Port and Harbor Development System-2

A+M. Univ. Sea Grant Prog.

Port and Harbor Development System
Phase 2 - Planning Summary

October 1972 TAMU-SG-72-209

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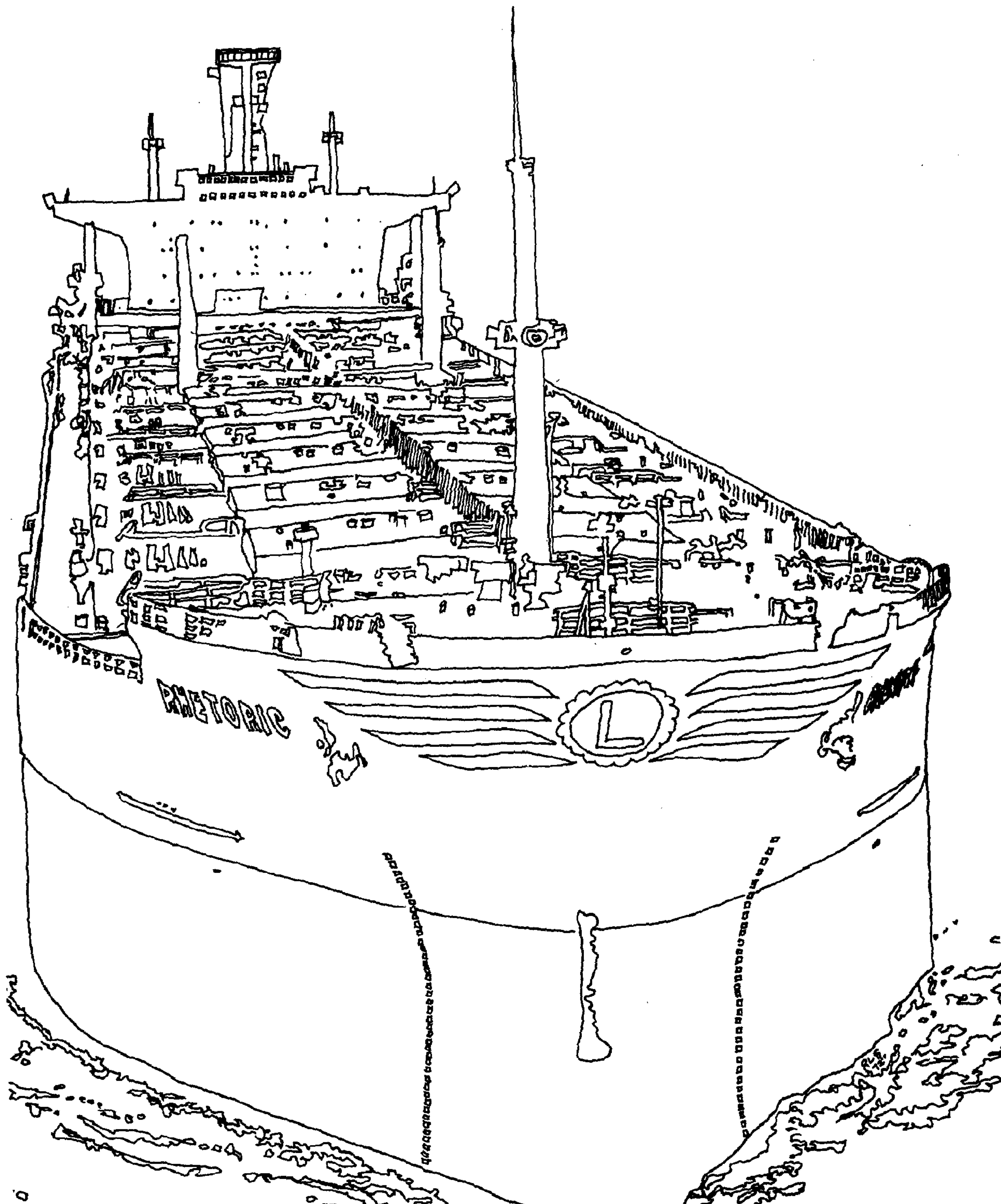
Photo: Leatha Miloy

2 Introduction



Drawing: Russell Stogdill

The coastal zone has been defined "as that part of the land which is affected by its proximity to the sea and that part of the ocean which is affected by its proximity to the land." It includes the inshore part of the continental shelf, ocean shore line, and estuaries with their marginal shores. Tides, waves and coastal currents mark this zone of frequently varying environment, which supports a multitude of plant and animal life."[1]

Ports have traditionally developed within coastal zones. Port activity generated industrial development, which depended on imports to produce exports. Industrial development created the need for laborers, who in turn established communities. These communities constitute some of the largest urban areas.

People continue to migrate to these urban areas. It is estimated that 73.5% [2] of the U.S. population now resides in urban areas. The nation's ten most populous states adjoin coasts of the oceans and Great Lakes. The trend toward concentration of people in coastal urban areas creates many problems -- increased demands for housing and industrial development, electric power, potable water, improved waste disposal systems, to name a few.

Technological advancements in the transportation industry, particularly in shipping, affect both equipment and cargo handling methods used by ports, creating additional problems that demand immediate attention. Mammoth carriers, for instance, capable of single-trip deliveries of over a million barrels of liquid cargo, are now in service. Even larger vessels are under construction. Great cost savings are realized through use of these giant vessels, but they require substantially greater channel and harbor depths than are now available in U.S. ports. To provide the necessary depths in existing ports involves "unprecedented physical, ecological, safety and financial difficulties or constraints."[3]

This report represents the efforts of the research team to present a future development concept for a total off shore port.

The solution presented is not meant to portray a panacea but rather to indicate a basic philosophy of planning representing an appropriate environmental character and general direction for growth with sufficient built-in flexibility to accommodate changing concepts as they occur.

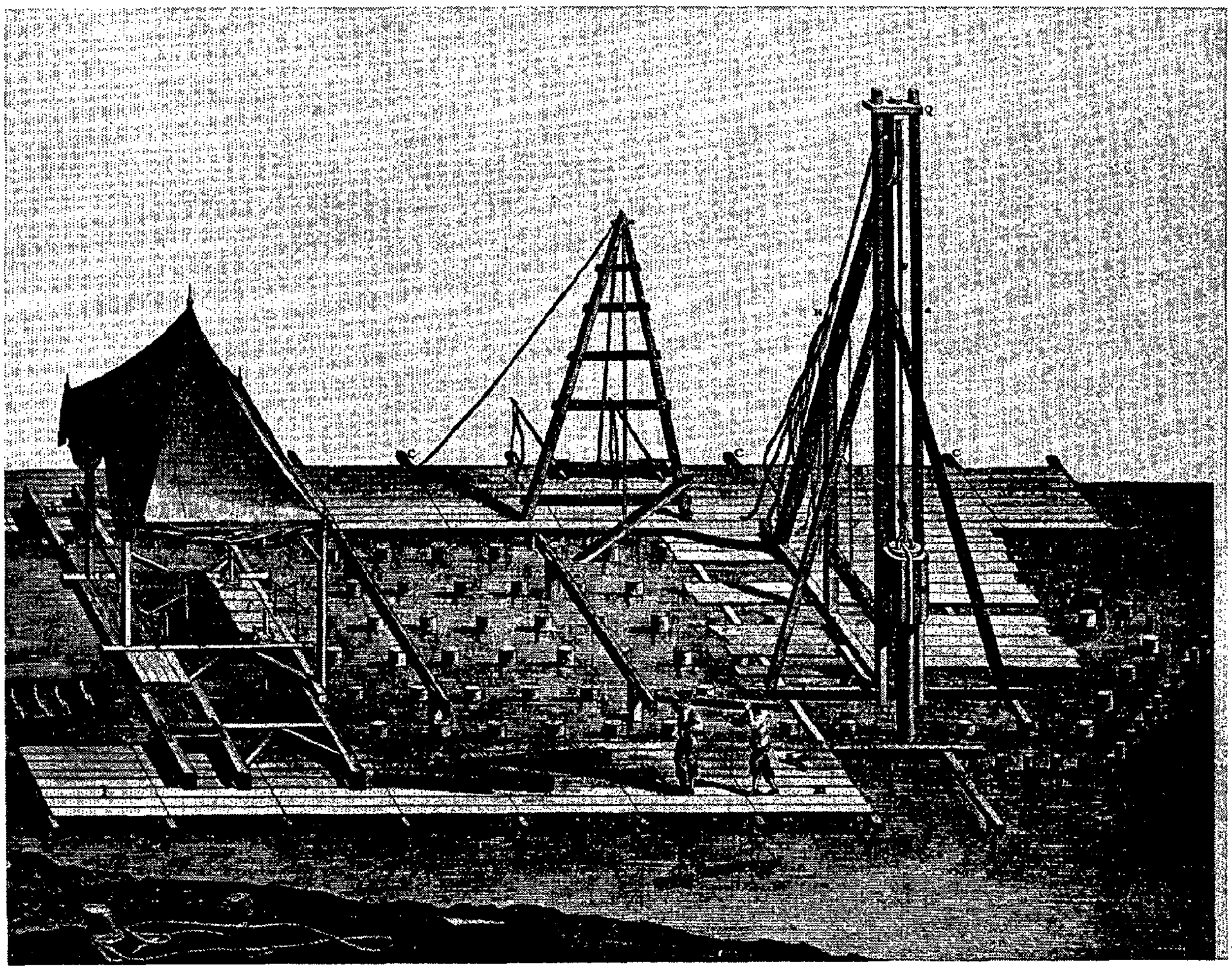
Periodic review and evaluation of actual needs and trends are necessary, in order to render any long range planning proposals valid. Only through a systematic analytical and evaluative process of each implemented phase of construction can the repercussions of such implementation be anticipated with respect to achieving established long range goals. Such a program will assume the evaluation of a well-ordered, truly functional land use plan that will efficiently and effectively support the region it must serve.

1. Koisch, Francis P., "Supercarriers Versus U.S. Harbor Dimensions", Journal of the Waterways, Harbors and Coastal Engineering Division, ASCE, Vol. 97, No. WWI, February 1971

2. Long, Luman H., 1972 Edition The World Almanac and Book of Facts, Newspaper Enterprise Association, Inc., 1971

3. "The Corp's Perception, Conclusions of 1968", Water Spectrum, Vol. 3, No. 1, Spring 1971

3 Offshore Construction



Reprinted by permission of Raymond International

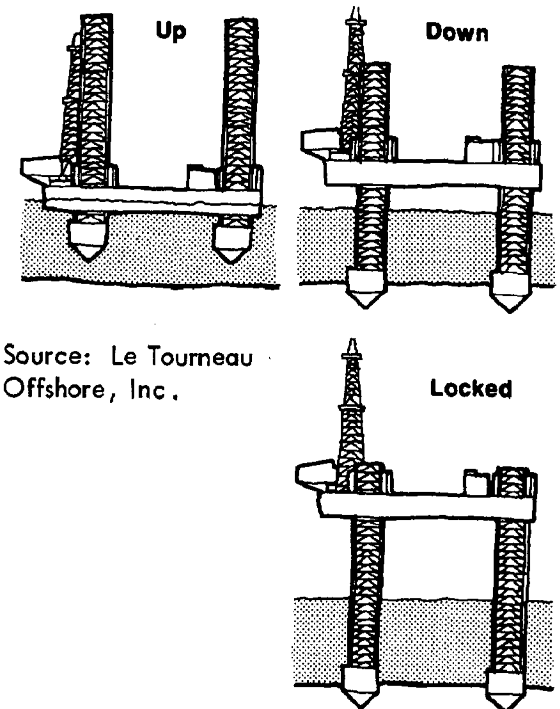
This rare copperplate engraving shows a pile driver at work in a river in France between the years 1770 - 1780. Entitled "Charpente, Nouvelle maniere de fonder les piles" the engraving lists the artist's name as Lucotte on the bottom left and the engraver's name on the right as Benard. The original engraving and several others are in the collection of Raymond International in New York.

History

The petroleum industry appears to be the pioneer in offshore construction. Oil was first produced about 1894 in California from wells drilled from wooden wharves. In 1936, operations began in the Gulf of Mexico. These wells were all visible from land. In 1948, off the coast of Louisiana in the Gulf of Mexico, the first offshore platform beyond the sight of land was completed in conjunction with the first offshore pipeline. This early platform was designed to house a crew of 50 people. Water depth is 50 feet. The platform is still in operation today.

As drilling continued seaward with rapidly increasing costs of construction and greater incidence of dry holes, the fixed platform approach become economically unfeasible. To meet the need of deeper water exploration at economical cost levels, mobile platforms were developed.

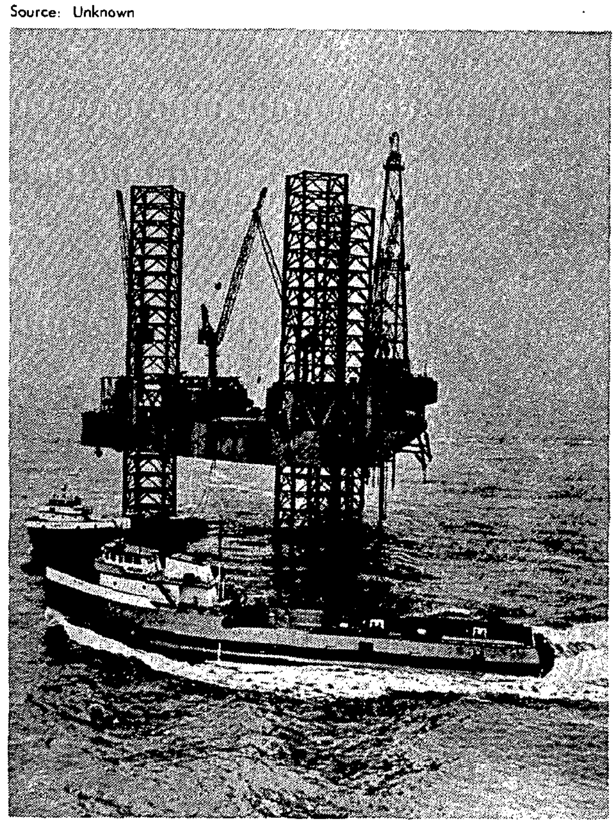
Mobile platforms first appeared in the form of barges with the platform constructed above. They were floated to the site and submerged for operation. Their operating depths were generally in 20 to 40 feet of water.



Source: Le Tourneau Offshore, Inc.

Mobile drilling platform in various stages of erection

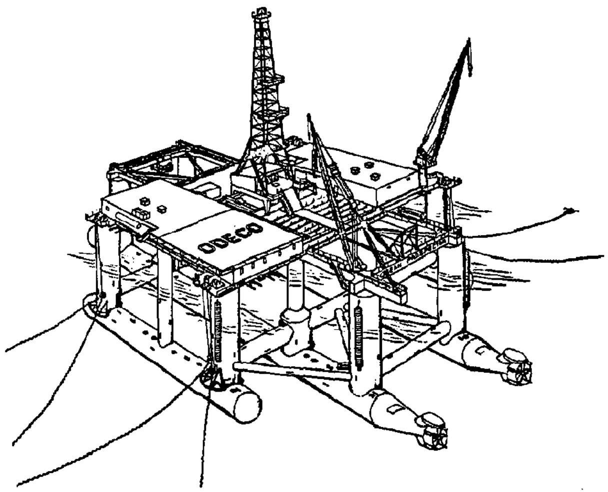
Source: Unknown



Mobile Platforms

Self-elevating (jack-up) mobile platforms were developed for use in greater water depths. These platforms are constructed with a buoyant hull and leg assemblies that can be raised or lowered. They are towed to the site with legs raised by tugs; on site, the legs are lowered and the platform is raised above the waves. Designs have been proposed for jack-up platforms in water up to 600 feet deep.

