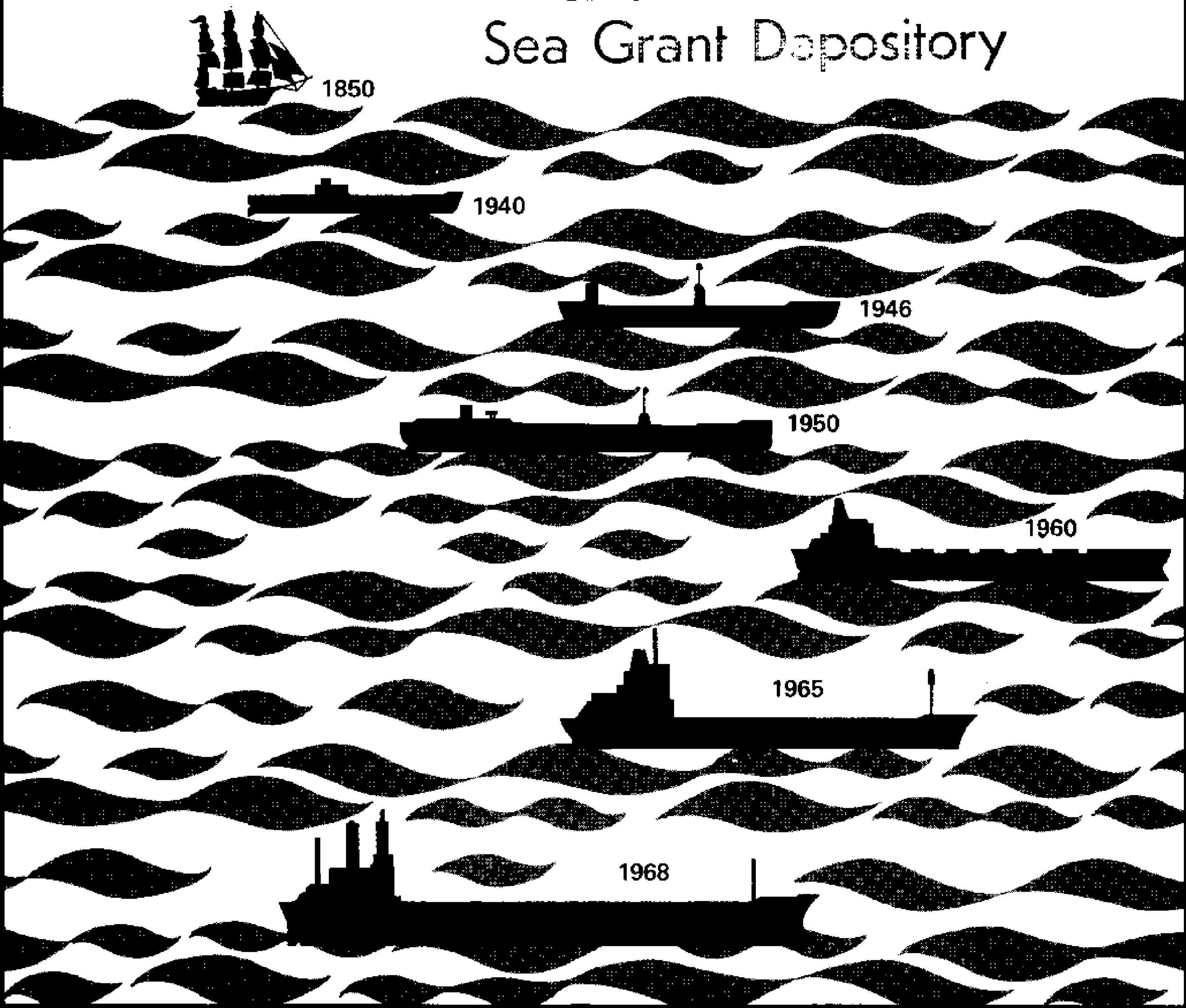
Work plan for a study of the feasibility of an offshore terminal in the Texas Gulf Coast Region



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Texas A&M University
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SUMMARY

In the past three decades the economic base of Texas has changed from one dominated by agriculture to one oriented toward manufacturing with a very strong dependence upon water transportation. Recent trends in ship sizes threaten to make existing Texas ports obsolete, and there has developed a growing need for a port with water depth adequate to handle the larger ships.

Design and construction of an offshore port will enter into areas of consideration involving such things as storm protection, concern for the environment and other factors of similar complexity that can be satisfactorily resolved only through an in-depth engineering study.

To justify the expenditure of the large sums of money required to build an offshore port, a study must be made of the economy of Texas' Gulf Coast region to ascertain the impact that the port will have and to determine the dollars-and-cents benefits that will result from the port.

Location of the offshore port is critical and should be carefully studied. Depending upon the distance from shore that a site is located, the legal and jurisdictional implications can be serious and a detailed analysis of the legal aspects of a port offshore from Texas is a requirement in any feasibility study.

The type of entity that is created for the purpose of building and operating the offshore port must be one that permits the greatest flexibility of operation, offers the most favorable tax position and has the range of authority and power necessary for operation of the port.

In conclusion, the building of deep water terminals and harbors throughout other parts of the world, along with the continuing trend to ever larger sizes in new ship construction, makes it mandatory that Texas shippers and ports plan for the establishment of a deep water facility for the Texas Gulf Coast region at the earliest possible time.

A necessary prerequisite to constructing such a port is a study of its physical and economic feasibility. The work plan contained herein describes the individual studies required. Estimated cost of these studies is $460,000, and total time required to do them should not exceed 18 months.

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FOREWORD

This "Work Plan for a Study of the Feasibility of an Offshore Terminal in the Texas Gulf Coast Region" has been prepared to serve as a means of identifying specific areas of research, assigning priorities and supplying a schedule of activities to achieve the desired goal of determining the feasibility of an offshore terminal for superships in the Gulf of Mexico off the Texas Coast.

Preparation of the work plan has been preceded by an intensive literature search to ascertain what has been done before, plus extensive worldwide correspondence, discussions with agencies and consultants concerning offshore ports in general, and investigation with universities, port authorities and industry shippers to determine the needs of the Texas Gulf Coast.

The Industrial Economics Research Division is grateful for the assistance received from many individuals and organizations in preparing this report. Special credit must be given to Ray R. Brimble, chairman, and Messrs. Rex Grabill and Charles Kroll, members of the South Texas Regional Export Expansion Council as well as to C. S. Devoy of the Port of Galveston, Dow Wynn of the Port of Port Arthur and the board of commissioners of the Port of Freeport for their support and help. Professors Vernon L. Engberg and Eliezer Ereli of the University of Houston and John J. Pepe of Pepe Engineers, Houston, Texas, also made many invaluable contributions.

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This project was partially funded by the Department of Commerce's National Oceanic and Atmospheric Administration Sea Grant Program, through an institutional grant GH-101 made to Texas A&M University, and by the South Texas Regional Export Expansion Council with funds supplied by the Texas ports of Galveston, Freeport and Port Arthur.

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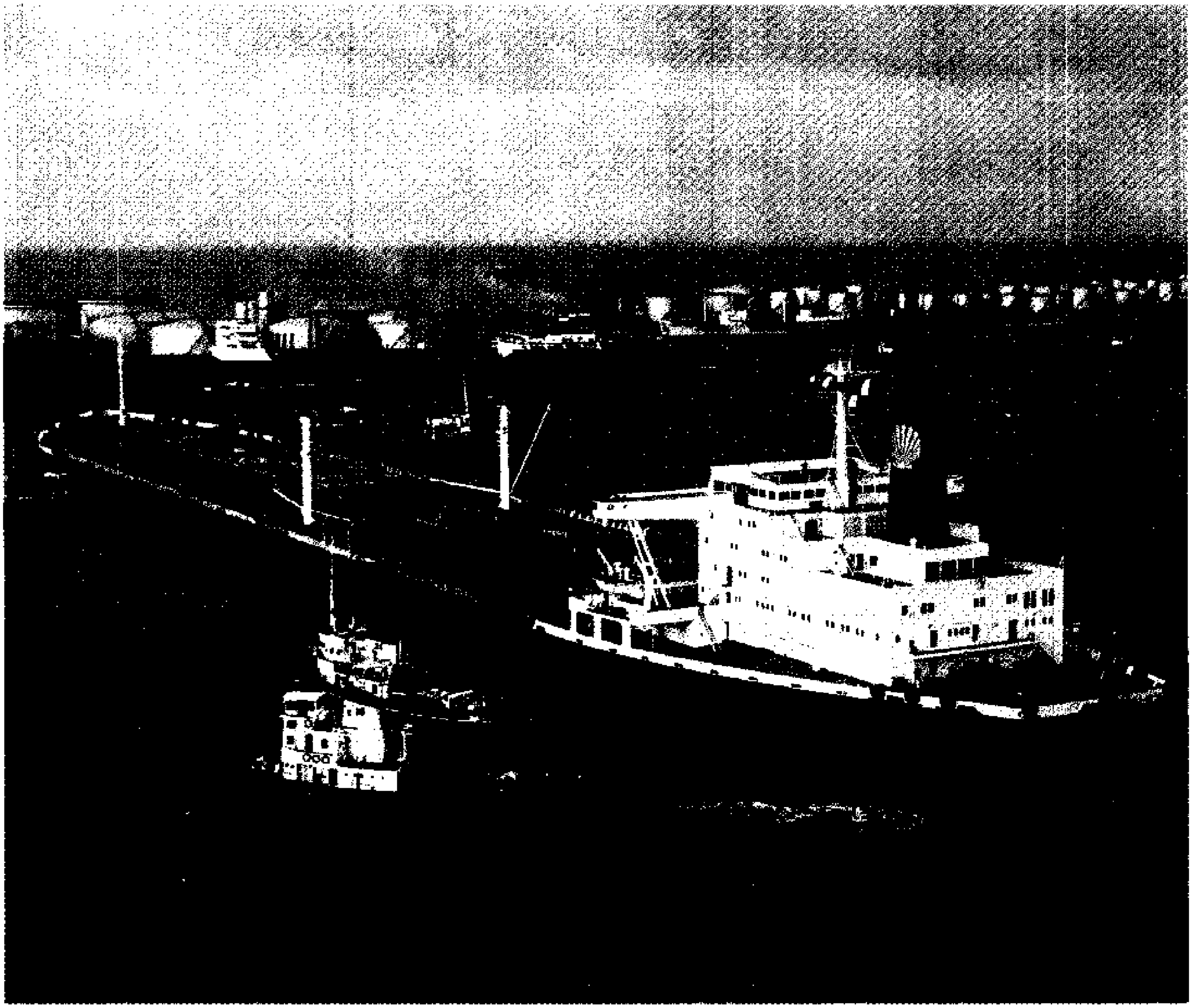
June, 1971



Supertanker Mactra, 206,885 deadweight tonnage, being led into the Port of Le Havre.

INTRODUCTION

There has been a considerable amount of discussion, and a lot of publicity, regarding the pros and cons of establishing a deep-sea terminal to serve the industrial complex along the Texas Gulf Coast. The interest in this subject has been generated by the development in recent years of ocean-going ships built to gigantic proportions. These vessels, called "supertankers," dwarf all previous liquid-hauling tankships and as a matter of fact are much larger than any vessel that ever sailed the seven seas, even the huge aircraft carriers of World War II.

A brief review of worldwide shipbuilding trends brings into focus the problem facing shippers and port managers in the Texas coastal zone. Figure 1 indicates the deadweight tonnage of ship construction from 1937 to 1967 and gives projections based on these trends to the year 2040. Ships of up to 470,000 deadweight tons (dwt) in size are presently under construction, and shipbuilders are already planning for vessels that will be as large as one million tons in size in the not-too-distant future. Existing channel depths of major Texas ports are shown in Figure 2. No port in Texas has a depth of more than 40 feet. No port in Texas is actively planning for more than 45 feet. No ships larger than 80,000-90,000 deadweight tons size can come into Texas. By 1983 more than 1,400 of the projected world tanker fleet of 4,384 ships will be unable to enter Texas ports.

Ray R. Brimble, Chairman of the South Texas Regional Export Expansion Council, in a recent article entitled "Establishment of a Deep-Sea Terminal Off The Texas Gulf Coast" which apeared in the Spring 1971 issue of **Water Spectrum,** a Corps of Engineers publication, emphasizes the fact that—regardless of its controversial nature—the offshore port concept is a valid one and that it is needed in Texas because "nowhere else in the entire world does the mammoth process industries capable of utilizing the superships exceed the establishments found in the Texas Gulf Coast area." Brimble goes on to say that the issue presently being debated, "whether the United States ought to build deep-sea terminals" should be re-phrased to the question of "**when** will the United States build deep-sea terminals?"

The solution for the problem facing shippers and port operators in Texas is to establish a cargo terminal on the Texas Gulf Coast with sufficient water depth to allow docking of supertankers and other behemoths of the ocean shipping lanes. Before such a facility can be started, however, it will be necessary to study in great detail the feasibility of the project. Although individual and specific studies will be of paramount importance to the value of such an investigation, it is of equal importance that a work plan be devised to serve to designate pertinent areas of research, assign priorities and schedule programs to achieve the desired goals of the study. Such a work plan will assist those persons who are now or who may be responsible in the future for the formulation and implementation of an offshore port facility for Texas.

Therefore, it is with this intent that the following discussion is being presented. It is hoped that a detailed feasibility study leading to construction of a deep water port in Texas will be conducted in the immediate future.

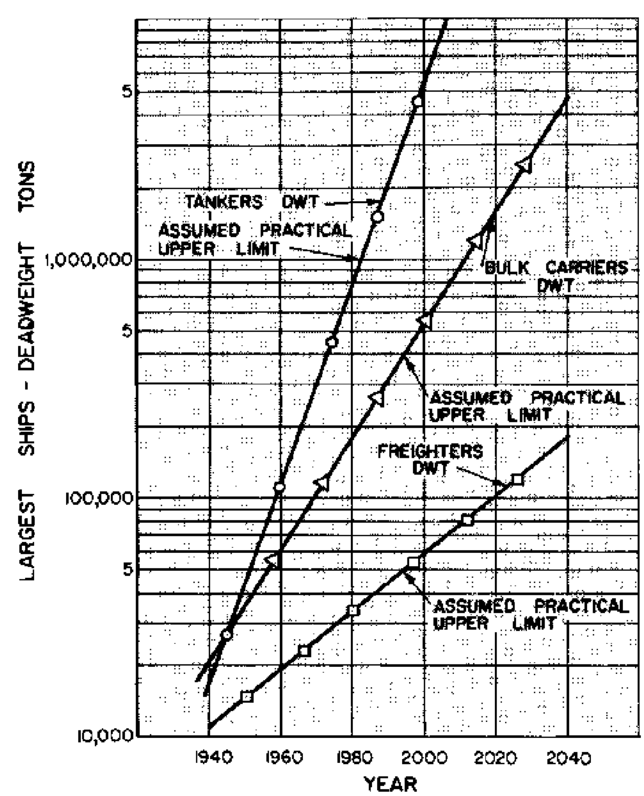


FIGURE 1. Projected Deadweight Tonnage of Large Ships to Year 2040 Based on Trends from 1937 to 1967.

Source: Casimer J. Kray, "Supership Effect on Waterway Depth and Alignment," *Journal of the Waterways and Harbors Division*, Proceedings of the American Society of Civil Engineers (May, 1970), p. 498.

