OCS Technical Memorandum 2

Service Bases for Offshore Oil

Maine State Planning Office
New England River Basins Commission
Alaska Consultants Inc.

Maine Coastal Program
Maine State Planning Office

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NEW ENGLAND RIVER BASINS COMMISSION
ALASKA CONSULTANTS, INC.

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INTRODUCTION

In January 1978, the U.S. Department of the Interior will sell leases allowing drilling for oil and gas in an area of the North Atlantic called Georges Bank, which is approximately 200 miles south east of Maine. The first onshore facilities established to support offshore drilling operations are Service Bases, which serve as the logistical link between onshore suppliers and offshore operations.

This report provides a detailed description of the modern Service Base, its characteristics, requirements, and potential impacts. It was developed from two other publications on the subject. The first is the Factbook, published by the New England River Basins Commission's RALI Program. The second was Marine Service Bases for Offshore Oil, prepared by Alaska Consultants, Inc., for the Alaska Department of Community and Regional Affairs. Material from these publications was extracted and edited, and additional material was written to form a report on Service Bases, and how they might affect New England and Maine.

It should be remembered that it is not at all certain where in Maine Service Bases would locate, or even if Services Bases will be located in Maine at all. The State Planning Office report, Maine and the Search for OCS Oil and Gas, discusses in more detail the factors which affect the siting of Service Bases and other onshore facilities associated with OCS.

In addition to this report on the general characteristics of Service Bases, several Maine towns have undertaken preliminary studies to determine the possible sites for a Service Base and to make a preliminary identification of potential impacts. The communities which prepared these reports, under grants from the State Planning Office are: Portland, South Portland, Bath, Rockland, and a joint report on potential sites in the towns of Belfast, Searsport, and Stockton Springs, which was prepared by the Eastern Maine Development District. Copies of these reports may be obtained from City and Town Manager's offices in these communities.

THE SERVICE BASE CONCEPT - I

Service bases have existed since the beginning of offshore oil activity. Initially, they could often be identified as the dock site from which supplies were loaded or unloaded. Frequently multiple landings were required of supply boats to take on other supplies, fuel, and water.

There are two types of service bases, both of which play important functions in the offshore oil industry.

Temporary service bases serve as the logistical links between onshore and offshore activities during the exploration phase of offshore oil and gas development. The siting of a temporary service base in a frontier area is the first decision involving onshore facilities associated with OCS development. The main activity of a service base is the transfer of materials and workers between shore and offshore operations. Supply and crew boats and helicopters operate from the base, which is active on a 24-hour, 7-day a week basis. Since service bases are primarily transfer points, their first priority is to ensure maximum efficiency in "vessel turnaround" time -- the amount of time needed for a boat to unload and reload before returning to the offshore site.

The permanent service base performs essentially the same functions as the temporary base. The principle differences are size, intensity of activity, and ownership.

During development drilling, the service base provides the same types of goods and services needed during exploratory drilling. However, the fact that as many as fifty wells can be drilled from one platform, combined with the fact that one company's success often stirs up increased exploratory activity by other lease-holding companies, and the fact that offshore operations continue for a long time, all causes the size and intensity of support services to increase drastically over those provided by a temporary base.

I. HISTORICAL EVOLUTION OF THE COMPREHENSIVE SERVICE BASE

Large scale offshore activities in areas such as the Gulf of Mexico resulted in the development of bases offering a more comprehensive service. These bases, which were usually operated by one of the major oil field chemical suppliers, offered a complete range of muds and cements as their primary commodities; however, they also provided docking space, space for offices, fuel, water, and lift equipment to load other supplies onto the supply boats. Actually, some of the bases in the Gulf of Mexico provide comprehensive services across their docks even though the supplies and the products of the services may be trucked many miles from storage yards or plants to the dock for direct loading of the supply boats. The storage of supplies on site for immediate retrieval or the presence of oil field shops (welding and heavy machine shops) for instant repair are costly operations which are not considered critical to efficient operations in this area.

However, once offshore activities began in deeper and rougher waters where weather is a critical factor in the cost and safety of operations, service bases with quick turn-around times became imperative. From these circumstances, and with increased offshore activity throughout the world, the comprehensive service and supply facility, or the modern service base, evolved.

At the full extent of its development, this one-stop shopping center for vessels supplying offshore rigs, construction barges, and platforms, can accomodate all stages of offshore activity. The most developed of these bases also offers a full range of engineering services, repairs to rigs and supply boats, and even the manufacture of items such as anchors and anchor chains.

In the North Sea, most of these comprehensive service bases are not run by the offshore operators, which are the oil companies or firms such as the chemical suppliers or drilling companies under contract to them. The service base is most often operated by a firm which has elected to specialize in the operation of service bases and to operate them as distinct profit centers. However, some bases are, in fact, run by offshore operators themselves, and others are operated by firms whose major business is obtained through contracting with the offshore operators in areas other than service base operations.

A brief summary of the historical evolution of this service function prepared for the Shetland County Council, Scotland, illustrates the trend toward independent, comprehensive service bases provided for joint-use. In the early days of North Sea exploration, the pioneering companies established their own bases, consisting usually of a jetty, marshalling yard on the quay (pier), and warehousing as near as possible to the quay. The Main supply requirements were tubular goods, bulk chemicals, bagged chemicals and cement, water and fuel. For loading the supply boats that serviced the rigs, 25-ton cranes with a working radius of 40 to 50 feet were needed, and sometimes a 50- or 100-ton crane. Finally, a heliport was required for moving personnel and, in a drilling emergency, small pieces of equipment, etc. In other aspects, generally speaking, the company depended on the local community -- for tool repair and welding shops, tele-communications, accommodations, secretarial personnel, medical facilities, etc. -- the services, in other words, that are implied by the requirement listed as "a center of population"...

It was usually only when the pioneers had established themselves to the above extent and in sufficient number that the supply and service companies moved in. Nowadays, on the other hand, there is a tendency for general supply bases to be established by a contractor, or group of contractors, offering space and a range of centralized services even before the selection by oil operators of a specified base. This is clearly to the advantage of the smaller companies who, under the other system, were likely to be delayed by the problem of setting up expensive support services for what might prove to be an area of dry holes; to a certain extent, it also meets a criticism implied by the spokesman of a major oil company as follows: "Having ourselves incurred the initial capital cost of land, buildings, and equipment to meet the early operations, it is difficult for any general supply house, thereafter, to be able to compete with the cost of an 'in-house' warehousing and procurement service". The same speaker added: "As the search in the North Sea turns north to the areas of the Orkneys and Shetlands, operating companies will be required to make careful assessments of the degree to which they will construct purpose-built exploration bases for their sole use, as opposed to forming a consortium or employing the services of a contractor offering a joint-user facility".

II. BASIC OPERATIONS OF INDEPENDENT COMPREHENSIVE SERVICE BASES

The comprehensive service base is premised upon providing dock space, along with sufficient indoor and outdoor storage contiguous to the dock, to allow all of the various suppliers to lease sufficient space to satisfy their needs in supplying the offshore oil operations. The service base firm then handles all of the materials from their arrival to their departure from the service base. Thus, there is a single contact for the ordering of supplies, and a single point of responsibility for the delivery of supplies on board the supply vessels.

