction of fill, alternate concepts, causeway, environmental considerations, and cost estimates.

36. VARIOUS USES FOR THE ARTICULATED COLUMN ELFOCEAN, A NEW CONCEPT
Chassy, Frankhauser, and Picard
(Paper #OTC-1392, Offshore Technology conference, April 19-21, 1971)

This article gives a full description of articulated platforms and discusses their construction and installation. Various uses are presented, and a comparison is made with monomooring buoys. The paper states that the columns become economically comparative at 54-meter depths. It also states that the apparent limit to mono buoys is 100 meters, whereas articulated columns can be used in up to 400 meters. Various studies which have been carried out on the columns are discussed.

37. ELFOCEAN -- FULL SCALE TESTS AND MATHEMATICAL MODEL
Blazy, J. P., Quichaud, C., Sagot, A., and Leturcq, M.
(Paper #OTC-1401, Offshore Technology Conference, April 19-21, 1971)

This article discusses and presents data which have been obtained from the existing ELFOCEAN platform since it was installed in 1968. A mathematical model is developed and a comparison of experimental and calculated results is given.

38. OFFSHORE STRUCTURE MODEL TESTING FACILITY
Tam. W. A.
(Paper #OTC-1406, Offshore Technology Conference, April 19-21, 1971)

The author discusses an existing model testing facility which is capable of generating 18-inch- to 20-inch-high waves up to 40 feet long. The tank is 250 feet x 33 feet and 18 feet deep. A discussion is given to justify model testing as opposed to mathematical models. Other aspects of model testing and operation of the facility are given.

39. SITE SURVEYING FOR OCEAN FLOOR STRUCTURES
Hironaka, M. C.
(ASME paper #71-UnT-8, Sept. 19023, 1971)

This paper identifies more than 20 site parameters significant to designing, constructing, operating, and maintaining a sea floor structure; outlines a site survey and selection procedure; and identifies equipment available for conducting on-site tests for foundation engineering parameters as part of the site survey. Twenty references are cited.

40. CONTROLLED SINKING OF LARGE CONCRETE OCEAN STRUCTURES
Gerwick, Ben C., Jr.
(ASME paper #71-UnT-6, Sept. 19-23, 1971)

Methods of sinking large concrete structures to be used as underwater oil storage, habitats, and mining chambers are discussed. It states that in most cases the best method is to pull the structure down while there is a positive buoyant force on it.

41. UNDERWATER CONCRETE CONSTRUCTION
Gerwick, Ben C., Jr.
(ASME paper #71-WA/UnT-8, ASME Winter Annual Meeting, No. 28-Dec. 2, 1971)

Paper discusses the four basic methods of underwater concrete cons-ruction: tremie, bucket, grout-intruded aggregate, and grouting. It lists the parameters which must be considered in selecting the proper method to be used in a given case.

42. APPLICATION OF THE FINITE-ELEMENT METHOD FOR ANALYSIS AND OPTIMIZATION OF SUBMARINE STRUCTURES
Vinson, T. J., and Yates, D. N.
(ASME paper #71-WA/UnT-7, presented at the ASME Winter Annual Meeting, Nov. 28-Dec. 2, 1971)

The authors discuss the use of finite-element analysis for optimizing submarine structures. The techniques presented may be applicable to underwater superport structures and tanks.

43. LARGE-DIAMETER SUBMARINE PIPELINES FOR TANKER TERMINALS
Small, S. W.
(ASME paper #71-UnT-1, September 19-23, 1971)

Discussed in this paper are planning, design, and construction of large-diameter submarine tanker-loading lines. Geologic, oceanographic, and meteorologic conditions are described, and the importance of environmental conditions is emphasized in a discussion of submarine pipelines design. Discussed in detail is construction by the bottom pull method, which appears to be the most likely method for making future installations of large-diameter lines.

44. FORCES ON SUBMARINE PIPELINES FROM STEADY CURRENTS
Jones, Warren T.
(ASME paper #71-UnT-3, Sept. 19-23, 1971)

Paper reviews the hydrodynamics of forces on a submerged body in a steady flow and of turbulent boundary layers. Dimensional analysis is used to formulate three methods of data reduction. Cylinder surface roughness, bottom roughness, cylinder diameter, height above bottom, and water velocity are varied in experiments conducted to measure the lift and drag forces.

45. CANADA WILL GET $60 MILLION SUPERTANKER PORTS & TERMINAL
no author
(Ocean Industry, December 1971)

Article briefly discusses terminal to be built in the Bay of Fundy. The terminal will include docking at three berths, unloading and loading facilities, onshore storage, and elaborate safeguards for environmental protection. It will handle 300,000 dwt ships and will have throughput capacity of 300,000 barrels. Onshore storage will be 4.5 million barrels.

46. LARGEST FLOATING STORAGE BARGE
no author
(Ocean Industry, November 1971)

This article briefly discusses a floating storage barge of 900,000 barrels capacity. It is moored to an SBM terminal.

47. FLOATING OCEAN PLATFORMS
no author
(Ocean Industry, November 1971)

This article discusses scale model testing of a semisubmersible stable platform constructed of concrete. Tests were carried out at the Naval Undersea Research and Development Center, San Diego, Calif. Article states that one pound of structure will support several pounds of cargo.

48. UNDERWATER CONCRETING
Barlow, P. G. R., et al.
(Technical Report TRCS-3, The Concrete Society, London, 1971)

This report describes and gives guidance on the methods commonly in use for placing concrete underwater, together with notes on concrete mix design and formwork for this work.

49. FOREIGN DEEP WATER PORT DEVELOPMENTS
de Frondeville, et al.
(IWR Report 71-11, Vols. I, II, & III, Submitted to the Institute for Water Resources, Corps of Engineers, December 1971)

The subjects covered in this report are as follows:

General: Examine the interrelationships among engineering, environmental, socio-economic, and political aspects of port development; identify socio-economic and environmental consequences of port deepening; and present the positive and negative aspects of each approach.

Specific: For each approach considered and selected, present the lessons learned and future plans; and further outline rationale of decision to develop a deepwater port; port management structure and funding; socio-economic impact; environmental appraisal, prevention, and correction; and engineering solutions.

Subjects: Area screening of the United Kingdom, Japan (receiving ports), Australia, and the Persian Gulf (loading ports); and individual ports at Le Havre and Dunkirk, France; Antwerp, Belgium; Amsterdam and Rotterdam, the Netherlands; Bantry Bay, Ireland; and Port Cartier, Canada.

Part III. MODEL

I. Introduction

A. Background

The movement of people and goods is fundamental to growth and development of a region. River and canal transportation has made many of the major inland cities in the United States: to name a few, New Orleans and Baton Rouge, Louisiana; Memphis, Tennessee; and Saint Louis, Missouri. Their port activity continues to create additional wealth in the urban areas through added employment and capital flow.

Growth and expansion of inland waterways transportation have resulted in construction of new terminals for handling of freight to and from barges, and for exchange of freight between water carriers and other modes of transportation at ports throughout the United States. Each mode of transportation (water, rail, highway, and pipeline) acts as an economic stimulant to the others. The need for low cost delivery of raw materials determines and supports distribution patterns among these individual modes, and encourages the development of innovations such as the Lash (Lighter aboard ship), Seabee and piggyback carriers.

More than 50 percent of all domestic freight shipments and nearly 100 percent of all foreign trade cargoes require more than one form of transportation. Rail and highway commerce is generally greater where water traffic is heavy than where there is no access to waterborne traffic. Thus barge-to-rail, barge-to-truck, barge-to-pipeline, and other transportation combinations are vital to the commercial and industrial development of the United States.

Port development is measured in terms of size, complexity, cost and, most important, in terms of its significance for maintaining essential trade. Exports and imports move by vessel to ports where they may be distributed to other modes of transportation. Transfer to other adjacent and remote areas enable these areas to grow economically. According to the Gulf South Research Institute, "In 1956 the port of Baton Rouge handled 13,947,105 tons of cargo, and in 1966 handled 34,104,315 tons of cargo, an increase of 180%. Each ship adds approximately $100,000 to local earnings." The Institute estimated in 1966 that past activities added 220 million dollars to regional income.[1] This contributed almost $5.5 million to Louisiana sales and income taxes and $2.3 million to municipal and local sales taxes.[2]

Progress in the technology of shipping, not only in terms of greater size but also speed, greatly affects existing ports. (Supertankers of 326,000 dead weight tons (dwt) are now in service; a 477,000 dwt vessel is entering production; and 800,000 dwt vessels are in the research stage. Nearly 300 ships of the 100,000 dwt class are in service, and by 1974 this number will be doubled (see Appendix A-1).[3] The increase in vessel drafts has forced ports formerly established at the heads of estuaries or inland waterways to seek deeper

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[1] Long-Range Financial Requirements of the Port of Baton Rouge, Gulf South Research Institute No. EL-226.