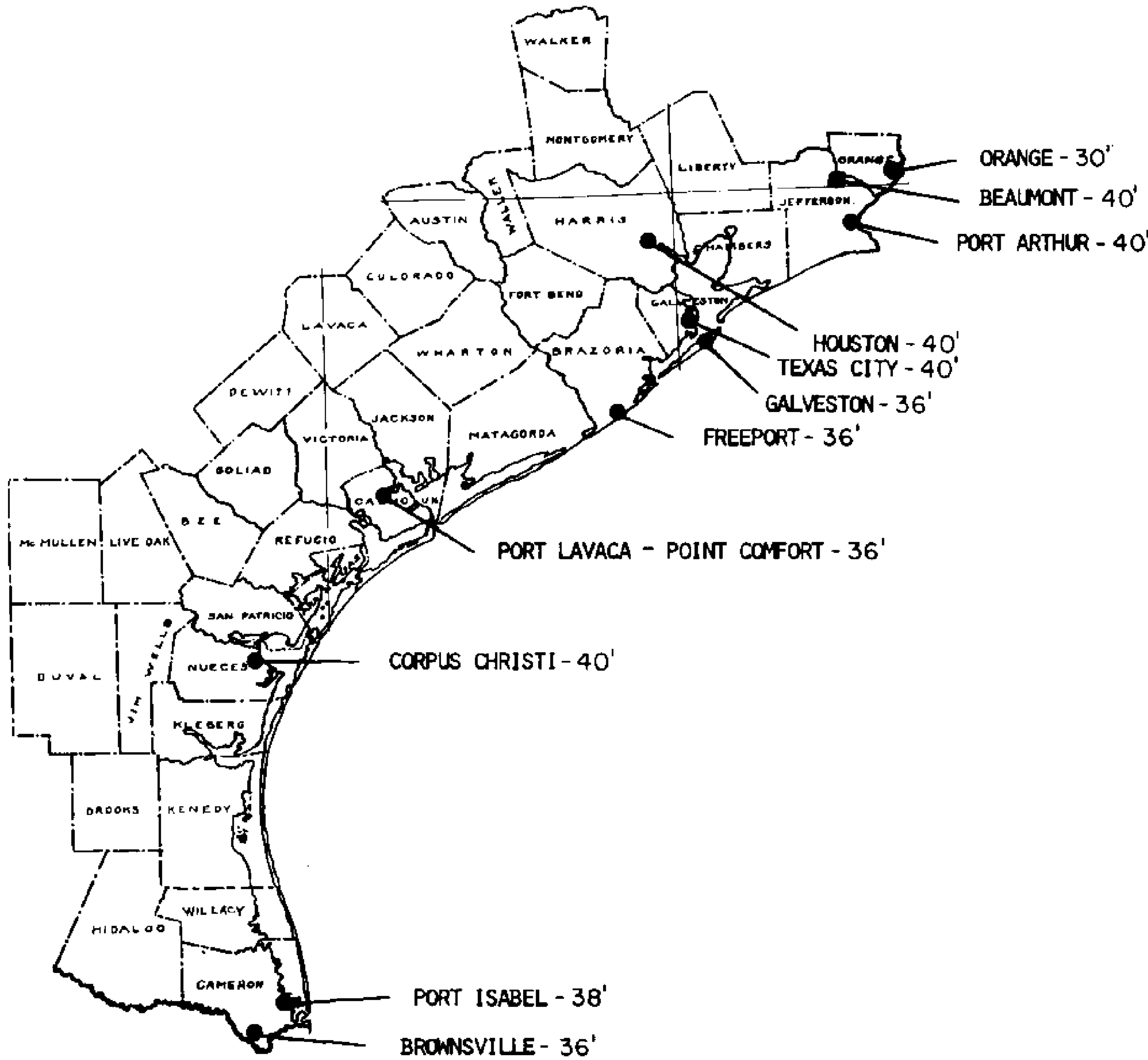


FIGURE 2. Channel Depths of Major Ports in the Texas Coastal Zone.

NEED FOR FACILITY

THE GENERAL CASE

The growth in the economy of Texas over the past three decades has been a result of growth in several different sectors of the economy—agriculture, minerals, tourism and manufacturing. Agriculture has gradually lost dominance during this period in favor of minerals and manufacturing. The most dynamic segments of growth have been those associated with petroleum mining, refining and processing, particularly the processing of petroleum to obtain refined products for direct consumption such as gasoline, heating residuals and jet fuel, as well as fractions such as ethane, butane and propane which are used as raw materials for petrochemicals and petrochemical-based products. At the outset, growth in this industry—hydrocarbon processing—was a natural development resulting from the ready availability and abundance of petroleum and refined products, minerals and natural gas in the state. In more recent years access to water transportation has achieved greater significance in the overall picture, not only because the effects of shrinking supplies and rising costs domestically have combined to make foreign oil more attractive, but also because transportation is a big factor in the cost of petroleum. Transportation carries the strongest promise of a cost breakthrough that may hopefully ease the downward trend of profits in the industry.

In spite of the tremendous vitality and dynamism of the hydrocarbon processing industry (HPI) in Texas, a growing dependence upon water transportation — coupled with the present trends in ocean shipping—can well become the Achilles heel that not only seriously inhibits future growth but jeopardizes the continuation of the status quo. The one trend in the ocean-shipping industry which is of most concern to the HPI involves vessel size, particularly the growth in the number of so-called "supertankers" plying the international trade routes. Most aspects of supertankers are good: the per-barrel cost of transportation is much lower than with conventional-sized tankers; their owners and operators claim that they are safer because their size makes them more seaworthy; and the increased use of automation on supertankers reduces manpower required aboard-ship as well as at the loading/unloading terminals thereby reducing the effect of labor strikes on their operation. However, the very bigness of the giant ships that gives them—through economies of scale—their inherent cost advantages, is also the factor that curtails their flexibility in choice of routes and ports. This is because tankers, as opposed to general cargo ships or container ships, require significantly deeper drafts as their deadweight tonnage is increased. Enlargement for the quantum jumps (in capacity) has been largely in the depth of hull, meaning much deeper loaded drafts. For example, a fully loaded 100,000 dwt tanker draws about 47 feet and this rises to an average of 55 feet for 150,000 dwt, 61 feet for 200,000 dwt, 73 feet for 300,000 dwt and so on—the 372,400-ton "Nisseki Maru" now being built for Tokyo Tanker by Ishikawajima-Harima in Kure is designed to have a draft of 27 meters, or 89 feet.[1] The relationship between deadweight tonnage of ships and channel depths needed to accommodate them is shown in Figure 3.

United States tanker trade requirements have had little, if any, influence in recent determinations of maximum tanker size. The bulk of the United States tanker trade is from Venezuela and the Gulf Coast to the Atlantic Coast. Volume movements from the Persian Gulf and Africa to the United States are smaller by comparison. However, projected increases in domestic petroleum demand along with the general growth in world trade will tend to generate constant pressure to deepen and widen United States ports, including those in Texas.[2] Limits are necessary on sizes of ships entering Texas ports. Deepest berths available are 40 feet at Beaumont, Port Arthur and Houston while other major Texas ports average 36 to 38 feet with the exception of Orange which is 30 feet.[3] Elsewhere in the United States the maximum maintained channel or entrance depth is 45 feet except for Long Beach, California, and Seattle, Washington, where vessels of 100,000 deadweight ton size can be accommodated.[4] According to figures from the U. S. Army Corps of Engineers, there are 50 harbors in the world deep enough to handle 200,000 deadweight ton tankers but none are in the United States. The same source states that the present world tanker fleet includes 700 ships that are too large to enter United States ports. And average ship sizes will continue to increase—the million dwt tanker is just over the horizon. A recent news release reveals that the Nippon Kokan Shipbuilding Company will build a $69 million facility with capacity for ships of a million tons size at Tsui, Japan.

Broadened usage of the giant ships in world commerce has created a boom in the enlargement of ports to berth them and has given rise to a new concept in ocean transportation. Figure 4 shows Casimir J. Kray's concept of how the pattern of ocean transportation will need to change to accommodate supertankers. As indicated earlier, very few harbors in the world have enough natural channel depth to accommodate the greatly increased drafts of superships and, where possible, dredging is being undertaken by local authorities in an attempt to keep up with the trend. Europoort, the Continent's biggest refinery center near Rotterdam, will dredge to an average depth of 70 feet, eight miles to the North Sea, while the port of Fos, near Marseilles, plans a 115-foot channel to receive

[1] A. J. Tucker, "Boom in Tankers Ahead," *Ocean Industry*, Vol. 5, No. 1, (January 1970), pp. 35-39.

[2] John Miloy and E. Anthony Copp, *Economic Impact Analysis of Texas Marine Resources and Industries*. National Science Foundation Sea Grant Program (College Station: Texas A&M University, 1970), p. 71.

[3] Ibid., p. 64.

[4] A. J. Tucker, op. cit., p. 37.

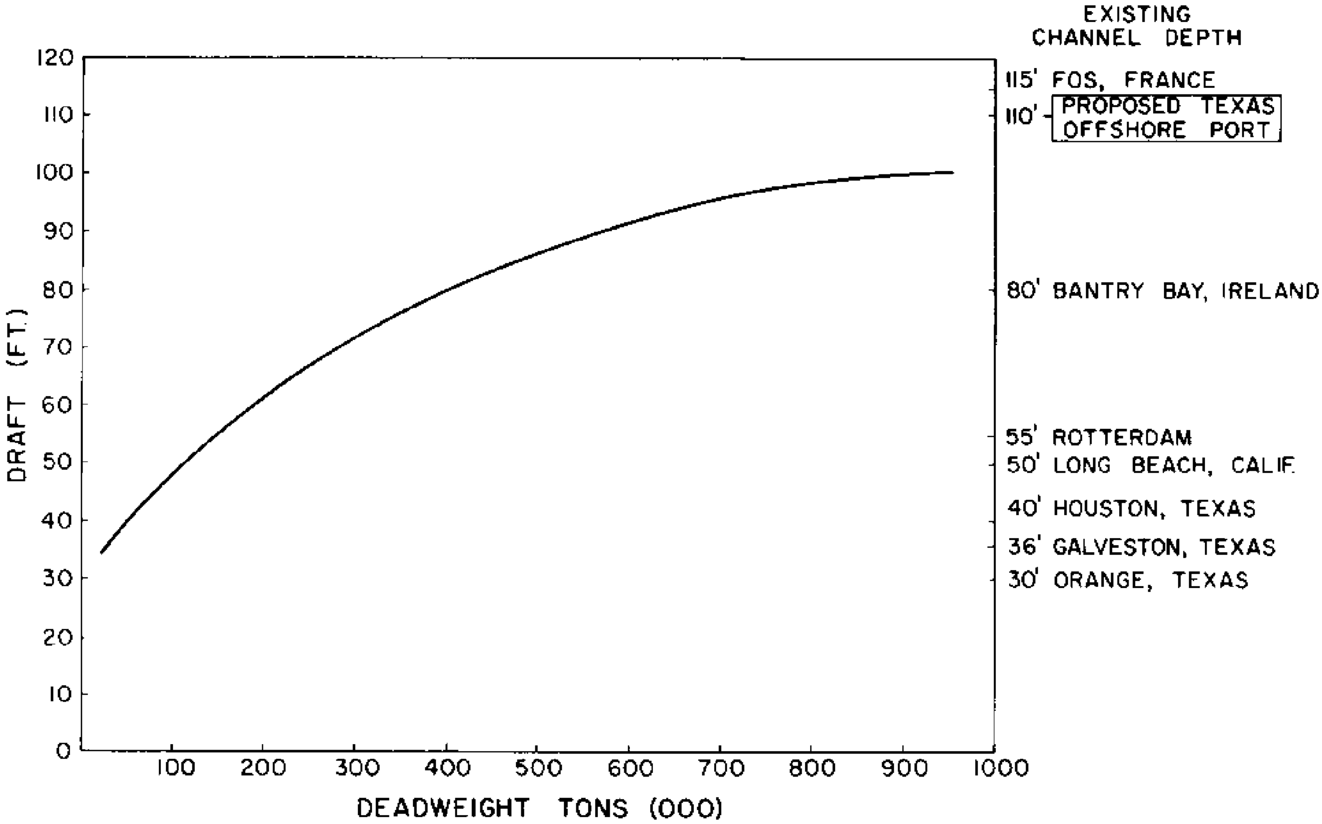


FIGURE 3. Ship Deadweight Tonnage and Channel Depths Required.
Source: Industrial Economics Research Division, Texas A&M University, College Station, Texas.

the largest ships now being contemplated.[5]

Unfortunately, obstacles, both natural and man-made, will prevent most ports from following conventional practices like dredging and widening to update their facilities. Such things as pipelines, telephone cables and vehicular crossing structures—those already emplaced as well as those being planned, such as the proposed crossing between Galveston and Bolivar, Texas—almost certainly will preclude the deepening of most channels and established ports throughout the world. However, even when man-made or natural obstacles are not present, a major factor preventing channel enlargement is the expense. The Milford Haven Conservancy Board, for example, estimated a cost of 12 million pounds ($30 million) to deepen and straighten eight miles of channel from 55 feet to 65 feet.[6]

A particularly frustrating aspect of the supership berthing problem in the United States will arise if plans are implemented by the Maritime Administration to use authorized shipbuilding subsidies for the construction of economical ships, meaning supertankers and the like—a proposal that has already been argued in Congress.

To reduce the expense of providing berthing facilities for supertankers, ore-bulk-oil (O.B.O.) class, and similar oversized vessels, other solutions to the problem besides dredging have been sought. Several alternatives have been developed, and some have been put into practice. These alternate methods fall into two general categories: trans-shipment—transfer of cargo in deep water to smaller vessels or lighters, and unloading of cargo at sea through use of offshore terminals. Gulf Oil has adopted the trans-shipment method at its Bantry Bay operation on the southwest coast of Ireland. Bantry Bay has ample water depth but is not near a population center or any of Gulf's European refineries. Their "Universe" class ships make the Arabian Gulf-Ireland runs at full load and peak turnaround efficiency, then smaller ships make the shuttle runs to the berths at the refineries. Gulf is using the same technique in Canada and in Okinawa.[7] However, the double handling costs incurred in moving products by this method tend to offset the advantages of using supertankers for the deep water portion of the haul and, in the case of aromatic products such as gasoline, the hazards inherent in handling are compounded when lightering is introduced as a link in the transportation chain. The potential for accidental spillage and pollution also increases with each handling.

The other method commonly used as an alternative to dredging is the offshore terminal. This is basically a structure, either floating on the water surface or resting on the ocean bottom, that is designed for the mooring of large ships and also contains provisions for loading and/or unloading bulk cargoes of liquid or non-liquid commodities. At the present time, the most prevalent use of this technique is in handling liquid cargoes—usually crude oil—in underdeveloped locations where ports do not exist or

[5]Ibid., p. 38
[6]Ibid., p. 38.
[7]Ibid., p. 38.

are inadequate. The method involves the use of offshore loading and unloading buoys anchored in deep water and connected to refineries onshore via undersea pipelines. These buoys are usually turret moorings at which ships tie up bow-to while cargo hoses are floated to the ship's manifold amidships. Hoses with 24- to 30-inch diameters are used in these operations so that turnaround time can be kept to a minimum (24 to 36 hours maximum). Subsea lines up to 48-inches in diameter then connect the buoys to onshore terminals.

The big selling point of the buoy system is low cost. But it is a highly specialized, single-purpose system that lacks flexibility for adaptation to commodity trends over a period of time and, in all likelihood, will probably not become a strong candidate for use at an offshore port unless it is combined with complementary facilities to give the installation a multi-cargo-handling capability.

On the other hand, man-made islands built for the storage and handling of bulk non-liquid commodities are rapidly gaining favor. A recent example of this is the proposed island in Delaware Bay to be built by Zapata Norness for use in movements of metallurgical coal, iron ore and other non-liquid commodities aboard O.B.O. vessels which are too large to enter or leave existing East Coast ports fully laden. The island will cover 300 acres and will cost about $160 million.[8]

THE TEXAS GULF COAST CASE

Regardless of the method of construction and manner of operation decided upon, the providing of a facility on the Texas coast to handle cargoes transported in giant ships is a matter of utmost importance to the area's economic structure. It is necessary not only for the perpetuation of the status quo but also for the maximization of future economic growth in the region. The advantage of petroleum that is both low in cost and available in the region—at one time almost a monopoly in Texas—is no longer a clear-cut one. Today, industry in Texas is looking increasingly to imports of crude oil to meet growing production and consumption demands. Protests of domestic producers notwithstanding, increased oil and gas imports are a certainty for the future if domestic energy demands are to be met and if the local petrochemical industry is to survive in world trade.