Submersible platforms and self-elevating platforms have the advantage of being able to rest on the bottom while standing clear of the highest waves, enabling operation to continue during rough seas.



Floating Platforms

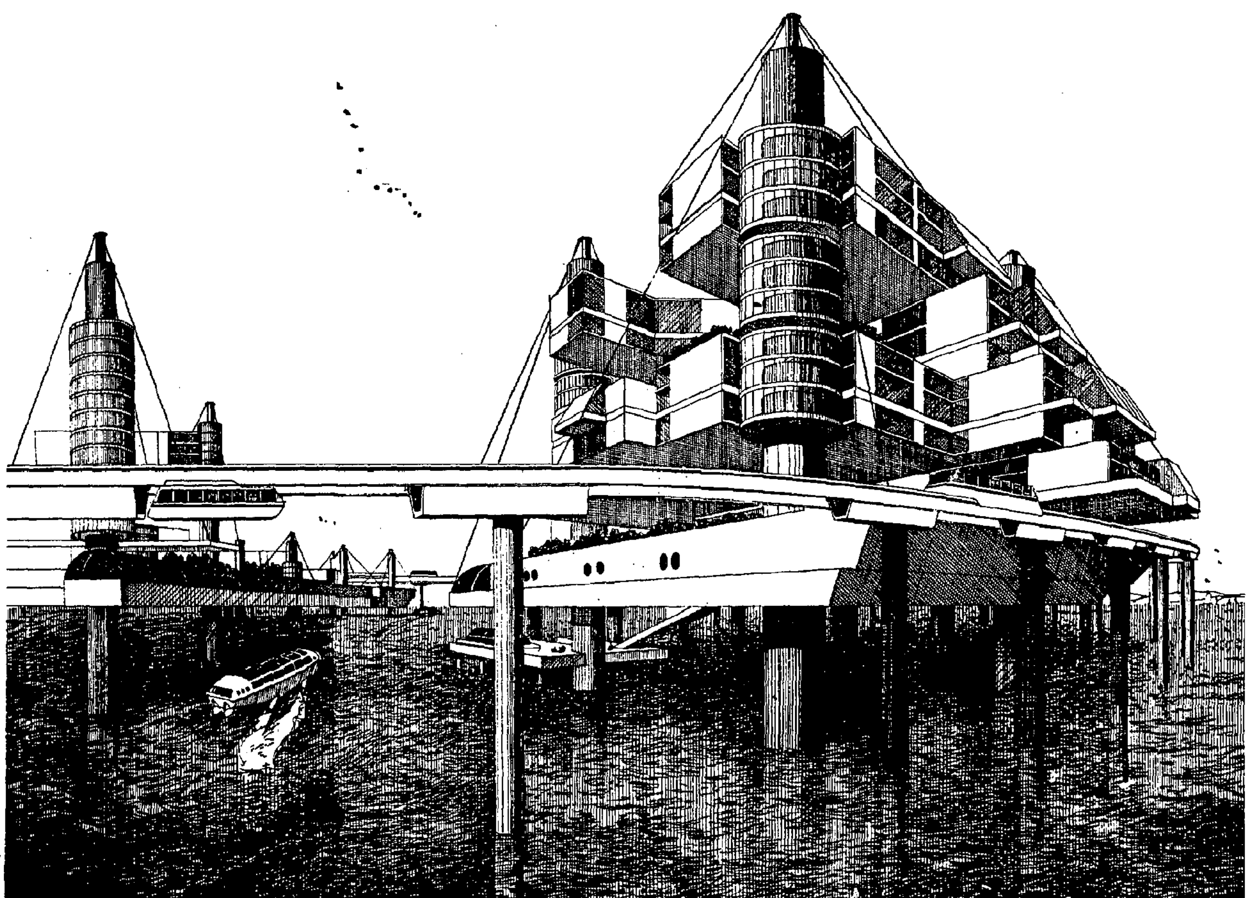
Floating platforms do not have the stability of bottom-supported types. They are not, however, restricted by water depth and are competitive in operating costs for water depths of 200 feet or more.

Semi-submersibles are floating platforms supported on columns which are attached to buoyant, barge-like hulls or cylindrical tubes. When the structure is on-site the hull is ballasted until approximately one-half of the unit is below water. Semi-submersibles are raised by pumping the ballast water from the hull. Most semi-submersibles are towed to their site by tugs. Many newer models, however, contain their own propulsion systems.

Artificial Islands

Artificial islands are created where large areas of surface area are required. Many bulk loading terminals and oil production facilities have been constructed on man-made islands. These islands require large volumes of fill material, which may inflate construction costs, depending upon availability of fill and ease of transportation.

The need for large ocean platforms is increasing for industrial as well as scienfific, municipal and military uses. Multi-use platforms offer many advantages such as: In situ scientific research being conducted simultaneously with industrial activities. A good example would be studies of the effects of oil spill on marine life in conjunction with the testing of oil spill containment devices at a liquid terminal. In this example the scientist, engineer and private industry would jointly be working for a commongoal. Undesirable facilities currently located along the waterfront, could be relocated offshore, to provide more area on the waterfront for people-oriented activities.



Drawing: Ron Love

4 Site Information

After establishing the need for a port, it is necessary to make a preliminary site study. The preliminary study should define an area of consideration that will possess several actual site alternatives. Each alternative must be investigated and compared with the other alternatives to determine an optimum location.

The several alternatives will be derived on the basis of the following types of information:

- Oceanographic data - depth of water, general character of bottom, range of tides and currents
- Meteorologic data - wind, temperature, rainfall
- Topographic data - shoals, reefs, mouth of rivers, shoreline
- Geographic data - depth and presence of rock, depth of overburden, soils.

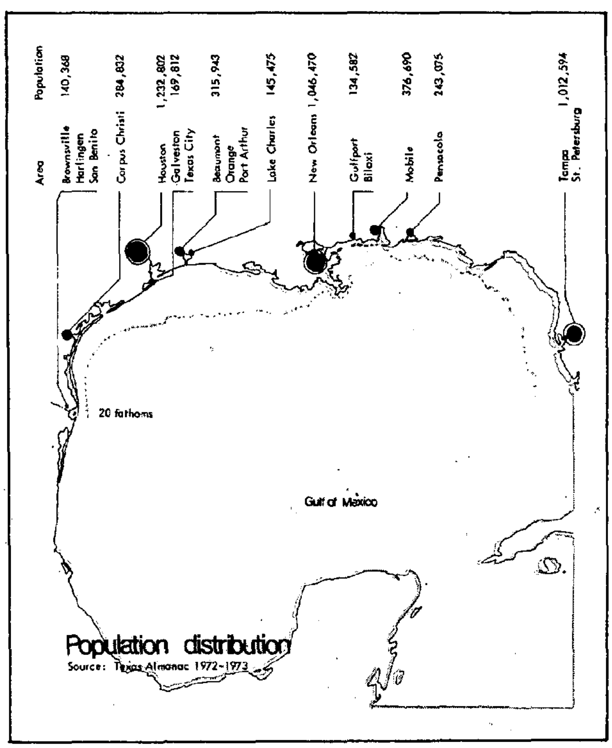
Factors that will determine the final selection of an individual site include:

- amount of dredging required
- most favorable bottom conditions
- most suitable area for terminal installation or development
- transportation accessibility
- area for future development or expansion
- water depth
- exposure/orientation
- economic considerations.

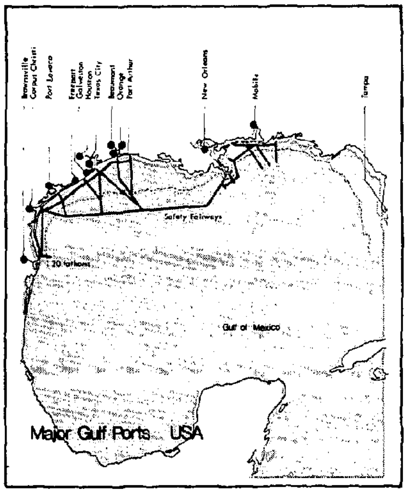
Additional factors that must be considered include:

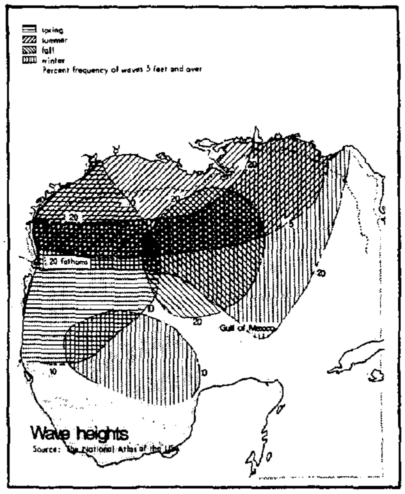
- population concentrations - traditionally, coastal urban concentrations center around existing port locations. As ports and associated industrial development grow, so does urban density. Urban growth creates larger demands for fresh water, electric power, leisure and recreation opportunities as well as more sewage treatment facilities.
- Environmental factors - more and more consideration must be given to the effects on the environment resulting from construction and operation.

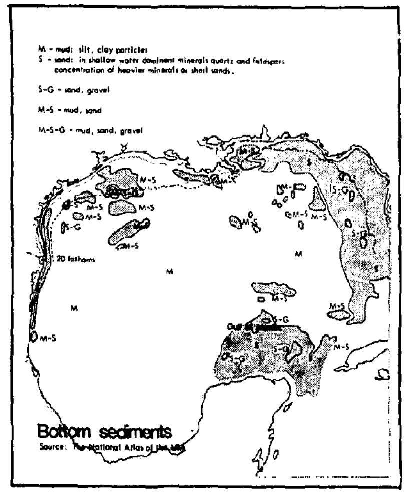
Such considerations include the need for advanced precautionary measures to prevent accidental spills. Containment systems must be perfected to control spills as soon as they occur to prevent damage to the environment.



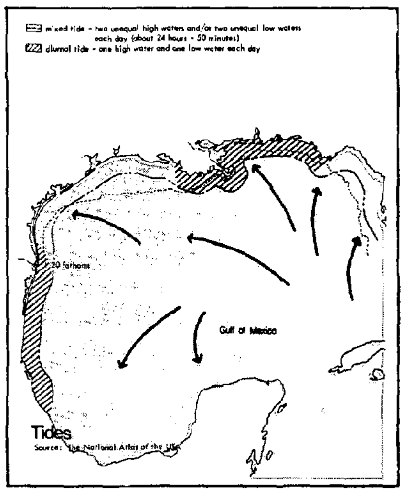
Population distribution
Source: Texas Almanac 1972-1973

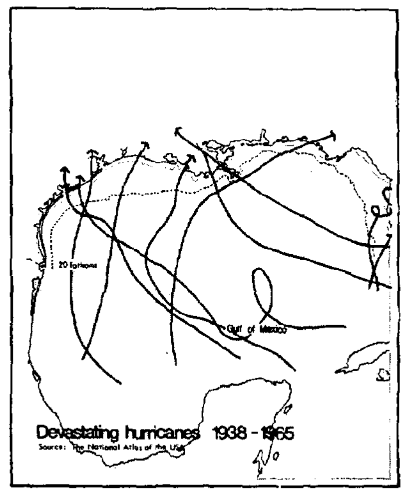

Major Gulf Ports USA
New Orleans
Mobile
Tampa
Safety Fairways
20 fathoms
Gulf of Mexico

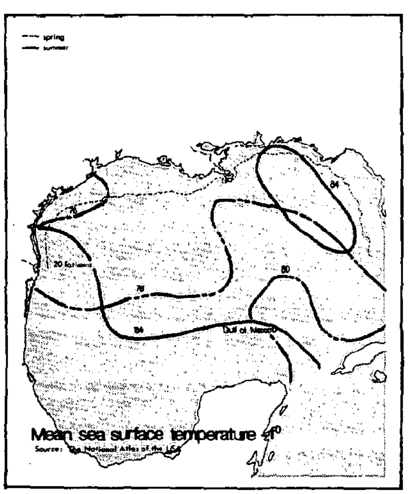

spring
summer
fall
winter
Percent frequency of waves 5 feet and over
20 fathoms
Gulf of Mexico
Wave heights
Source: The National Atlas of the USA

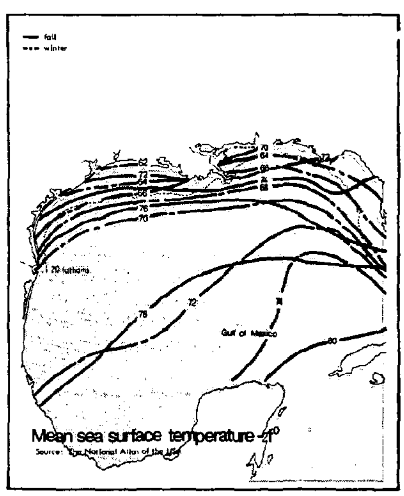

S-G = sand, gravel
M-S = mud, sand
M-S-G = mud, sand, gravel
20 fathoms
Bottom sediments
Source: The National Atlas of the USA

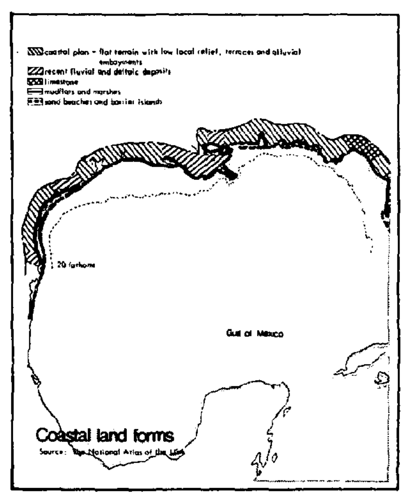

summer
winter
Mean speed in knots
20 fathoms
Gulf of Mexico
Surface currents
Source: The National Atlas of the USA

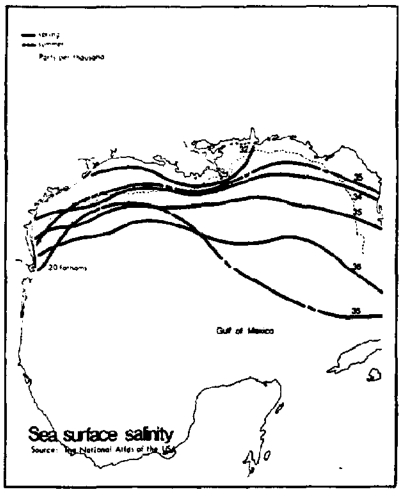

20 fathoms
Gulf of Mexico
Tides
Source: The National Atlas of the USA

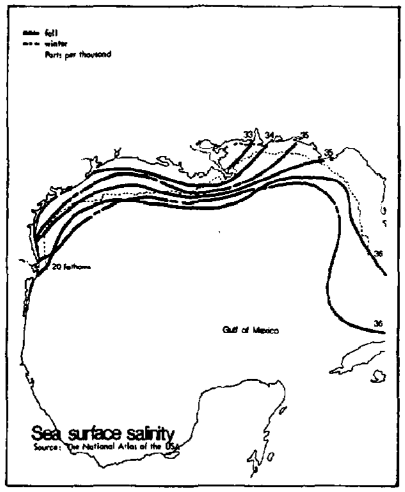

20 fathoms
Gulf of Mexico
Devastating hurricanes 1938 - 1965
Source: The National Atlas of the USA