[2] TRANSPORTATION REPORT NO. 2, Water Transportation in the Capital Region (July 1968), Capital Region Planning Commission.

[3] SUPERPORT, Arthur P. Little, Institute of Water Resources.

waters. Supplemental locations are being sought by these ports to serve the larger, deeper draft ships carrying petroleum, ore, and industrial raw materials.

Port development planning starts with an appraisal of the ships to be accommodated. Is the port to be designed for deep-draft tankers, ore carriers, or passenger ships? Can portions of the port be designed for smaller coasters, packet boats, or other comparatively shallow-draft vessels? These questions are best answered from a calculated projection of the future traffic to be served. An overall transportation survey of the region to be served is needed as a prelude to port planning.

Most ports have several functional systems involving different types of ships, cargoes, and ancillary transportation, and characteristics are different at various locations within the port. Some ports are of a predominately industrial type, particularly where the principal industry is a pulp or paper plant, oil refinery, petrochemical plant, or steel mill. Different types of cargoes may require different handling facilities. However, all types are adaptable and need access to waterborne shipping. The integration of inland transport operations with the dock system for vessels involves careful planning. Provisions must be made for rail, pipeline, and trucking terminals, containerized cargo facilities, and other methods of product movement. It is therefore necessary to be able to forecast the portions of the ships' cargoes which will move by the various individual modes of transportation.

B. The Mississippi River Corridor

The Mississippi River provides an avenue for transportation which supplies a major portion of the central United States with goods and products (see Appendix A-2, A-3). In 1969, products moved via the Mississippi River (see Appendix A-4) totalled 229,479,806 tons.[4]

Because of this access to the interior United States, ports have developed at strategic points along the river, as have inland distribution systems. (See Appendix A-2; ports shown are those considered in this study.) These transportation systems in turn have increased the amounts of products handled by the ports.

The transportation modes operating at the ports compete with and, at the same time, complement each other in the movement of products to and from areas served by the port. For example, both railroads and barges may carry bulk ore, or barges may carry rail cars loaded with ore. Factors in transportation of commodities are the cost of transferring products from one mode to another versus the use of containerization. Such trade-offs are especially significant at ports where large quantities of products of several types are warehoused for distribution.

A Louisiana Superport could significantly affect operations of existing ports and established cargo-handling practices by increasing

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[4] Waterborne Commerce of the United States, Part 2, Waterways and Harbors, Gulf Coast, Mississippi River System, Antelles, 1969.

amounts of certain commodities to be handled.

A strategically placed superport facility could become a catalyst for industrially developing areas; infusion of capital for development could lead to new industrial-urban centers. This would change the actual distribution of goods and products along the Mississippi River in terms of quantities shipped and modes by which they are shipped (see Table, Appendix A-5). A superport serving large vessels (which are replacing the smaller, shallower draft vessels that can serve inland ports),[5] would necessitate transshipment facilities for moving goods and raw materials inland (see Appendix A-6).

Larger ships are replacing smaller ships at an increasing rate (Arthur D. Little states, "By 1975, bulk carriers will make up one-third of the bulk carrier tonnage; since the end of World War II, the deadweight of the largest tanker afloat has been multiplied by ten (10) every twenty (20) years and its draft about doubled in the process").[6]

It is this aspect of goods' distribution by particular transportation modes that concerns this investigation: how the development of a superport will affect product distribution to modes of transportation and how this distribution will affect the transportation modes operating along the Mississippi River.

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[5] Superport, Arthur D. Little, Institute of Water Resources.
[6] Ibid.

II. Problem Definition

A. The Problem

The purpose of this research is to study the mechanics by which products and raw materials move along the Mississippi River corridor. Such information will help to ascertain the deficiencies, if any, that transportation facilities operating within the corridor might experience owing to the development of a superport off the Louisiana coast.

B. Scope

The development of a superport is dependent upon the economy of the region it would serve, the type and quantity of products it would handle, the available labor force, its location, its utilization as a point of transshipment, the various modes of transportation serving it, and the supply-demand characteristics of the region.

This analysis is concerned with the corridor served by the Mississippi River and the products and modes operating within the corridor. Because the Mississippi River serves the central United States with import-export goods and movement of goods internally, the location of a superport off the Louisiana coast would be influential both in this product movement and in the modes that move the products. The study area will include the Mississippi River transportation corridor and all major ports from Saint Louis, Missouri, to the mouth of the passes. Saint Louis is set as the northern boundary because the areas above it are more readily served from the northern United States (Great Lakes Region, Appendix A-2 and A-3) , and the quantity of product flow significantly decreased beyond that point.

The Interstate Commerce Commission has a standard classification for coding commodities. This coding consists of 16 classes of specific commodities (i.e., group 01 - Farm Products) which will be condensed for use in the programming model. In this analysis the products shall be classified as bulk, liquid (crude petroleum, all others), containerized, or requiring cold storage.

Owing to such factors as shipping costs, available modes of transportation, types and quantities of products, availability of shipping space in a particular mode, the manner in which the product is "packaged," the methods by which a product is capable of being transported (i.e., liquids by pipeline, barge, truck, or rail tank cars), the product may be shipped from origin to destination by more than one mode.

By analyzing the parameters outlined above at several stages between origins and destinations, one can simulate the product classes and the quantity of each that will be transported by a particular mode. By determining the demand placed upon the different modes at different stages along the Mississippi River corridor, one may define a range of transportation facilities that should be incorporated with a superport in order to facilitate the expected increased in transportation demands. Once the estimated transportation demands have been analyzed, the deficiencies, if any, in existing facilities can be ascertained, and the planning necessary to obviate the anticipated deficits may be initiated.

A mathematical programming model will be developed to simulate existing product allocation to particular modes at each port.

The modes to be studied within the corridor shall include:

1. Highway transport - tractor trailers, types 251, 252, and 352,[7] as classified by the Interstate Commerce Commission (these are tractor trailers with one or more rear axles). These three carriers account for 68% of all highway ton miles.[8]
2. Railroad transport[9] -- box, flat, gondola, hopper (open and covered top), refrigerator, rack, and tank cars.
3. Water transport ships of 80,000 deadweight tons (dwt) and less traveling the Mississippi River to Baton Rouge (no other ships will use the Mississippi), and barges[10] -- hopper, covered dry cargo, tank, and deck barges, both oceangoing and inland.
4. Pipeline transport -- crude collector lines used mainly for taking petroleum from the wellhead to a refinery or processing facility, and product lines, which carry almost any liquefied material.

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[7] Shifts in Petroleum Transportation, Highway Research Record #82, Freight Transportation, publication 1267, 1965.

[8] Highway Ton Miles, Highway Research Record #82, Freight Transportation, publication 1267, 1965.

[9] Yearbook of Railroad Facts, Association of Western Railroads, 1966.

[10] Big Load Afloat, The American Waterways Operators, Inc., U. S. Inland Water Transportation Resources.

This will be based upon the following:

1. The cost of shipping a particular type of product by a particular mode.

2. The quantity of a particular class of product to be shipped at a particular port.

3. The modes by which a class of product can be shipped (liquids by pipeline, barge, rail, and highway tank cars).

4. The modes of transportation available at a particular port.

5. The available space in a particular mode for receiving a particular type of product.

6. The way in which a type of product is packaged (bulk, cold storage, in tanks, containerized).

7. The cost of transferring a product from one mode of transportation to another (transshipment).

8. The number of trips per mode per year; the average number of units (i.e., rail cars per train); and the average number of tons per unit.

C. Approach

At any specific port it will be necessary to determine what types of products will be allocated to individual modes of transportation. This will be simulated through the use of a programming model.

The initial model will function as follows: It will be assumed that a product is being shipped by the least-cost mode for moving it (cost/ton-mi/product type), subject to the constraints that each port places upon its movement (i.e., modes available, available space on the mode, and those parameters named in the previous section).

The products that each port handles each year will be classified as bulk, liquid-crude petroleum and any other liquefied material, containerized, or requiring cold storage. It will be determined that there are "a" tons of bulk, "b" tons of crude petroleum, "c" tons of liquefied material, "d" tons of containerized products, and "e" tons of products requiring cold storage. Also, the modes available at each port will be determined (crude pipeline, product pipeline, rail, highway, and barge service, each having a specified available shipping capacity given in tons/year). The costs of shipping these products are known (national mean for each type of product/mode type will be used) at this port.

The products will be coded with reference not only to class, but also to the means by which they can be shipped. Assume that a liquid is to be allocated to a mode: It is coded, say L_1, for crude petroleum; it would be coded further to show that it can be transported by rail tank car, tank barge, crude petroleum line, and truck tank trailer.