Even natural gas in our "land of plenty" is becoming a major problem. Liquid natural gas (LNG) imports to the United States appear imminent because of a number of growing problems such as the following:

1. There are signs of a developing shortage of indigenous piped gas, particularly on the United States eastern seaboard, and supplementary supplies might be needed during periods of peak demand.
2. The ratio of indigenous gas reserves to annual production and consumption has shown a steady decline. In 1968, gas reserves were estimated to be sufficient for only 15 years' consumption. During that same year, the net production (and consumption) exceeded the gross addition to United States reserves.[9]

An increased level of imports means an increased usage of ocean transportation. And based upon the trends in ocean vessel size as mentioned earlier, this means an increased probability of giant ships being used to transport cargoes to and from the Texas coastal region. Passage of time will also play a part in this. History shows that there is a trend to bigness in transportation, as evidenced by the "unit train" concept and the "jumbo jet" airliners. Ocean transportation is no exception. Figure 5 indicates how vessel sizes have changed from the days of sailing vessels to the present. Great Lakes ore carriers and barges used on the inland and deep-sea water routes have shown the way. Now ocean-going tankers are caught up in the trend, and even though the world tanker fleet is composed mostly of ships under 10,000 dwt size, the number of supertankers in service and under construction is rapidly rising, while almost none of the new construction is in the smaller sizes. Table 1 shows the deadweight tonnage of vessels and the number of vessels in each range for 1966 with projections for 1983. As normalcy returns to the world oil shipping situation, as it did some time after the closing of the Suez Canal, charters of ships will tend to be awarded more and more to the operators of large vessels because of

[8] "New Island Urged as Giant-Ship Port in Delaware Bay," *The New York Times*, February 1, 1971.

[9] "Why the LNG Tanker Market Will Grow," *Ocean Industry*, (December, 1970), p. 37.

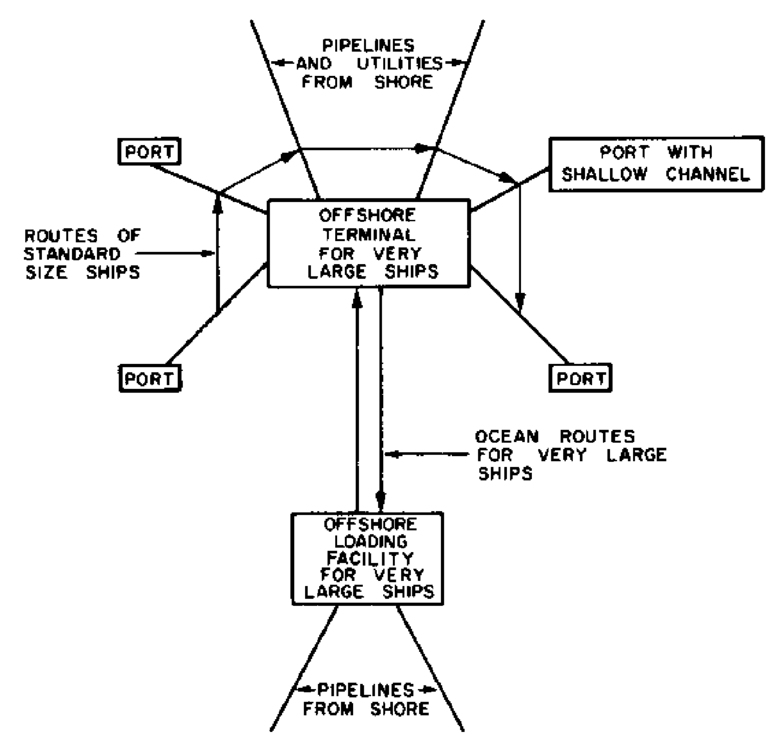


FIGURE 4. New Concept in Ocean Transportation for Large Ships.

TABLE 1

WORLD TANKER FLEET

1966 and 1983

VESSEL DEADWEIGHT TONS (In Thousands)	NUMBER OF VESSELS 1966	1983*
10- 20	1,184	1,337
20- 40	889	456
40- 60	467	317
60- 80	202	429
80-100	86	760
100-125	29	397
125-150	5	48
150-200	2	224
200-300	——	371
400-600	——	45
TOTAL	2,864	4,384

*Projected

Source: *Merchant Vessel Size in United States Offshore Trades by the Year 2000*, June, 1969. The American Association of Port Authorities Committee on Ship Channels and Harbors, Washington, D.C.

the lower rates they offer. Smaller ships with higher costs per unit of cargo moved will be less in demand on the large-volume, long-haul routes and will end up being mothballed or scrapped due to their marginal economies.

The net effect of these profound changes in shipping technology, which are already underway, will be to forcibly define future destinies of port operations and to crystallize the long-range thinking of port authority people. Evidence that the more progressive ports recognize the coming revolution in shipping technology shows up in the growing rush toward establishment of container-handling facilities at many port locations and in the increasing use of the term "intermodal" in announcements of expansion plans at many of the ports. Also, there is a rising interest, as expressed in expenditures of facilities monies, in the relatively new SEABEE and LASH concepts of shipping, which involve transporting laden barges aboard specially designed relatively deep-draft ships between major ports with the barges being set off into the water at the deep port and then being towed to their final destinations over shallow waterways. These techniques reduce shipping costs because they eliminate double-handling of bulk cargoes between shallow- and deep-draft carriers.

THE NEED FOR AN OFFSHORE PORT IN TEXAS

Modifying existing docks by installing large, special-purpose handling equipment, paving large vacant areas for container storage, and establishing attractive rate structures to encourage traffic are all sound moves by the ports, but they are stop-gap measures to say the least. Without provision of adequate depth to accommodate the large ships that are coming, all of the other changes installed by the ports will become obsolete before they can be amortized due to the quantum growth in ship sizes. Since bulk shipments are a significant factor in the Gulf Coast economy, the area's present facilities will create a rising freight rate plateau that will mean higher costs for area users and will tend to stifle economic growth in the state. On the other hand, providing such facilities as that shown in Figure 6 for the unlimited accommodation of the maximum size ships predicted to be built promises to benefit the local economy significantly. For example, according to recently published figures, the Dutch port of Rotterdam, which started in 1967 to create a deep water facility on the Meuse Shallows (now known as Europoort), reports that its refinery capacity has now more than doubled.

Failure to build a deep water port may be looked upon by future economists as the "turning point" that marked the beginning of the decline of the Texas Gulf Coast as a dominant figure in the world economic picture. For it is a proven fact that in any competitive activity, whether it be in areas of business or national defense, it is vital to have growth and innovation just to stay even with your competitor. The pre-eminent position of Texas in water transportation and petroleum is no exception.

Already there is talk that Texas has reached its zenith of influence, and affluence, in the petroleum and HPI areas. Historically called "the balance wheel of the oil industry" because of its tremendous influence on

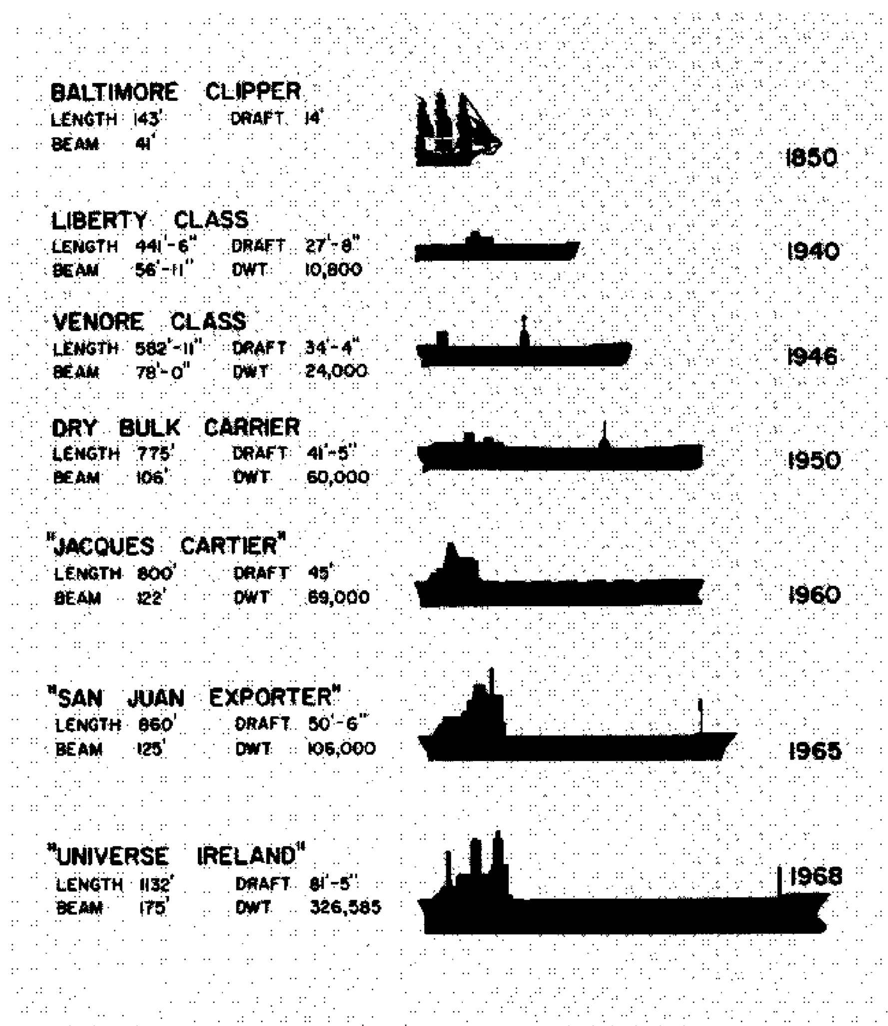


FIGURE 5. Vessel Sizes Past and Present.

Source: *Water Spectrum*, Dept. of the Army, Corps of Engineers (Spring, 1971), p. 11.

world oil and gas business, Texas now appears to be losing its standing in this respect as a result of an increasing level of oil activity elsewhere in the world. However, from the standpoint of business volume in the overall petroleum-related picture, Texas is still quite dominant due to the huge concentration of HPI plants in the state, particularly along the Gulf Coast. In the immediate area of Galveston, Freeport, Port Arthur and also in Corpus Christi exists the greatest concentration of oil refining, petrochemical process industry, aluminum producing, sulphur, and chemical producing establishments in the world. In fact, 40 percent of the total United States production of basic petrochemicals comes from this area; 19 percent of the total United States petroleum refining and 80 percent of the United States production of ethylene is produced in the Texas Gulf Coast area. In addition to the petroleum refining, petrochemical industry, and other named industries; the steel industry has located in this same area. With present production of some 2,800,000 tons per year and projected production of an additional 7,000,000 tons per year in this decade, Texas has a new basic industry of giant proportions.[10] It should be noted, however, that a large factor in the success of these segments of business has been and will be the accessibility of deep water transportation because the viability of all the industries mentioned depends upon manufacturing in bulk for bulk shipment with cheap transportation. Cheap transportation means water movement and, in order to keep cheap transportation, Texas industries —both the shippers and the ports— are going to have to plan and prepare for the size revolution taking place in water carriers.

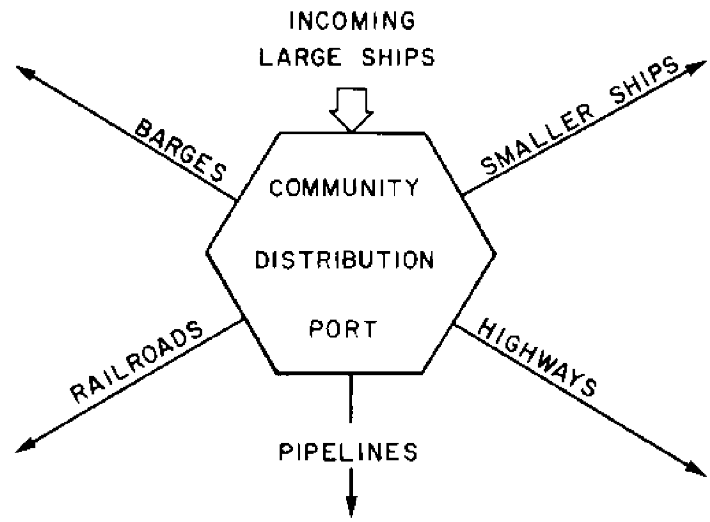
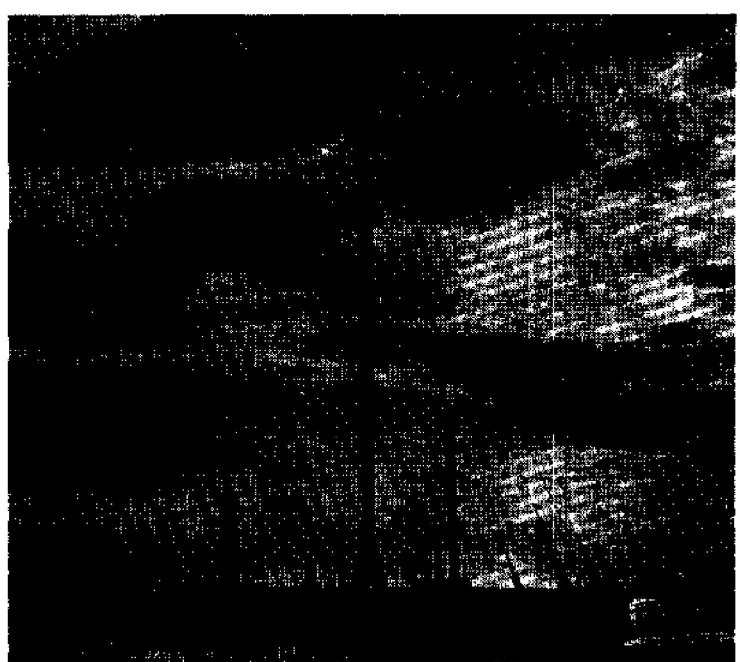


FIGURE 6. Community Distribution Port Serving Large Ships.
Source: Casimer J. Kray, "Supership Effect on Waterway Depth and Alignments," *Journal of the Waterways and Harbors Division*, Proceedings of the American Society of Civil Engineers, (May, 1970), p. 501.

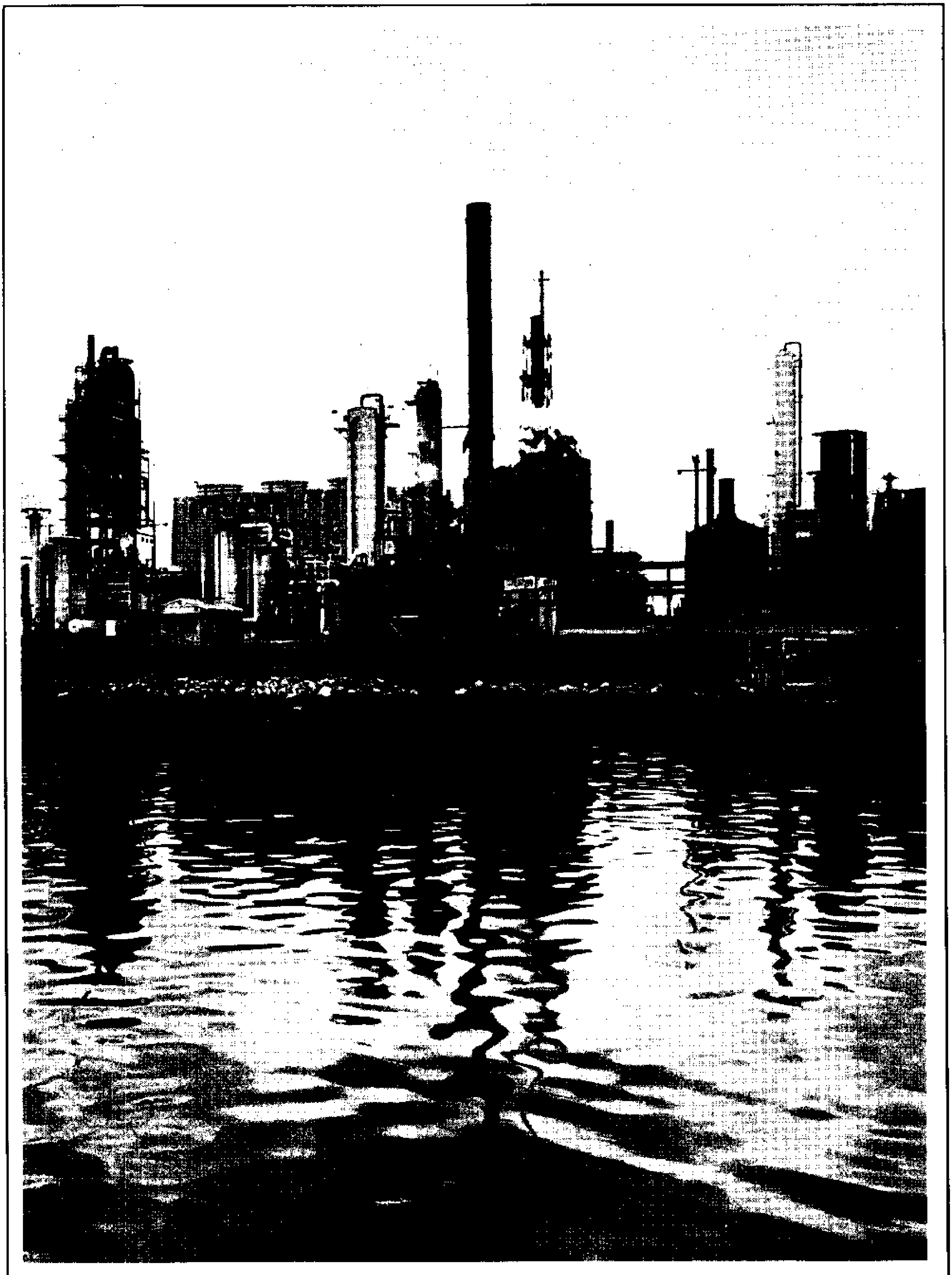
John A. Creedy, President, Water Transport Association, in a March, 1971, address before the Southwestern Transportation Round-up in Houston, succinctly stated the case when he said, ". . . big ship technology of supertankers and super ore and grain carriers . . . can't make money for you if the ships can't get to you."[11] Or, looking at it in another way, the motto of the builders of Rotterdam's Europoort says "The quay must be there before the ship calls."