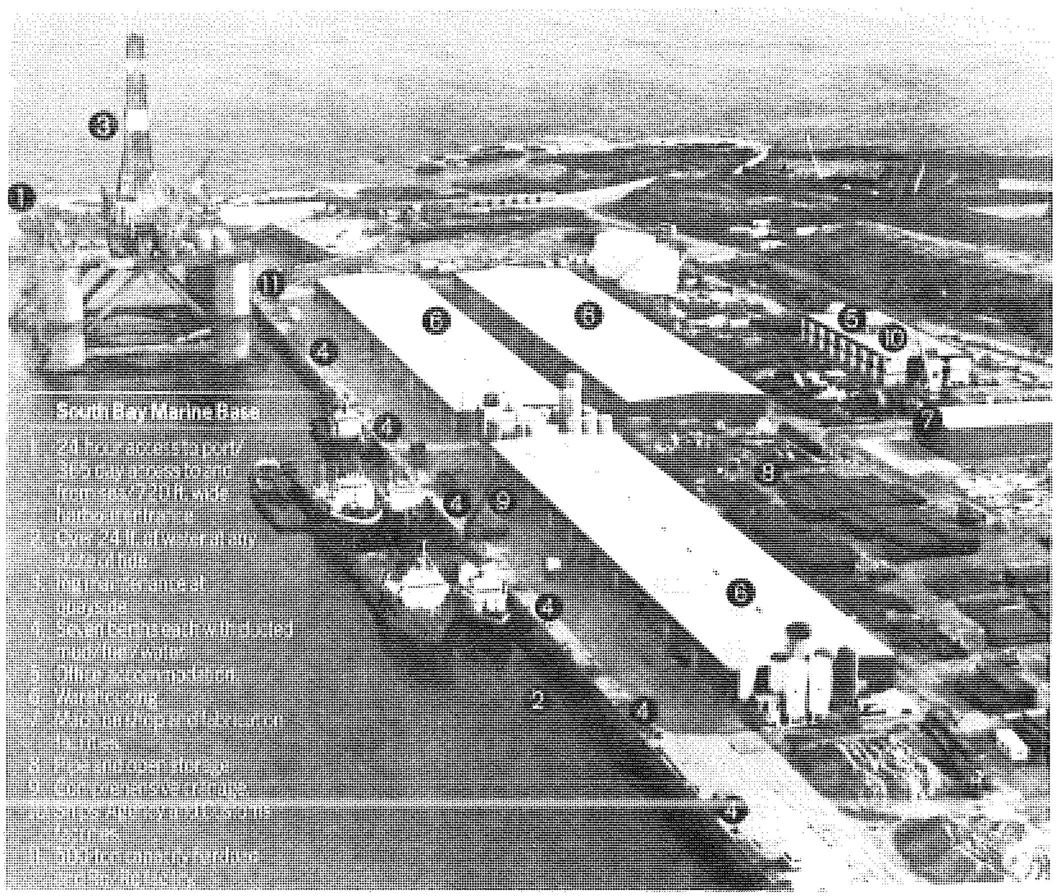


FIGURE 1.1

Layout of the Peterhead Service Base in Scotland

The service base is designed to receive incoming supplies from ocean-going barges or other cargo vessels, directly to dockside where they can be offloaded by crane. If sufficient quantities of material are to be handled by containers, a roll-on/roll-off facility is considered at the base. Thus, the service base is supplied directly by water carrier without having to truck heavy loads across community roads. A service base may also be supplied by rail, if a rail line is available. All incoming items are then checked and recorded. The bulk of the material, at least through the development state, will be tubular goods, i.e., casing, drill pipe, tubing, drill collars, and perhaps cement-coated pipe for sub-sea pipelines. These items are generally 40-feet-long and come in a variety of diameters, which must be stacked separately by the base operatives, primarily using cranes and forklifts, and must be readily accessible. This is not a random warehousing operation.

The API (American Petroleum Institute) regulations on the stacking of materials are followed closely as are their regulations for the conduct of other activities on the service base. Furthermore, each lot coming onto the service base must be programmed as to the time and sequence of use, so 13-inch casing may be stacked nearest the dock while 7 3/8-inch casing may be the farthest away, depending upon which is to be used first. Outside storage is also required for such items as large anchors and anchor chains, and other heavy or bulky items from the offshore operations.

Warehousing space is also a necessity for a variety of smaller items, or those which must be protected from the weather. Most of these items must be packaged and containerized for shipment offshore, or held in the warehouse as spares. In either case, they are stacked separately or placed in bins where they are readily accessible and conform to the sequential needs of the offshore operation.

Other major commodities, such as powdered drilling muds and drilling cement, are stored in silos near the dock, although some additives are stored in sacks in the warehouses. The mud and cement can be blown from ocean-going barges or other vessels at quayside directly into the silos at the rear of the quay apron, or metal bulk containers can be moved ashore and eventually emptied into the silos prior to the commodities being compressor-blown into bulk tanks on the supply boats.

Fuel is pumped directly from the ocean-going barges or coastal tankers into steel storage tanks on the base while water is most often obtained from a municipal water system, although tank storage may be maintained.

All of these materials are stored until they are required to fit into a development program, such as a group-loading program for a particular well where each requirement has been itemized, and the materials to satisfy this requirement are scheduled on board the supply vessels. Of course, there are also many requests outside the programmed requirements, such as special tools or equipment needed in specific situations which must be supplied by the service base.

The practice during normal operations is for the offshore operators to give the service base advance notice of the supplies to be put on board a particular supply boat. There should also be notice of what is to be offloaded. Once the order is received, the small items and provisions are checked, packed, and placed in containers which are moved from the warehouse to quayside. The larger items, such as the tubulars, will be checked, preslung often in bundles, and moved to quayside. Preslinging is a requirement dictated by weather and safety so that regardless of the weather conditions, valuable time is not lost in fitting slings on the decks of the supply boats, and the crew is not forced to clamber among cargo with a consequent risk of injury.

When the supply vessel arrives, it offloads garbage and other solid wastes in refuse containers, plus items scheduled for repair or modification at the workshops. At the same time, it is connected to fuel and water hydrant points for vessel requirements, and for transport in bulk tanks to the offshore facilities. The hydrant system also allows mud and cement to be air-blown into the vessel bulk tanks. While liquid and powdered materials are being loaded, the containers, tubulars, and other preslung items are loaded on board the supply vessel as deck cargo.

The loaded supply boats cast off and proceed to their offshore destinations. However, when weather conditions are favorable, they will remain at the berth or anchor in the harbor if the berth is required by another vessel.

SITING SERVICE BASES - 2

A shore base to support offshore oil or gas activity must be selected with care, so as to minimize the risk of causing delay to the high cost offshore operations. This caution is also exercised by state and local officials to reduce adverse impacts. But, the overriding concern is to have sound, potential sites available when they are needed by the oil industry.

Figure 2.1 gives an approximate picture of the steps which are taken in the siting, development, and operations of a service base. These steps are described from the time the necessity for a company to establish a service base becomes apparent. For most cases, this would be the establishment of a temporary service base. Permanent service bases, if they are not to be an expanded temporary base, would follow the same pattern. The process of expanding a temporary into a permanent base is described from the "Development" phase on in figure 2.1.

The central line represents the actions and decisions of the service base operator, whether that is a firm set up soley to operate service bases, an oil company, or a supplier of drilling material. The line of actions and decisions below are those of state and local governments, and private firms. The line above represents a feedback from decisions and operations.

This representation is designed to reflect the fact that the basic initiative belongs to the industry, but that there are numerous stages where input from local officials and businessmen is possible. The relationship between local officals and businessmen and the industry is depicted as being a reactive one, but in fact it should be an interactive relationship. Contacts should be made as early as possible and cooperative efforts undertaken from the beginning. Note that there are really only three stages at which there must be direct contact between the service base firm and local officials and businessmen (indicated by the solid arrows). The rest are "optional" in the sense that there can be as little or as much initiative on the part of local officials and businessmen as they choose to make.

The feedback from operations will of course force some changes in the operation and possibly the design of the service base, but for the most part these changes will be relatively minor, having little affect on the town. They may affect local suppliers to some extent, however. Once operations are underway, the only major changes in service base activity which would have major effects on the surrounding community would be the decision to expand to a permanent base, should a find be made, or to close down if no find is made or after a field is played out.

While the process is depicted as a sequence of steps, in actuality several steps do go on more or less simultaneously. Within the development stage, construction, staffing, and establishment of operating procedures will occur either at the same time, or at least in overlapping steps.