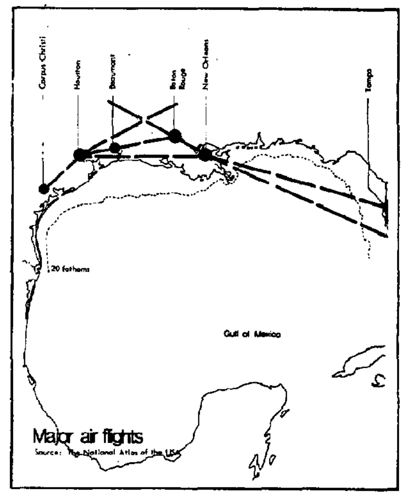

spring
summer
20 fathoms
Gulf of Mexico
Mean sea surface temperature -F°
Source: The National Atlas of the USA


fall
winter
20 fathoms
Gulf of Mexico
Mean sea surface temperature -F°
Source: The National Atlas of the USA


20 fathoms
Gulf of Mexico
Coastal land forms
Source: The National Atlas of the USA

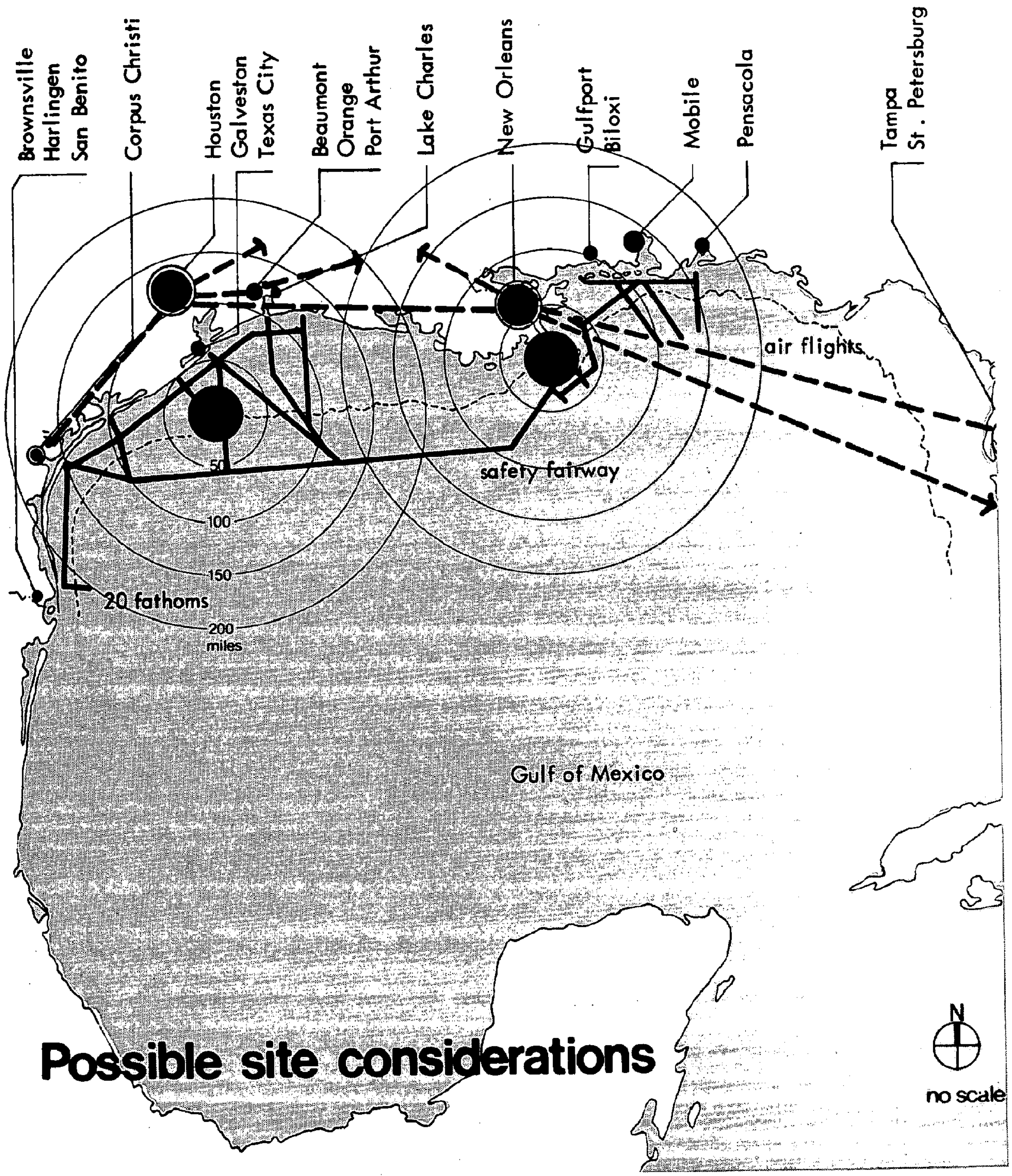






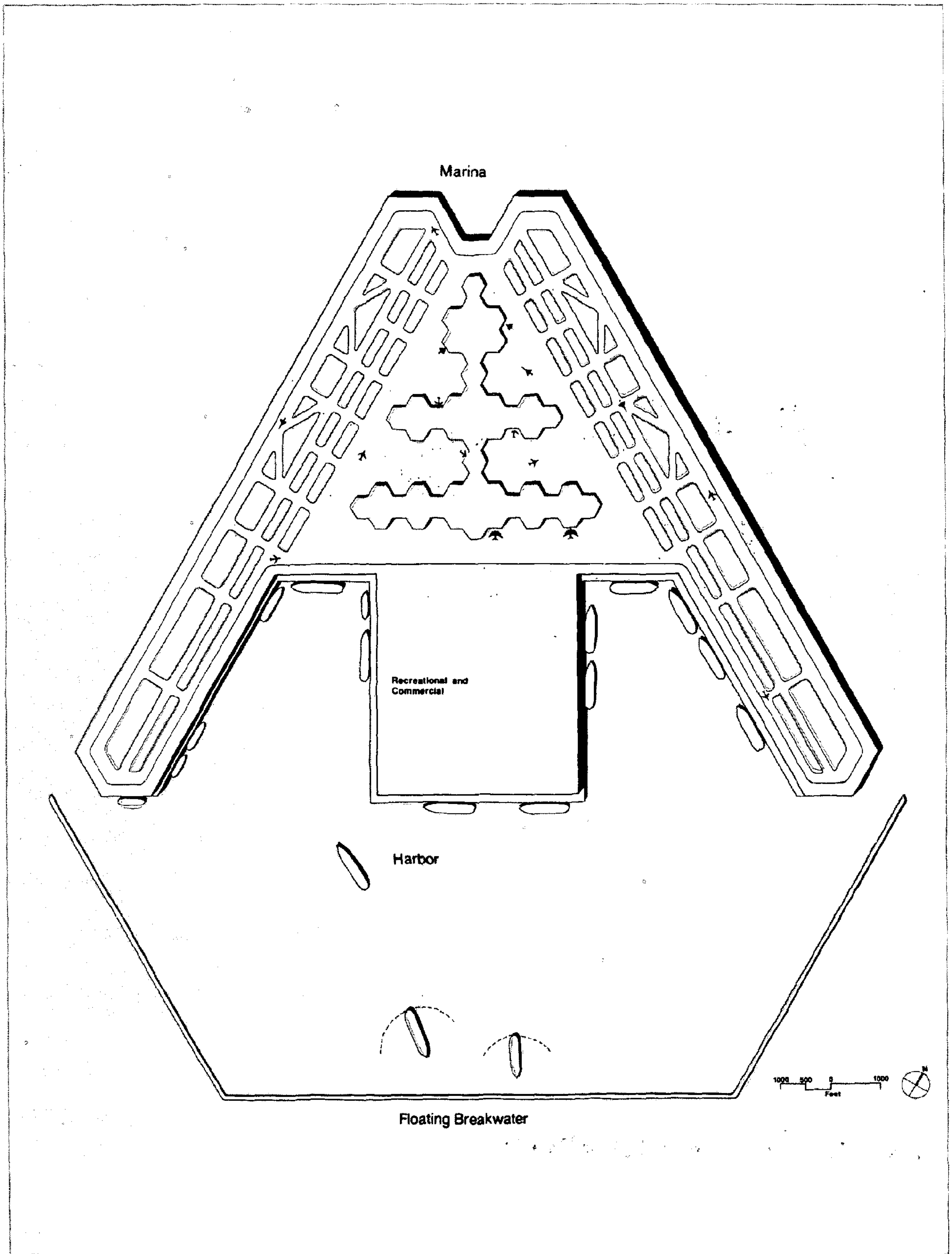
When a particular site has been selected detailed site information must be obtained prior to the final design phase. This information will include:

- hydrographic surveys: elevation of water, high and low tide information, locate and identify any submerged obstacles
- soil survey and analysis - penetration below water level to an area of rock or suitable bearing strata that will support pile or caisson foundations, soil classification , water content determination, specific gravity determination, void ratio, unconfined compression test, and triosial shear test.
- tide and current observation - general direction, velocity and average intervals between successive high tides
- wind
- earthquakes
- effect on the immediate and surrounding environment.
- effect on the surrounding economy.



Possible site considerations

5 Concept


Marina
Recreational and Commercial
Harbor
Floating Breakwater
Feet

Technological advancement is, and always has been, a major part of the maritime scene. Changes occurring now, however, are much greater and faster than ever before. There is a revolution in ocean shipping operations which affects equipment as well as cargo handling methods.

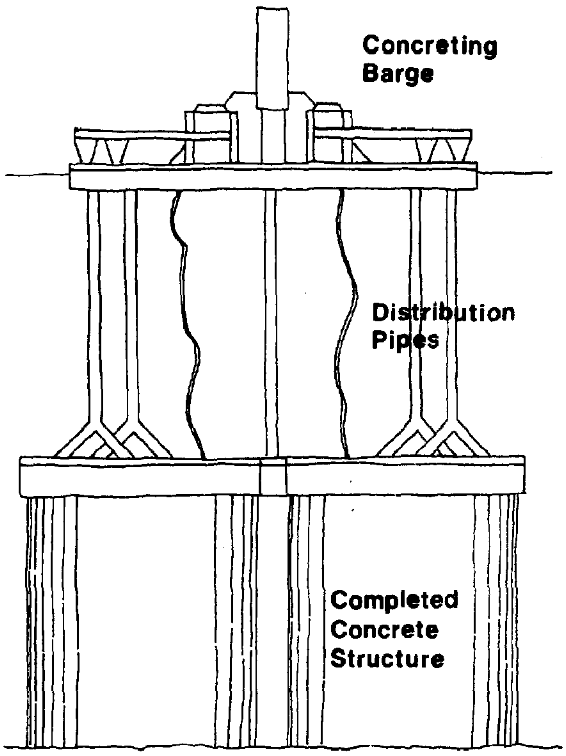
Supersized vessels, capable of single-trip deliveries of over a million barrels of liquid cargo, are now in service with vessels on the drawing boards that dwarf these. Tremendous economic benefits are made possible by large scale vessels. However, these vessels require deepwater mooring facilities or harbor and channel depths substantially greater than now available. To provide such depths creates a myriad of problems, both natural and manmade, including:

- physical
- ecological
- safety
- legal
- economic/financial.

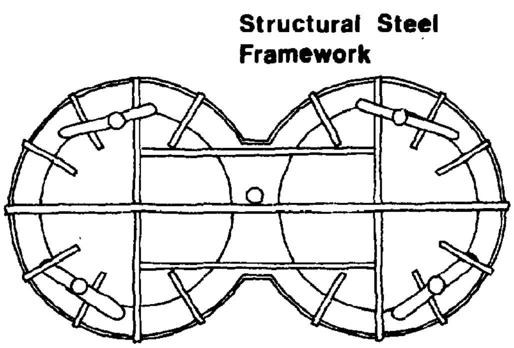
Containerization of non-bulk commodities is accelerating at an unprecedented rate. The benefits include:

- lower freight costs
- faster deliveries
- less shipping damage to cargo
- more economical handling costs.

To realize these benefits, it will be necessary to expend a large amount of funds, either in renovating existing port facilities or building new ports.



Elevation



Plan

Source: Dock and Harbour Authority, April 1972

Construction

The best structural system for this proposed complex appears to be a combination of land fill and pile-supported structures.

An entirely pile-supported structure would be prohibitive in cost because of unstable sea floor conditions. Such a structure would require a tremendous amount of extremely expensive equipment and manpower.

An artificial island constructed of land fill will provide the most stable structure. This type of construction, however, requires time for the fill material to settle before it can support major construction. One means to reduce the settling process is to construct a barrier much like a retaining wall, which prevents the fill material from moving horizontally or sloping. These barriers have the added feature of providing deep water adjacent to the land fill area.

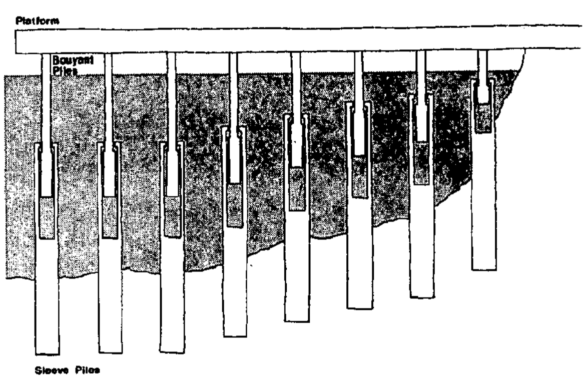
A System to construct bulkheads has been developed in England. It consists of slip forming concrete underwater. The process involves the use of bouyant tanks to continuously pour cylindrical concrete structures in water depths that exceed 100 feet. By building these silos adjacent to one another, retaining walls are formed to contain fill material. Voids created by the silos can be used as storage space for bulk cargoes.

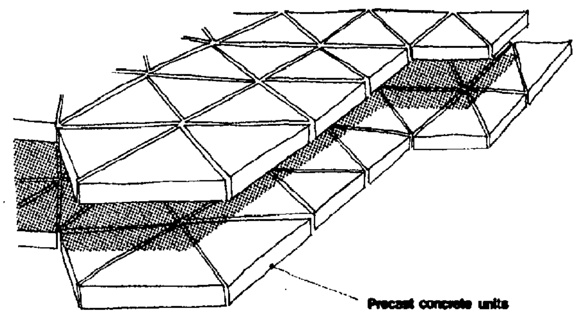
Initially, a construction platform will be required at the site. On this platform will be located a concrete manufacturing plant and housing facilities for construction personnel.

The pile-supported section of the complex will utilize a pile system composed of two basic elements, a buoyant pile and a sleeve pile.

The principle is to reduce the lateral or horizontal movement to practically zero while permitting controlled gradual vertical movement during times of extremely high sea states. The movement vertically can be computed since the pile system operates basically like a simple piston.

Concrete is an excellent material for use in the marine environment. It does not corrode; it can be formed or moulded and can be treated so that it is completely waterproof. Concrete units, constructed of light weight air-entrained concrete sandwiched between two layers of more dense concrete, form lightweight units with extremely long-wearing surfaces.