[10] Roy R. Brimble, "Establishment of a Deep-Sea Terminal Off the Texas Gulf Coast," *Water Spectrum*, Vol. 3, No. 1, (Spring 1971), pp. 10-12.

[11] "Gulf Intracoastal Canal Said Obsolete," *The Houston Post*, March 3, 1971.



Sophisticated data-gathering techniques could be employed in an offshore port facility. (Photo: General Dynamics)



Thriving oil and petrochemical complexes place increasing demands on water transportation.

ENGINEERING STUDIES

Without a doubt many facets of the feasibility study for an offshore cargo terminal to serve the Texas Gulf Coast will be complex and will require astute investigation before satisfactory answers are obtained. Legal implications promise to be quite complicated; consideration and protection for the environment are factors of absolute necessity; and the economics of the proposed facility—that is, cost versus benefits—must be carefully weighed before any significant expenditures are obligated.

Another factor of consideration that should not be taken lightly is the one involving the physical engineering and construction of the port installation. Things such as structural soundness — considering operating requirements and extremes of weather, functional suitability, long-range flexibility of operation, and environmental compatibility must all be provided in a facility with a design that also optimizes first cost as well as continuing costs of the facility.

Before engineering studies can begin, however, it will be necessary to establish certain data of a non-technical nature on which to base engineering studies. Economic investigation and analysis, for instance, will be required for the development of data relative to the projected traffic demand in the various discrete areas of the Texas coastal zone. Results of these studies can be summarized in such a way that "epicenters of demand" (ED) will be developed for certain geographic locations along the coastline. These ED points may then be refined using inputs such as commodity types, volume of movement of each commodity, projected trends of movement types and volumes, and classification of commodity movements by volume to determine the capabilities of the existing ports for handling these movements. At the conclusion of this phase of the study, there will be one or more well defined ED's that have need for a facility capable of handling the ships which require more water depth than the existing 40 feet available in some of the Texas ports.

PRELIMINARY STUDIES

Determination of the supership ED locations lays the foundation for commencement of physical investigations leading toward construction of the offshore port. The first step that would most likely be taken at this time would be the preparation of a comprehensive map of the Texas Gulf Coast area. By comprehensive, it is meant that such a map would include but not be limited to the following items of interest:

1. Location and route of Intracoastal Waterway
2. Location and condition of rail facilities
3. Location and alignment of crude oil pipelines and owner of each
4. Abandoned pipelines and owner of each
5. Refineries and other petrochemical plants (locate and identify)
6. Location and capacity of utilities in the area
7. Location of existing wells and structures in the Gulf of Mexico
8. Location and route of shipping fairways
9. Bathymetric data for the study area (out to 25 fathom line)
10. Identification of existing uses and users of the land/water interface zone

After preparation of the comprehensive map of physical data, an important follow-on step will be to obtain background data from the oil companies who own pipelines in the area of each ED and also pipeline companies who own product pipelines in the same area concerning (for each pipeline) size, what type petroleum products could it handle and when would it be available on an hourly, monthly and yearly basis to handle various products. Also, what is the capacity of each line on a gallons-per-minute or barrels-per-hour basis.

Another item of information important to this phase of the investigation would be a determination in regard to the refineries and petrochemical plants concerning the types and volumes of raw materials received and the same data on finished products shipped. In addition to petroleum and petroleum-derived products, this analysis should include natural gas, liquid petroleum gas (LPG) and other bulk raw materials moving in the commerce of the Gulf Coast area.

At the same time and in parallel with the above described study, an investigation should be made of the feasibility of a terminal either near shore or ashore that could be served by superships by way of a dredged channel of an appropriate depth and width, including an adequate turning basin, extending from a point where the required depth occurs naturally thence shoreward to the terminal site. The purpose for such a study, of course, would be to permit an early decision concerning the economic, operating and environmental advantages and disadvantages of the dredged-channel type facility as compared to an offshore installation so that the balance of the study can be funneled along the correct path with a minimum of wasted effort.

The dredged-channel investigation should consider at least the following points:

1. "First cost" of dredging, including overdepth for advance maintenance
2. Estimated annual maintenance costs
3. Availability of spoil disposal areas, both initially and over a period of time
4. The influence of depth-limiting factors such as pipelines, cables, bedrock, and the proximity of underground aquifers

5. Environmental effects of dredging in the shallow, near-shore bays and estuaries
6. Need for excessive depths and widths in the dredged channel to compensate for bank suction, squat, passing interference and other negative effects of channels and waterways

Without access to confirming data which could either bolster or negate such an opinion, it appears that the only justification for considering the dredged-channel type of deep-draft facility lies in the fact that, at first glance, such an onshore location would tend to favorably impact certain environmental factors—but this is not true. A look at the whole picture quickly shows that these rather questionable advantages are far outweighed by other considerations. For example, an onshore facility would seemingly be more secure and offer greater protection to vessels in the event of a hurricane, thereby avoiding the possibility of a tanker being sunk at an offshore berth with a resultant oil spill that could cause widespread damage in the ocean and on the shore. But, the hazards inherent in bringing a large vessel that has almost zero maneuverability into a congested area, thus greatly increasing the likelihood of a collision, plus the possibility of greater havoc from a close-in spill than from a spill far at sea would appear to weigh against a close-in port. Generally speaking, the more confined and near-shore a spill occurs, the greater its environmental impact—especially in the sense of altering the environment or posing pollution threats to the shoreline and beaches. Another point against the dredged-channel, close-in port is that the harmful aftereffects of ever-increasing dredging and connected high costs to accommodate superships are compounded by the strain that these monsters of the shipping lanes place on already-overtaxed shore developments, structures and waterways. Add to this the high initial cost plus the continuing high cost of maintenance not to mention the long cycle time that it takes for such improvements if Federal assistance is required. Such projects normally take from 4 to 10 years to get underway from the time the need is made known and this waiting period makes the dredged channel appear even less attractive. On the other hand, an offshore terminal of the type envisioned in this study could be under construction six months to one year after its feasibility is established from the feasibility study. Nevertheless, a study of the dredged channel should be made to permit an intelligent choice as to what route to pursue in design and construction of the supership port.

If as a result of the investigation of the dredged-channel versus offshore port concepts, it is decided to pursue the route leading toward the offshore, or deep water, type of installation then certain sequential actions should be taken immediately after this decision is reached. These steps are covered in the following discussion.

INTERMEDIATE STUDIES

From data obtained in earlier studies such as the location of the epicenters of demand, or ED's, and the designation of supership ED's as evolved from the study of commodity flows versus capabilities of existing ports, it now becomes necessary to establish one or more general site locations in the Gulf at places where the water depth at mean low tide (m.l.t.) is at least 110 feet.* These general areas should be further refined geographically based upon the constraints of shipping fairways, anchorage areas and the rules governing the spacing of structures therein and the location of existing structures, pipelines or other obstructions in the area of study. Simultaneous with this study, or soon thereafter, a program should be started to study and record periodic data such as the following:

1. Water depth below chart datum
2. Highest spring tide above chart datum (if tides exist at this or these locations)
3. Lowest spring tide above or below chart datum
4. Significant wave height
5. Significant wave period
6. Prevailing wave direction (if any)
7. Significant wind velocity
8. Prevailing wind direction (if any)
9. Velocity and direction of currents (surface, subsurface and bottom)

This study should also involve investigation of meteorological records and use of synoptic surface weather charts as a means of "hindcasting" to determine the size and intensity of a design storm and its anticipated period of recurrence (e.g., 50-year storm, 100-year storm, etc.). From these data can be established the parameters of three general conditions of meteorological forces, or weather, that are critical to port operations, and the frequency of occurrence of the three conditions. These are:

1. Average case
2. Frequency of "no-operation" case
3. "Worst" or "design" case, plus frequency

An integral part of the design storm investigation would be the determination of several pertinent factors relating to the limiting of offshore port operation because of storms and inclement weather. These would include:

1. Maximum wave height in which a vessel can remain on mooring
2. Maximum wind velocity in which a vessel can remain on mooring (average velocity in knots and prevailing direction)

A study of the response of tankers and cargo ships, of the type and size expected to berth at the proposed offshore port, to wave motion and related mooring problems is needed to establish the wind and wave conditions which will prevent a ship from docking. It may be necessary and desirable to conduct model studies to better establish ship behavior characteristics under various conditions expected at the study location.

Other environmental data required (to be taken at various depths):

1. Oxygen--ml/l
2. pH
3. Salinity—0/00
4. Temperature—°C
5. Pressure--psi
6. Biological studies—material immersion to determine level of biodeterioration (that is, effect of micro-organisms and borers) but more particularly rates of corrosion of various types and grades of metals.

From data obtained in earlier studies relating to epicenters of demand, commodity types and volumes, location of pipelines and location of refineries, the researcher should at this time establish what quantity and type of raw materials and finished products will be handled through the

*It should be noted that prints of location of study area or areas must be tied in to at least two points (triangulation stations) onshore by electronic triangulation.

proposed deep water port. From this information, a Projected Traffic Load can then be evolved which will in turn generate essential information such as the following (for both loaded and unloaded conditions):

1. Volume of ship traffic (number of ships)
2. Type of ship (tanker, LPG, O.B.O., other)
3. Average and maximum length of ships
4. Capacity (dwt) of each ship,
5. Draft (both loaded and empty)

Also, statistical studies should be made of present and projected future tanker sizes, projected frequency of call, present and future lost time due to queuing, and projections of the frequency and duration of the periods when the port is weathered in. From this data the cost of tanker loading and waiting time could be determined and weighed against the capital expenditure costs of the terminal. Also, a determination can be made of the optimum storage capacity, loading rates and number of supertanker berths required.

From the above environmental data readings and Projected Traffic Load studies, an Environmental Impact Statement should be prepared for study by the Corps of Engineers and other agencies in order that when it becomes time to construct the offshore facility, the need for such an impact statement will not be a delaying factor.

FINAL STUDIES

With analysis of all of the above data, studies can be started on the physical characteristics of the deep water port facility. Requirements for the offshore berth, the supporting facilities ashore and the interconnecting pipeline manifold must all be determined at this time so that conceptual designs can be formulated for structures, site layouts, site preparation, breakwaters, piping layouts and other factors.

A study of operating characteristics of the offshore port complex will be necessary in order to determine certain choices of design and layout. For instance, during the unloading of liquids at the offshore berth, will it be feasible to pump the incoming cargo directly to shore as a part of the unloading operation or will it be more feasible to unload the ship's cargo into on-site storage tanks for later transfer to shore at lower pumping rates? If a trade-off analysis shows that on-site storage at the offshore berth is the best choice, then the facility could possibly be one like the Khazzan Dubai installation in the Persian Gulf shown in Figure 7 (built by Chicago Bridge & Iron Company for Dubai Petroleum), or it might resemble the concrete structure shown in Figure 8. Other functional and operating requirements will necessitate design decisions concerning such factors as:

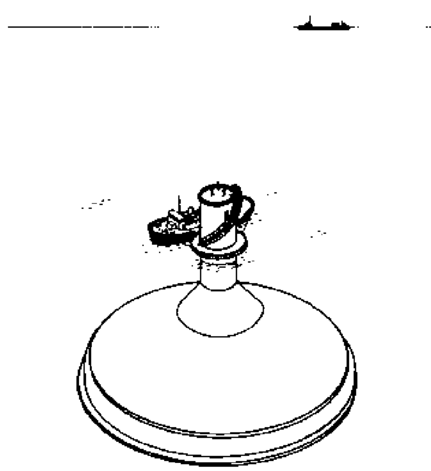


FIGURE 7. Khazzan Dubai I Underwater Oil Storage Tank Built by Chicago Bridge & Iron Co. for Dubai Petroleum Co.

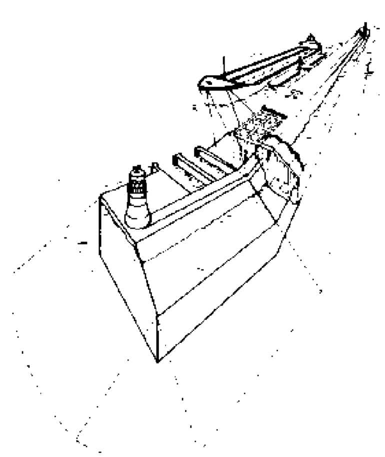


FIGURE 8. Proposed Offshore Terminal of Concrete Construction.

1. For onshore facility

- Power substation — if required to furnish power to offshore facility
- Waste treatment plant — if required to handle effluents from offshore facility
- Tank batteries for petroleum or related products
- Barge slips and barge connection to Intracoastal Waterway and offshore facility
- Product/pipeline routing control center
- Freshwater treatment and supply facilities if required to furnish to offshore facility

2. For offshore facility

- Berthing arrangement based upon study of wind, waves, tides, currents and other factors affecting mode of docking. Also, consideration of ship sizes and cargo types.
- Structure configuration, size and compass orientation
- Freshwater requirements (domestic and other)—should desalination unit be located at facility?
- Waste management (domestic, ballast, oily)—treated on-site or pumped ashore?
- Materials handling and pumping facilities
- Protected barge slips
- Fire protection
- "People" facilities (housing, food preparation, supplies, communications, heliport)
- Pollution control and spill containment
- Foundation requirements
- Storm protection

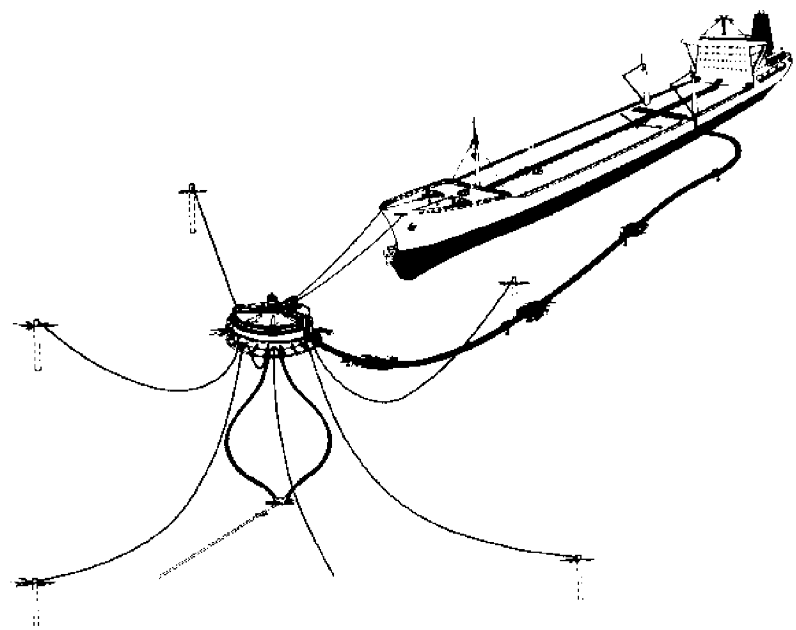


FIGURE 9. The Imodco S. B. M. System: A Complete Offshore Terminal Facility.