1. TANGIBLE REQUIREMENTS FOR LOCATION

The following requirements are desirable, if not essential, for an efficient service base:

Proximity to offshore oil or gas activity

A sheltered harbor of suitable size and draft with available capacity

An adequate waterfront site with contiguous back-up land

A good airport/heliport

Adequate roads

Proximity to an established community with a reasonable infrastructure

A. Proximity to Offshore Activity

A first requirement, of course, is being as close as possible to the area of offshore activity. Being close cuts down on the running time required of supply boats from the service base to the offshore installations. This is especially critical during the seasons of poor weather when the weather window may open for only short periods of time before closing again.

B. Sheltered Harbor

A adequate sheltered harbors in the general area of offshore leases or proposed areas of activity are the major factors in locating supply bases. The harbor must permit the loading and sheltering of supply vessels even though there may be high seas offshore.

AN OVERVIEW OF THE SERVICE BASE DEVELOPMENT PROCESS

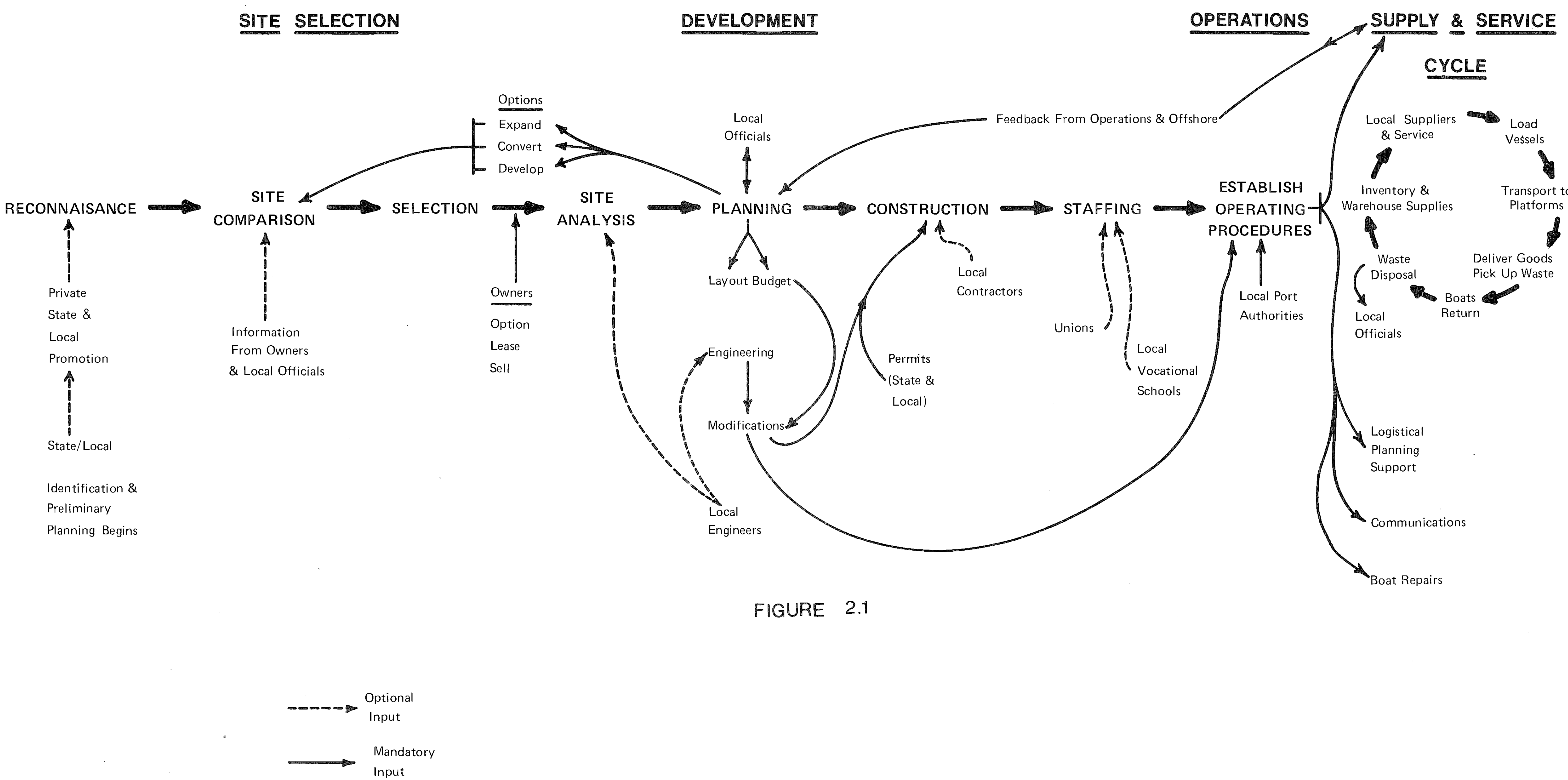


FIGURE 2.1

1. Size. At a minimum, the harbor should have the physical dimensions to allow the maneuvering, anchoring, and berthing of a large number of offshore supply boats, ocean-going barges, or other vessels supplying the base. Ideally, it should also have the dimensions to accomodate the anchoring and berthing of a large number of vessels, ranging from supply boats to large semi-submersible rigs and pipe-laying barges, which may be forced to call at port for emergency repairs, or for refuse from storms.

2. Draft. The harbor must be deep enough to quayside during all tides to take supply boats and ocean-going barges alongside to load or unload all the various items of cargo necessary to support an offshore operation. These supply boats must operate around the clock throughout the year, often in stormy seas. During the exploration and construction stages, they may also be called upon to haul anchors for rigs and pipe-laying barges, and tow rigs and platforms. As a result, they must be rugged, powerful, and seaworthy vessels. These are "class" vessels, not converted fishing boats or other bottoms. An example is a recently launched Tidewater Marine supply vessel. It has an overall length of 218 feet, with a breadth of 43 feet, a draft of 19 feet, and four diesel engines producing 10,340 hp. This vessel was designed as a supply boat, but with the added ability to tow rigs and to haul anchors.

   Industrial personnel estimated that 200-foot, 6-7,000 hp-class vessels with a crew of 10 to 12 men would be used for Georges Bank. Although it is helpful to know the dimensions of the average vessel, or the class of vessel to be used, it is desirable to plan service base facilities based on the upper-size ranges so as not to limit the number of vessels which can operate, including the special functions of the more powerful, deeper draft vessels.

3. Capacity. Harbor capacity is measured primarily as berthing space by the oil industry. It is essential to be able to load supply vessels in a relatively short period of time, and space must be available to carry out this function. Furthermore, after these vessels are loaded, they

are sometimes forced to wait for the weather to improve before going to sea. Ideally, all service vessels within the harbor should be able to moor at quayside. However, if sufficient berths are not available, the harbor must at least be of the size to enable the service vessels to moor two or three abreast at quayside or safely anchor in the harbor.

At times, large numbers of supply vessels may leave the harbor to face stormy seas if weather reports indicate that more favorable weather conditions should prevail by the time of their arrival at the offshore facilities. However, if the weather does not improve, the vessels may, in extreme circumstances, remain in the vicinity of the offshore facilities for hours, or even for days, for the opportunity to offload.

C. Waterfront Site. The siting of the supply base within the harbor is also important. Since service base operations are premised upon taking optimum advantage of suitable weather conditions, their measure of efficiency must be in terms of turn-around time, or the time required by a vessel to dock, to load all of the supplies requested, and to start back to the offshore operation. To do this, the vessels must be able to move to and from the service base with as little impediment as possible. It is, therefore, desirable that oil service bases be segregated from the plants and boats of the fishing industry and other users of the waterways to avoid delays caused by congestion with other vessels and conflicting use of waterfront facilities.

The location within the harbor also requires large quantities of flat land, or backup land, adjacent to the quay locations on the waterfront. At quayside, there are minimum requirements for staging areas, silos, warehouses, storage tanks, and open storage. If flat land is unavailable, it is, of course, possible to cut and fill during the construction of the service base facility. However, it must be kept in mind that an efficient service base must be flat due to the large quantities of tubular goods handled and stored.