The model will then analyze the factors and, based upon the least cost of transporting a product, will allocate all or part of that product to one or more of the available modes. This allocation will be given by the number of tons of that product class. The process will be iterated for each of the product classes at a port, and the cumulative total for each mode, in terms of the number of tons of product types allocated to it, will be determined. For example, 2,474,000 barrels of crude oil passed through the Baton Rouge capital region.[11] With 55 gallons per barrel, and each gallon weighing

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[11] Pipeline Transportation in the Capital Region, Transportation Report Number 7, Capital Region Planning Commission, 1968.

approximately 57 lb. per gallon, the total tons are

$$\frac{(2,474,000) \times (55) \ (57)}{2240 \text{ lb/ton}} = 3,000,000.$$

The division 2240 lb/ton, is the standard shipping long ton. It is calculated then that approximately 3,000,000 tons of crude oil is (or was) carried by pipeline through Baton Rouge.

The product allocations developed by the programming model will be compared to actual figures for a particular year to determine the accuracy of the model. This allocation will be iterated for each port under consideration within the Mississippi River corridor.

Once the model is operating accurately, a second phase will be initiated as follows:

The changes in shipping (size of ships using the Mississippi River), the increase flow of goods caused by the development of the superport, and economic growth projections for the next twenty years will be added to the model, and the process described above will be repeated. At each port, these changes and the growth in product flow anticipated could result in a condition of under-capacity with respect to the transportation facilities that now exist (Appendix A-7). The allocation of products to modes will, however, be implemented, and all products will be allocated to the available modes at each port without regard, initially, to exceeding the available tonnage capabilities of a particular mode. After the allocation has been made to a mode, it will be compared to the available shipping capabilities, indicating where deficiencies exist and the order of magnitude of that deficiency.

This process will be iterated at each stage, and all discrepancies along the Mississippi corridor will be pointed out.

The total requirements placed upon the transportation system will be a good indicator of the future traffic to be served by the superport and of the volume of that traffic. It will also indicate the predicted quantities and types of cargo that the superport would handle.

D. Assumptions for the Programming Model

- General

1. The superport will be built off the coast of Louisiana, and the modes accessible to it from the coast will be barge, pipeline, and shipping (large and small ships).

2. The superport will be the only point of transshipment for ships over 80,000 dwt.

3. The superport will handle all product types that are presently shipped along the Mississippi River (import-export commodities).

4. The only ships that will be sailing the Mississippi are those of 80,000 dwt and less, and they will not go beyond Baton Rouge.

5. Existing ports under study shall continue to handle the same products that they presently do (for the purpose of calibrating the programming model). Once the model is developed, projected product increases and new products (i.e., because of new train route to Baton Rouge from Illinois, a future influx of bulk corn for export is expected) may change some of the input data.

6. The cost coefficients used in the initial model will be the national mean for rail, highway, pipeline, water transportation,

and transshipment for cargo (i.e., mean transshipment cost for ship of 300,000 dwt is $8.50/ton of commodity).[12]

7. The allocation of products, the number of trips by specific modes of transportation, the amount of products handled by a port, and the quantity of products transported by a particular mode will be based upon annual data.

8. Products will be shipped by the least-cost method.

9. The supply-demand of certain commodities at particular ports will remain unchanged initially but will increase within the next 20 years (an assumption based on the national expected growth).

- Transportation Modes - Parameters

1. Highway transport--tractor trailer, types 251, 252 and 352[13] as coded by the Interstate Commerce Commission.

2. Railroad transport

   a. Box cars, general and special service

   b. Flat cars

   c. Hopper cars: open and covered top

   d. Refrigerated cars

   e. Rack cars

   f. Tank cars

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[12] Superport, Arthur D. Little, Institute of Water Resources.

[13] Highway Ton Miles, Highway Research Record, Number 32, Freight Transportation, pub. 1267, 1965.

Railroads will carry a national mean average of 1,685 tons per train, and the mean number of cars will be 70.[14]

3. Water transport

a. Barge traffic[15]

i. Hopper barges; 1500 ton capacity

ii. Open hopper barges; 1500 ton capacity

iii. Covered dry cargo barges; 1500 ton capacity

iv. Tank barges; 1500 ton capacity

v. Deck barges; 1500 ton capacity

The average number of barges per tow shall be fifteen (15).

4. Pipeline transport[16]

a. Crude collector lines; carry only crude

b. Product lines; carry only liquid or a liquefied commodity

III. Purpose and Objectives

A. Purpose

Because of Louisiana's location with respect to commodity flow along the Mississippi River corridor and the Gulf of Mexico, it is

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[14] Yearbooks of Railroad Facts, Association of Western Railroads, 1966.

[15] Big Load Afloat, The American Waterways Operators, Inc., U. S. Inland Water Transportation Resources, 1966.

[16] Pipeline Transportation in the Capital Region, Capital Region Planning Commission, Transportation Report No. 7, 1968.

in a position, functionally, of being the main transshipment point for products imported and exported by the central United States. The development of a superport within the state will exert a major influence upon the transportation systems operating along the Mississippi. The superport would have to be planned to handle the quantities of products shipped along this corridor (presently 229,479,806 tons)[17] and the traffic operating along this corridor as well as projected increases in traffic and commodity flows.

B. Objectives:

The model being developed will determine the following:

1. The existing types and quantities of products allocated to particular modes at the ports under study

2. The allocation of estimated future volumes of products in the corridor

3. The deficiencies, if any, that would result from the projected commodity allocation to modes of transportation

By determining these factors, transportation facilities can be planned which would be capable of handling the commodity flow anticipated in the Mississippi River corridor. Model outputs will indicate which modes now existing along the Mississippi River corridor would have a capacity deficiency as a result of increased demand. This

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[17] Waterborne Commerce of the United States, Part 2, Waterways and Harbor, Gulf Coast, Mississippi River System & Antilles, 1969.

information can be used by private industries as well as state governments for planning the construction of additional transportation facilities in the corridor.

The state could use the information for identifying potential growth areas resulting from the density and availability of existing and/or planned modes of transportation and commodities. This information could be used by the state as an inducement to industries to locate in the corridor.

IV. Solution Method

From the initial assumption that the superport will be built, certain conceptual ideas of its influences evolve. For the purpose of this study, it is assumed that the port will operate as shown in Appendix 8.

The initial step in optimizing the performance of a physical system (transportation systems, in this case) is to represent the system in an abstract or symbolic form known as a mathematical programming model. The model generally consists of:

A. An objective function which defines the total system utility in terms of independent parameters affecting its behavior

B. A set of constraint equations which defines the range of variation for each of the parameters

Solution of the problem through the use of optimization techniques constitutes the second step. In this particular study we will be maximizing the product allocation to the modes of transportation. It will be of the form:

SUM PRODUCT ALLOCATION TO MODES $\leq$ TOTAL

COMMODITY FLOW THROUGH A PORT =

(barge) + (rail) + (pipeline) + (highway) $\leq$ b TONS

The constraints will consist of the following:

A. Modal

1. Number of trips per year

2. Quantities of commodities shipped per year

3. Ton-miles per mode per year

4. Modes available at the particular port

5. The number of units (rail cars, barges) and their average load per unit at a particular port per year

6. Cost per ton-mile for shipping a particular commodity per year

B. Commodity

1. The commodities handled by particular ports

2. The quantities of those commodities handled per year

3. The means (modes) that a commodity can be shipped by

This model will be used at each of the ports under study to determine the total product allocation to the modes operating along the Mississippi River corridor.

V. The Data List

Data are being collected concerning the modes of transportation, the ports under study along the Mississippi River corridor, the products handled by each of these ports, the products and quantity of products shipped by particular modes, the costs involved in shipping a particular product by a specific mode, the average quantity (number of tons) shipped by a particular mode in a single trip (i.e., train load, barge load), and the number of ton-miles per mode on an annual basis.

All data which are available from governmental and private associations are collected on an annual basis. It would be practically impossible to handle any smaller time interval; and, even if it were possible, there would be no control within the model that would guarantee that in a specific time period, say a week or a month, a specific quantity of products would be shipped through a particular port or by a particular mode. In addition, the annual period is more stable and predictable with respect to projections of future traffic volumes. This approach is analogous to urban transportation planning; commodities are substituted for persons and vehicles.

Data have been collected from the following sources:

1. Interstate Commerce Commission
2. Army Corps of Engineers
3. Specific ports under study
4. National associations for the individual modes
    a. Railroad
    b. Barge and shipping
    c. Pipeline
    d. Highway

VI. The Model: Basic Formulation

The aim of this section is to present the underlying logic and the mathematical model that will be used to analyze the transportation segment of the product distribution systems operating along the Mississippi River corridor.