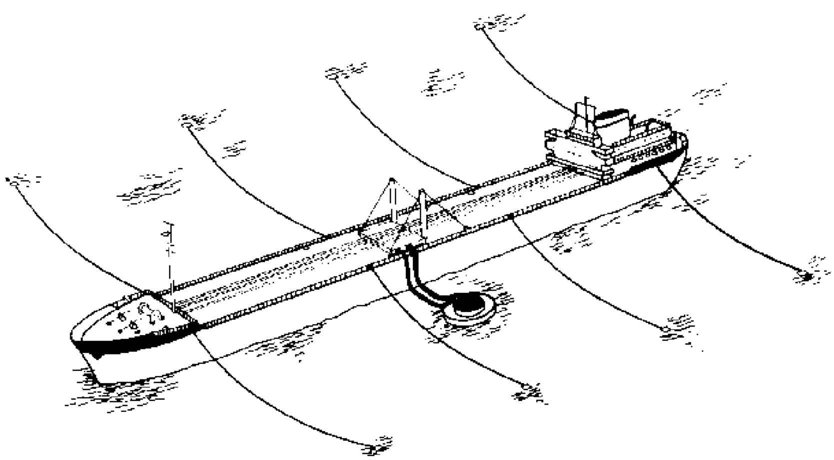


FIGURE 10. Typical Multiple Buoy Fixed Mooring.

ALTERNATE DESIGNS OF OFFSHORE FACILITY

In addition to the all-concrete type of offshore facility illustrated in Figure 8, which is actually both a structure and an artificial island, and the underwater steel tank shown in Figure 7, there are several other basic design approaches which can be considered for the proposed installation. Each of these types has advantages over any other one depending upon the function and location of the facility. A listing of the basic types of offshore installations to be considered and now in use in various locations around the world would include the following:

1. Buoy type—multiple buoy system or single-point system (which allows ship to rotate freely to a balanced-force heading) — buoy system has advantage of low cost but is restricted to the handling of liquids and is susceptible to storm damage. Figues 9 and 10 illustrate two buoy concepts.

2. Mother-ship (or floating storage) system—in which a permanently-anchored tanker is used as a docking point for ships discharging and loading —the number of ships required on station is a function of Projected Traffic Load—"mother-ship" concept has certain flexibility and cost advantages but it is principally used for the handling and interim storage of liquids although slurried solids-handling is another possibility.

3. Floating wharf—an adaptation of the single-point buoy concept with the added capability to handle other cargoes besides liquids. This concept uses massive barges which are moored in a single-point fashion, permitting them to assume the best heading in the sea, while allowing large vessels to tie alongside. The decks of the barges are equipped with material-handling equipment like a fixed dock, and storage space is provided in the barge's hull. Draft of the barge can be changed through use of a ballast pumping system. Figure 11 illustrates the floating wharf concept.

4. Island type—may be of two different designs

   a. Structural platform—may be of steel construction with corrosion-inhibiting system or may be of pre-cast concrete pilings supporting precast or cast-in-place concrete deck structure. May be designed to accommodate barges underneath (including allowances for wave- and tide-caused elevation changes). Should have flexibility to accommodate ships with different freeboards. Figures 12 and 13 present some typical platform designs.

   b. Artificial island of man-made and dredged material—composed of a cofferdam with the interior occupied by "fill" — embankment or cofferdam could be built of quarried boulders or precast concrete "tribars" (interlocking shapes) — fill could be sand if available, otherwise such materials as slag, broken concrete, or other waste as may be available locally could be considered.

Both island types would be highly resistant to storm damage if properly designed.

ESTIMATES, PLANS AND SPECIFICATIONS

If sufficient data have been collected from the many studies outlined above, then cost estimates for each of the proposed designs at each of the proposed locations should be prepared. These estimates should cover (for each location and structure type):

1. Cost estimate of berthing facility
2. Cost estimate of supporting facilities ashore
3. Cost of connecting facilities

A summary of the costs for the various proposals should be prepared and should include a ranking of each proposal, starting with the best, with an explanation as to why each was ranked as it was. Cost figures from this analysis can now be fed into the cost benefit studies discussed in this report under "Socio-Economic Studies."

After a decision has been made regarding design and location, the next step to be taken in the area of engineering studies is the preparation of the final structural design to be followed by the drawing-up of the final plans and specifications:

1. Plans for—
   a. Berthing structure
   b. Onshore supporting facilities
   c. Connecting facilities
2. Specifications
   a. Materials specifications
   b. Bid item specifications
   c. Construction sequence specifications

CONSTRUCTION PHASE

The final phase of the engineering involvement in the Texas supership port project will come during the bidding and construction of the port. Successful implementation of this phase will require that the following general steps be taken by the engineering consultant:

1. Take bids
2. Prepare contract documents
3. Inspection of work, and
4. Start-up and check-out

SUMMARY

Although it is recognized that there are many important aspects to be considered in regard to the proposed Texas deep-draft cargo terminal for the berthing and loading/unloading of supersized cargo vessels, none can have more lasting consequences than those that are classified as being of an engineering nature.

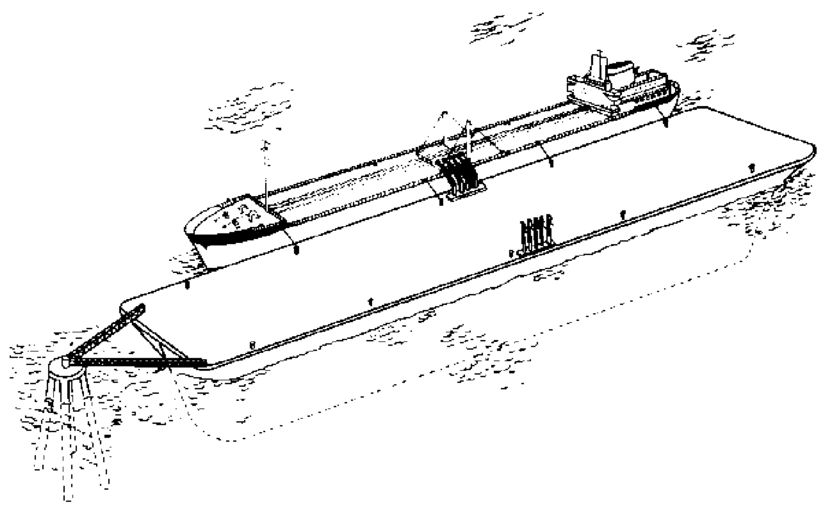


FIGURE 11. Floating Wharf Concept by Blakely Smith and Sharp-Delong Offshore Company.

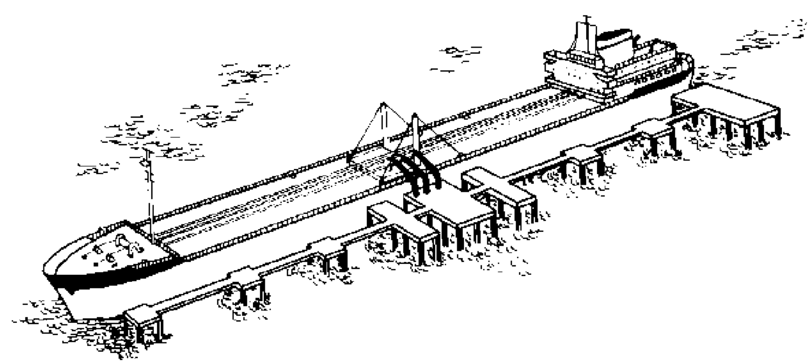


FIGURE 12. Platform Design by John J. Pepe Engineers, Houston.

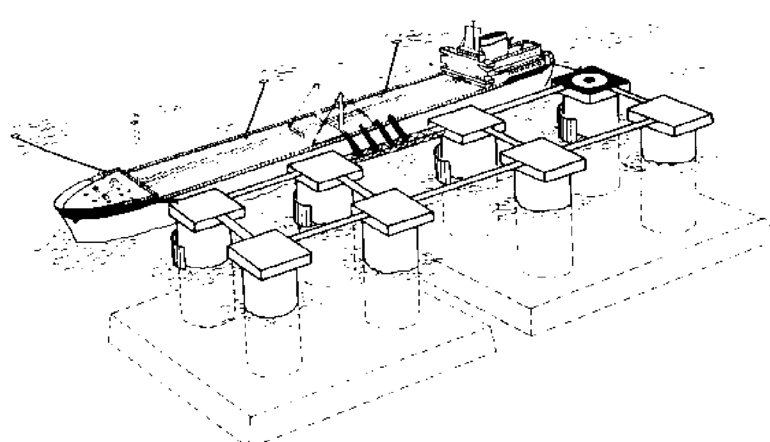


FIGURE 13. Platform with Subsea Oil Storage by Bethlehem Shipbuilding Company, Beaumont, Texas.

SOCIO-ECONOMIC STUDIES

IMPACT ON EXISTING ECONOMY

Cattle, cotton, rice, grain sorghum, citrus fruits, and lumber have all made important contributions to the prosperity of the Gulf Coast of Texas. In recent years, however, the industrial growth of the area has rested on seven important natural resources combined with access to low-cost transportation, making it possible for Texas industries to market their products in the population centers of the United States and throughout the world at competitive prices. The natural resources are petroleum, natural gas, sulphur, salt, lime (from oyster shell), seawater, and fresh water. The low transportation costs exist because of the ready availability of railroad facilities, an excellent network of highways, modern airports, an extensive network of pipelines, the Intracoastal Waterway, which provides barge service via the Mississippi to the industrial heartland of the nation, and the ports which provide access to all the nations of the world.

Petroleum, natural gas, sulphur, salt and oyster shell are all limited in amount; and their supplies will eventually be exhausted. Some will be depleted in the near future, such as oyster shell and sulphur, and some over a longer period, such as petroleum and natural gas; while some, such as salt, seawater, and fresh water, will last indefinitely if reasonable conservation procedures are followed. Sulphur domes, oil pools, and natural gas deposits all are said to have limited lives. Some may be exhausted in 10 to 20 years, and it seems likely that all of the oil will be recovered to the limits permitted by today's technology in perhaps 20 to 50 years. Increased exploration will bring to light some additional reserves while new technology will permit commercial production from deposits now considered too marginal for economical recovery. In the main, these developments will not greatly ameliorate the growing United States demand for supplies of energy.

As long as the seven resources are available in Texas the operation of our refineries, petrochemical plants and other elements of the HPI complex will continue. Undoubtedly, as the supplies of oil and natural gas in our area decrease and costs begin to rise, we will begin to import these raw materials from other areas. Then as local supplies become exhausted or become too expensive for practical use (considering our competitive relationships), we will begin to see an almost complete dependence upon imported materials, some imported from other parts of the United States, including Alaska, and the balance from other countries. We will not be dismayed by our increasing dependence on foreign sources of supply; we will be dismayed only when we can no longer sell our products at competitive prices. By allowing the continued and increased use of foreign oil, we can continue to utilize the capital we have invested in refineries, petrochemical plants, and other production facilities. We can continue to provide employment for the highly trained labor force we have developed; and we can maintain the prosperity of the Gulf Coast area as well as that of the nation as a whole.

If free enterprise is allowed to reign and imports of raw materials are increased as needed, then the dynamic HPI segment of our state's economy can continue to flourish even in the face of gloomy prospects of diminishing domestic supplies of basic raw materials. It is important to note, however, that in order to ensure this growth we must continue to improve our technology and remain at least abreast of our competition in production, management and distribution techniques. And certainly, as we begin to depend more and more on raw materials brought into the Texas coastal zone, one of the key factors will be our ability to handle the vessels of commerce that haul the imported commodities and raw materials that our industries will be so dependent upon.

Big things are taking place in transportation today. A new technology is developing in sea transportation, a technology which involves the use of supertankers and larger cargo vessels. Tankers of 200,000 to 300,000 deadweight tons, drawing 70 feet of water or more, are already in use; and many more of them are being built. Available evidence indicates that these tankers can cut transportation costs to one fourth of the cost made possible by their predecessors in the 10,000-30,000 tons size range. Tankers of nearly 500,000 tons have already been ordered and tankers of a million tons are probable during the decade of the seventies. And there is not a port in the United States where these supertankers can be accommodated today. In most ports it would be impractical to deepen the channels enough to provide sufficient water for these monsters of the ocean lanes and, depending on the characteristics of the coast, this may mean a port will have to be 2 miles, 10 miles, or perhaps 65 to 75 miles offshore to ensure adequate water depth without the need for constant dredging.

Are such things possible? Certainly. A number of these offshore port facilities have already been built in various parts of the world and many more are on the drawing boards. What does this mean? It means that industries located in the Gulf Coast area of Texas will not be in a competitive market position if we do not take advantage of new developments in transportation. It means that other areas, perhaps in the United States or other countries, will be able to reach our markets with their products at lower cost if we do not build an offshore port facility in time to remain competitive. An alternative would be for our industries to build new plants in other countries where low-cost raw materials or low-cost transportation or both are available. This would be quite detrimental to the economy of Texas and the entire Gulf Coast.

The time to study this question, to get all of the answers, is upon us. It is already late, but not too late if we can begin immediately to study the costs involved, to estimate the benefits, and to develop the information relevant to the need for an offshore port facility off the coast of Texas in the Gulf of Mexico.

Need for Economic Studies

To justify the allocation of resources to the creation of a port facility designed expressly for the accommodation of supersized ships, a study of the various economic aspects of the proposition is necessary. This study should include detailed investigation into questions such as:

1. What will this facility do for the area's economy?
2. What happens to the economy of the area if the port is not built?
3. What will be the dollars-and-cents benefits that the facility will bring about and how do these compare to its cost?

The first two questions have been mentioned, but the detailed studies which are required to provide quantitative answers have not been discussed. The following is an outline of the studies proposed.

Recommended Studies

● Studies designed to measure the potential economic benefits of an offshore port facility to the coastal area of Texas as defined in the study and hereinafter referred to as the "study area."

1. A study of the structure and operation of the economy of the study area to determine:

The resource base of the study area; including a study of the supply of those natural resources on • The production, transportation, which the economy of the area is based, existing trends in the demand for such natural resources, and the estimated life of those nonrenewable resources which exist in finite quantities.

The economic structure of the study area; including the identification and study of those basic industries which produce the major portion of the gross product of the study area, and those basic industries which supply a major portion of the employment in the study area including, among others, the following:

- The production, transportation, processing, and distribution of petroleum and petroleum products (exclusive of the products of the petrochemical industry); processing and distribution of natural gas and natural gas liquids;
- The production, and distribution of petrochemicals; including studies of world market prices for petrochemicals and the effects of raw material costs on the location of production facilities.
- The production, processing and distribution of sulphur;
- The manufacture and distribution of iron and steel;
- The utilization of coal within the study area, existing and potential sources of coal for use within the study area, and the possibilities for exporting coal through an offshore port facility in combination with existing or potential new transportation facilities;
- Potential uses of nuclear energy within the study area and the effects of nuclear energy use on the demand for an offshore port facility; and
- Existing and potential exports of agricultural and livestock products from the study area and the effect of such exports on the demand for an offshore port facility.

Probable changes in the economic structure of the study area between 1970 and the year 2040 resulting from probable exhaustion of existing supplies of raw materials, or from probable changes in demand, or from other causes.

Total amounts of the principal raw materials used in the principal industries of the study area, the sources of raw materials, the cost of raw materials, and the percentage of costs attributable to transportation costs.

The markets for the products of the principal industries in the study area; and the effect of competition and especially of foreign competition on the markets for the products.

The effects of transportation costs on the cost of production of the products of the principal industries in the study area; on the delivered prices of the products in their principal markets; and on the competitive relationships between such products and similar products produced in other parts of the United States or in other producing areas of the world. These studies would include studies of existing transportation facilities within the area and

Export-import studies are needed. (Photo: Port of Port Arthur) the effects of their operations on the level of transportation costs in the study area.

2. A study of the probable effects of the potential reductions in transportation costs which might reasonably be expected to result from the establishment of an offshore port facility off the coast of Texas in the Gulf of Mexico.

On the delivered costs of raw materials delivered to the principal industries in the study area, and on the distribution costs of these same industries.

On the competitive relationships between the products of the principal industries of the study area and similar products produced in other areas of the United States and in other producing areas of the world.

On the total savings in transportation costs, in-bound and outbound, which might be enjoyed by the principal industries in the study area.