Assembly pattern for precast concrete deck units

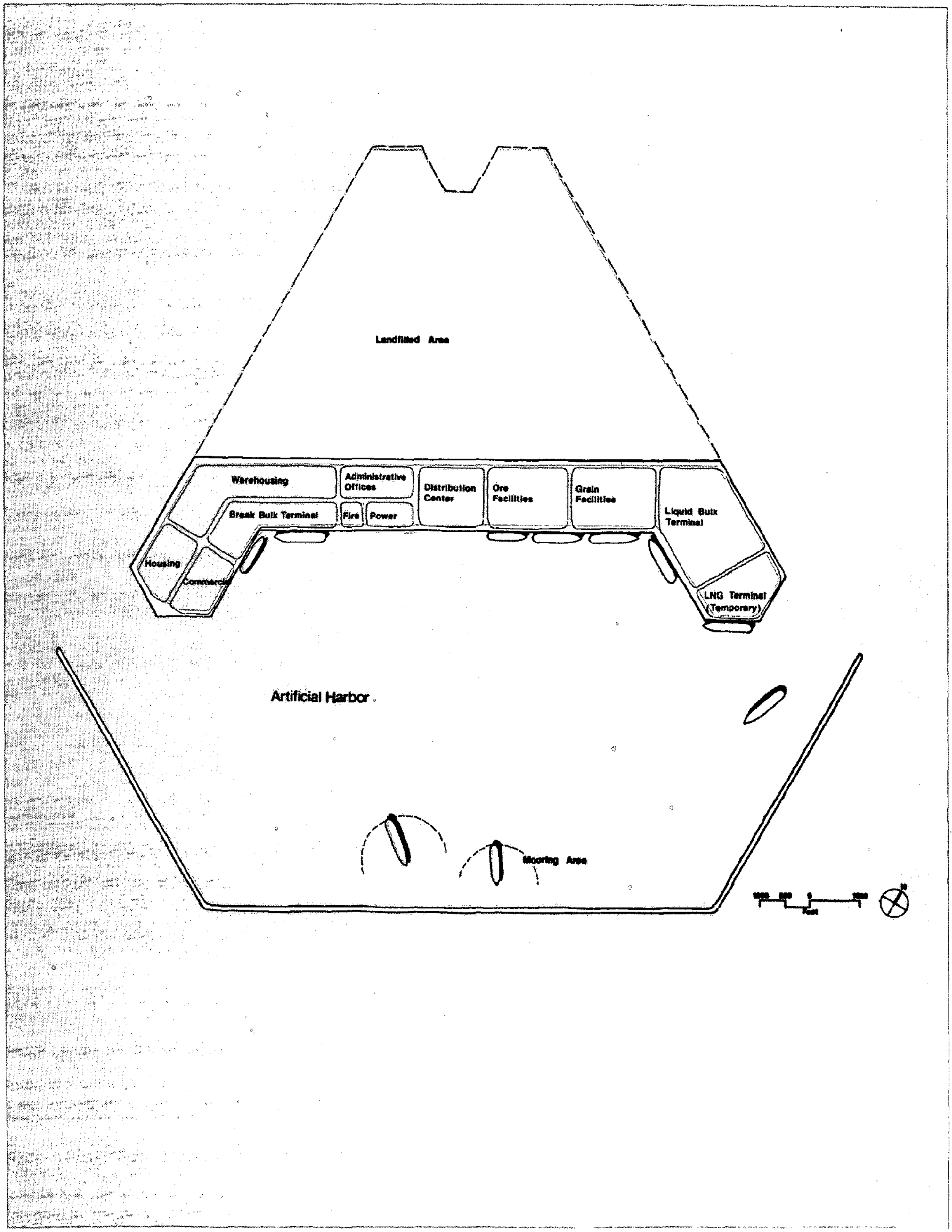
Deck Construction

One system for deck construction is to manufacture repetitive modular units that can be assembled in many configurations. By using modular units, connection details and components can be standardized and minimized. At-site construction time can be reduced by producing modular units on land and floating them to the site for erection.

The following sections of this report reflect five phases of construction over an extended length of time. Each phase provides a brief description of facilities applicable in the growth sequence. The end product is a port that meets the needs of the region it serves. The facilities indicated are not the only ones applicable to offshore location; they are, however, activities that logically fit together to form a multi-use complex capable of meeting a wide range of future demands.

Grouping of facilities cannot be considered as fixed absolutes. During construction phases different uses with greater impact to the region concerned may evolve. Plans should be flexible enough to provide for additions to the complex or replacing existing obsolete facilities.

Plan-phase 1


Landfilled Area
Warehousing
Administrative Offices
Distribution Center
Ore Facilities
Grain Facilities
Break Bulk Terminal
Fire
Power
Liquid Bulk Terminal
Housing
Commercial
LNG Terminal (Temporary)
Artificial Harbor
Mooring Area
Feet

Phase 1

The first phase focuses on existing needs as generated primarily by deep-draft vessels. Possible future demands are also included -- Liquid Natural Gas (LNG), liquid bulk, ore, grain and break bulk facilities. Support facilities constructed at this phase include administrative functions, security and safety control centers, power generating facilities, desalination facilities, fire, emergency and spill containment facilities as well as housing and commercial facilities for construction personnel and port operations personnel. As these facilities are being constructed, long-term land fill operations are underway to create an artificial island for future construction.

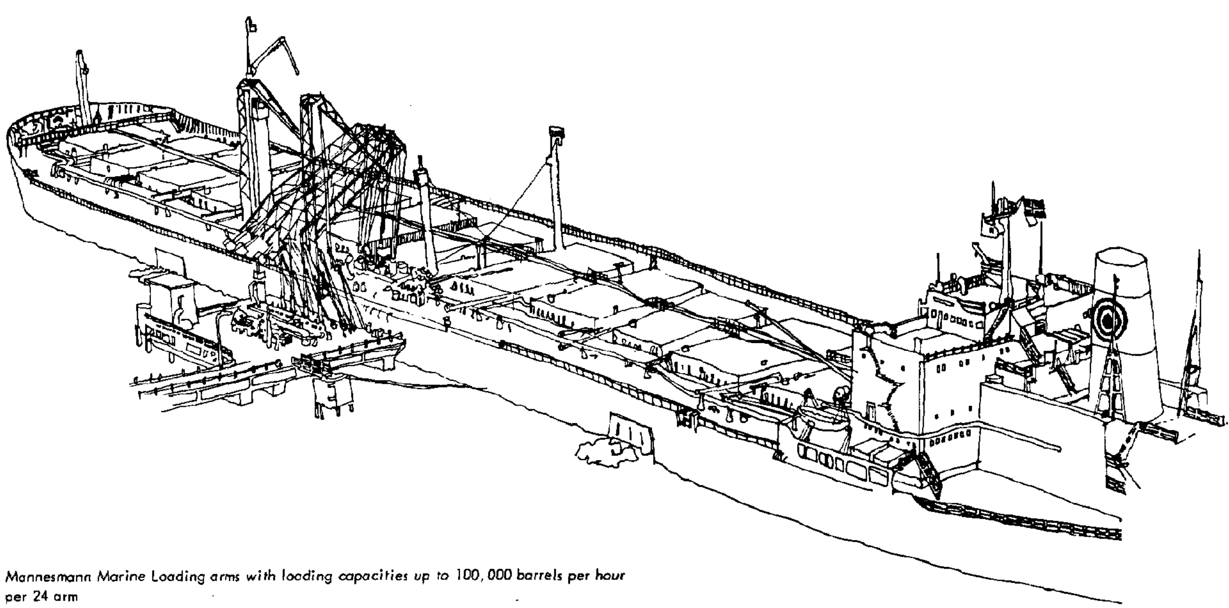
An artificial harbor will be provided by construction of a floating breakwater. Entrance and exit permits will be controlled to direct ship traffic, thereby reducing the chance of navigational mishaps. The floating breakwater will be designed in such a manner that it can double as a spill containment device. By utilizing the harbor as a holding basin for possible spills, delicate estuaries, bays and beachfront should be free from dangers created by spills.

Liquid Bulk Terminal

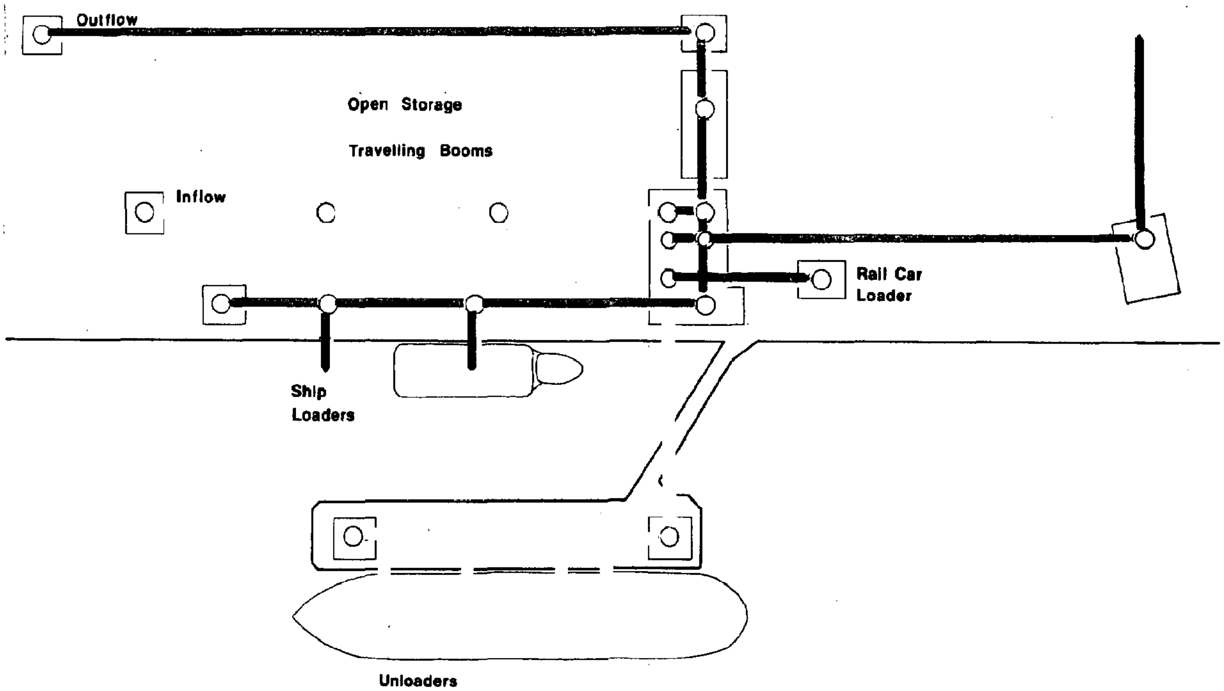
Liquid terminals generally are located on the seaward side of a port, near the deepest available water. Loading facilities are light, open structures capable of carrying pipes and valves. Major elements of liquid bulk terminals include pumping equipment, pipelines, tank storage facilities and emergency equipment for the prevention and control of fire and explosion. A major design consideration in new liquid bulk terminals designs is oil spill prevention and containment devices.

Liquified Natural Gas (LNG) facilities will be provided initially at the liquid bulk terminal. Many similarities exist in the handling techniques of the two cargoes.

Drawing: Russell Stogsdill



Mannesmann Marine Loading arms with loading capacities up to 100,000 barrels per hour per 24 arm



Product flow pattern of a typical ore terminal
Source: Port of Le Havre

Ore Terminal

Required facilities for an efficient ore terminal include:

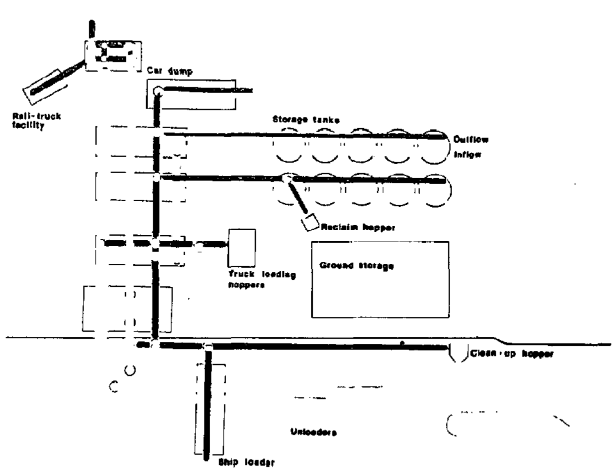
- Large stockpile area for open storage
- bins and elevators for special storage
- a delivery system such as conveyors to carry the cargo to and from the ship loaders and unloaders. Type of equipment used for loading and unloading includes grabbing equipmenr, tower unloaders and floating cranes.
- discharging stations for cargo to other transportation modes
- circulation area for transportation modes.

In Phase 1, the designed capacity for open storage is 1,000,000 tons of 140 lb/cu. ft. material with expansion capabilities to 2,000,000 tons during Phase 3.

Some ores are slurried (mixed with a liquid) then pumped into the vessel. After the slurry is aboard, the ore settles out and the liquid is pumped into a holding tank for future use. For a slurry ore terminal pumping equipment with necessary pipelines and a liquid storage area must be provided.

Grain Terminal

The requirements for grain terminals are very similar to the requirements for ore terminals. In Phase 1, the designed capacity for grain storage is 24,000,000 bushels (890,000 tons) with expansion capabilities to 50,000,000 bushels during Phase 3.

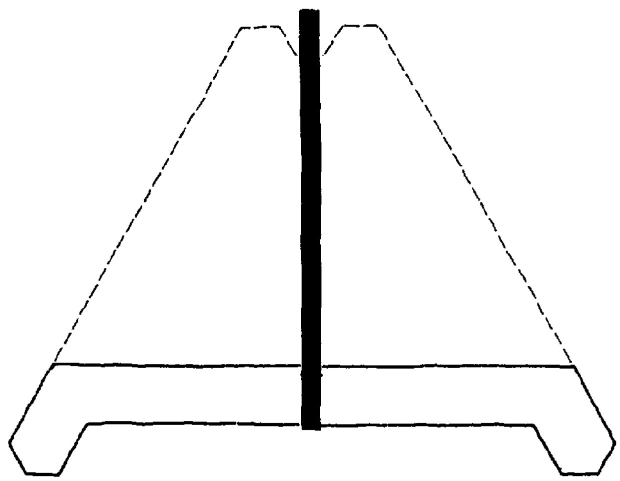


Product flow pattern of a typical grain terminal
Source: Master plan for Long-Range Development of the Port of New Orleans

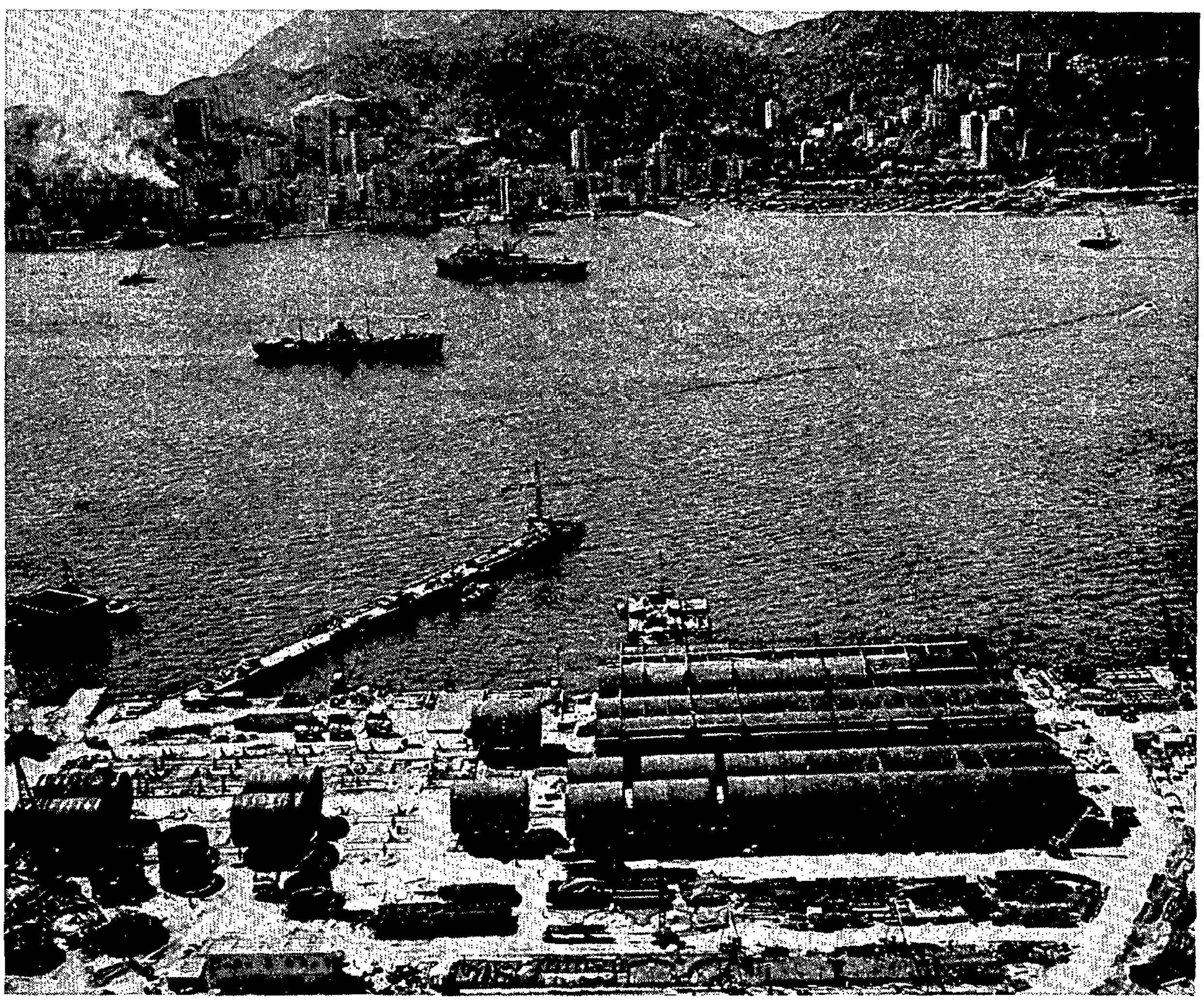
Transport System

All-weather cargo movement can be achieved by the construction of a tube connection from the deepwater facility to the mainland. Inside the tube, conveyor systems, rail systems, personnel conveyors and pipelines can operate simultaneously year round. The tube can also be designed to double as a horizontal storage system, which would reduce the amount of storage required at the offshore site.