D. Airport. It is desirable that a service base be near an airport, preferably one with scheduled service, and with facilities to handle cargo service. A helicopter operation may also be near by, or on the base. The principal function of an airport serving offshore oil operations is the transport of crews to and from the offshore facilities. However, the marine service base also requires the services of the airport to permit the rotation of the supply boat crews, to transport emergency supplies and service personnel via helicopter to offshore locations, to receive emergency supplies for trans-shipment by supply boats to offshore facilities, to transport sick or injured workers to major medical facilities, and to enable a range of administrative and technical personnel from both industry and government to have ready access to the service base. In addition, a portion of the perishable food supplies may be flown by scheduled air-carrier for trans-shipment from the service base to the offshore facilities. In all probability, crew transport and other related activities will be carried out by helicopter in the vicinity of Cape Cod because of shorter flying times to Georges Bank. However, a nearby airport will be needed to bring in management personnel and special supplies.

E. Roads. Road service to the base should be sufficient to allow for a moderate amount of truck service and automobile traffic. Since most construction equipment may be required in the construction of a base, the entrances will usually be of sufficient size for large equipment.

While it is not a requirement, proximity to main roads, especially interstates, may be a desirable feature.

F. Proximity to an Established Community. The presence of a community should serve to provide the service base with elements essential to its operation that would otherwise have to be brought in or constructed.

1. Labor Force. The most important of these is a labor force. The bulk of the labor required will be in the area of materials handling and transport, with requirements for jobs such as stevedores, laborers, warehousemen, truck drivers, forklift operators, and crane operators. Fortunately, many people in coastal communities may already possess the skills and experiences for many

of these jobs, with little or no additional training required. Other service base operatives with highly specialized skills will be brought into the base from elsewhere, but these should be few in number. On the other hand, a major influx of employment at the service bases may come from the office employment required by the offshore operators or specialized services.

2. Utilities and Other Infrastructural Elements. In most cases, the service bases will depend upon the local utility companies. Reasonably large quantities of water and electricity are required by the service bases. There is also the need to handle sewerage at the base, and solid waste from the base and offshore operations. In addition, excellent telephone systems with adequate capacity to insure good communications with offices outside the local area are essential.

Besides the utilities provided directly to the service base, the base will depend upon the community, to varying degrees, for medical and dental services, public safety needs, and other requirements. Of course, the base employees recruited from outside the community, whether on a temporary basis or as permanent residents, will place demands upon the full range of community infrastructural elements, including recreation facilities, schools, museums, and libraries, to name a few.

3. Local Purchase of Supplies. Beyond the labor and infrastructural elements, service bases depend upon the local commercial sectors for the purchase of minor supplies that they do not carry; some of an emergency nature. Depending upon the availability of services not found on the bases, these may also be purchased locally.

In addition to the direct effects of the service bases and other oil-related activities on the communities through increases in employment and income, it is assumed that there will be substantial indirect effects through the operation of the multiplier process. Therefore, both the public and private sectors in affected communities will be called upon to satisfy demands beyond those directly requested by the service bases and other oil-related activities.

II. INTANGIBLE FACTORS

Experience in Scotland has indicated that, despite disadvantages in location, some communities have attracted service base activity through a willingness to satisfy industry demands in a timely manner. The Peterhead Refuge Harbor, with two large comprehensive service bases, is an example:

> While physical factors of site and location relative to concession areas have obviously been important in establishing this pattern of growth, the readiness of communities to respond to the challenges offered has also been a considerable influence. Where there have been local disagreements about the desirability of developments, delays and changes in the eventual location pattern of the industry have resulted.

When possible, an oil company will prefer to have a complete base, or its equivalent area for its own use because of the extreme importance which such firms attach to having a degree of independence in the control of loading and turn-around of ships serving the rigs which operate for them is evidenced by the way they are prepared to spend money in getting control of even small units of waterfront land.

Therefore, possession of the physical factors of site and location provides no absolute guarantee that the share of offshore activity, which in geographical terms would logically accrue to an area, will be realized. Also, the fact that an established service base with ample capacity is available to all firms engaged in offshore activities does not guarantee that some firms will not seek a site for their sole use.

As with all capital-intensive extractive enterprises, time is a critical factor. Large initial capital investments must be recovered. Recovery begins with the production of the resource. Therefore, other factors ranging from the environment to the political climate which threaten the programmed recovery, or the time element, must be evaluated before locational decisions are made. If there is concern, the location pattern of the industry will reflect this fear.

Another intangible factor that is very significant is the supply of manpower and their willingness to cooperate with employers. The labor force must be flexible in order to accomodate the requirements set by the oil industry. Work policies, such as 7-days on, 7-days off and an employee capable of performing tasks of various job descriptions, are an essential ingredient expected by the service base operator. 'Down time', the amount of time when normal offshore operations cease, can cost as much as $50,000 a day. Strikes or manpower shortages which hamper the usual supply cycle, must be resolved to insure maximum efficiency. Considerations for the competition of local labor, especially between the fishing and oil industries, have also been studied. Based upon available reports, it is believed that this will not be a serious impact. The reasoning for this is discussed in a later chapter.

SERVICE BASE FACILITIES - 3

A physical plant containing diverse facilities is required to assure the prompt supplying of offshore activities with necessary materials and services. On the independent bases, the base operator acts as a landlord who rents a range of facilities, principally to firms supplying the offshore oil field operations, and secondarily to the offshore operating companies. In addition, the base operator charges for services like the movement of materials, while some base operators also sell supplies such as foul-weather and safety clothing.

The facilities required by the oil operating companies and their oil field suppliers are as follows:

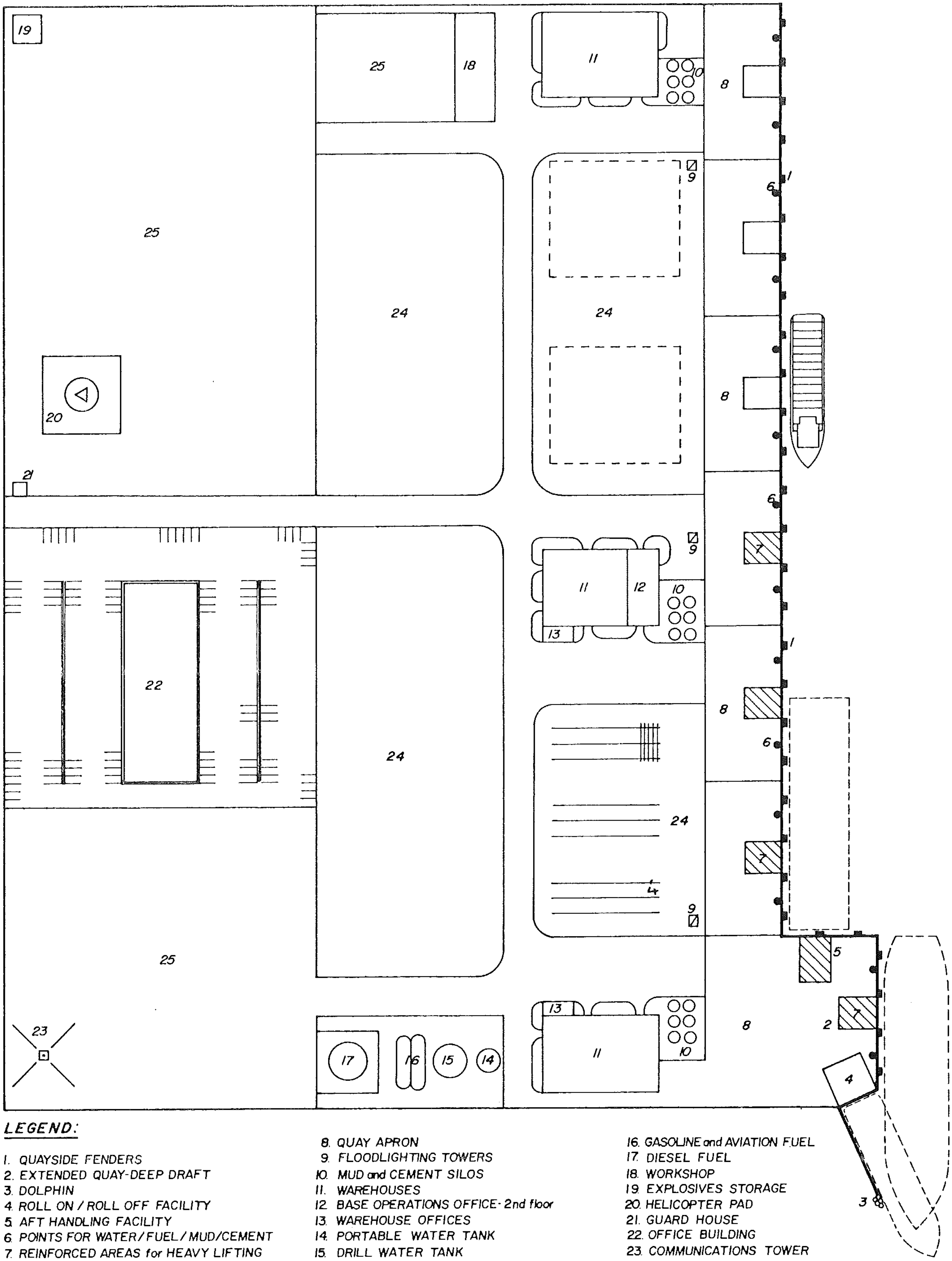
BASIC FACILITIES AND SERVICES

- Berths
- Staging Areas
- Floodlighting
- Warehousing
- Open Storage
- Fueling Facilities
- Water (potable and drilling)
- Mud and Cement Supplying Facilities
- Mobile Equipment
- Agency Facilities (ship-chartering, freight-forwarding, customs, etc.)
- Office Accommodations
- Communications
- Refuse Removal Facilities

SUPPLEMENTARY FACILITIES AND SERVICES

- Engineering Facilities
- Food Procurement and Cold Storage Facilities
- Service Base Store
- Other Facilities
    - facilities for arrangement of laundry services
    - secretarial facilities
    - conference rooms
    - car rental facilities
    - security service facilities
    - explosives storage
    - heliport

MARINE SERVICE BASE PROTOTYPE



Alaska Consultants, Inc.

Figure 3.1

1. BASIC FACILITIES

The following basic facilities are provided at almost all service bases, and they are claimed to be essential to an efficient service base.

A. Berths

Berths in a protected harbor are obviously essential to a service base supplying offshore facilities. Because most materials will be barged to the service base, quay space must be available to berth ocean-going barges periodically supplying the base. This function can easily be performed at the berths required for the normal supply boat operations, although it would be preferable to avoid conflicts for quay space with the supply boats. These supply boat berths require a minimum 20-foot water depth at mean low tide to accomodate a typical North Sea type supply vessel. Since 200 linear feet are required at quayside for each supply boat, and a minimum of two quay spaces is generally required even on the smallest bases, 400 linear feet at dockside is generally required for berthing one ocean-going barge or two supply boats at a given time. However, in temporary service bases, it is possible to get by on one berth plus space to moor or anchor another vessel.

Using the North Sea as an example, the important bases all have the capacity to accommodate several vessels at quayside for loading or unloading at the same time. For example, the Dundee Petrosea base can handle three supply vessels and a roll-on/roll-off ship at once. The Peterhead base has seven berths available as does the Aberdeen Service Company in the same prot, although the latter is forced to use double-berthing which enables it to accommodate up to 14 service vessels at one time. In Aberdeen the new Seaforth Maritime base has three berths, while the Norscot base near Lerwick has berths for nine supply vessels.

In order to minimize turn-around time, many of the bases have ducts, constructed under the quay apron to each quay space so that mud, cement, water, and fuel can be taken on board directly from the storage tanks for these products on the base.

B. Staging Areas

The principal staging area on the service base is the apron, which extends from the supply boat berths at quayside back to the mud and cement silos and warehouses. This staging area must be totally reinforced or have reinforced areas, especially along the quay, capable of bearing the heavy loads lifted by mobile cranes. Ducts under or through the quay apron, which contain the lines to transport the fuel, water, mud, and cement, may be provided. An extensive quay apron enables the boatloads of tubular goods, containers, and other items to be assembled prior to being lifted and swung aboard the vessels by the cranes.

The quay apron must be broad enough to allow the movement of various types of mobile materials--handling and other equipment along the quay, as well as allowing the materials to be assembled. Consequently, the new custom-built service bases have large quay aprons width over 100 feet not being uncommon. However, the width of the aprons are generally limited by the distance which powdered materials can be blown by normal-sized compressors from the silos through the ducts in the quay apron and onto the supply vessels. The expansive quay aprons are, generally, the most prominent feature of the custom-built supply base.

C. Floodlighting

Since service bases are required to provide service 24 hours per day, seven days per week throughout the year, lighting of the base is essential. The entire base is required to be well-lighted. However, the quay and quay apron areas require excellent light to enable crews to work at night effectively and safely. Often, this lighting is provided from floodlighting towers approximately[1] 100 feet high, containing six or more 1,000 watt bulbs.

D. Warehousing

Inside storage is essential to the operations of a service base. A large number of smaller items are stored in bins or lockers. These items are generally assembled inside the warehouse and placed in containers for shipment to offshore operations. In addition, tools, powdered commodities such as mud and cement additives, and other material requiring protection from the elements are stored in warehouses. If possible, the warehouses are directly behind the quay apron, where the containers or loose material can be moved directly to quayside for loading.

E. Open Storage

Flat land with a good soils base for supporting heavy loads of casing, pipe, and other materials is required by the service base. These materials, although programmed in sequence of use, must all be accessible. Therefore, approximately 40 percent of open storage areas is usually devoted to providing access for mobile equipment to select or store materials.

F. Fueling Facilities

In case of custom-built service bases, fuel is provided at fueling points at each quay space. Most bases have their own fuel storage tanks, although some receive fuel that is piped directly from distributors located nearby.

If fuel storage tanks are located on the base, they are usually located in a remote area of the base with a dike constructed around the tanks as a safety provision.

Some bases also have fuel storage for helicopters. This aviation fuel is put in small bulk containers for transport to the rigs for helicopter refueling. Bases with helicopter landing areas also provide for helicopter refueling at the base.

B. Water

Water must be carried to rigs, both for crew usage and to mix with mud and cement, and a great deal of water is required. For example, the drilling of a 14,000-foot exploration well will require approximately 3,750 tons of drill water despite recycling of water on the rig. Although large quantities of water are required, most bases in the North Sea, for example, receive water from the municipal water utility, and it is all potable. As with fuel and bulk powdered materials, water is available to the supply boats at points on the quay. For example, 70 tons of water per hour can be taken aboard a supply vessel from the water points at the Norscot base.

H. Mud and Cement Supply Facilities

Bulk drilling mud and cement in powdered form are stored in silos which are usually owned by the companies supplying the materials. These steel silos are placed on reinforced concrete pads and are located as close to the quay as possible, generally directly behind the quay apron which is used as a staging area. Since there are practical limitations on the distance these powdered commodities can be blown on board the vessels, most bases have more than one group of silos along the quay apron. As previously stated, there are points at quayside for taking mud and cement on board vessels. Examples of the quantities which are maintained are the Seaforth Marine base with a 2,000-ton capacity, and the Norscot base with 5,000 tons in two identical groups of silos.

I. Mobile Equipment

A range of mobile equipment is required to carry out the expeditious loading of supply vessels required for quick turn-around times. The backbone of this operation are cranes and fork lifts. On the custom built bases, the cranes are either the crawler or rubber-tired types, which, when not in use loading or unloading at quayside, are used to stack or retrieve materials in the open storage areas. The requirements of most bases dictate the use of cranes with a range of lifting capacities. For example, the large Aberdeen Service Co. base at Peterhead, Scotland, has ten cranes ranging from 15 tons to 125 tons, while the smaller Hudson's base has three cranes, one of 40 tons and two of 30 tons.