On the additional gross product which might be produced by the principal industries in the study area because of improvements in competitive relationships resulting from the savings in transportation costs, and

On the additional employment which might be provided within the study area as a result of increases in gross product resulting directly or indirectly from the savings in transportation costs made possible by the offshore port facility.

- Studies designed to measure the costs incurred in the establishment of an offshore port facility off the coast of Texas in the Gulf of Mexico. The figures to be obtained from engineering studies outlined in another section of this report.

- Studies which show the additional expenditures which existing ports would have to make, if any, in order to provide suitable facilities for interchanging either liquid, dry bulk, or containerized freight with any offshore port facility which might be established, and

- Studies which compare the estimated benefits of an offshore port facility with the estimated costs resulting from the establishment of such a facility.

FUTURE OPPORTUNITIES

Another area that should be studied is that of future opportunities that could become attainable because of the advantages offered by the offshore port. New economic concepts such as "new towns," new technology in transportation and materials-handling, and the secondary benefits that spin-off from the influx and growth of primary industries should all be considered along with the traditional considerations of growth and change in the present economic base.

New Towns

The concept of going into a relatively undeveloped area and creating a community from the ground up—known as the "new town" plan—is being fostered on Federal levels as a possible answer to overcrowded urban areas. Since overcrowding also exists in certain of our industrial areas, the "new town" idea could be considered for the creation of new industrial complexes. The building of a supership port may be the vehicle that will encourage such long-range thinking in Texas. Portions of the Texas coast are undeveloped and are very suitable for such a plan if the planning can be broadened to include a nuclear power plant in the complex to provide low-cost power, large quantities of desalinated water, process heat, and chemicals from sea water. Other areas of the world are going ahead with similar plans for new economic development and it behooves us to study the idea. For example, on the Gulf of Fos near Marseilles, France, the Marseilles port authority is spending $400 million to create a deep port and a 12,000-acre complex to attract new industry. This "Europoort of the South" is expected to attract a combined investment of $3 billion by American and European industrialists for new oil refineries, petrochemical, steel and plastics plants as well as a plethora of ancillary supporting plants and plants which make use of the output of the basic industries. The French authorities are also negotiating with Japanese interests to use Fos as Nippon's back door to Europe. A major auto-assembly plant is in the picture as well as other large steel-using industries. Detailed investigation of such a concept is beyond the scope of this offshore port study, but the planning and building of the first Texas offshore port could well create a chain reaction. This could result in follow-on developments in Texas to build more deep water terminals at other points on the coast to encourage growth of presently under-developed areas. Texas has the land, the ocean and the resources, along with the drive and initiative, to start massive projects of the "new town" variety and make them pay.

New cities may result from a supership port, relieving crowded urban-industrial areas.

New Technology

In addition to looking at the long-range possibility of a "new town" resulting from offshore port construction along the Texas coast, consideration must also be given to other future opportunities that may arise.

The major economic activity of Southeast Texas is bulk traffic. And for bulk products — petroleum, liquified natural gas, chemicals, iron ore, bauxite, coal, sugar, wheat, corn, milo and rice — transportation efficiency is vital. A number of new developments in the area of bulk handling, in addition to the super-sized ships, are beginning to appear on the horizon. Unless Texas shippers recognize them and use them where applicable, their profitability will suffer accordingly. Texas port operators must also be aware of these developments and encourage their utilization where possible.

Such concepts as slurried transport of minerals — as exemplified in the system known as Marconaflo (developed by the Marcona Mining Company and presently sold by the Dravo Corporation) — will become more widely used as more foreign ore deposits are tapped to provide raw materials for United States industries and as transportation costs enter more strongly into the overall profit/loss picture. The maximum realization of savings from such concepts as this can only come from full utilization of all new technology, including the supership. Other bulk-handling systems are being developed; however, the supership will remain an essential link in the trans-

Port of Liverpool showing Seaforth Dock Project designed for deep-draft ships.

portation process and must be included in any plans.

Japan is an excellent example of high-level utilization of bulk-handling systems and inexpensive water transportation. Their use of these technologies, coupled with a national zeal for productivity, have been strong factors in their climb to economic prominence among nations. When they can buy coal in the United States at our prices and ship it to Japan, buy iron ore in other areas remote from home and ship it to their mills and then combine these ingredients into steel products that can be shipped to the United States and sold at prices cheaper than American steel, it appears that we are missing the entire point of the lesson. We must revise our thought processes and our problem-solving methodology if our products are to compete in the world marketplace.

Changing markets, new technologies, Texas' increasing involvement in foreign markets and other future opportunities must all be scrutinized closely during the Texas offshore port feasibility study. Only in this way can a meaningful decision be reached as to the viability of the proposal.

Competitive Factors

The building of superports in other parts of the world is a development that puts pressure on United States port operators because it places them on one end of a transportation pipeline using vessels that cannot berth in United States ports. Since the United States cannot accommodate these vessels, our foreign trade will be affected accordingly.

Closer to home, the biggest threat to foreign trade that affects the Texas coastal zone is competition from other Western Hemisphere port operations. Although United States ports on both the east and west coasts are threatened by the operation of deep-draft ports in Nova Scotia and British Columbia, along with a connecting "land bridge" railroad system across Canada, perhaps the greatest threat to Texas ports is that taking shape in Louisiana. A proposed superport, to be operated by private interests, is presently under study involving a site of 600 acres located about two miles east of the end of South Pass, Louisiana. According to published reports, the port will be capable of receiving ships with drafts of 70 to 80 feet and will be designed principally for tankers. The probability of this port being built and, if built, its impact on the economy of the Texas Gulf coast region, including the future earnings of Texas ports, should be thoroughly explored by the economists during the Texas offshore port feasibility study.

SITE LOCATION STUDIES

The portion of the Texas offshore port feasibility study which promises to be the most intriguing is concerned with determining the best site location for the facility. This includes finding sites for the berthing terminal and for the supporting complex on shore, as well as deciding on a route for the connecting pipeline manifold. It would be well to recognize at an early stage, however, that site selection in this project will be a more difficult task than the process normally associated with a site on land. Yet, the two sites, although physically separated, must bear a certain relation to each other because of their mutual interdependence and because a pipeline system must connect them at minimum cost. For these reasons, the site location study for the offshore port should, for the sake of clarity, be split into two separate studies—one for the onshore facility and the other for the berthing facility which may or may not be offshore. To help delineate and clarify the need for separate studies, the discussion which follows will be split into two sections — one relating to offshore factors and the other to those features that will be important in selection of an onshore site.

At the completion of the two independent site studies, selection of one or more of the best sites should be made so that other studies which are site-dependent may be carried forward. To arrive at conclusions necessary to recommend one or more site locations for further study, exhaustive investigation of a number of locations will have to be performed. Resulting data should be included in a matrix-analysis or optimization program for the purpose of conducting simulations or modeling studies. These studies should provide enough data about the operating requirements of the port complex to permit a good choice of a site location. Hopefully, this choice will be a pair of sites (one offshore, one onshore) which separately embody the best salient features of all sites, and synergistically result in a superior dual-site.

General Location Requirements

Certain basic criteria relating to an offshore port cannot be ignored during the site location studies. Such things as economic rationale, the physical constraints of superships and other similar items are best categorized as **governing factors.** Of all the factors so designated, probably the most important ones are:

1. The facility must have a high degree of accessibility to the shippers and receivers located in the Texas coastal zone and hinterlands who are the most likely to use superships for a portion of their transportation needs. In other words, the superport must be close to its users.
2. The proposed facility must be located adjacent to water that is navigable by ships having deep drafts, i.e., over 50 feet and up to as much as 100 feet. Assuming a minimum of 10 percent overdepth for safe operating clearance, this would indicate a need for water no shallower than 110 feet, mean low tide.

In addition several other important and basic factors exist. These include such things as:

1. Bottom sediment with adequate bearing strength to support the offshore structure
2. Water depth of 110 feet as close as possible to shore to minimize cost of connecting pipeline
3. Maximum availability of onshore transportation facilities such as railroads and highways
4. Closely-located and highly-concentrated user facilities such as pipelines, barge docks, refineries, petrochemical plants and product loading terminals, and
5. Good availability of suitable land sites of adequate size which can be served by rail and which are close enough to existing pipelines to permit economical tie-ins.

There are certainly other factors which may be considered governing; however, in general, most of the remaining ones are not as critical as those listed above and their importance to the success or failure of the supership terminal exists in degrees and is not absolute.

It should be noted here that no attempt will be made in this work plan to define site location requirements in a quantitative or exact manner. This is for two reasons: (1) quantitative recommendations such as number of acres, elevation of site in feet, and distance to nearest user facility can be made only after an intensive analysis of the total picture of the Offshore Port Study and (2) it is not the intent or purpose of a work plan such as this to render exact definitions of requirements. Therefore, only a general discussion of factors felt to be important in determining a site will be attempted herein.

ONSHORE SITE

The onshore facility, which is required along with a deep-draft berth to make up a complete offshore port, can best be described as performing a support role in the overall operation of the terminal. This is because the shore-based site probably will be secondary to the deep water terminal in terms of original and continuing costs, and also it will not be involved in the movement of as many commodities as will the deep water structure due to the fact that some cargoes will likely move directly between customers' docks and the offshore dock without passing through the shore-end of the cargo terminal. This is because, as now envisioned, the shore-based facility will mostly concern itself with large-volume pipeline movements of commodities such as crude oil, jet fuel, heating residuals and certain chemicals while the offshore port will probably see the movement of many commodities lightered directly to and from a user's dock as well as those that are pumped via undersea pipelines to the shore-based site.

Even though it will be subordinated to the offshore facility in terms of value and volume of commodity movements supported, the onshore facility will be essential to successful operation of the total port complex because, without the existence of the land base with its pipeline terminus, its receiving and storage facilities for enroute commodities, the piping manifold controlling the collection and distribution of commodities to and from customers of the offshore port, and the myriad of other facilities required to provide a transportation service to users, the offshore terminus will be severely limited in its function.

The first step in the selection of a site for the onshore supporting facility most likely should be a geo-economic survey of the entire Texas coastal zone from the Sabine River to Brownsville. By a geo-economic survey it is meant that the locations of the industrial megalopoli of the above-defined coastal zone will be laid out on a map of the Texas coast. Then, on large-scale subsection maps of the coast, details of each megalopolis (or industrial complex) should be inserted giving facts on ownership, type, size, raw material inputs and product outputs of each **major** plant in the proximate area. Also, each map should show the following features:

1. Gulf Intracoastal Waterway
2. Rail lines in the area
3. Crude oil and product pipelines and their owners. Also size and capacity of these lines
4. Abandoned pipelines and owners, also sizes of lines
5. Topography
6. Existing uses and users of land adjacent to the water and extending several miles inland.

Data from this study can be used to define the epicenters of demand used in the engineering studies.

Additional investigation should then be conducted to determine where possible sites might exist. Prior to starting this aspect of the study it will be necessary to ascertain the approximate required size of the site, including space for future expansion, in order that only those acreages which are large enough will be considered. Possible suitable sites should then be indicated on the geo-economic maps in their proper location with map notations to include specific acreages and pertinent location factors.

Land

Size — enough acreage must be acquired to permit construction of:

- A battery of storage tanks for the collection and interim storage of liquid commodities
- A piping manifold of a design and capacity sufficient to collect and route both import and export commodities to and from ships at the deep water berth, users in the immediate vicinity, holding tankage on-site or loading racks on-site adjacent to rail or truck spots
- Truck loading ramps and racks including maneuvering space
- Rail spur tracks
- Water — and sewage — treatment plants if such is part of the master plan. Also, a power substation if required
- Fire-fighting facilities
- Barge slips
- Personnel facilities
- Space for expansion

Topography — variations in topography on the site are not overly critical in the case of a tank farm for liquid handling and storage. However, a level area is required for rail sidings, truck ramps and any future expansions of the facility not involving liquid commodities, such as grain storage, ore handling or others.

Elevation — it is desirable to have a site elevation that will mitigate the dangers of floods from rainfall or tides. Usually such elevations do not exist on sites adjacent to the ocean and preventive measures such as dikes and pumps are rather routinely specified in these cases.

Location — next to the Intracoastal Waterway, if possible, or a short distance away, and either close to users or to transportation modes connecting with the users, such as pipelines, roads and rail spurs.

Utilities

Assurances must be obtained from the utility service suppliers as to the uninterrupted adequacy of the basic utilities such as electric power, treated water and natural gas. If it is anticipated that the onshore facility will be responsible for receiving and disposing of waste effluents from the deep water facility, then arrangements should be made in advance for the acceptance of these effluents into an adequate sewer system.

Geology

Foundation borings should be performed on sites considered prime in other respects.

If site is remote from sources of treated water, underground sources must be evaluated.

Transportation

The site must be accessible to rail and truck service. If at all possible it should be inside the yard limits of the nearest town to enjoy savings in rail transportation costs.

Socio-economic factors

Labor supply — onshore site must be within reasonable commuting range of a source of labor.

Legal and jurisdictional implications in the location of an offshore port are critical factors in selecting a terminal site.

Other location factors — investigation should be made of the many diverse and sundry other factors relating to the general suitability of the site such as tax structure, land prices, community attitudes toward industry, zoning, labor stability and others considered significant to the issue.

OFFSHORE SITE

Investigation of possible offshore sites for the supership cargo terminal will involve a study of factors unusual to most site studies. This is because the selection process for a typical landlocked site involves investigation of the site's suitability from the standpoint of location and the socio-economic advantages thereof as well as the physical characteristics of the site itself such as size, topography, elevation and foundation conditions. In the case of an offshore site, however, several new dimensions of consideration enter the picture. Many of these involve various aspects of the water itself. Such things as depth, temperature and chemical composition as well as the many mechanical factors such as waves, currents and tides all enter the picture because their effect on suitability of the site can be quite pronounced and they are inescapable forces which must be dealt with.

In the case of an offshore site which is to be used as a deep water berth for supertankers, the site requirements are even more restrictive as to possible locations because of the need for close proximity to a suitable onshore site and, also, because of the need to be situated in water of adequate depth (no less than 110 feet, m.l.t.) at a location as close to shore as possible to minimize the cost of the interconnecting pipeline.

Depth Considerations

The required depth of water which should be made available at the supership berth is 110 feet (m.l.t.) based upon two assumptions: (1) that the port is intended to have the capability of receiving the largest ships projected to be built in the foreseeable future, i.e., through the year 2040 and (2) that the largest vessels in common use by the time the superport is placed into service will have drafts requiring close to the 110 foot water depth anyway. Anything less than a depth of 110 feet will restrict the size of ships that can berth at the superport and this type of restriction as it exists in Texas ports is one of the major reasons for considering the superport idea.

The 110-foot depth requirement does not, however, automatically mean that the supership berth has to be located where the water has this depth occurring naturally. Rather, location should be determined on the basis of an economic weighing of the ancillary costs resulting from a far-out location in water of 110-foot depth, such as the cost of the additional length of pipeline required to reach a distant terminus, compared to a closer-in location requiring some dredging, the cost of which may be considerably less than the incremental pipeline cost. This decision should be made as a result of information developed from a trade-off cost study.

If a site with a natural depth of 110 feet is found to be superior to one involving partial dredging, then the general location of the offshore site could range from approximately 17 statute miles offshore east of Brownsville, 27 statute miles southeast of a point near Sargent, Matagorda County, 30 miles south-southeast of Freeport Entrance, or 65 miles almost due south of Sabine Pass. Figure 14 shows the 20-fathom line along the Texas coast and points where 110-foot water depth occurs.

Ocean Bottom and Environmental Conditions

Once a decision is made on locating the supership berthing facility offshore rather than along the shore or inshore, its optimum location will have to be determined on the basis of other factors in addition to depth:

- Ocean bottom foundation conditions
- Wave characteristics
- Tidal currents and
- Littoral currents

The study will include determination of foundation characteristics at various proposed locations and characteristics of waves, tides and currents. Some of this information will be available from the Corps of Engineers, oil companies and various Federal agencies. The study will include physical coring and sampling and laboratory determination of foundation properties.