A. Programming

Extensive literature now exists on programming techniques, covering both theoretical foundations and applications. The techniques are, in general terms, a means of solving maximization or minimization problems in which some or all of the variables are under the influence of constraints; that is, variables entering into the general function (the "objective function"), which is to be maximized or minimized, also may appear in one or more additional equations or inequalities which are interpreted as constraints on the system.

A programming model for the allocation of product classes to given modes of transportation will be formulated. The objective is to simulate this product allocation to modes of transportation currently operating along the Mississippi River corridor.

A network with the nodes defined as points of convergence of transportation systems will be selected along the Mississippi River. The computational complexity and available data make it necessary to select a relatively small number of product-generating areas for study. Given the available modes serving the nodes selected, direct costs and other operating characteristics of the available modes between each possible pair of nodes, and the existing commodity demand, it is possible to distribute this demand among the modes by means of a programming model, in such a manner as to minimize total direct shipping costs while meeting a series of availability constraints, balance equations, and demand requirements. Optimal assignment will be understood to be that which can be carried out at least cost.

The model will study product flow in one direction at a time (i.e., downriver), but is developed to handle product flow in any direction (though not simultaneously).

For the remainder of this study the following notation will be adopted. Superscripts K and L will refer to origins or destinations, i.e., they are locations; subscript h refers to product class; subscript i to mode type; and subscript m indicates modal unit type (i.e., rail box cars).

The unknowns (all with reference to the time period selected for analysis) are:

Unknowns:

$_h^K X_{im}^L$ — the total quantity of product class h allocated to mode i, modal unit type m, originating at node K to be shipped to node L.

$_h^K T_{im,\,qr}^L$ — total quantity of product h transshipped from mode i, modal unit type m to mode q, modal unit type r at node K. (This is transshipment that occurs by modes operating within the study corridor.)

$_h^K U^L$ — unsatisfied transshipment demand due to unavailable modal space for the transshipped product h at node K. (U implies that some of the commodity classes to be transshipped may have to be warehoused at node K due to unavailable modal space.)

${}^{K}_{h}f^{L}$ unsatisfied product demand for product h at node K (not enough available product h to meet the demand at node--supply on the modes insufficient--products removed from modes).

${}^{K}_{h}d^{L}$ unsatisfied product demand at node K. This is the number of tons of product h not allocated to the modes at node K.

${}^{K}_{h}T^{L}_{im,\ ac}$ products h transshipped from mode i, modal unit m to mode a, modal unit type c at node K. These products either are destined for distribution outside the study corridor or were brought to node K from outside the study corridor to be shipped from node K to node L.

${}^{K}_{h}A^{L}_{im}$ the unused (thus available) modal tonnage for product h on mode i, modal unit type m.

${}^{K}_{h}e^{L}_{im}$ the quantity of product class h removed from mode i, modal unit type m at node K.

Relevant Parameters:

${}^{K}_{h}B^{L}$ total quantity of product class h available for shipment to node L and originating at node K. This quantity is those products brought to node K from outside the study area and are destined for flow, within the study corridor, in one direction only (i.e., downstream, from Baton Rouge to New Orleans or for export, but not to any upstream destination.

${}_{h}^{K}R^{L}$ — total demand for product class h at node K. This is total demand for products that would be removed from the modes to be distributed outside the study corridor.

${}_{h}S_{im}$ — total available modal capacity for product h on mode i, modal unit type m.

${}_{h}^{K}Q^{L}_{im,\ qr}$ — the cost of transshipment of product class h on mode i, modal unit type m, to mode q, modal unit type r at node K.

${}_{h}^{K}P^{L}_{im}$ — added costs due to product h not being shipped by mode i, modal unit type m at node K. This includes wharfage, inventory costs, storage, etc.

${}_{h}V_{im}$ — average number of tons of commodity class h carried by mode i per modal unit type m (i.e., 1500 tons/ hopper barge.

W_{im} — average number of modal units type m per trip for mode i (i.e., the average number of barges per tow).

${}^{K}Z^{L}_{im}$ — the number of trips made by mode i between any two nodes K and L.

${}^{K}_{h}g^{L}_{im}$ — Revenue lost due to an inadequate quantity (supply) of product h on mode i, modal unit type m at node K.

${}^{K}_{h}C^{L}_{im}$ — the cost of transporting product class h by mode i, modal unit type m, from node K to node L. This cost is only the cost of actual shipment.

The Model

The working model for the remainder of the study is set forth in this section. By the systematic compounding of more assumptions into the basic structure, a so-called "Master Model" is developed. An "Operational Model" will be developed from the additional factors to be discussed in subsequent sections.

Conceptual Model

Objective Function

$$\text{Min:} \sum_K \sum_h \sum_i \sum_m {}^{K}_{h}C^{L}_{im} \; {}^{K}_{h}X^{L}_{im} + \sum_K \sum_h \sum_i \sum_m {}^{K}_{h}Q^{L}_{im,\,qr} \; {}^{K}_{h}T^{L}_{im,\,qr}$$

$$+ \sum_K \sum_h \sum_i \sum_m {}^{K}_{h}Q^{L}_{im,\,qr} \; {}^{K}_{h}T^{L}_{im,\,ac} + \sum_h {}^{K}_{h}P^{L}_{im} \; {}^{K}_{h}d^{L}_{im}$$

$$+ \sum_{h} {}^{K}_{h}P^{L}_{im} \; {}^{K}_{h}U^{L}_{im} + \sum_{h} {}^{K}_{h}g^{L}_{im} \; {}^{K}_{h}f^{L}_{im}$$

Subject to: (at each node K)

1. $$\sum_{h} {}^{K}_{h}B^{L} - \sum {}^{K}_{h}X^{L} - \sum_{h} {}^{K}_{h}d^{L} = 0$$

2. $$\sum_{h} {}^{K}_{h}R^{L} - \sum_{h} {}^{K}_{h}e^{L}_{im} - \sum_{h} {}^{K}_{h}f^{L}_{im} = 0$$

3. $$\sum_{h} {}^{K}_{h}X^{L}_{im} + \sum_{h} {}^{K}_{h}e^{L}_{im} = \sum_{h} {}^{K}_{h}T^{L}_{im,\, ac}$$

4. $$\sum_{k}\sum_{h}\sum_{i}\sum_{m} {}^{K}_{h}X^{L}_{im} - \sum_{k}\sum_{h}\sum_{i}\sum_{m} {}^{K}_{h}e^{L}_{im} + \sum_{k}\sum_{h}\sum_{i}\sum_{m} {}^{K}_{h}T^{L}_{im,\, qr}$$

$$+ \sum_{h}\sum_{i}\sum_{m} {}^{K}_{h}A^{L}_{im} = {}_{h}S_{im} \qquad K = n-1 \qquad n = 1, 2, \ldots, N$$

5. $$\sum_{h}\sum_{i} {}^{K}_{h}X^{L}_{im} \left(\frac{1}{{}_{h}V_{im} \; W_{im}} \right) + \sum_{h}\sum_{i} {}^{K}_{h}T^{L}_{im,\, qr} \left(\frac{1}{{}_{h}V_{im} \; W_{im}} \right) \leq {}^{K}Z^{L}_{i}$$

6. $A, X, e, T, d, f \geq 0$

The objective function seeks to minimize total costs, where this cost is composed of four elements: first, that of shipping products between nodes K and L; second, that of transshipment costs at node K; third, that of lost revenue due to insufficient supply of a particular commodity h on mode i; and fourth, storage and inventory costs as a result of product h not allocated to mode i because of lack of modal space. The total cost is cumulative at each node, adding the cost of all preceding shipments from all preceding nodes.

Explanation of Constraints

It will be assumed, for the sake of simplicity, that "leakage" (unforeseen demand requiring extra modal units at a particular node) will not occur. Leakage would require the entering of surplus modes (i.e., extra rail cars, barges) from outside the study corridor.[18]

Constraint (1) The first constraint indicates all products brought from outside the study corridor to node K for shipment in a particular direction within the study corridor (i.e., downstream). The second summation indicates all of those products class h of the quantity B that have been allocated to mode i, modal unit type m at node K for shipment to node L. The third summation indicates the unsatisfied product demand at node K. This is the inbound quantity constraint (into the system) at node K. The unfulfilled demand is the balancing item.

Constraint (2) The first summation indicates the total demand at node K for products to be removed from the system to be distributed outside the study corridor. The second summation indicates those products that are removed from the system to satisfy the demand R. The third summation is the unsatisfied demand at node K, which is the balancing item.

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[18] A detailed explanation of "leakage" can be found in Domestic Airline Efficiency, Ronald E. Miller, Appendix B, M.I.T. Press, 1963.