The lifting capacities of the various cranes on a base is predicated upon the materials to be lifted which, in large part, are based upon the stage, or stages, of offshore activity. However, often the returns to the service base company from large but infrequent lifts do not warrant the purchase of extremely large cranes. Frequently large barge cranes will be contracted to perform the extremely large (and infrequent) lifts as required.

Of course, trucks are an essential part of service base equipment, although service bases in remote settings such as the Norscot base on the Shetland Islands require few trucks. Besides materials-handling on the base, these vehicles are commonly used to pick up commodities from local suppliers, and occasionally to pick up emergency supplies flown in to the local airport.

J. Agency Facilities

The basic facilities requirement for ship-brokering, freight-forwarding, customs, and other agencies which might operate from the service base is office space and communications. These functions include arranging for tugs, storing materials associated with these ship operations, and carrying out customs functions and other agency tasks.

K. Office Accommodation

There are generally three different requirements for the location of office space on service bases. However, the smaller bases generally function with only a formal office building or makeshift offices in the warehouses.

1. Quayside Office Space. Office space is required at the quay preferably as a second story to a warehouse overlooking the quay. From this office, the scheduling and movement of vessels at the base, the staging of the cargo and the loading and unloading of vessels would be supervised. This operations area would include the operations manager, the agents for the vessels, the foreman charged with vessel loading and unloading, and those performing stevedore functions, among others.

2. Warehouse Office Space. Office space attached to warehouses is required by firms leasing space to conduct their activities within the warehouses. These offices should be attached to, rather than within, the warehouses for reasons of safety. Although this warehousing may be custom-built for the use of a client, a minimum amount of space should be required. The minimum required at the Norscot base is 1,500 square feet, although the intensive use of this office

space probably should have dictated a minimum requirement of 3,000 square feet.

3. General Office Space. Client office space for the oil companies, their contractors and their suppliers should be removed from the quay, since there is usually too much noise along the quay. In addition, this type of office accommodation usually requires a reasonable amount of parking space. The valuable land near the quay would be more productive in other uses.

L. Communications

A good communications system is essential to the operation of a service base. This system should include telephone, telex, and radio communications. These systems are available at all service bases.

Normally, the independent service bases provide a communications tower suitable for the attachment of its clients' own aerials for the purpose of maintaining radio communications with the offshore facilities and the supply boats. Orders for supplies to be taken on board supply boats, and material to be off-loaded as refuse or fro repair, are radioed to the supply base in advance of a boat's arrival so that cargo may be assembled for loading and provisions may be made for unloading.

Telephone and telex are used for ordering supplies and for numerous other business activities which involve the service base. The Norscot base began with 10 exchange lines and 40 extensions. The following year, Norscot was forced to expand the system to 20 exchange lines and 100 extensions. Even a single telex proved not to be adequate so a second was added for reception only. (U.S. telephone usage is much higher than that of the United Kingdom, and so these figures are probably low).

In addition to these systems, new service bases should anticipate the installation of computer terminal facilities to monitor offshore activities for inventory center, and possibly to provide an instantaneous reporting to the district offices of the operating companies.

M. Refuse Removal

The service base operators are required to provide a means of refuse disposal for trash from the offshore facilities and boats, as well as the trash resulting from the operations of the service base. This refuse removal is most often carried out through contracts with local refuse-hauling firms that provide containers for this function.

II. SUPPLEMENTARY FACILITIES

Facilities are also required to perform supplementary services required by the offshore oil activity, but these are not necessarily located on all service bases.

A. Engineering Facilities

Engineering facilities or workshops are not present at all supply bases. Although they are not an essential function of an individual service base, this function is required by the offshore oil industry. Services such as fabrication, machining, welding, and others, are either provided at larger service bases or within communities adjacent to the bases. If the facility is located on a supply base, it is generally located behind the warehousing area away from the quay, since large quantities of materials are not transported to and from the workshops. In addition to a wide range of engineering services, some bases provide shipboard repair and maintenance services. Two Norwegian bases also provide these services for exploration rigs.

The repair of vessels or rigs at a service base necessitates the consideration of design features not necessarily required at the base. Consideration should be given to providing a recessed quay or dock at one end of the main quay for the maintenance and repair of supply boats when hauling or dry docking is not required.

This recessed quay would remove the vessel from the supply operations on the main quay, as well as providing more protected waters.

When rigs are serviced, an extended quay to deeper water may be required and it is necessary to have bollards of a suitable size firmly implanted in the quay so that these large vessels can be held tightly to the quay during bad weather. Otherwise, the rigs simply lay at anchor in the harbor during repairs. Since large, sophisticated engineering facilities and services are required for rig repairs, all but the simplest of these repairs will probably not be carried out in most ports. The major repairs will be done by large shipyards, such as Bath Iron Works.

B. Food Procurement and Cold Storage Facilities

Some service bases buy the foodstuffs required for offshore activities. The dried or canned goods can be stored in typical base warehouses; however, fresh or frozen commodities require a cold storage facility. These provisions are assembled when ordered, placed in containers and taken by the supply boats to the offshore facilities. The location of this storage facility should be convenient to the quay because of the constant flow of supplies to the boats.

Normally, however, catering firms located in the larger communities provide this service with containers ready for shipment offshore being delivered to the base on a regular schedule. Some service bases are expected to receive this type of catering service. Therefore, possibly only a cold room would be required for interim storage.

C. Service Base Store

Some service bases operate a store for the supply of foul-weather clothing, safety clothing, toiletries, and other items required by the people employed offshore. The Norscot base, for example, stocks approximately 500 items.

The location of the base store need not be close to the quay since it does not involve large tonnage. However, this facility should be convenient to areas of containerization.

D. Other Facilities

Other facilities such as those for laundry services, secretarial facilities, conference rooms, and car rental facilities, are functions that can be carried out in the offices and stores previously mentioned.

Security facilities have become a major part of service bases as losses from theft have increased. The increases in offshore drilling operations around the world have meant very short supply on a variety of drilling equipment, which has in turn lead to thefts of equipment from stockyards, service bases, and warehouses. In one instance in Texas, an entire drilling rig was stolen. This has meant that service bases are now usually surrounded with fences and may have a security force guarding the base.

The storage of explosives is a function which requires extreme care in location, as well as, handling. Explosives should be stored in a suitable structure in a remote, fenced area of the base.

If the base is located at some distance from the local airport and near a medical facility which has no heliport, there may be a reason for consstructing a pad for helicopters at the base. An ill or injured person can then be transported from offshore to the base where he can be met by an ambulance.

There are other facilities ranging from diving services to the manufacture of items for the offshore oil industry. Of course, the services and supplies offshore are great in number, but not all are provided directly at the marine service base, although most of the material will pass over the service base dock.

Supplementary facilities may not be available at all bases. Smaller bases, such as those supplying pipelaying operations, are especially not likely to contain these facilities and services. But they may be located at any base.

Service Base Facilities Chart

Type	Dimensions/requirements
Basic Facilities:	(Essential)
Berths	200' per boat (400' minimum)
Staging Areas	heavily reinforced docks
Floodlighting	100' Towers w/six 1,000 watt
Warehousing	Sturdy Buildings
Open Storage	Flat slopes
Fueling Facilities	26,000 bbls.
Water - Fresh	4,750,000 gal*
- Potable	460,000 gal*
Mud	19,363 cu. ft*
Cement	12,852 cu. ft*
Mobile Equipment	50 Ton traveling crane
Agency Facilities	included in office space
Office Accomodations	house trailers (temporary base)
Communications	telephone, telex, and radio
Refuse Removal	6 tons per day
Supplementary Facilities:	(Desirable)
Engineering	relevant to size of base
Food Storage	minimum is a cold room
Store	convenient location on base
Security	Gatehouse at entrance
Explosives	Remote corner of base
Medical	Infirmary w/access to hospital
Other	handled by Office Personnel

* based on one rig drilling four 15,000' wells in one year

Table 3.1

LAND REQUIREMENTS - 4

From observations of competitive service bases operating in the Scottish sector of the North Sea and from information provided by the service base operators and the communities in which they are located, generalized land use requirements for service bases and their employment have been developed. It is important, however, to emphasize that these quantities are generalizations. The differences in location, site, operating procedures, and the phase, or phases, of offshore activity being serviced directly affect the kinds of facilities located at the base, the workforce required to run the base, the quantities of land needed, and the community infra-structural demands.