Tube systems currently are being fabricated out of steel and concrete. Constructed into repetitive units, they are floated from the point of fabrication to the point of erection, then submerged, connected, and anchored in place.

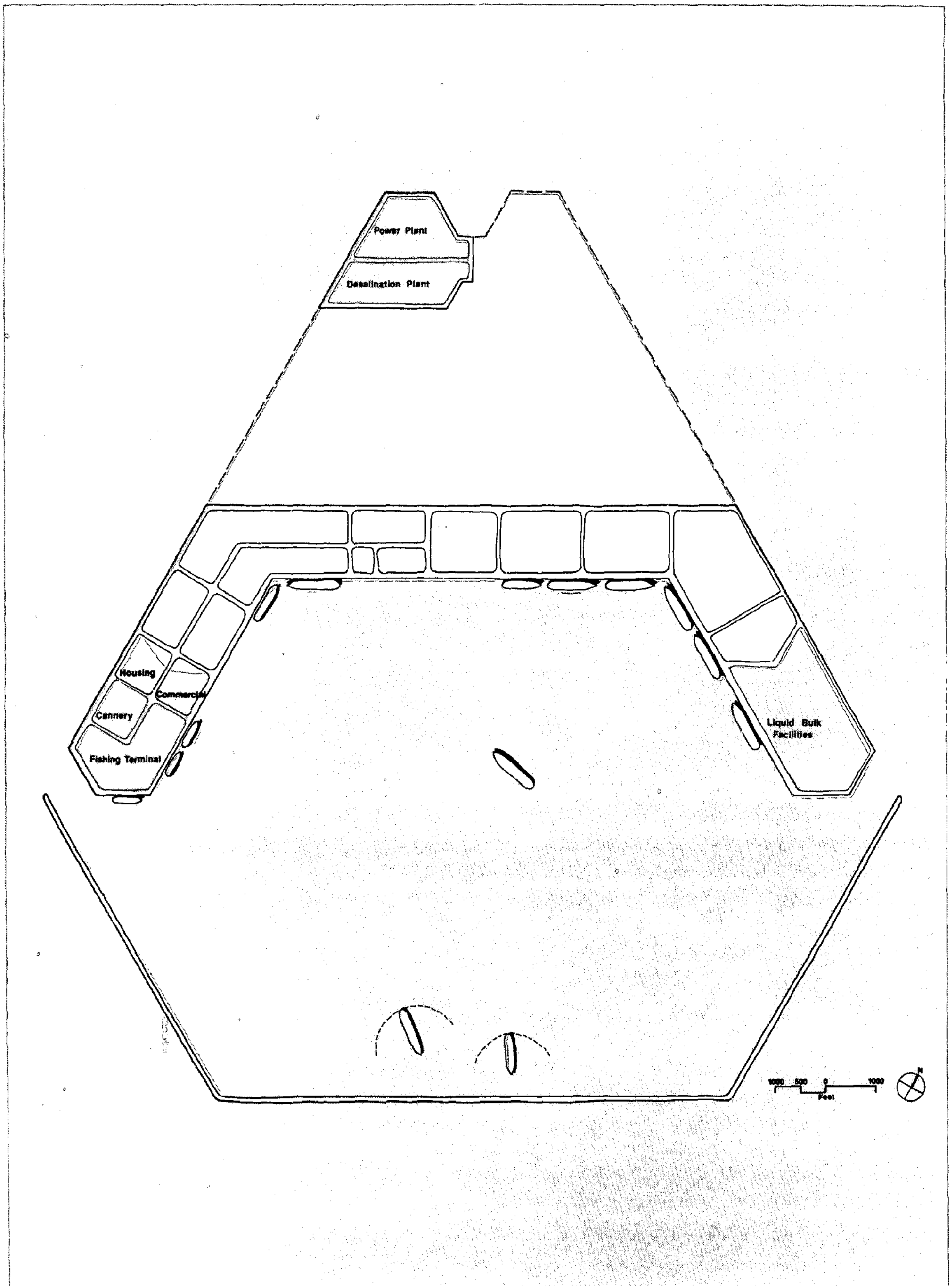


Plan of Transit Tube - Phase 1



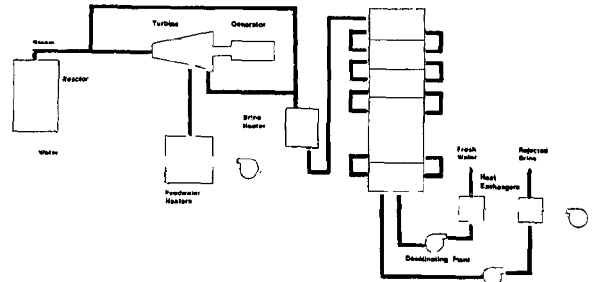
Assembly process for an underwater tunnel to connect Kowloon with Hong Kong Island
Source: Port of Hong Kong

Plan - phase 2


Power Plant
Desalination Plant
Housing
Commercial
Cannery
Fishing Terminal
Liquid Bulk Facilities
1000 500 0 1000
Feet
N

Phase 2

Phase 2 requires the floating breakwater to be repositioned about 3000 feet farther out to sea and expanded in length. The two arms of the port are extended to accommodate growth for the liquid bulk facilities. New facilities are added. The power plant and desalination plant are relocated to the solid land fill and expanded to their maximum size.



Flow diagram of a combination power and desalination plant

Fishing Terminal

Spoilage from point of catch to consumer retail outlet is a serious problem for the fishing industry. By locating a fishing terminal at the deepwater port, the fishing fleet would not have to travel as far with their catch. Modern handling facilities would be available to process the catch quickly utilizing strict sanitation standards. Inland distribution systems would be readily available by land, air, and water. These factors add up to reduced handling time from point of catch to consumer retail outlet. The consumer gets a better product and the fishing industry can make a better profit from their catch.

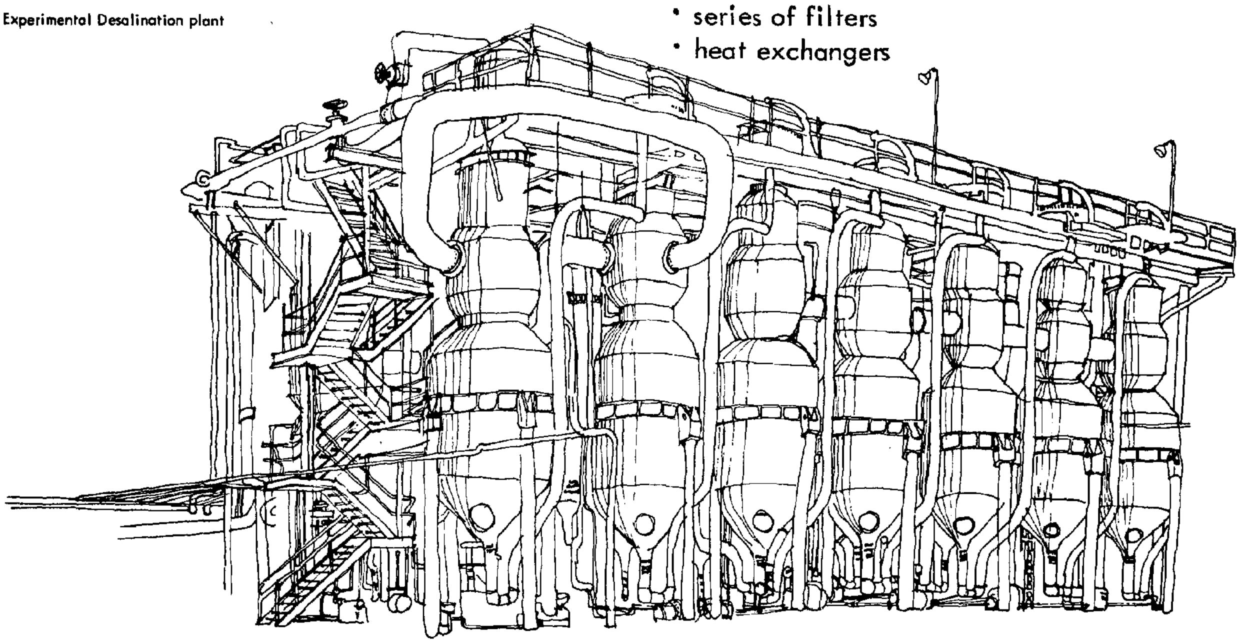
Power & Desalination Plants

The power and desalination plants require large volumes of water. The power plant uses water for cooling, while the desalination plant produces fresh potable water from salt water. The equipment for both is similar when nuclear power is used in the desalination process.

A single purpose nuclear power plant requires:
- large water source
- demineralizer
- feedwater heaters
- secondary steam generators
- reactor
- turbine generator
- condenser

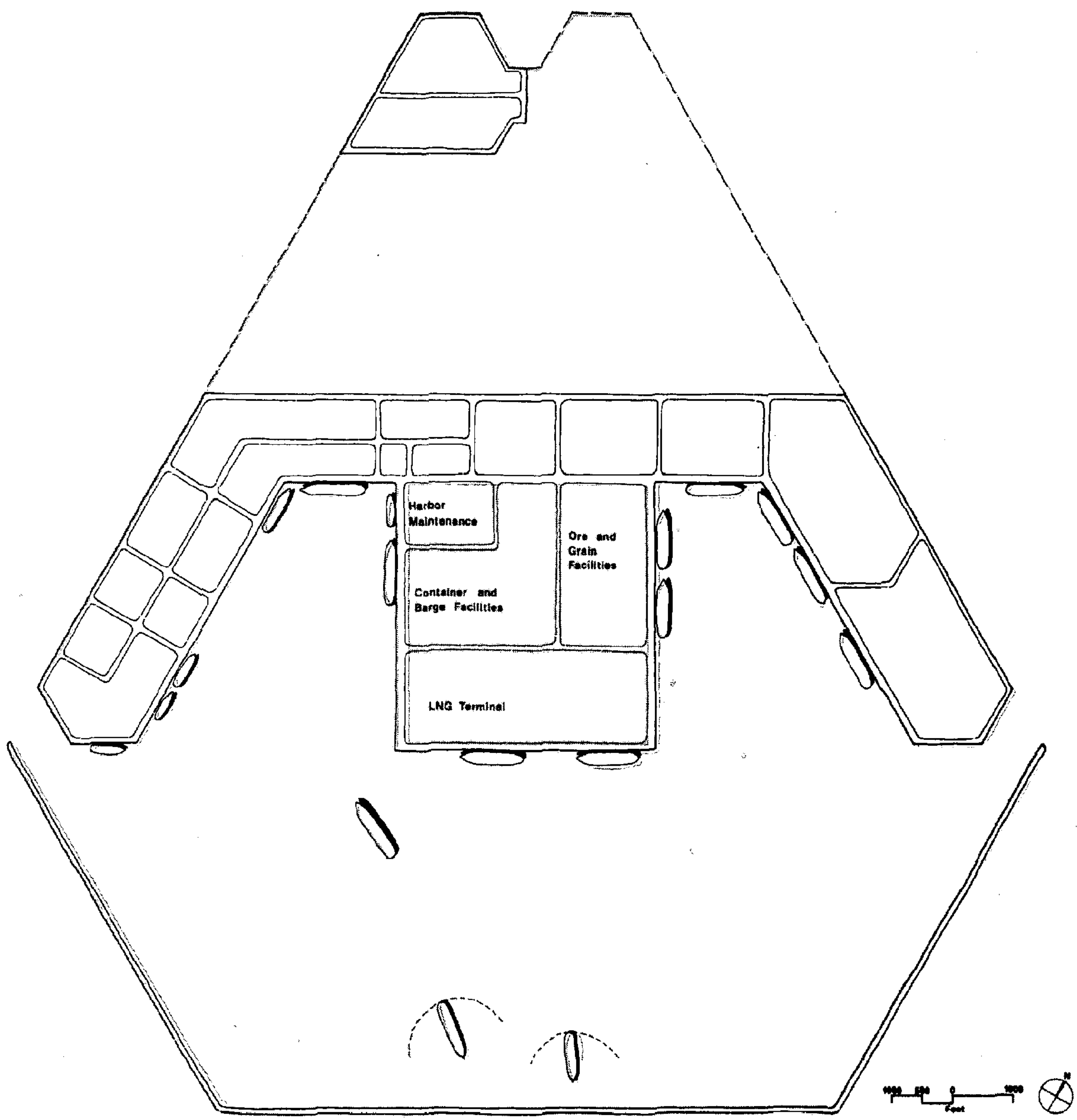
To create a dual-purpose plant requires the addition of:
- brine heater
- series of filters
- heat exchangers

Experimental Desalination plant



Drawing: Russell Stogsdill

Plan - phase 3


Harbor Maintenance
Ore and Grain Facilities
Container and Barge Facilities
LNG Terminal
0
N

Phase 3

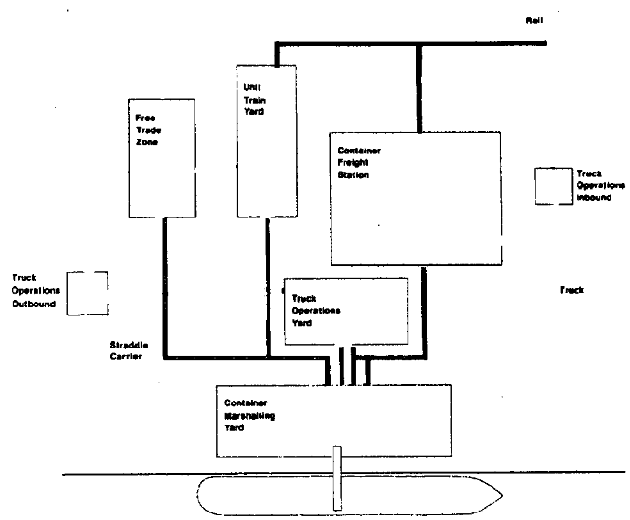
Construction is begun on the extension of the central waterfront section to provide for growth and expansion of bulk facilities. Liquid Natural Gas facilities are permanently located and a container terminal is provided. Harbor maintenance facilities are also permanently located in the harbor area.