Constraint (3) The first summation indicates those products added to the system from outside the study corridor. The second summation indicates those products removed from the system to be distributed outside the study corridor. The sum of these two summations is external transshipment of products. This is a definitional item.

Constraint (4) The first summation is all products that have been added to the system; the second summation those products removed from the system; the third summation is those products that have been transshipped (internal transshipment--between modes operating within the study corridor); the fourth summation is any unused tonnage on a particular mode. The sum of these variables must equal the total available tonnage on a particular mode.

Constraint (5) The first summation indicates the number of trips required by mode i to ship those products allocated to it between any two nodes K and L. The second summation indicates the number of trips required by mode i to ship those products transshipped to it between any two nodes K and L. The sum of these two must be less than or equal to the total number of trips made by mode i between any two nodes K and L.

Constraint (6) A negative value for any of the unknowns would be meaningless, and is therefore not allowed.

B. Parameters Affecting the "Operational Model"

The data that will be used will be for two time periods, base year and design year. The base year 1970 (latest data collected for all modes and ports under study), will be used in the initial phase of the study. The model developed will be used to simulate the existing product allocation at each of the ports under study. The second phase will be to estimate future demands on the transportation systems in the corridor resulting from the construction of the superport off the coast of Louisiana. The results of the model for the projected time period will provide material for comparison of overall requirements upon individual modes of transportation. This information will also indicate the optimal allocation of commodities to modes of transportation based on projected demand conditions and established "target values" as a guide to long-range planning.

1. Special Problems

The general model that has been presented in this section will be made more specific in further sections.

A number of problems have arisen during the initial data collection phase. Most of these problems require decisions that clarify the exact meaning of terms in the formulation. While they do not alter the basic philosophy or function of the model, they should be investigated and discussed at length in order to sharpen the precise meaning of the model. As an example, look at unfilled demand.

The unfilled demand term ${}_h d_{im}^K$ appears in both the objective function and the constraints. It is proper to assume that an individual mode (i.e., rail) will consider lost revenue as a cost which should be avoided or at least minimized, and the increased cost associated with additional facilities would be weighed against revenue lost to competition and perhaps public confidence or modal reputation (i.e., the plight of railroads today). But, our problem will be posed, initially, as that of moving all present demand at the least cost. Therefore, the constraints and objective function will have this term ${}_h d^K_{im}$ removed.

It is in the light of the above discussion that the "operational model" will be developed as Section III of this study. Data Sources and Projections will also be discussed in Section III.

VII. Potential Benefits Derived from the Transportation Analysis of the Superport

The benefits that can be derived from the information generated by this analysis are many. The demand on the transportation systems, in terms of volumes and types of traffic, could stimulate the development of a comprehensive policy for the use of waterway resources, not only along the Mississippi River corridor but also along its tributaries.

A reasonable estimate could be made of the facilities required to upgrade safety standards along the waterways in view of the greater traffic load that would be generated by the superport.

The study could indicate feasible locations for new industrial, petrochemical, and other economic units (i.e., "new towns").

The study could determine what new facilities in existing ports would be required to facilitate the expected changes and growth in commodity movement resulting from the development of a superport.

The output could define a reasonable range of transportation and commodity handling facilities for the superport on an annual basis. This would be an indicator of the labor force requirements within the next 20 years.

The output generated by the model in terms of quantity of cargo will establish the amount of capital flow through particular ports, and thus, through economic analysis, the economic impact to a particular area could be ascertained.

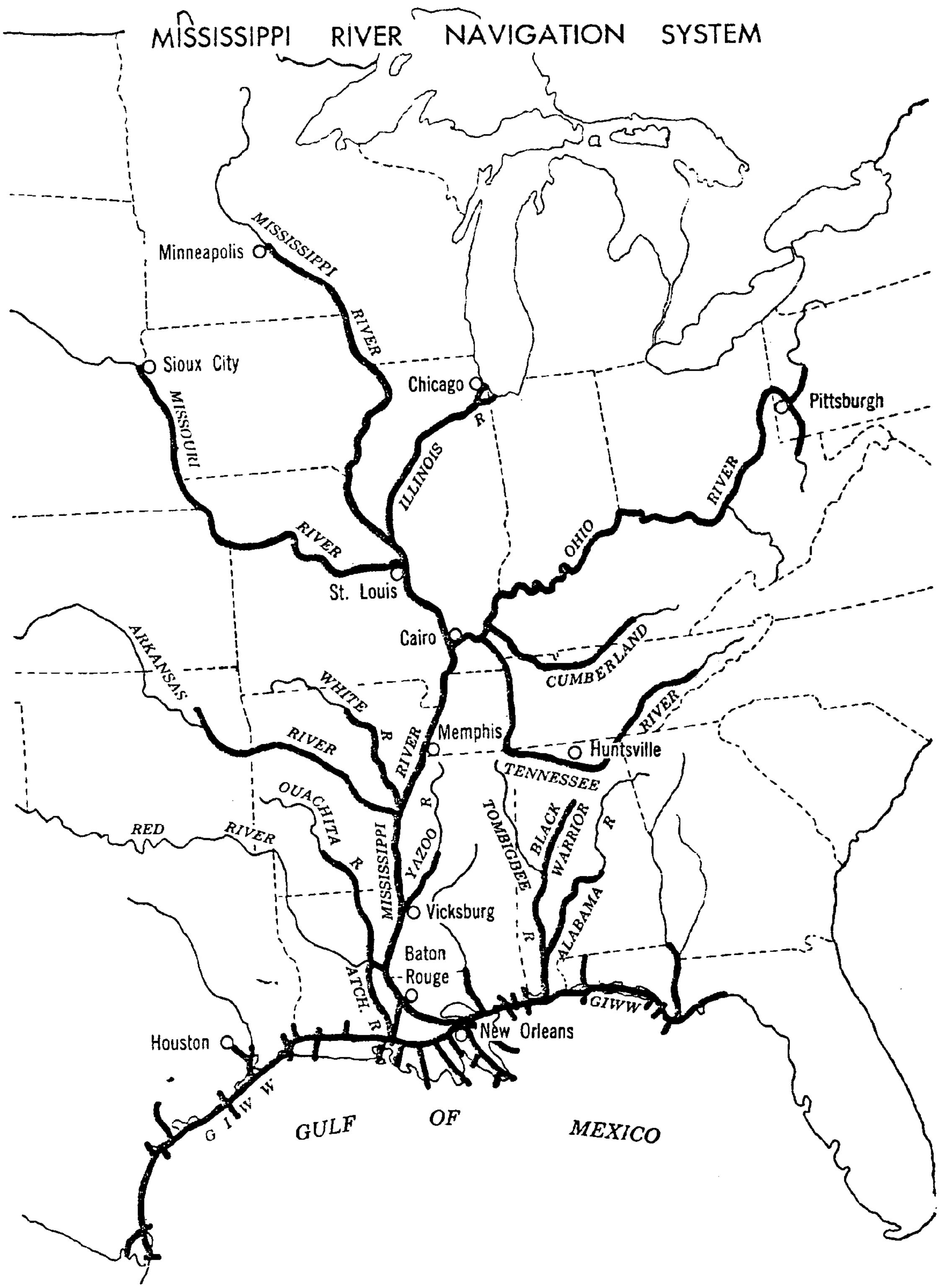
These benefits are but a few which could be derived, either directly or indirectly, from this analysis.