1. LAND REQUIREMENTS

Land on a service base can be divided into two broad categories -- that required to be adjacent or close to quayside, and the back-up land uses which, while not absolutely required to be in the quay area, ideally should be a part of the same contiguous service base site.

A. General Base Requirements

Land requirements for service bases can be estimated from the demand for berths. This demand, based upon vessel movements in response to offshore activities, assuming that the normal turn-around time for vessels is eight hours. Therefore, the theoretical maximum berth capacity of a 24-hour day, 30-day per month schedule would be 90 vessels turned around per month. Of course, there are factors which serve to reduce this maximum capacity significantly. Among these are the following:

(1) Supply boats will arrive and depart at uncertain times; berths must be capable of handling something approaching peak traffic to avoid delays and waiting vessels.

(2) Most operators will insist on preferential rights to a single quay space to provide for company emergencies, flexibility, etc.

(3) Weather conditions on Georges Bank will often be the deciding factor as to when supply boat flotillas launch and return to base.

(4) Ships or ocean-going barges supplying the base will, on most bases, occupy two or more berths for long periods of time while unloading.

The experience of operators in the North Sea indicates that 30 vessels per month per berth is a more realistic figure. This figure, therefore, represents the capacity of a 200-foot berth. The addition of another trip per berth per month beyond 30 would create the demand for an added berth. Thus, the following range of initial and incremental land use quantities per berth can be applied to the supply boat berth requirements to elicit the total amounts of land required at a marine service base to support a variety of offshore activities.

Although the operating companies hope that a service base will support all operations running concurrently from exploration through production for several fields, this is often not the case. Servicing of the phases leading to production may not be that distinct. The service base may support exploration rigs, pipe-laying activities, platform installation, and production platforms in several different fields, all at the same time. However, it is assumed that the sequence of offshore activity and service base activity will generally run concurrently. Thus the major activities associated with exploration drilling, pipe-laying, platform installation, development drilling, and production will proceed generally in that order.

1. Exploration Phase -- Initial and Incremental Area Requirements. Assuming a single, relatively flat, usable waterfront site and a well-planned service base, it is estimated that a minimum of 3.5 acres of land would initially be required with the construction of 1 berth to support a single exploration rig. At the other extreme, a maximum of 7.5 acres would be required. A reasonable figure for planning purposes is estimated to be 5 acres to support the first rig.

TABLE 4-1

INITIAL AND INCREMENTAL AREA REQUIREMENTS FOR SERVICE BASES

(acres per berth)

Land Uses	Initial Requirement with Construction of One Berth: Servicing One Rig		Servicing Two Rigs		Full Capacity Servicing 2.50 Rigs		Incremental Requirements Per Berth at Full Capacity	
	Low	High	Low	High	Low	High	Low	High
RECURRING REQUIREMENTS								
Quay apron and silos*	.50	1.00	.50	1.00	.50	1.00	.50	1.00
Warehousing	.25	.50	.50	.75	.50	.75	.50	.75
Open Storage	2.00	2.50	4.00	5.00	5.00	6.25	5.00	6.25
Offices	.25	.50	.25	.50	.25	.50	.25	.50
NON-RECURRING REQUIREMENTS								
Workshops	-0-	.50	-0-	.50	-0-	.50		
Tank storage	.50	.50	.50	.50	.50	.50		
Other (including helicopter pad, radio mast, etc.)	-0-	2.00	-0-	2.00	-0-	2.00		
TOTAL LAND USE REQUIREMENT PER BERTH	3.50	7.50	5.75	10.25	6.75	11.50	6.25	8.50

* Silos not required during the non-drilling construction phase.

SOURCE: Alaska Consultants, Inc.

TABLE 4-2

LAND USE, SPACE PER OFFSHORE RIG, AND SPACE BER BERTH,

SELECTED SERVICE BASE SERVICING EXPLORATION PHASE,

SCOTTISH SECTOR, NORTH SEA

	AREA (acreage)	SPACE PER RIG (ac.)	SPACE PER BERTH (ac.)	SPACE PER BERTH ASSUMING TWO BERTHS (ac.)
RECURRING REQUIREMENTS				
Quay apron and silos	1.50	.38	.50	.50*
Warehousing	1.25	.31	.42	.62
Open storage	11.50	2.87	3.83	5.75
Offices	.50	.12	.17	.25
NON-RECURRING REQUIREMENTS				
Workshops	.00	.00	.00	.00
Tank storage	.25	.06	.08	.12
Other	.00	.00	.00	.00
TOTAL	15.00	3.75	5.00	7.25

* Assuming the apron behind the third berth is unused.

If the initial installation were to support 2 rigs from a single berth, the land requirements are estimated to range between 5.75 and 10.25 acres with 8 acres appearing to be a reasonable figure for planning purposes. However, if the service base were essentially designed as an advance exploration base, or forward base, to accommodate 1 or 2 rigs in total, a minimum site of 10 acres would appear to be preferred by the operators.

The addition of a third rig, even in an extremely efficient operation, would require the addition of a second berth since it is assumed that only 2.5 rigs can be serviced from 1 berth. It is estimated that the servicing of,3 rigs from 2 berths would require roughly 9 to 14 acres. However, because of the many uncertainties involved in the initial exploration of an offshore petroleum province, it is anticipated that exploration by even 2 rigs would be preceded by the construction of 2 berths. The servicing of 2 rigs from 2 berths would effectively utilize 8 to 10 acres of land area.

The increments of land added with each additional berth are estimated to range between 6.25 and 8.50 acres. The first figure is the total of minimum recurring requirements to service 2.5 rigs (or the maximum needed to service 2 rigs), while the second figure represents the maximum recurring requirements to service 2.5 rigs.

Table 4-3 provides a picture of what might happen in New England for capital investment, land use, and the number of service bases established. This estimate is described under the high, medium, and no find scenarious and only suggests what Georges Bank development will be.

TABLE 4-3 - SCENARIO COMPARISON

	Number			Land Use (in acres)			Capital Investment (in million)		
Scenario	High	Medium	No	High	Medium	No	High	Medium	No
Service Bases									
Temporary	4-5	4-5	4-5	75	75	75	$ 0.7	$ 0.7	$ 0.7
Permanent	10-20	6-12	0	500	300	0	24.0	15.0	0

B. The Quay Area

The quay area generally consists of the quay apron, silos, storage tanks, warehousing, and transportation corridors permitting access to the quays. It is possible for open storage to be in a remote location and the offices for operations to be temporarily located in trailers away from the quay, but the other uses listed above must be located contiguous to the quay.

1. The Quay Apron, Silos, and Transportation Corridors. A distinction of the custom-built service base is a substantial quay apron for the assembly of cargo and access along the quay. It is estimated that .5 acres per quay space is a minimum area for the quay apron plus adjacent mud and cement silos and access to the quay.

2. Tank Storage. Storage tanks for fuel and water are generally required on the service base. The quantities of fuel stored vary considerably, depending not only upon the quantities demanded offshore, but also upon the frequency of delivery to the service base. Figures showing fuel storage capacities of selected bases in the Scottish sector of the North Sea exhibits these differences. Although the average approaches 700 tons of fuel storage per berth, individual bases range from 250 tons to 1,333 tons per berth. However, in all of these cases, the fuel storage shown was the initial capacity installed.

In terms of water supply, all custom-bult North Sea service bases are supplied potable water from a municipal water system, principally for uses other than drilling, since sea water is used for most North Sea drilling. In most cases, the supply is sufficient and dependable enough to avoid storing large quantities in tanks. An exception to this is the Norscot Base at Lerwick which stores 700 tons of water in a single tank to assure an adequate supply for offshore uses, and for fire-fighting on the base.