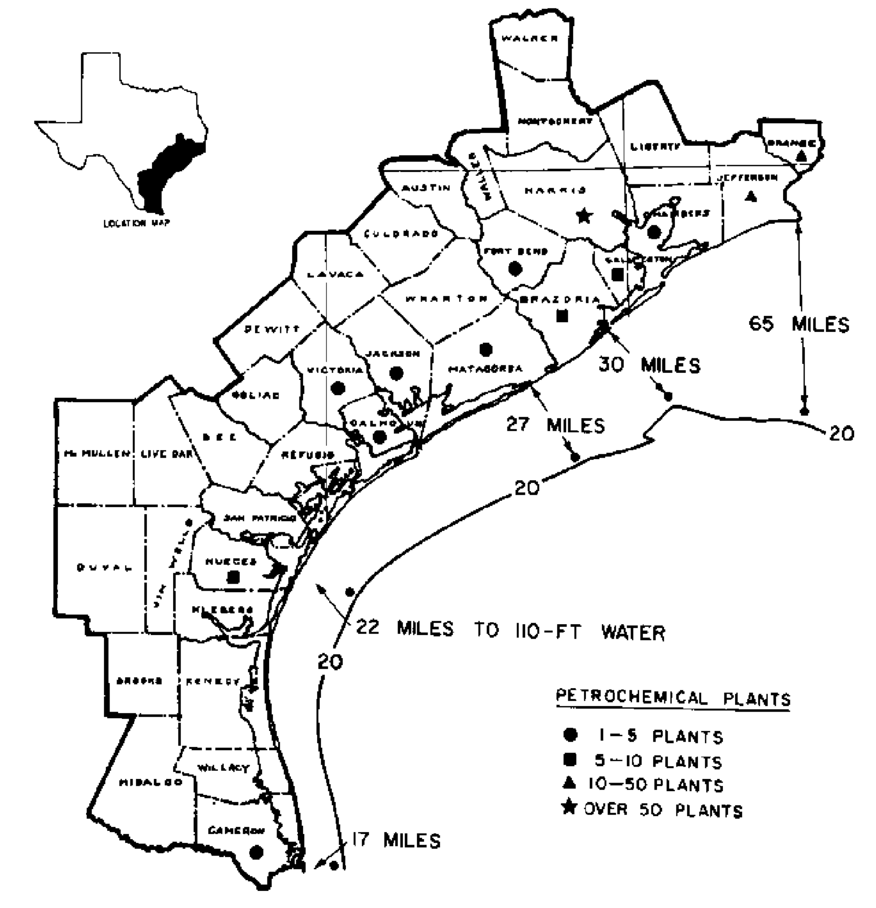


FIGURE 14. Texas Coastal Zone showing Petrochemical Plants by County and Distance Offshore to 110-ft. Water.

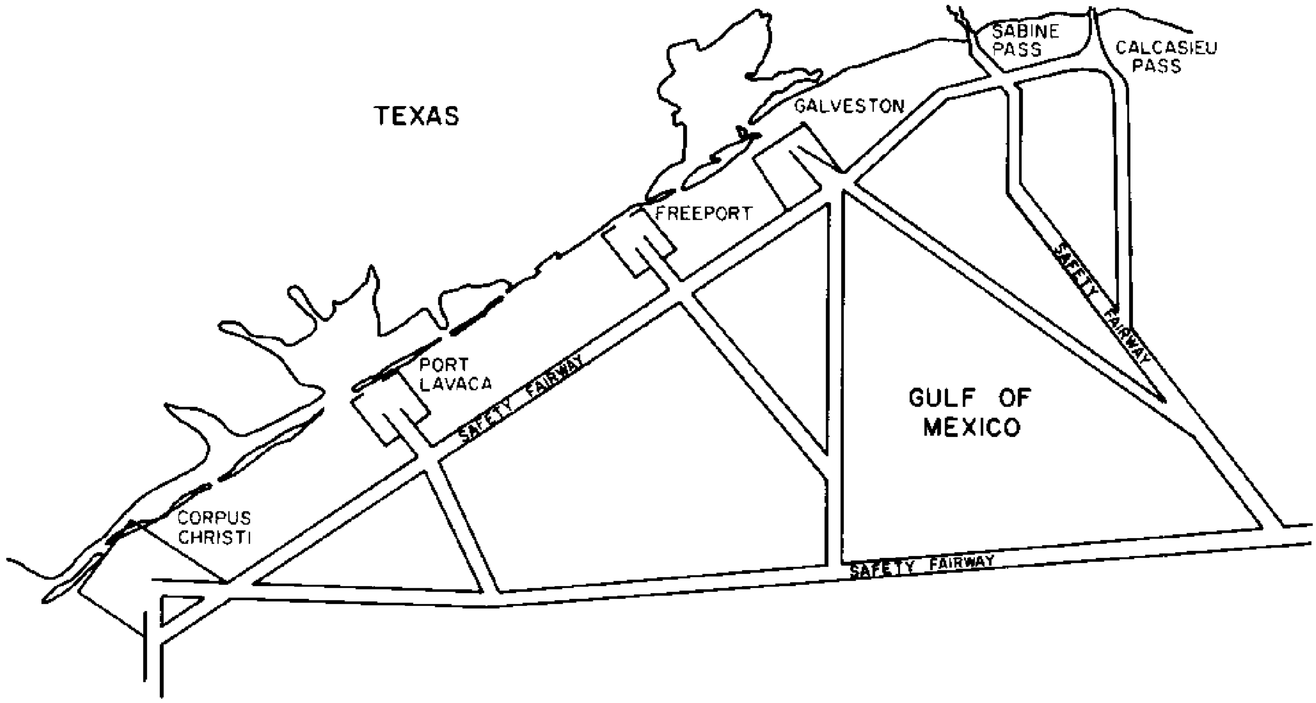


FIGURE 15. Upper Texas Coast Showing Shipping Fairways.

Conflict of Uses

In certain areas of the Gulf of Mexico three factors, offshore mineral exploitation, a rising volume of ship traffic and military activities of the federal government, have combined to drastically reduce the amount of area available for consideration as a site for the offshore terminal. The proliferation of drilling and production platforms, wellheads and navigational aids, and closed areas used as military ordnance ranges has left the Gulf literally studded with no-trespassing zones. These problems, plus those caused by the large areas set aside as shipping fairways and anchorage zones, make the process of offshore site location complicated. Also to be considered as areas to be avoided are those that have a set of unusual features which make them likely candidates for future scientific studies or mineral development. These would include any salt domes showing promise of possible oil or gas reserves and, in the area south of Galveston, the Flower Gardens Reef which promises to be an area of active scientific study.

Before a potential offshore site can be pinpointed, the general location most desirable for a site must be determined from other studies. Then a map of the general location should be prepared which gives the location of all existing obstacles such as operating and abandoned platforms, pipelines, wellheads, navigational aids and submerged objects. Finally, the map should show the shipping safety fairways and anchorage zones that presently exist. Figure 15 shows the present shipping fairways on the upper Texas coast.

There will be no difficulty in determining the location of operating and existing platforms from the records of the U. S. Coast Guard and petroleum companies. However, the location of pipelines is not always known, and it may be difficult to determine their position. The use of magnetometers and gradiometers to sweep the proposed site is recommended. These devices detect, through variations in the earth's magnetic field, the presence of metallic objects on or in the ocean floor. Navigation buoys and structures will be easy to locate from U. S. Coast Guard records.

Other Offshore Factors

- Map of bottom contours and profiles
- Evaluation of availability of sand or other suitable fill material in vicinity of site for use in case an island structure is built
- Evaluation of meterological conditions at location for use in predicting docking procedures and problems
- Layout of approach and departure patterns for superships of the type and size predicted to use the port and
- Study of anchor-holding characteristics of ocean bottom for application to the design of anchoring systems for mooring buoys located outboard of each berthing space

THE LEGAL QUESTION

LAW AND THE SEA

Traditionally when planning is undertaken for a project such as an office building, a home or a factory, certain practices must be followed and precautions taken to assure success of the venture. For example, during the design phase good engineering practice must be exercised to ensure that the structural integrity as well as the functional and esthetic requirements of the facility are fully considered. Consideration must be given to building codes, zoning regulations and other laws to ensure that the completed structure will be in compliance with these covenants. Care must be taken to ensure that possible influences on the environment resulting from the construction and operation of the facility are not harmful.

In the case of the proposed Texas Gulf offshore port, however, the legal considerations of design, construction and operation will be considerably more complex than they would be for almost any type of land-based facility. On land a facility will always be located in an area subject to the legal jurisdiction of a city, a township, a county or a parish—as well as that of the state and/or federal governments. A facility located on the high seas exists in a shadowy twilight zone of sometimes conflicting, usually overlapping codes of law which do not clearly delineate zones of jurisdiction. These codes require interpretation to ascertain the appropriate ones under which injured parties must seek relief. And, until recent years, the only injuries subject to review under existing law were those related to purely maritime activities. With the advent of offshore oil exploration and production in the late thirties, relief under the law became more difficult to provide by the courts and the uncertainty increased. Not until 1953 was anything done to significantly alter the situation.

Recognizing the growing confusion and uncertainty concerning the inadequacy of existing law to cover situations brought about by offshore oil activities, including such things as liability for the safety of the workers and the welfare of their families in the case of death or disablement of the worker, establishment of the right of free passage and safe navigation of vessels of commerce and control of exploitation of the mineral wealth of the continental shelf, Congress undertook in 1953 to do something to improve the situation. What resulted were two landmark bills that have since served to provide a greater clarification and delineation of the rights of individuals and entities in matters involved with non-maritime offshore pursuits. These two bills—the Submerged Lands Act of May 22, 1953, and the Outer Continental Shelf Lands Act of August 7, 1953—have become the principal means of alleviating the doubt and indecision surrounding matters of jurisprudence involving cases which are not aptly covered by the provisions of such admiralty laws as the Death on the High Seas Act, the Longshoremen's and Harbor Workers' Compensation Act and the Jones Act. The new laws, although rather omnibus in nature, have served with interpretation by the courts to fill a void which has existed since the inception of offshore oil activity.

There is little doubt that the two laws have helped to clarify the situation. For example, the Supreme Court has held that, based upon legislative history, it was the intent of Congress that the Outer Continental Shelf Lands Act (OCS), rather than the Federal Death on the High Seas Act, will apply in cases involving remedies for wrongful deaths on artificial drilling structures. Under the terms of the OCS Act, courts must look to the law of the adjacent state as surrogate Federal law, the rationale being that Congress intended artificial drilling structures to be treated as islands rather than as vessels. As islands, or federal enclaves, the substantive law to be assimilated will be that of the adjacent state . . .[12]

It is of interest to note that the term "artificial drilling structure" was used in the aforementioned court ruling in an attempt to designate applicable laws under which remedies should be sought by injured parties. Can it be said then that the proposed offshore port falls into the same category of function as artificial drilling structures? Without a doubt such a decision will probably have to be reached in a court of law in order to establish it as precedent for subsequent application.

Referring further to the Outer Continental Shelf Lands Act, Congress stated:

> The Constitution and laws and civil and political jurisdiction of the United States are hereby extended to the subsoil and seabed of the outer Continental Shelf and to all artificial islands and fixed structures which may be erected thereon for the purpose of exploring, developing, removing, and transporting resources.

Does this provision of OCS without interpretation mean that the offshore port, if used for the transporting of petroleum and its derived byproducts, falls under the jurisdiction established by the OCS, that is, under the laws of the adjacent state?

These and many other questions will require satisfactory answers before the Offshore Port Study Committee can proceed with implementation of this project.

LEGAL IMPLICATIONS OF THE OFFSHORE PORT

Without knowing the manner of creation or the mode of operation of the offshore port, or whether it

[12] "Outer Continental Shelf Lands Act Requires State Wrongful-Death Act Rather Than Federal Death-On-High-Seas Act Be Applied on Artificial Drilling Structures on Continental Shelf," Rodrigue v. Aetna Casualty & Surety Co., 395 U.S. 352 (1969), Jour. Mar. Law & Comm., Vol. 1, No. 4, July 1970, pp. 621-623.

will be a private or public enterprise, it is difficult to foresee the type and nature of legal complications which will develop as a result of the port's unusual geographic siting. However, even a cursory analysis of the conditions of construction and operation which have the greatest probability of occurrence, gives rise to a list of factors that are the most susceptible to uncertainties of law. No such list in a report of this type can be considered complete, but the following ones are important.

Suggested Legal Studies

The factors which are most likely to become significant in any legal considerations of the offshore port project will probably fall in one of the following major categories:

- Jurisdiction for construction, maintenance and operation of the port facility
- Legal aspects of financing and ownership
- Determination of responsibility and limits of liability for spills, pollution and other environmental involvements resulting from operation of the port
- Legislation to create an offshore port authority or other entity as a vehicle for the operation of the port
- Creation of an operating "table of organization" and a proposed set of policies and procedures to ensure that the new port supplements rather than competes with existing ports in the immediate market

Legal studies concerning the offshore port will probably be performed along the lines of a three-dimensional matrix analysis as illustrated in Table 2. This is because the planning, financing, implementing and regulating of a deep sea facility involves several distinct areas of consideration. For example: (1) it will require an evaluation of existing law and administration on three levels—international, Federal and state; (2) it will be necessary to consider three different zones of possible location of the port and connecting pipelines and; (3) there is a possibility that at least five different construction methods will be considered for use at the offshore facility. More specifically the following factors and their interrelationships will be of prime interest in the legal studies:

Zones: The site of a deep sea port could be placed in any one of three alternative zones, all outside United States territorial waters and hence within the high seas. Figure 16 indicates the legal zones along the coast of Texas.

1. Texas Submerged Land — seaward from the coastline for a distance of three leagues (10.4 miles)
2. The Contiguous Zone—between 10.4 and 12 miles from the coast
3. The High Seas — over 12 miles from the coast but within the Outer Continental Shelf, i.e., no more than 600 feet of water depth

Structure: The deep sea port may be constructed in one of several ways. Hence, each method should be assessed as to each of the three zones of location. The alternative types of construction to be considered will likely include buoy, platform, artificial island, subsea facility, and a combination of above alternatives.

Law: Each zone and structure combination would need to be assessed in each of the following legal-administrative frameworks:

- International law: custom and treaties — present and anticipated
- Federal law: admiralty, legislation, regulation and administrative bodies involved
- State law: legislation, regulation, administrative bodies and special districts

Topics of consideration which will have to be evaluated using the three-dimensional matrix method may include but not be limited to the following:

- Planning (of the port)
- Financing (the establishment of the port)
- Construction (of the port)

TABLE 2
MATRIX OF LEGAL STUDIES RECOMMENDED FOR OFFSHORE PORT

TYPE OF OFFSHORE STRUCTURE	Zone 1 TEXAS SUBMERGED LAND			Zone 2 CONTIGUOUS ZONE			Zone 3 HIGH SEAS		
	Int'l	Federal	State	Int'l	Federal	State	Int'l	Federal	State
Buoy Floating Wharf Mother-Ship									
Platform									
Artificial Island									
Subsea									
Comb. Type									

- Administration (management, policies, procedures)
- Safety and security (of the port facility)
- Fishing and navigation (in the port's vicinity)
- Civil liability
- Criminal liability and
- Oil spills and discharge

The study would thus present an assessment of legal - administrative implications for each structure in each zone in view of international, Federal and state law and administration. The study should also advise what changes in the law and/or administration, if any, may be needed or desirable to accommodate the alternatives that would be recommended for the site and structure of the port due to economic and scientific considerations.