Appendix A-1

DEEP WATER ACCESS
MAXIMUM SHIP SIZE

Port	Approximate Maximum Ship Size in dwt		
	Current	Planned	Potential
Amsterdam, Netherlands	90,000	150,000	150,000
Antwerp, Belgium	80,000	125,000	125,000
Dunkirk, France	125,000	300,000	750,000
Le Havre, France	250,000	500,000	1,000,000
Rotterdam Europort, Netherlands	250,000	300,000	350,000
Rotterdam Botlek, Netherlands	80,000	80,000	80,000

Source: Under Contract No. DACW 31-71-C-0044, issued by the U. S. Army Corps of Engineers, Baltimore District, on 8 December 1970, the Institute of Water Resources, Alexandria, Virginia, commissioned Arthur D. Little, Inc. (ADL) to conduct an interpretive study of the development and operation experience at selected foreign deep water ports


MISSISSIPPI RIVER NAVIGATION SYSTEM
Minneapolis
MISSISSIPPI
RIVER
Sioux City
MISSOURI
RIVER
Chicago
ILLINOIS
R
Pittsburgh
OHIO
RIVER
St. Louis
Cairo
ARKANSAS
RIVER
WHITE
R
CUMBERLAND
Memphis
RIVER
Huntsville
TENNESSEE
RIVER
OUACHITA
R
RED
RIVER
MISSISSIPPI
YAZOO
R
TOMBIGBEE
R
BLACK
WARRIOR
R
ALABAMA
Vicksburg
Baton
Rouge
ATCH.
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New Orleans
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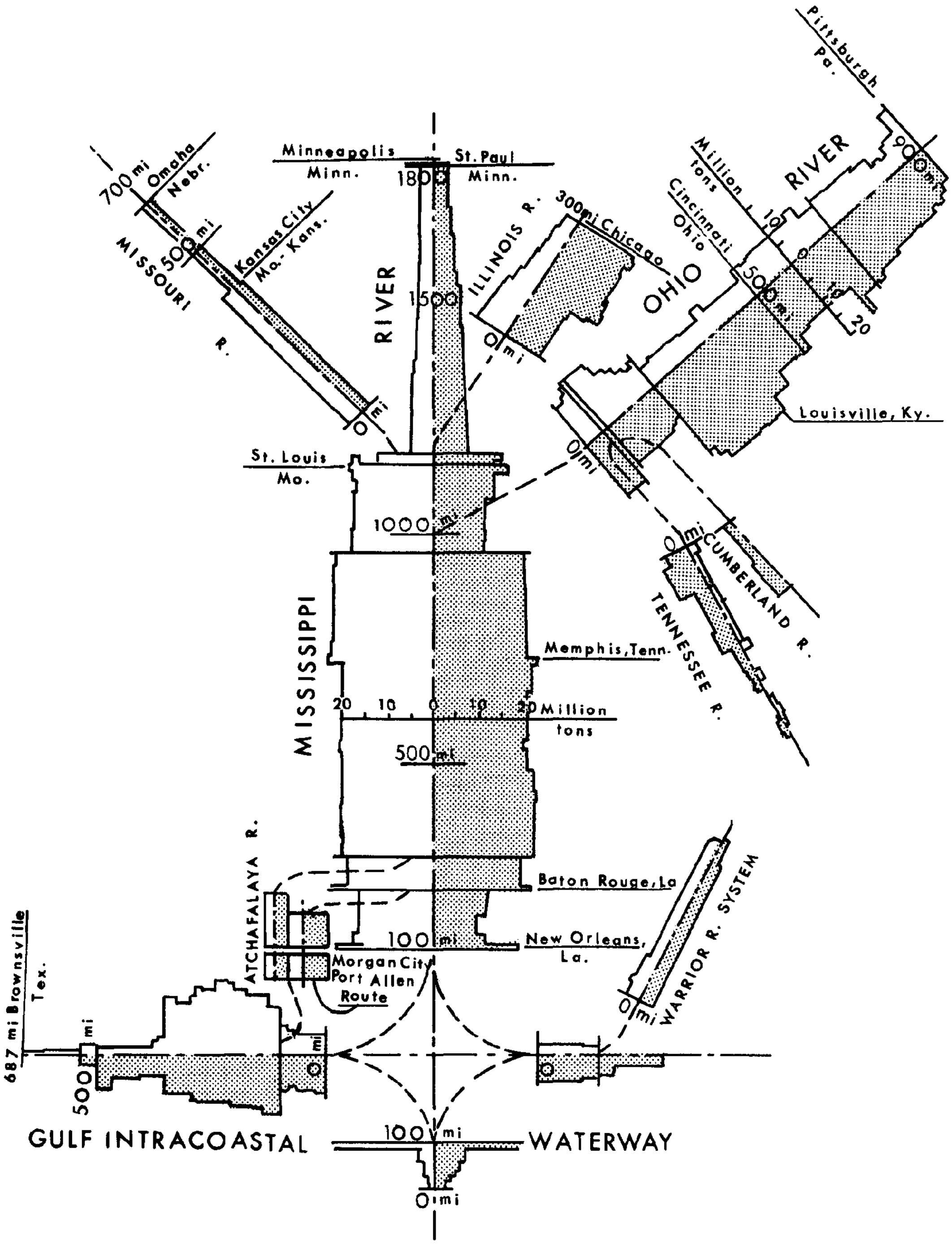
Houston
G I W W
GULF
OF
MEXICO

APPENDIX A-2

APPENDIX A-3



Inland Freight Tonnage on the Mississippi River System and the Gulf Intracoastal Waterway, 1964

APPENDIX A-4

WATERBORNE COMMERCE OF THE UNITED STATES, 1969

Comparative Statement of net total traffic on the Mississippi River from Minneapolis, Minn., to the mouth of Passes, calendar years 1960-1969

(Net traffic)

Year	Foreign and coastwise traffic					Inland Traffic	Grand Total
	Foreign		Coastwise		Total		
	Import	Export	Receipts	Shipments			
1960	11,284,080	12,583,743	1,348,657	20,645,079	45,861,559	82,486,236	128,347,795
1961	10,837,966	14,513,556	1,436,260	22,463,932	49,251,714	87,136,590	136,388,304
1962	12,631,642	18,329,147	1,246,146	25,714,120	57,921,055	91,976,547	149,897,602
1963	11.081,881	20,327,138	1,886,276	26,483,985	59,779,280	98,028,011	157,807,291
1964	11,125,233	24,196,427	1,815,967	25,880,479	63,018,106	101,635,626	164,653,732
1965	13,030,981	22,723,637	2,342,818	26,051,783	64,149,219	112,003,222	176,152,441
1966	14,479,240	24,916,783	3,116,983	32,043,680	74,556,686	119,393,719	193,950,405
1967	13,846,632	26,571,602	3,273,853	28,057,547	81,749,634	131,354,912	213,104,546
1968	14,635,265	25,633,969	3,836,775	36,482,728	80,588,737	138,573,494	219,162,231
1969	15,938,845	26,569,874	3,885,325	35,433,653	81,827,697	147,652,109	229,479,806

Ton-miles (000 omitted)

Year	Import	Export	Receipts	Shipments	Total	Inland Traffic	Grand Total
1960	1,821,474	1,883,926	184,098	3,000,349	6,889,847	33,372,686	40,262,533
1961	1,843,849	2,188,470	183,842	3,269,496	7,485,657	35,348,802	42,734,459
1962	2,223,058	2,779,861	161,593	3,141,180	8,305,692	39,295,631,	47,601,323
1963	1,928,435	3,023,807	469,184	3,264,521	8,685,947	41,648,544	50,334,491
1964	1,976,453	3,601,084	470,649	3,106,279	9,154,465	46,134,295	55,288,760
1965	2,333,375	3,269,573	548,559	2,958,304	9,100,811	50,924,426	60,025,236
1966	2,560,659	3,660,847	605,427	3,567,950	10,394,883	57,399,627	67,794,510
1967	2,446,887	3,796,204	636,974	4,222,649	11,102,714	63,112,317	74,215,031
1968	2,494,355	3,673,252	694,407	4,224,619	11,086,633	66,768,804	77,855,437
1969	2,694,786	3,903,262	673,583	3,891,332,	11,162,963	69,793,057	80,956,020

APPENDIX A-4 (continued)

Comparative statement of net total traffic on the Mississippi River System,*
Calendar years 1960-1969

(Net traffic)

Year	Foreign and coastwise traffic					Inland Traffic	Grand Total
	Foreign		Coastwise		Total		
	Import	Export	Receipts	Shipments			
1960	11,284,080	12,583,743	1,348,657	20,645,079	45,861,559	188,097,922	233,959,481
1961	10,837,966	14,513,556	1,436,260	22,463,932	49,251,714	190,367,806	240,219,520
1962	12,631,642	18,329,147	1,246,146	25,714,120	57,921,055	200,040.501	257,961,556
1963	11,081,881	20,327,138	1,886,276	26,483,985	59,779,280	211,540,238	271,319,518
1964	11,125,233	24,196,427	1,815,967	25,880,479	63,018,106	226,474,828	289,492,934
1965	13,030,981	22,723,637	2,342,818	26,051,783	64,149,219	237,630,872	301,780,091
1966	14,479,240	24,916,783	3,116,983	32,043,680	74,556,686	247,199,721	321,756,407
1967**	13,846,632	26,571,602	3,273,853	38,057,547	81,749,634	258,367,224	340,116,858
1968**	14,635,265	25,633,969	3,836,845	36,482,728	80,588,807	270,557,281	351,146,088
1969	15,938,845,	26,569,874	3,885,325	35,433,653	81,827,697	286,803,513	368,631,210
			Ton-miles (000 omitted)				
1960	1,821,474	1,883,926	184,098	3,000,349	6,889,847	62,366,714	69,256,561
1961	1,843,849	2,188,470	183,842	3,269,496	7,585,657	64,839,942	72,325,599
1962	2,223,058	2,779,861	161,593	3,141,180	8,305,692	70,999,266	79,304,958
1963	1,828,435	3,023,807	534,341	3,308,495	8,795,078	73,520,069	82,315,147
1964	1,976,453	3,601,493	529,981	3,152,816	9,260,743	80,087,305	89,348,048
1965	2,333,376	3,260,819	613,689	2,978,433	9,186,317	87,407,020	96,593,337
1966	2,560,659	3,661,160	670,791	3,612,901	10,505,511	95,870,451	106,375,962
1967	2,446,887	3,796,208	637,518	4,233,733	11,104,342	103,474,600	114,578,942
1968	2,494,355	3,673,383	748,445	4,258,216	11,174,399	109,1641714	120,339,113
1969	2,694,786	3,903,262	673,583	3,891,332	11,162,963	114,032,045	125,195,008

* Includes the main channels and all tributaries of the Mississippi, Illinois Missouri, and Ohio Rivers.