Container Terminal

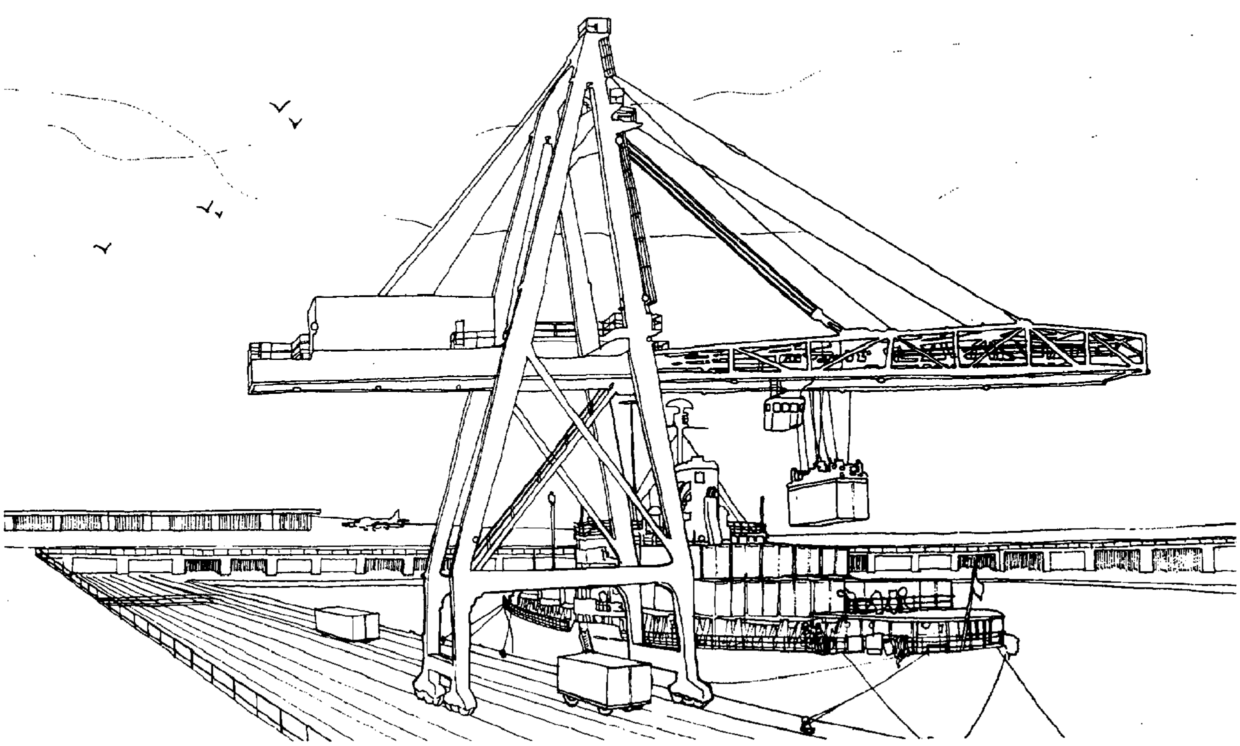
By the completion of Phase 3, over 100 acres of storage area will be available for container handling facilities, this does not include the storage capabilities of the submerged tube. The initial container facility will be able to handle an excess of 8,000 containers. The container terminal will have provisions to handle the LASH and SEABEE vessels as well as standard container vessels.

Container facilities require:

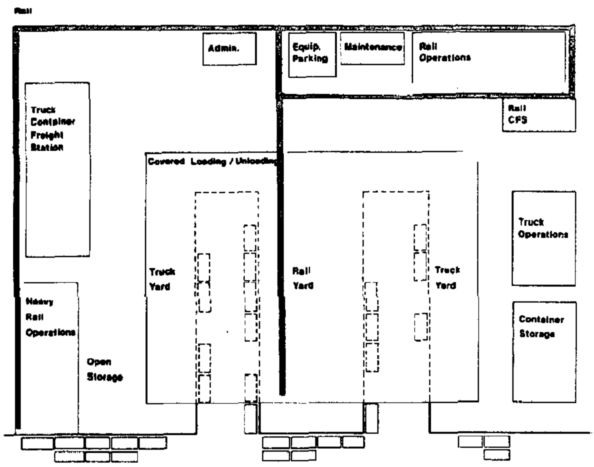
- Container marshalling areas for storage
- Container freight station to handle less-than-container load shipments
- Considerable vehicle circulation area
- Covered loading area for LASH and SEABEE barges.



Flow diagram of a typical container facility
Source: Container Services of the Atlantic



Drawing: Mike Willingham

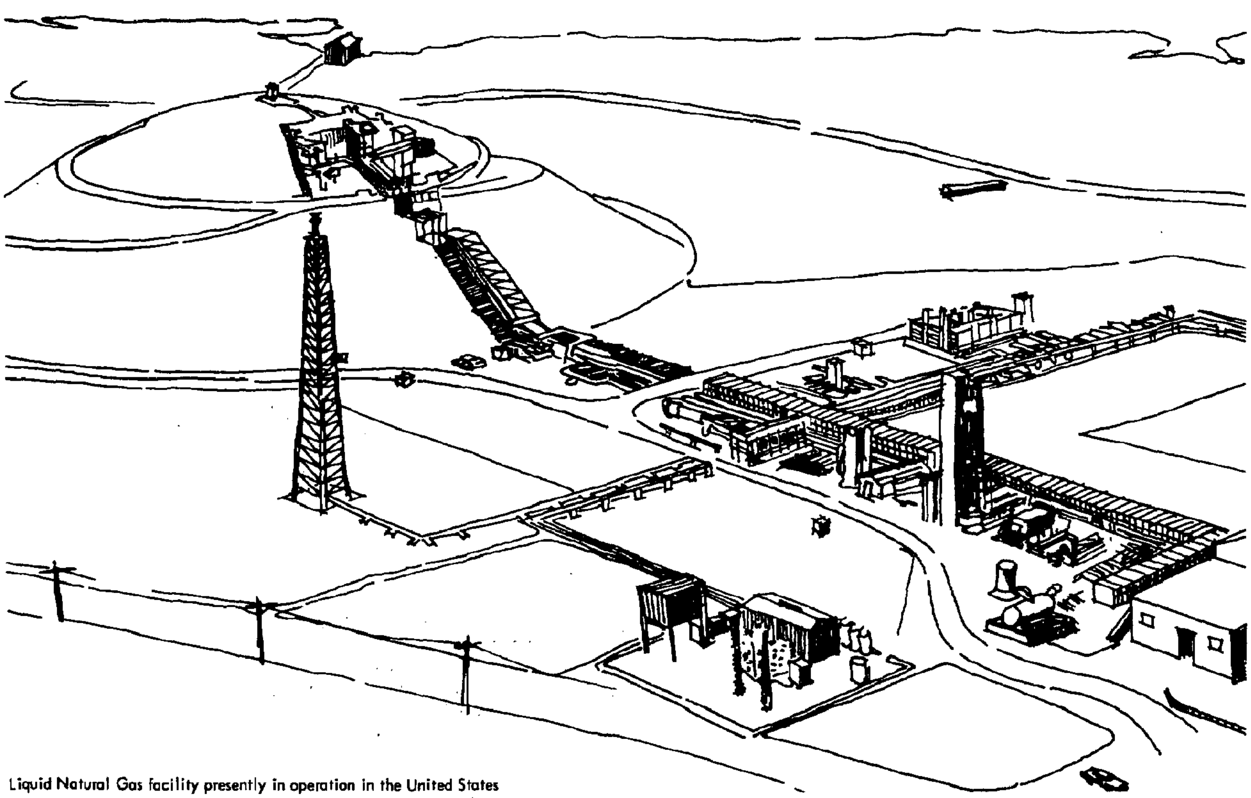


Functional Layout for a LASH or SEABEE barge terminal
Source: Masterplan for Long-Range Development of the Port of New Orleans

Liquid Natural Gas Terminal

Equipment and areas required for the handling of LNG are basically the same as those required for a standard liquid bulk terminal, with the exception that all material coming in contact with LNG must stay serviceable at minus 260°F. This condition requires insulation of piping to reduce heat leakage. It also requires the use of aluminum or stainless steel connections and valves.

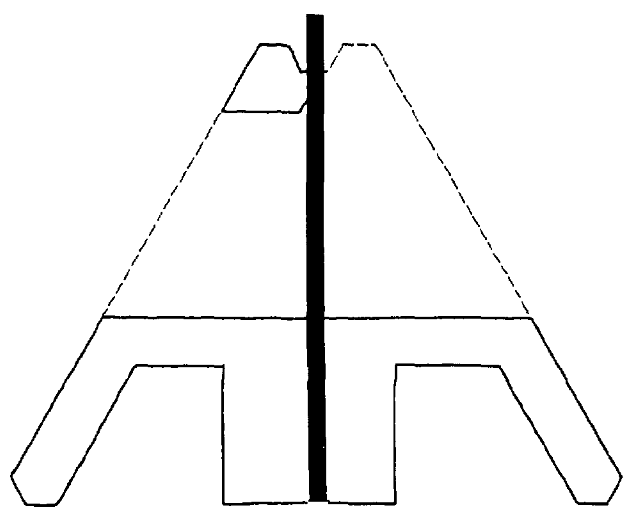
Down time for LNG tankers is extremely expensive therefore they have been designed to load and unload in a minimum amount of time (15 hours). Ample facilities should be provided to expedite the turnaround time. The design storage capability at the completion of Phase 3 will be approximately 20,000,000 barrels.



Liquid Natural Gas facility presently in operation in the United States

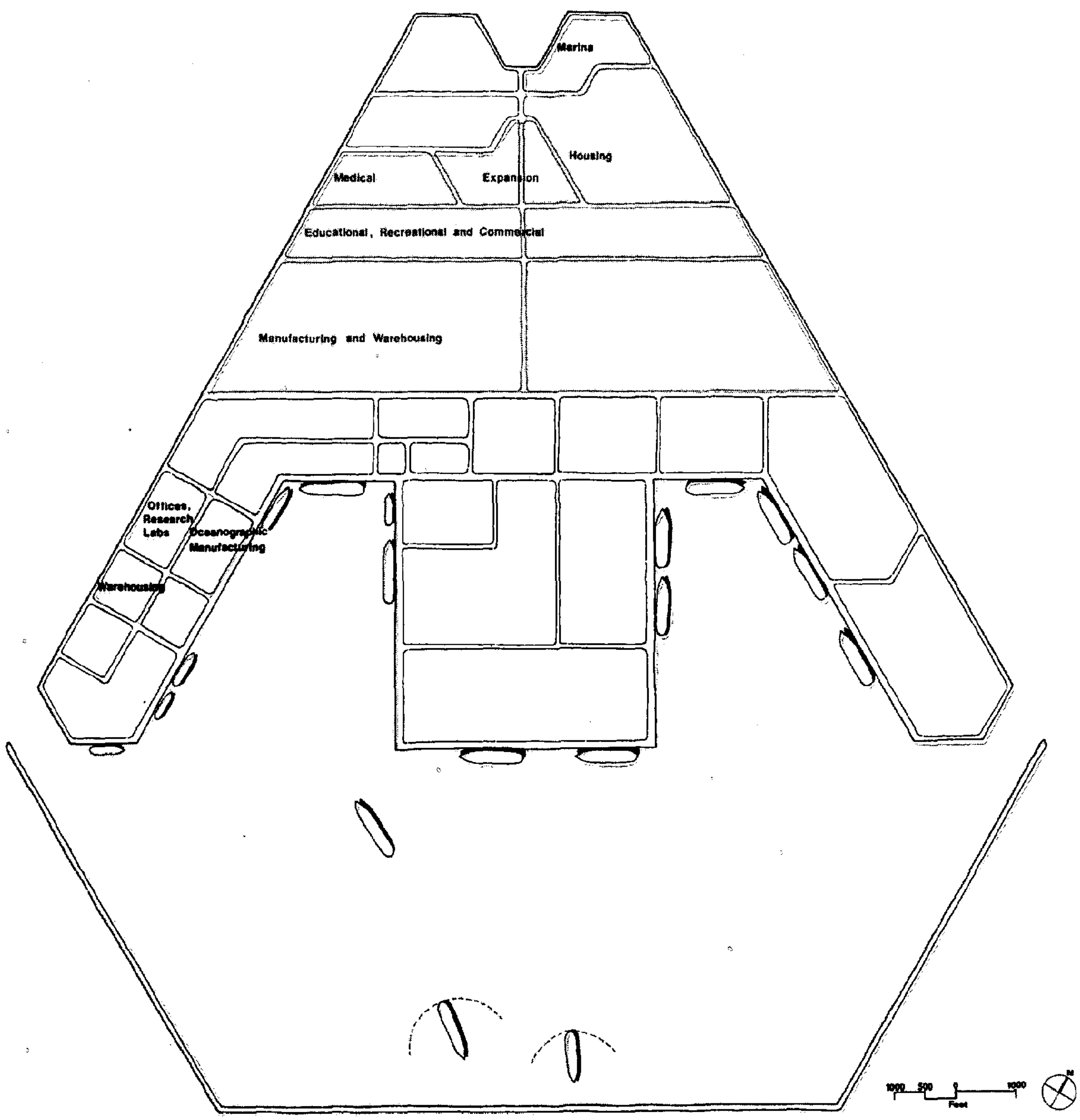
Drawing: Nick Maselli

During construction of Phase 3 the transit tube must be extended to provide access to the container, LNG and dry bulk facilities.



Section Through Port Showing Completed Transit Tube

Plan - phase 4


Marina
Housing
Medical
Expansion
Educational, Recreational and Commercial
Manufacturing and Warehousing
Offices,
Research
Labs
Oceanographic
Manufacturing
Warehousing
1000 500 0 1000
Feet
N

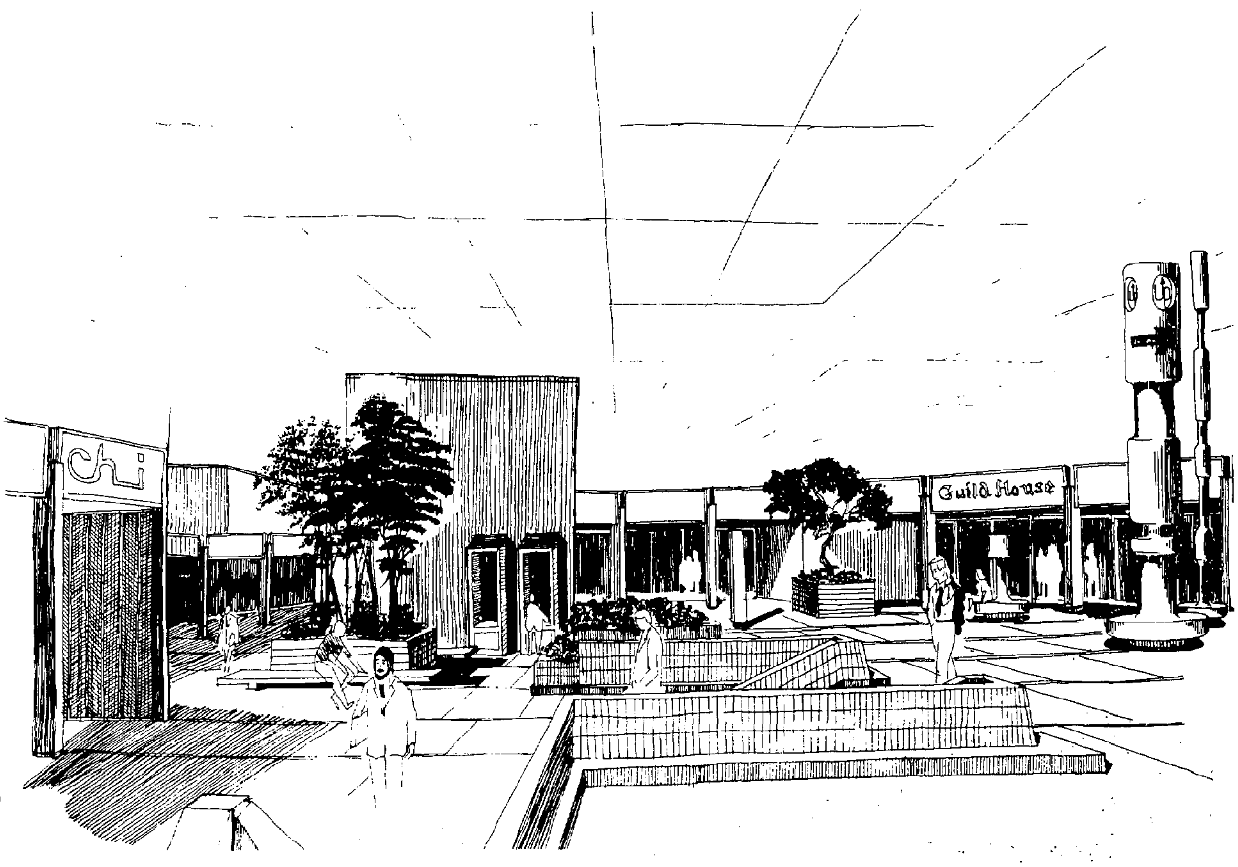
Phase 4

Phase 4 will initiate construction on the solid landfill. Support facilities programmed for this phase include the addition of new industrial facilities, expansion of warehousing capabilities and expansion of people-oriented facilities.