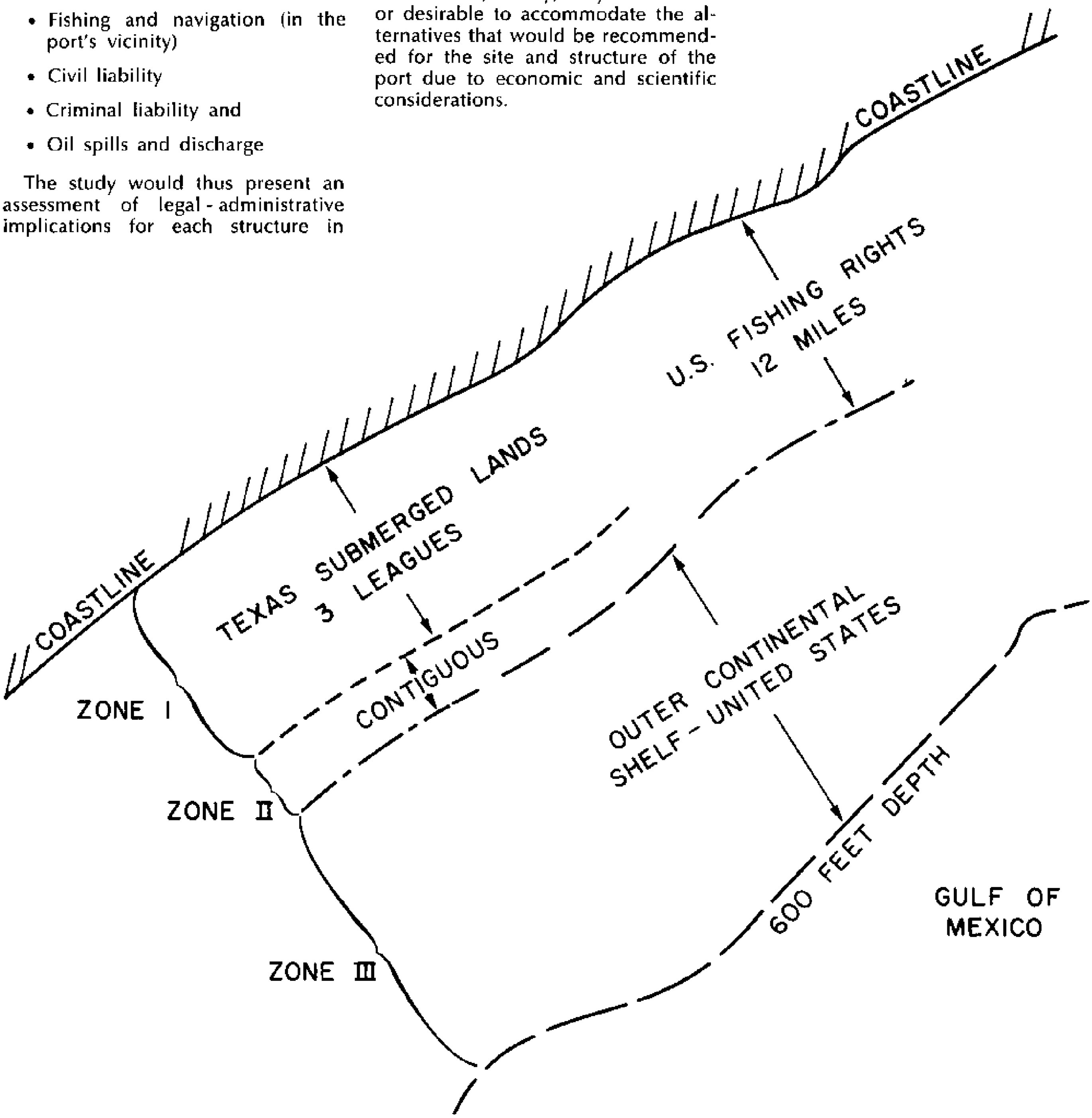


FIGURE 16. Legal Zones Along the Texas Coast.

PORT MANAGEMENT STUDIES

The management aspects of the Texas offshore port facility are important to the feasibility study because the port facility, no matter how well located or well constructed it may be, will be marked for failure if it is not operated in an aggressive and positive manner once it is built. For this reason, a careful analysis of the proposed port from the standpoint of such things as location, charter of operation, relationship to other ports, extent and degree of authority, financial and tax status and many other similar factors will be required to ensure that the physical facility continues to exist as a viable entity in the Texas Gulf economy.

FORM OF OPERATING ENTITY

The first decision required concerning the management of the offshore port involves deciding what type of operating entity must be created to run the port. Much of the thinking in regard to this subject will, of course, be influenced by the manner and source of funding obtained for construction of the port complex. The legal implications of the offshore site location will possibly have a bearing on this aspect.

A number of alternatives are available for consideration as possible forms of operating entity for the port:

1. A Texas corporation — if possible within the legal constraints of location
2. A navigation district, created by action of the Texas Legislature, with bond-issuing authority
3. A port authority with taxing, police and navigation control powers plus bond-issuing authority
4. A Federal enclave — possible if financing is obtained from the Federal government
5. A subsidiary of an existing port or ports

Other alternatives to the above are certain to be suggested. Many alternatives will be studied. However, the importance of deciding upon a type of operating entity that provides the most favorable tax position, gives the maximum advantage in obtaining financing and offers management the greatest flexibility in day-to-day operations cannot be over-emphasized.

EXTENT OF AUTHORITY

The entity established to operate the offshore port should be given the authority to implement any actions necessary to ensure viability, to promote profitability and to permit flexibility to adapt to changing requirements with the passage of time —such powers to be derived within the realm of law and in the general and public interest. These powers most likely will include the right to issue revenue bonds and to collect monies to apply toward retirement of these bonds. Whether they also will include police power for the controlling navigation in the vicinity of the port and assessing penalties against polluters of surrounding waters remains to be decided. Since the proposed facility will be a dominant center of activity in the waters it occupies, proper structuring and allocation of powers are important considerations affecting every aspect of the operation of an offshore port.

PARTICIPATION IN MANAGEMENT

Deciding who is going to control the supership port will be a controversial decision. Several interest groups exist—the ports, the shippers, the shipping companies, municipalities and the state and Federal governments. All have a possible interest in the port's location, design and mode of operation for a variety of reasons. Careful consideration is necessary on the part of the feasibility investigators to ensure that the optimum recommendation is made.

The source or sources of funding will have the greatest influence on who participates in the construction and operation of the offshore port. If a group of industry shippers jointly feel strongly about the need for the port and, at the same time, doubt that the port will become a reality any other way, they may decide to form a consortium to build the port. The Texas ports, on the other hand, may look upon the supership port as a logical extension of the services now offered to shippers and proceed to take the reins and build the superport as a regional facility to complement existing facilities.

Again, the point to be noted is that an analysis must be made by the feasibility study researchers and a recommendation made regarding the best, most logical manner of managing the offshore port to ensure that those needing a voice in its operation are made active participants in the planning, building, and operation of the port.

MANAGEMENT HIERARCHY

The structure of the management team for the offshore port can be patterned after that used by many other port organizations, provided the form of operating entity permits such a setup.

Recommendations regarding the form taken by the organization chart should be made as a part of the feasibility study and should reflect a close analysis of the various forms of management structure in use in similar organizations.

CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF RECOMMENDED STUDIES

The recommended feasibility studies for the Texas offshore port project are summarized in Table 3. This table also gives a priority ranking for the performance of each study, scope of each study, possible sources of funds to support each study, an elapsed time to do each study and the estimated cost to perform each of the major study elements. Total estimated cost for the entire feasibility study is $460,000, and the calendar time to complete the overall study is estimated as 18 months.

Table 4 graphically illustrates the time factor for each major element of the feasibility study.

Conversion of the offshore port concept from nothing more than a dream into a three-dimensional reality of concrete and steel will involve a significant effort on the part of all concerned to overcome the many obstacles which now stand in the way of fulfillment of this project. Many of these obstacles, although quite sizeable, are nevertheless relatively tangible in nature and can be resolved through the application of good planning and hard work. Some of the others are of such a nature that they are difficult to grasp. Some of the more tangible ones, such as the physical construction of the offshore terminal portion of the port facility, are straightforward. For example, this phase of the project portends to be a logistically huge and financially costly endeavor, but the probability of completion is not really in question because (1) the technique of offshore construction has already been developed so a technology breakthrough is not required, and (2) without a doubt, the necessary dollars required to build the offshore port will be made available from one source or another.

Other obstacles, however, are far less tangible than money or the logistics of construction, but they are real insofar as their possible impact on the success of the proposed Texas Gulf offshore port is concerned. For instance, nationwide public opinion concerning pollution, particularly oil pollution of the inland waters and high seas, has created an atmosphere of negativism which will make it difficult to obtain approval and financ-

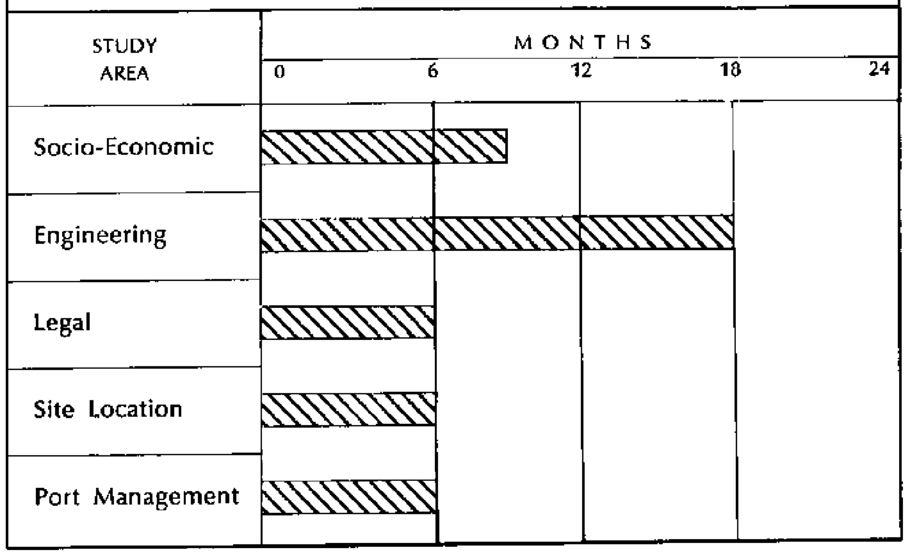
TABLE 3
SUMMARY OF FEASIBILITY STUDIES

	PRIORITY AND SCOPE OF STUDY	POSSIBLE SOURCE OF STUDY FUNDS: Federal	State	Private	STUDY TIMETABLE	ESTIMATED COST
1	SOCIO-ECONOMIC: Impact on Existing Economy Projected Trends & Needs Future Opportunities Competitive Factors Cost/Benefit Transportation Studies	U. S. Army Corps of Engineers, Department of Commerce, Department of Defense, Department of Transportation	Interagency Transportation Council and Coastal Resources Management Program	Texas ports or shippers	9 months	$ 90,000
2	ENGINEERING: Preliminary Studies Environmental and Pollution Control Dredged vs. Offshore Storm Protection Projected Traffic Load Alternate Structure Designs	↓	↓	↓	18 months	$250,000
3	LEGAL Liability and Jurisdiction Legal Implications of the Offshore Port	↓	↓	↓	6 months	$ 40,000
4	SITE LOCATION: General Location Requirements Onshore Site Factors Offshore Site Factors	↓	↓	↓	6 months	$ 40,000
5	PORT MANAGEMENT: Powers, Extent of Authority Form of Organization Control of Operation	↓	↓	↓	6 months	$ 40,000
					TOTAL COST OF STUDIES	$460,000

ing for offshore port construction. There is every reason to believe that a broad-based program of public education can build a favorable image for the project and can assure the backing of key groups in the community—essential ingredients in the success of a project of the magnitude envisioned here.

Before a construction permit is obtained, however, and before the first yard of concrete can be poured, it will be necessary to determine the economic and technical feasibility of the offshore port facility and also to determine the pertinent factors affecting the facility itself. Such things as location, type and design of structure, legal implications and environmental effects must all be studied in great detail before proceeding with the construction phase. This is the purpose of the feasibility study.

TABLE 4
FEASIBILITY STUDY TIMETABLE



STUDY ADMINISTRATION

The work plan for the study of the feasibility of an offshore port in Texas is designed to define, organize and schedule the work required in the feasibility study so that maximum benefits can be obtained from a given expenditure of time, money and manpower. The best efforts of many disciplines and organizations will be required for the execution of the work plan and these efforts must be integrated into a coherent overall program in order to avoid duplication of effort and omission of essential details.

The magnitude and unique nature of this project provide a major challenge to its successful implementation. Close coordination with government agencies, private industry, existing port authorities and financial sources is required. This extremely high degree of coordination makes it absolutely necessary that a competent project manager and management team, working closely with a diversity of agencies and groups, be chosen for the task. The success or failure of the entire project could very well hinge upon the manner in which the feasibility study effort is directed and controlled.

The study management team should be charged with at least the following responsibilities:

1. Creation of a Director and Coordinator of Studies
2. Recommendations for membership of an Offshore Port Study Review Panel
3. Preparation of requests for study proposals from others
4. Review of proposals received and recommendation of study contract awards
5. Establish and recommend schedule for completion of feasibility study and each of its component parts. Maintain surveillance of schedule and take steps to ensure compliance by study groups
6. Administer funds of study through a system of review and recommendation
7. Coordinate the evaluation of studies received and advise Study Review Panel as to their acceptability

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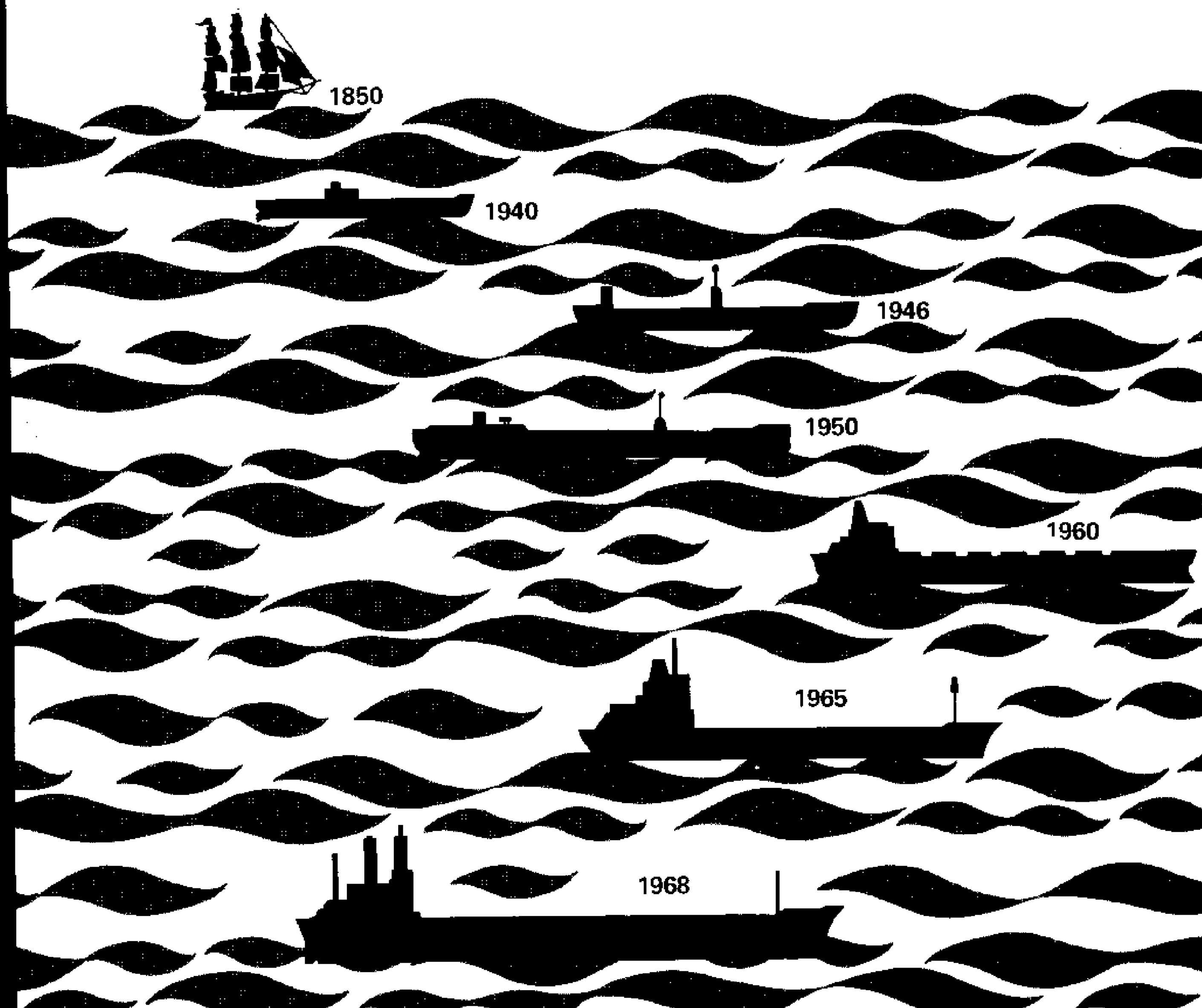

Work plan for a study of the feasibility of an offshore terminal in the Texas Gulf Coast Region

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