** Inland traffic and grand total figures revised.

APPENDIX A-5

SHIFTS IN DOMESTIC TRANSPORTATION OF CRUDE PETROLEUM AND PETROLEUM PRODUCTS[a]

Year	Total Crude and Products Carried	Pipelines		Water Carriers		Trucks[b]		Railroads	
		Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total
1938	354,420,630	139,220,962	39.28	137,728,491	38.86	20,538,060	5.80	56,933,147	16.06
1939	377,204,272	147,534,686	39.11	148,054,469	39.25	21,557,650	5.72	60,057,437	15.92
1940	385,742,696	153,502,082	39.79	149,594,453	38.78	21,849,000	5.67	60,797,161	15.76
1941	421,133,971	170,684,472	40.53	152,430,794	36.20	28,695,020	6.81	69,323,685	16.46
1942	426,905,706	175,486,660	41.11	120,076,511	28.13	49,524,400	11.60	81,818,135	19.16
1943	473,733,623	196,391,443	41.46	115,995,425	24.49	76,471,500	16.14	84,875,255	17.91
1944	539,713,995	244,001,439	45.21	117,688,301	21.81	99,048,800	18.35	78,975,455	14.63
1945	546,386,683	240,749,492	44.06	142,498,332	26.08	96,135,600	17.60	67,003,259	12.26
1946	545,329,125	222,266,138	40.76	172,513,605	31.64	88,852,600	16.29	61,696,782	11.31
1947	619,209,392	237,879,554	38.42	209,087,669	33.77	105,603,500	17.05	66,638,669	10.76
1948	686,273,830	262,452,531	38.24	237,516,329	34.61	120,897,800	17.62	65,407,170	9.53
1949	665,368,815	261,023,757	39.23	229,928,665	34.56	126,217,294	18.97	48,199,099	7.24
1950	731,282,314	283,853,383	38.82	252,765,749	34.57	145,780,986	19.93	48,882,196	6.68
1951	805,457,356	324,631,081	40.30	267,417,940	33.20	163,566,274	20.31	49,842,061	6.19
1952	831,289,595	337,426,840	40.59	274,913,642	33.07	171,744,588	20.66	47,204,525	5.68
1953	862,695,394	359,142,335	41.63	273,476,440	31.70	184,625,431	21.40	45,451,188	5.27
1954	876,949,886	373,327,262	42.57	268,524,812	30.62	192,564,326	21.96	42,533,486	4.85
1955	960,808,391	412,533,395	42.94	284,007,134	29.56	222,604,360	23.17	41,663,502	4.33
1956	1,014,930,276	441,386,180	43.49	297,826,330	29.34	235,960,622	23.25	39,757,144	3.92
1957	1,019,854,162	441,078,169	43.25	299,800,463	29.40	242,331,559	23.76	36,643,971	3.59
1958	1,017,179,215	443,027,566	42.57	298,656,025	29.36	252,024,743	24.78	33,470,881	3.29
1959	1,074,375,041	464,290,959	43.22	310,098,034	28.86	266,642,261	24.82	33,343,787	3.10
1960	1,089,137,729	468,409,682	43.01	318,295,654	29.22	270,375,253	24.83	32,057,140	2.94
1961	1,110,450,480	484,170,055	43.60	322,695,527	29.06	273,619,665	24.64	29,964,233	2.70
1962	1,158,752,236	502,464,600	43.36	329,734,358	28.46	297,698,196	25.69	28,855,082	2.49

[a]In tons of 2,000 lb; data from Association of Oil Pipe Lines.

[b]Amounts carried by trucks are estimates.

APPENDIX A-5 (continued)

SHIFTS IN DOMESTIC TRANSPORTATION OF CRUDE OIL[a]

Year	Total Crude Oil Carried	Pipelines		Water Carriers		Trucks[b]		Railroads	
		Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total
1938	180,508,947	128,175,000	71.01	46,173,283	25.58	2,115,000	1.17	4,045,664	2.24
1939	190,464,264	135,270,000	71.02	47,045,281	24.70	2,220,000	1.17	5,928,983	3.11
1940	196,197,117	140,985,000	71.86	47,927,090	24.43	2,250,000	1.14	5,035,027	2.57
1941	212,796,708	156,300,000	73.45	46,224,034	21.72	2,955,000	1.39	7,317,674	3.44
1942	220,834,215	159,255,000	72.12	35,299,423	15.98	5,100,000	2.31	21,179,792	9.59
1943	240,730,423	176,835,000	73.46	31,129,833	12.93	7,875,000	3.27	24,890,590	10.34
1944	267,468,834	208,560,000	77.98	32,371,496	12.10	10,200,000	3.81	16,337,338	6.11
1945	274,078,434	205,185,000	74.86	48,477,658	17.69	9,900,000	3.61	10,515,776	3.84
1946	265,601,728	193,545,000	72.87	56,287,368	21.19	9,150,000	3.45	6,619,360	2.49
1947	292,501,482	204,375,000	69.87	67,333,281	23.02	10,875,000	3.72	9,918,201	3.39
1948	322,991,312	221,198,250	68.48	75,126,140	23.26	12,450,000	3.86	14,216,922	4.40
1949	297,351,940	215,051,700	72.32	64,219,078	21.60	12,997,800	4.37	5,083,362	1.71
1950	318,280,275	231,198,150	72.64	67,551,132	21.22	15,012,459	4.72	4,518,534	1.42
1951	357,492,665	263,394,600	73.68	72,497,833	20.28	16,843,980	4.71	4,756,252	1.33
1952	365,081,250	269,105,100	73.71	74,812,548	20.49	17,686,179	4.85	3,477,423	0.95
1953	376,860,595	283,379,400	75.19	70,585,701	18.73	19,012,642	5.05	3,882,852	1.03
1954	372,447,048	284,438,700	76.37	64,572,121	17.34	19,830,186	5.32	3,606,041	0.97
1955	398,877,036	310,042,950	77.73	63,081,850	15.81	22,923,695	5.75	2,828,541	0.71
1956	421,673,677	327,846,900	77.75	67,335,912	15.97	24,299,117	5.76	2,191,748	0.52
1957	421,369,673	320,277,900	76.01	74,090,233	17.58	24,955,193	5.92	2,046,347	0.49
1958	402,173,215	307,059,000	76.35	67,965,254	16.90	25,953,401	6.45	1,195,560	0.30
1959	429,754,500	327,697,000	76.25	73,067,560	17.00	27,458,698	6.39	1,531,242	0.36
1960	432,318,282	328,449,000	75.97	74,137,775	17.15	27,843,120	6.44	1,888,387	0.44
1961	441,820,196	333,318,300	75.44	78,297,176	17.72	28,177,237	6.38	2,027,483	0.46
1962	452,024,545	338,642,644	74.92	80,969,520	17.91	30,656,834	6.78	1,755,547	0.39

[a]In tons of 2,000 lb; data from Association of Oil Pipe Lines.

[b]Amounts carried by trucks are estimates.