Educational

Educational facilities must be provided for the families of personnel inhabiting the offshore port. The location of such facilities is near the housing complex. Space is provided classrooms, auditorium, gymnasium as well as other required spaces. These facilities can double for adult facilities during the periods that school is out. Athletic facilities requiring large open areas such as football fields can be provided on the upper deck.

Within the educational complex, university research and training facilities for in-situ studies can be provided. The offshore complex will serve as an excellent monitoring station for oceanographic and meteorological data.



Drawing: Nick Maselli

Interior view of a portion of the commercial complex

Recreation

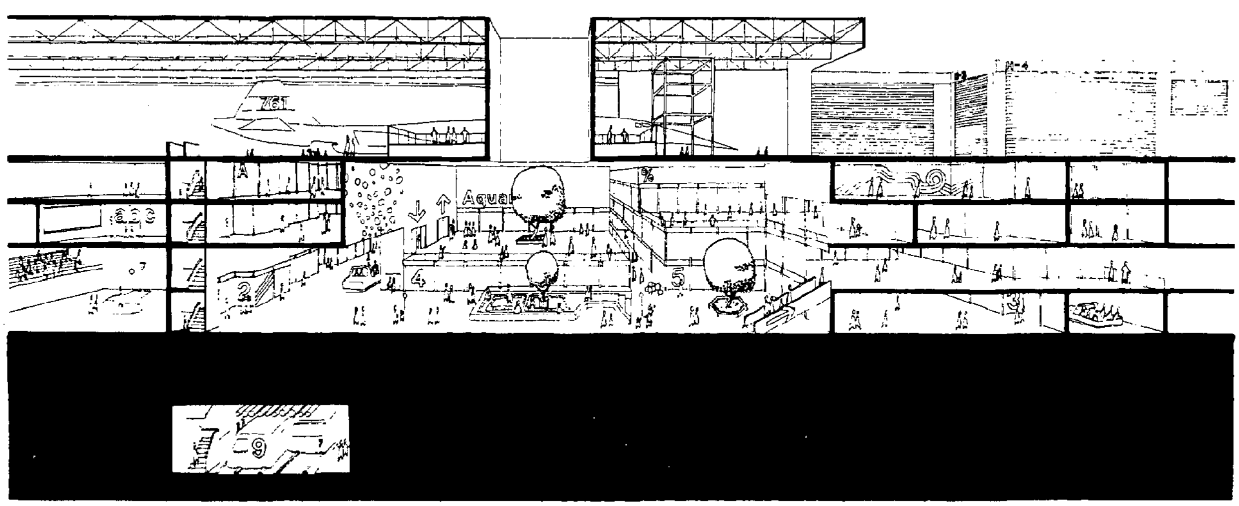
- Theaters
- Auditoriums
- Library
- Swimming Facilities
- Restaurants
- Night Clubs
- Pedestrian Shopping Areas

Housing

Total employment for the complete port/airport complex is estimated at 10,000 people. Using the average number of people per household times the number of jobs indicates a resident population of approximately 25,000 people.

Medical

As a result of the hazardous type work associated with port and industrial complexes, a complete emergency facility must be provided. Associated with the emergency facility should also be an out-patient facility to meet the general needs of the people living at the offshore complex. A minimal in-patient facility would be justified offshore with the majority of the in-patient load utilizing the facilities of an adjoining major metropolitan area.



Drawing: Mike Willingham

Section through aircraft terminal and support areas

Marina

Marina facilities provide a recreation opportunity for inhabitants of the island facility as well as pleasure sailors from the mainland. This facility will also serve as a refuge for crafts during periods of bad weather.

Functional items required for a marina include:
- protected waters
- navigation aids, buoys, markers
- basin flushing system
- anchorage area
- open and covered moorages
- marine service stations
- boat handling equipment, elevators, derrick lift, crane lift, dry docks
- administrative and supervisory facility
- restaurant facilities
- public toilet facilities
- boat sales
- boat building/repair
- dry boat storage
- miscellaneous

Industrial

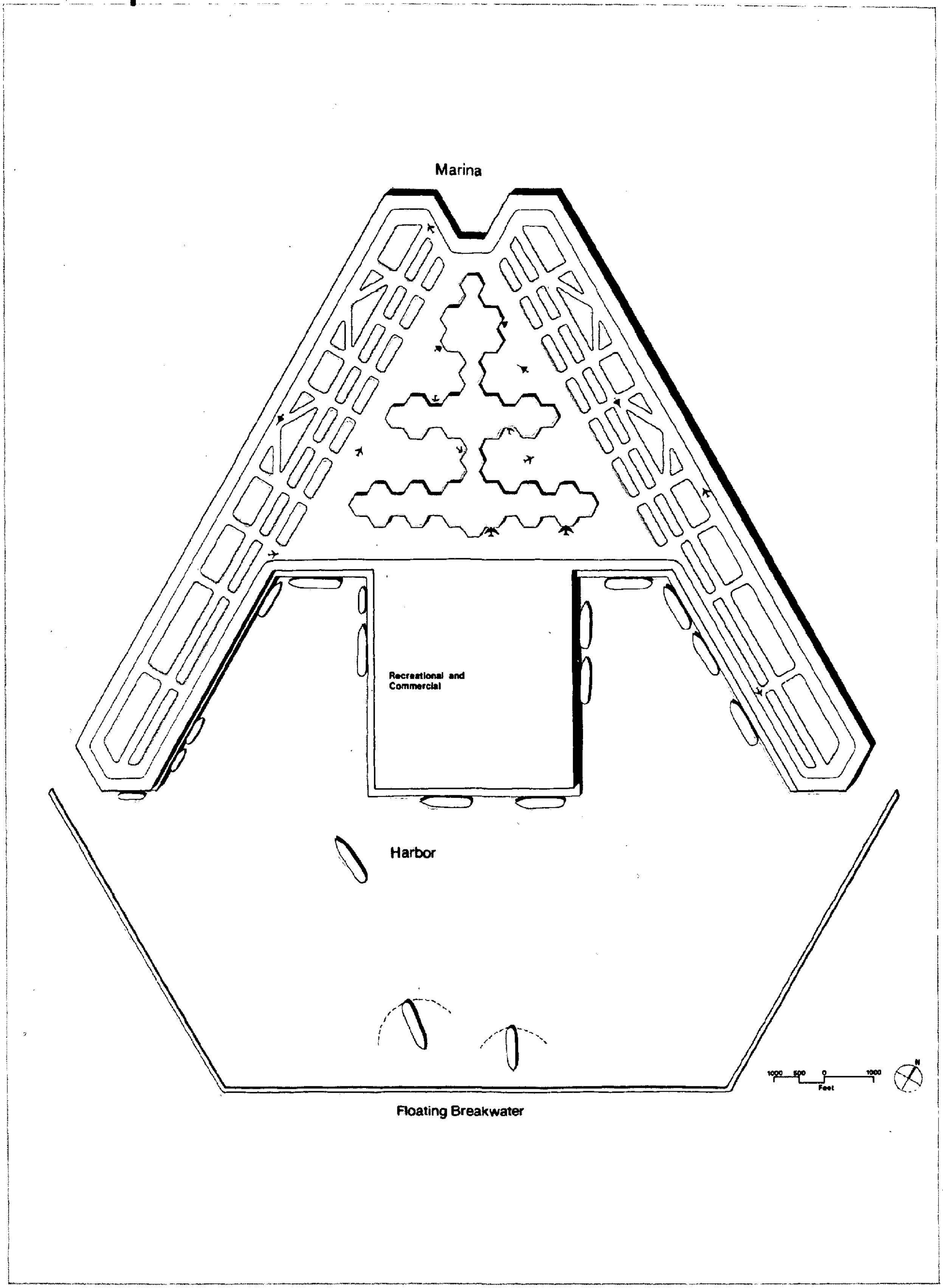
A wide variety of industries possess potential offshore applications. This list represents only a few:
- Manganese processing
- Engineering, research and survey
- Submersibles and related industries
- Underwater construction and dredging
- Salvage, diving and workboat
- Gypsum processing
- Watercraft manufacturing and service
- Marine instruments and devices
- Specialized equipment fabrication
- Winches, hoists and positioning equipment
- Communications, navigation and computing equipment
- Manipulators
- Acoustical equipment
- Distribution warehousing

Other Facilities

The island facility will have the capability of providing accommodations for:
- U.S. Coast Guard, responsible for the following:
  - search and rescue activities
  - safety and marine information
  - enforcing dangerous cargo and tanker regulations
  - inspecting and certifying vessels under
  - U.S. law and SOLAS requirements
  - investigating marine casualities in U.S. waters
  - licensing mates, engineers
- U.S. Army Corps of Engineers, responsible for the following:
  - administration of Federal law relating to the protection and preservation of navigable waters
  - regulation of construction in navigable waters
  - enforcement of assigned Federal law to
  - detect and prevent pollution of navigable waters
  - removal of floating debris

The National Weather Service provides information as follows:
- marine forecasts and warnings
- advisories and warnings of any hurricanes or
- tropical storms
- continuous broadcasts on marine radio stations

Plan-phase 5


Marina
Recreational and Commercial
Harbor
Floating Breakwater
Feet

Phase 5

The upper level of the artificial island is utilized for an intercontinental airport capable of servicing the aircraft of the future. The configuration of the island was established to meet runway criteria based on wind conditions. The connecting area between the runways is large enough to meet all airport facility requirements.

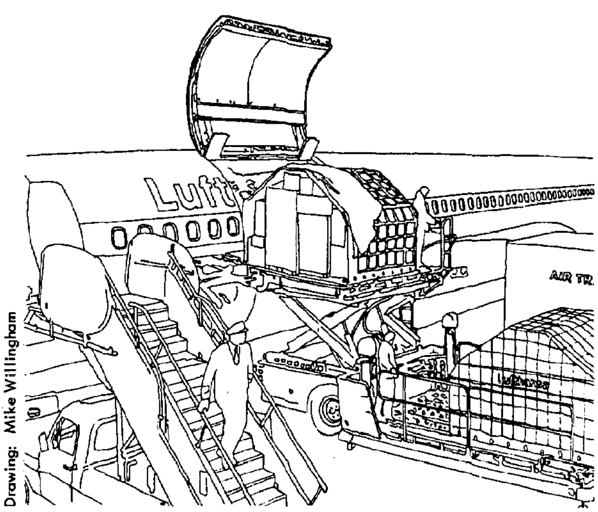
An offshore airport in conjunction with the port facility provides the opportunity for an intermodal terminal capable of surface, sub-surface and above surface distribution. Cargo can be distributed in the offshore terminal facility to meet the needs of air or surface transportation modes. Handling techniques and equipment can be standardized and used to meet the needs of all modes, thereby reducing the capitalization required to equip the same facilities if they were separated. Greater employment opportunities would exist for dock labor if they could double as a labor force for air cargo labor.

Air transportation of cargo is increasing with the development of aircraft capable of handling large volumes. Predictions have been made that by the year 2000, air cargo could absorb 25 percent to 35 percent of oceanborne general cargo.

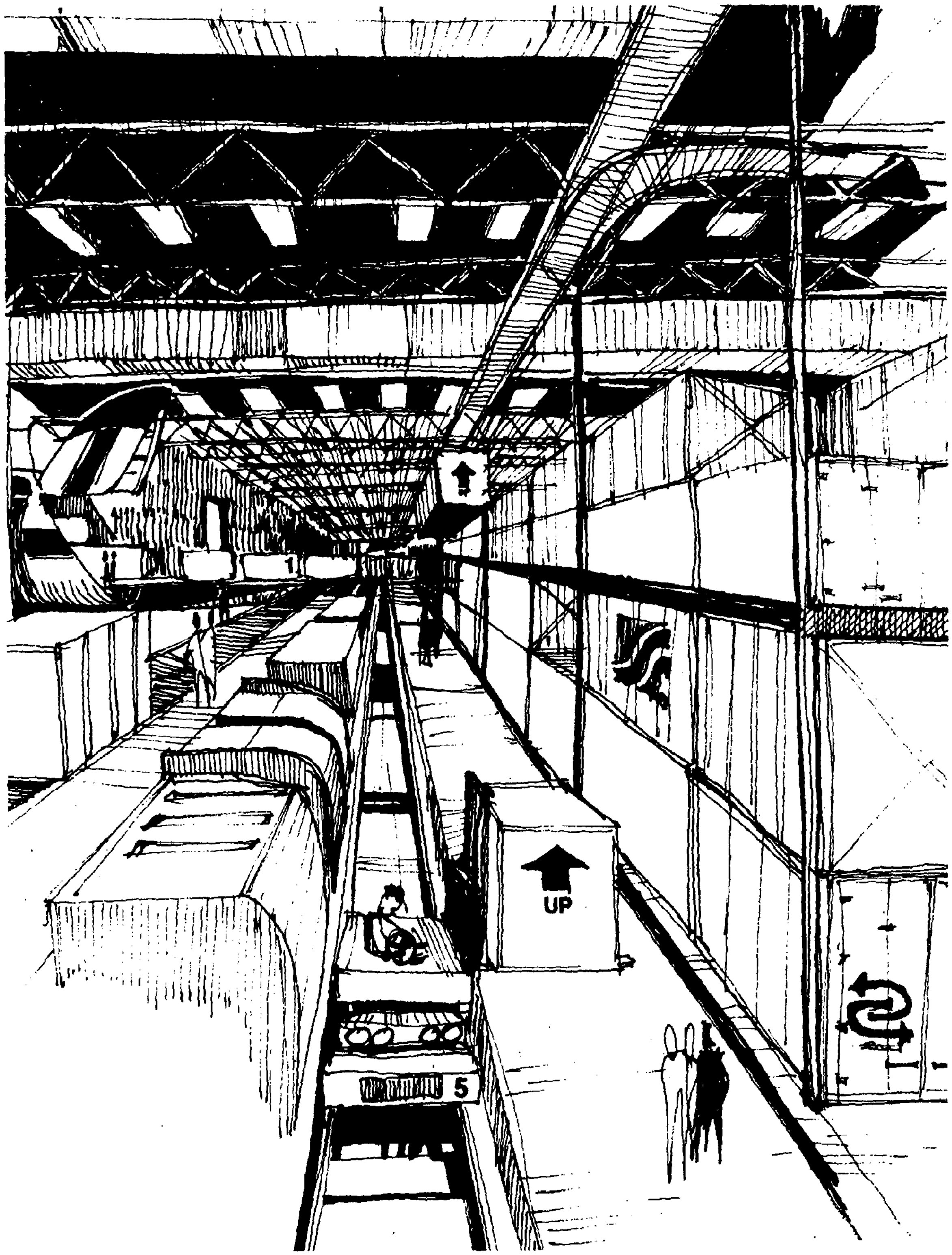
By utilizing VTOL and STOL aircraft in conjunction with rapid surface effect vehicles, such as hydrofoils and air cushion vehicles, overland distribution of air passengers from the island facility could be simplified with a net result being shorter travel time for passengers than presently exists.