APPENDIX A-5
(continued)
SHIFTS IN DOMESTIC TRANSPORTATION OF REFINED PRODUCTS[a]

Year	Total Refined Products Carried	Pipelines[b]		Water Carriers		Trucks[c]		Railroads	
		Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total	Tons Carried	Percent of Total
1938	173,911,713	11,045,962	6.35	91,555,208	52.65	18,423,060	10.59	52,887,483	30.41
1939	186,740,008	12,264,686	6.57	101,009,188	54.09	19,337,680	10.36	54,128,454	28.98
1940	189,545,579	12,517,082	6.60	101,667,363	53.64	19,599,000	10.34	55,762,134	29.42
1941	208,337,263	14,384,472	6.90	106,206,760	50.98	25,740,020	12.36	62,006,011	29.76
1942	206,071,491	16,231,660	7.88	84,777,088	41.14	44,424,400	21.56	60,638,343	29.42
1943	233,003,200	19,556,443	8.39	84,865,592	36.42	68,596,500	29.44	59,984,665	25.75
1944	272,245,161	35,441,439	13.02	85,316,805	31.34	88,848,800	32.63	62,638,117	23.01
1945	272,308,249	35,564,492	13.06	94,020,674	34.53	86,235,600	31.67	56,487,483	20.74
1946	279,727,397	28,721,138	10.27	116,226,237	41.55	79,702,600	28.49	55,077,422	19.69
1947	326,707,910	33,504,554	10.26	141,754,388	43.39	94,728,500	28.99	56,720,468	17.36
1948	363,282,518	41,254,281	11.36	162,390,189	44.70	108,447,800	29.85	51,190,248	14.09
1949	368,016,875	45,972,057	12.49	165,709,587	45.03	113,219,494	30.76	43,115,737	11.72
1950	413,062,039	52,655,233	12.75	185,214,617	44.85	130,768,527	31.66	44,363,662	10.74
1951	447,964,691	61,236,481	13.67	194,920,107	43.51	146,722,294	32.76	45,085,809	10.06
1952	466,208,345	68,321,740	14.66	200,101,094	42.92	154,058,409	33.04	43,727,102	9.38
1953	485,834,799	75,762,935	15.59	202,890,739	41.76	165,612,789	34.09	41,568,336	8.56
1954	504,502,838	88,888,562	17.62	203,952,691	40.43	172,734,140	34.24	38,927,445	7.71
1955	561,931,355	102,490,445	18.24	220,925,284	39.32	199,680,665	35.53	38,834,961	6.91
1956	593,256,599	113,539,280	19.14	230,490,418	38.85	211,661,505	35.68	37,565,396	6.33
1957	598,484,489	120,800,269	20.19	225,710,230	37.71	217,376,366	36.32	34,597,624	5.78
1958	615,006,000	125,968,566	20.48	230,690,771	37.51	226,071,342	36.76	32,275,321	5.25
1959	644,620,541	136,593,959	21.19	237,030,474	36.77	239,183,563	37.10	31,812,545	4.94
1960	656,819,447	139,960,682	21.31	244,157,879	37.17	242,532,133	36.93	30,168,753	4.59
1961	668,630,284	150,851,755	22.56	244,399,351	36.55	245,442,428	36.71	27,936,750	4.18
1962	706,727,691	163,821,956	23.18	248,764,838	35.20	267,041,362	37.78	27,099,535	3.84

[a]In tons of 2,000 lb; data from Association of Oil Pipe Lines.

[b]Products pipelines move light oils only--gasoline, kerosene, distillate, jet fuel and L.P.G.

[c]Amounts carried by trucks are estimates.

Appendix A-6

DIRECT ECONOMIC COSTS AND SAVINGS IN TRANSPORTING FUTURE U. S. CRUDE OIL REQUIREMENTS

	1969	1975	1980	1985
Oceanborne Imported Crude Oil Forecast	78	183	365	574
Crude Oil Supply From Short-Haul Sources Not Requiring Deep Draft Tankers	23	54	109	172
Crude Oil Supply From Long-Haul Sources	54	128	255	401
Annual Transport Cost Using 80,000 dwt. Vessels at $10/ton or	546	1,281	2,555	4,013
Annual Transported Cost Using 300,000 dwt. vessels with trans-shipment at $8.50/ton	464	1,088	2,172	3,415
Annual Transport Reduction of 300,000 dwt vessels with trans-shipment over 80,000 dwt	82	193	383	603
Annual Transport Costs Using 30,000 dwt vessels without trans-shipment at $6.50/ton	355	833	1,661	2,612
Annual Transport Reduction of 300,000 dwt. vessels without trans-shipment over 300,000 dwt with trans-shipment	111	255	511	806
Annual Transport Cost Reduction of 300,000 dwt vessels without trans-shipment over 80,000 dwt. vessels	191	488	894	1,406

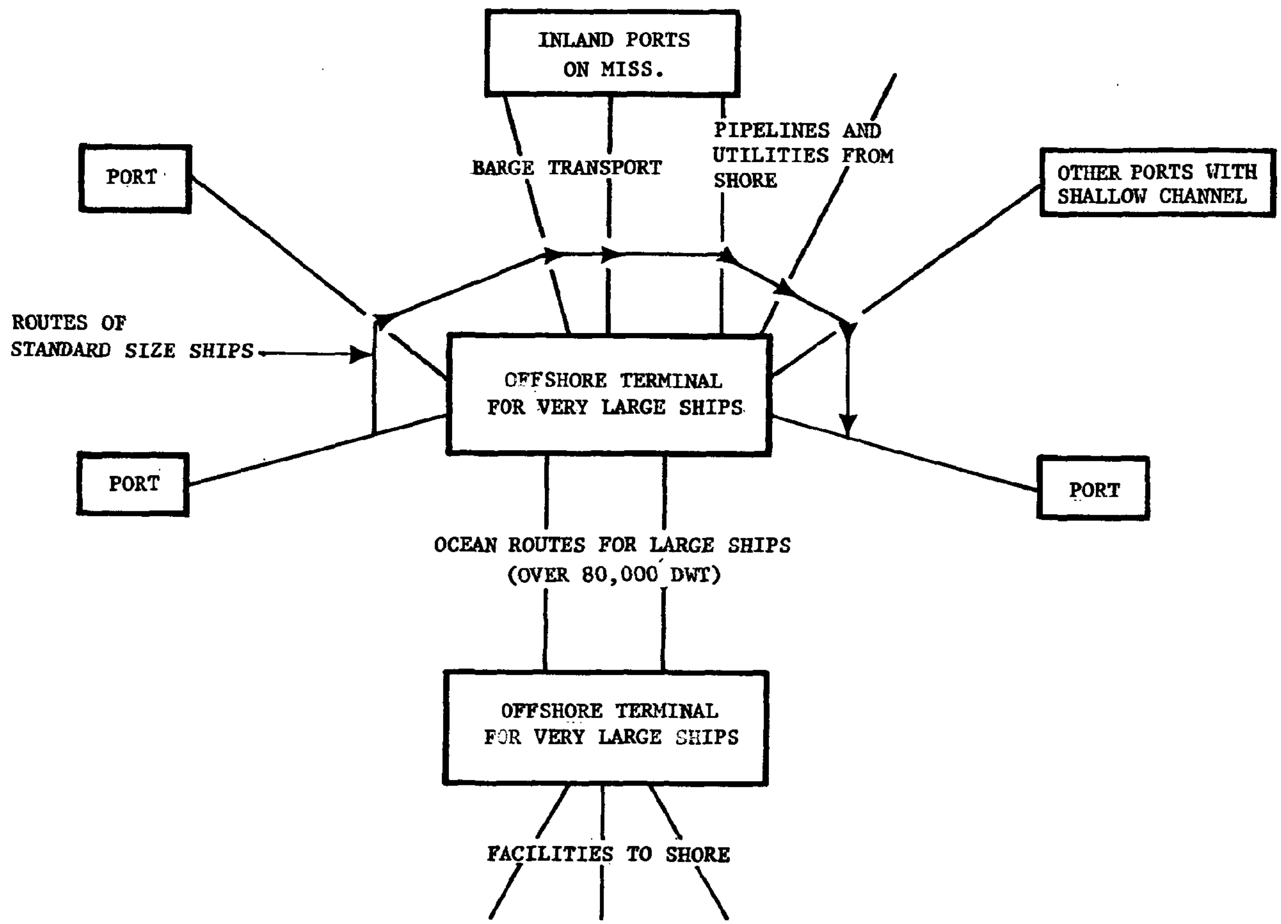
NOTE: tons and dollars in millions
SOURCE: Superport, Arthur D. Little, Institute of Water Resources

Appendix A-7 FREIGHT TONNAGE PER CENT BY MODES OF TRANSPORTATION FOR 1980 IN THE UNITED STATES

MODE	% CARRIED	NO. OF TON MILES
Air Freight	0.2	2.7 Billion Ton Miles
Inland Waterways	15.1	260.0 Billion Ton Miles
Oil Pipelines	20.5	353.0 Billion Ton Miles
Highway	21.7	373.0 Billion Ton Miles
Rail	42.5	732.0 Billion Ton Miles

SOURCE: Rail Transportation in the Capital Region, Transportation Report #5, August 1968

NOTE: Air freight not a factor in this study



Appendix A-8. Conceptual operations of an offshore terminal
from: Work plan for a study of the feasibility of an offshore terminal in the Texas Gulf Coast Region: Research Division, Texas Engineering Experiment Station, Texas A&M University, 1971.