Existing ports and airports would act as feeder terminals in the overall distribution network from the island terminal.

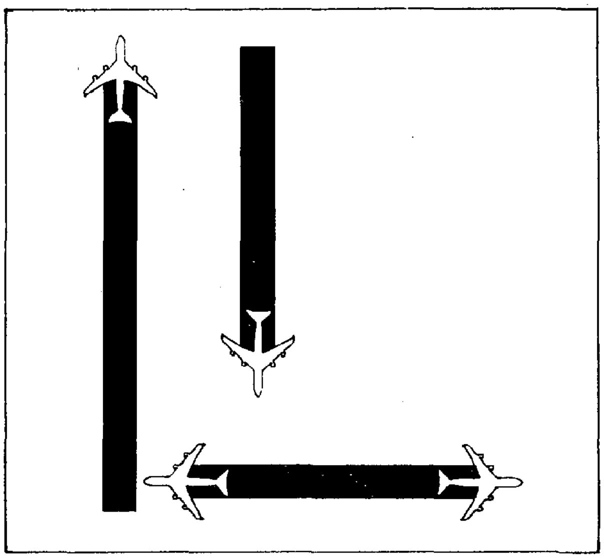
The offshore terminal will assist in reducing the problem of large supersonic aircraft by removing it from densely populated metropolitan areas. Damage resulting from air collision in densely populated areas will also be reduced.


Drawing: Mike Willingham

Existing aircraft container loading process

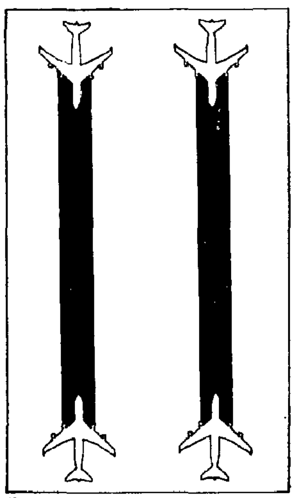


Section of lower level container marshalling area with facilities to direct load containers into aircraft



A

Source: Dallas/Fort Worth Regional Airport - 2001



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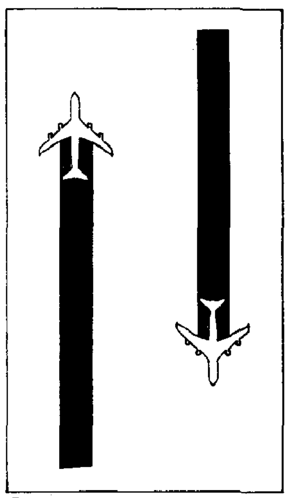
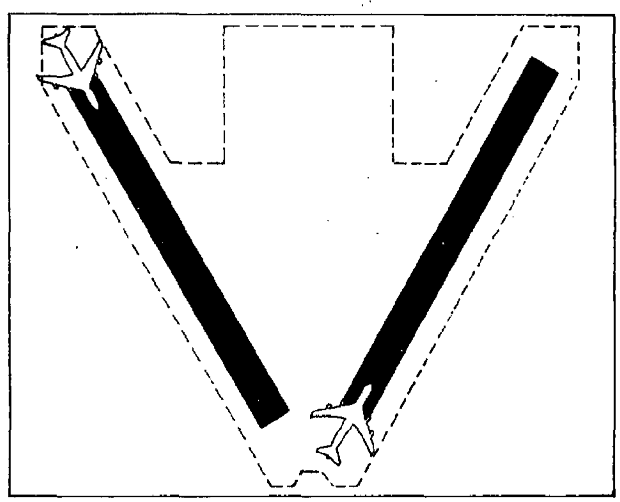
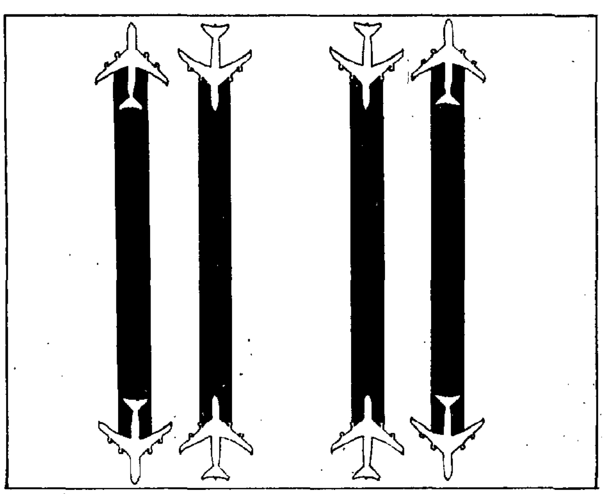


C



E



D

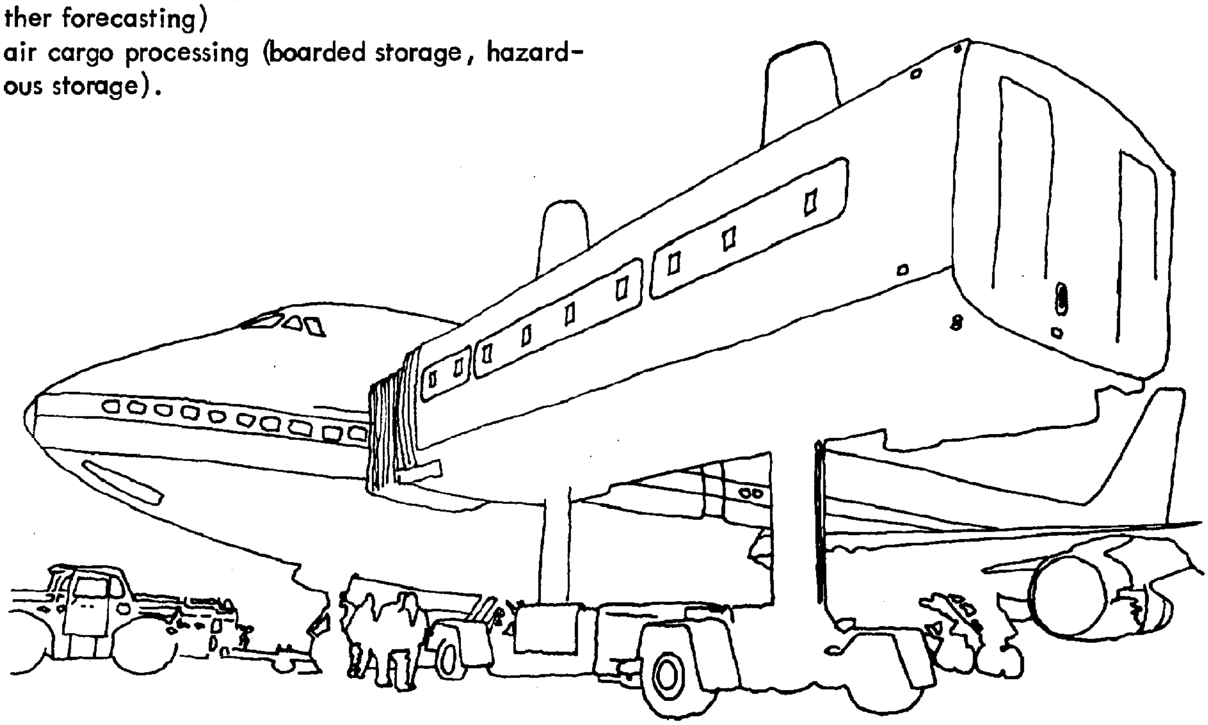
Design Considerations

Major factors in the design of an airport are prevailing weather conditions and flow of cargo through the area under consideration. Wind speed and direction have the greatest effect upon the layout and orientation of the facility. Runway layouts are designed to minimize crosswind effects.

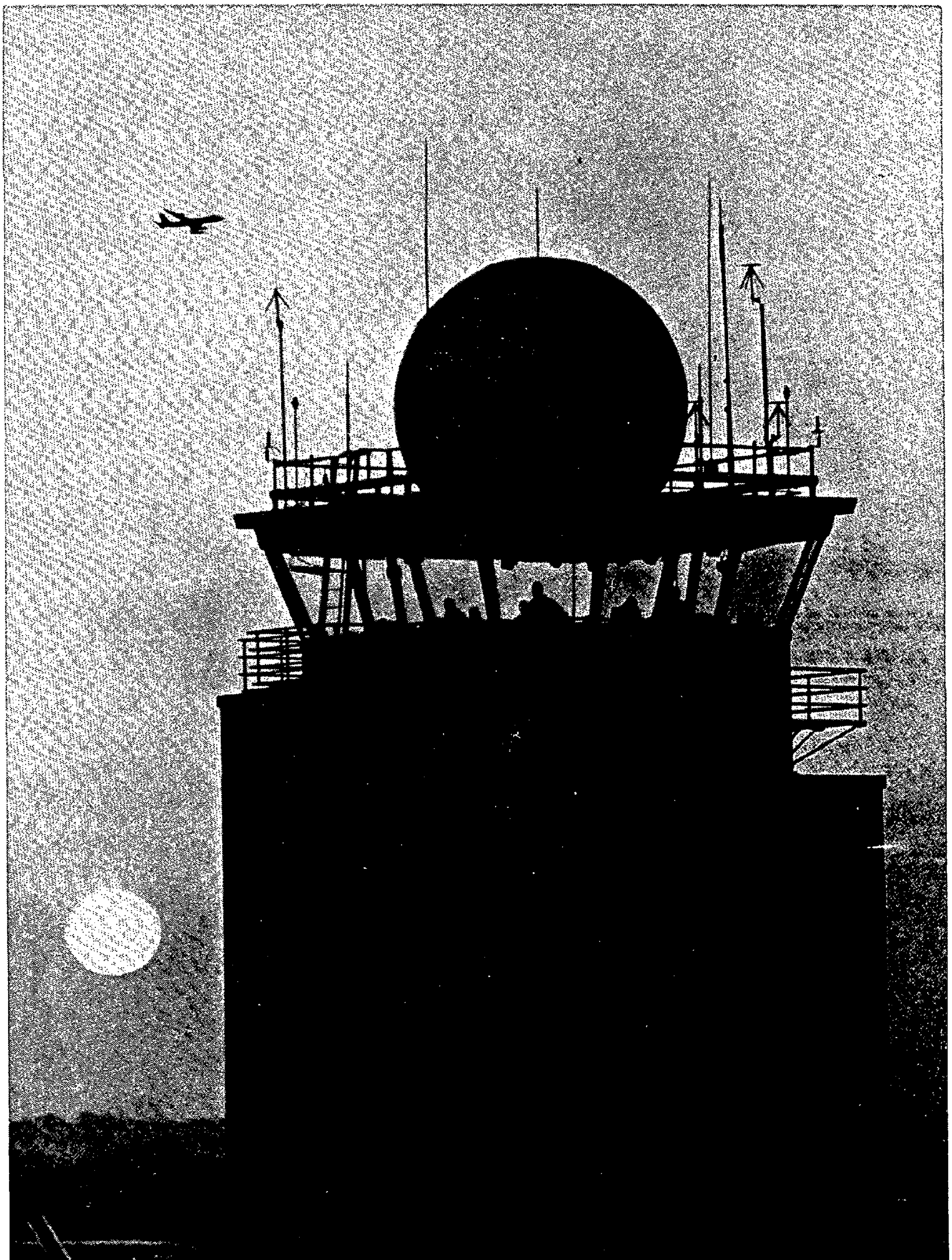
Of the five typical airport configurations pictured, configuration E was selected because it provides more flexibility for wind direction. It also provides the greatest possibilities for creating a protected harbor.

The physical facilities required would be the same as any major airport:

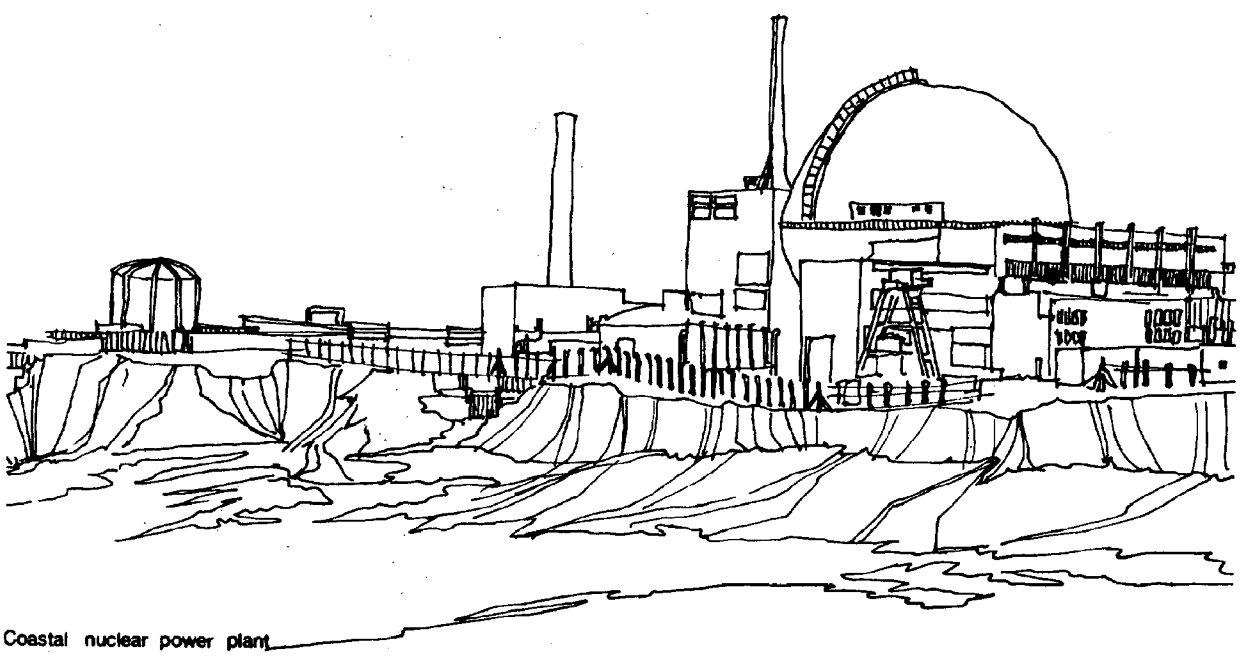
- custom inspection areas
- security offices
- baggage inspection areas
- flight and schedule information areas
- passenger enplaning/deplaning
- passenger waiting areas
- air passenger ground transportation
- baggage loading
- flight meal loading
- employee dining facilities
- vending services
- fire protection
- service vehicles
- air traffic control
- ground traffic control
- maintenance
- refuse collection
- petroleum, oil and lubricant facilities
- aircraft storage
- aircraft servicing (fueling, cleaning, food services, washing, etc.)
- air carrier operations (flight operations dispatch, ground crew, communications center)
- general aviation operations (flight filing, weather forecasting)
- air cargo processing (boarded storage, hazardous storage).



Drawing: Mike Willingham



6 Bibliography



Coastal nuclear power plant

Drawing: Russell Stogsdill

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