There are conditions which could require the separate tank storage of potable and drill water at the base, and also tank storage of aviation fuel for helicopter refueling at the base or for refilling small bulk containers to be transported to the offshore facilities for helicopter refueling.

Regardless of the initial tank capacity installed, it appears prudent to set aside at least .25 to .50 acres of land for tank storage.

3. Warehousing. The quantity of warehousing used in support of offshore oil activities at selected custom-built service bases in the Scottish sector of the North Sea can be seen in Figure 4.1.

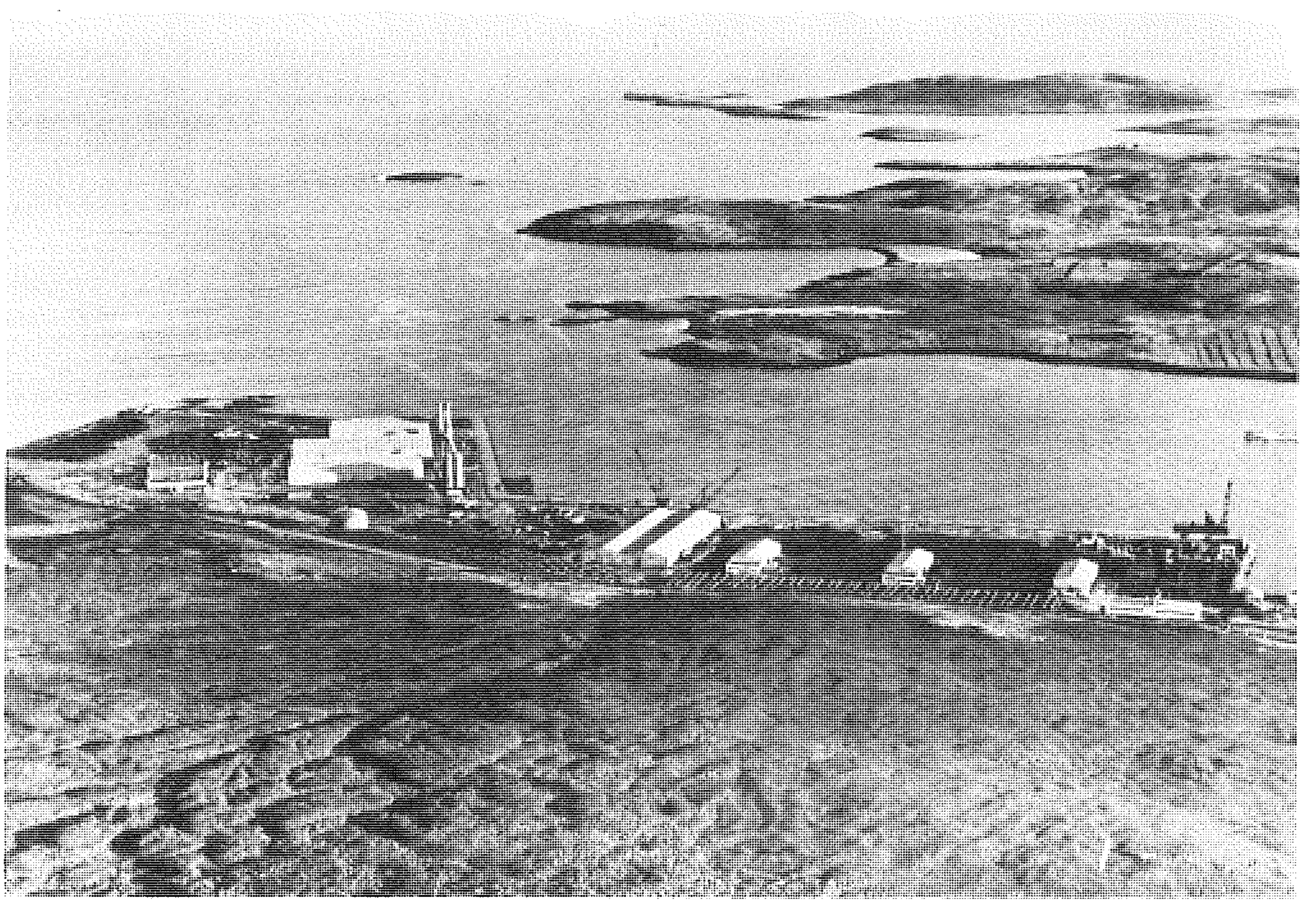


FIGURE 4.1

The Norscot Service Base during January 1976, Large quantities of 36-inch cement-coated steel pipe are being stored in the open for the summer pipe-laying season.

This represents an average overall demand for a little more than 17,000 square feet ber berth; the Norscot base has an additional 55,000 square feet planned and ready for construction which would raise this average close to 19,000 square feet per berth. Existing warehousing is generally claimed to be heavily utilized and additional warehousing space is expected to be added within the next few years. In fact, the lack of warehousing space is often cited as a problem by base operators. Interior space is not only required to store items, but flow space is also needed to retrieve, assemble, and containerize these items.

On Georges Bank, the addition of severe winters with heavy snowfall and icing conditions may necessitate the effective and efficient use of even greater areas of warehouse space (designed as should all structures in this area, with consideration given to snow loading). Perhaps the most pertinent examples would be the Dundee Petrosea base, since it is engaged exclusively in exploration activities, and the more remote Norscot base which is engaged in all phases with the exception of production activities. The Dundee Petrosea base has 17,000 square feet of warehousing space per berth while the Norscot base will have approximately 22,000 square feet per berth if its planned warehousing construction is included.

Taking into consideration the above factors, it appears reasonable to anticipate a minimum of 20,000 square feet of warehouse space per berth utilizing approximately .5 acres of land to be required for operations.

C. Back-Up Lands

Aside from lands accommodating uses required to be at quayside, there are also back-up lands. Preferably, these should be contiguous to the quay area. Although it is possible to operate open storage yards, offices, communications equipment, and workshops at other locations, it causes a certain amount of inefficiency in the operations of the base. Furthermore, the nearby community often suffers from inappropriate land usage and from noise and hazards associated with trucking heavy materials through developed areas.

1. Open Storage. The largest amount of open storage is required for tubular goods although there are often requirements to store a variety of additional items such as anchor chain, buoys, wire, and other items. The amount of open storage space required varies. The minimum tubular storage at any base serving an exploration rig would be two strings of casing, or enough to supply two wells of appropriate depth. If this casing were to line holes approximately 12,000 feet deep, it could be stored on as little as 16,000 square feet of land. However, additional reserves of three strings plus replacements for the drilling equipment and special drilling tools must be assumed, and this would result in a minimum requirement of one acre for each rig. When the storage of anchors and anchor chain, spare offshore equipment such as riser systems, metal bulk containers for resupply the silos with mud and cement, and other miscellaneous open storage is considered, another acre of open storage can easily be required.

2. Offices. A service base has its own operations office but it also normally provides office space for the oil service companies and the oil operating companies, either as an integral part of the warehousing or in a separate office building.

The office space in separate buildings provided at custom-built service bases serving the Scottish sector of the North Sea, including the preleased space of 6,000 square feet at the Dundee Petrosea base and 5,000 square feet now under construction at the Norscot base, is illustrated in figure 1.1.

The average office space requirement in this area is presently 4,000 square feet per berth. However, it should be pointed out that Scotland is part of a nation (United Kingdom) which is in the process of exploring and developing its first major domestic oil and gas. No major exploration and development offices existed in this area prior to the North Sea effort. A portion of the Scottish service base office space issued for administrative functions which do not have to take place at the service bases, although most of these functions do take place in a central community such as Aberdeen. In fact, BP established its United Kingdom headquarters for exploration and production in a large office block at Tyce, the site of Aberdeen's airport.

Much of the demand for office space depends upon the operations of the various oil suppliers and the operating companies, as well as the service base operators. Nevertheless, it may be advisable to plan for a minimum of 1,000 square feet per berth of office space on service bases. When parking requirements and access to the offices are considered, it is estimated that a minimum of .25 acres of space will be required per berth.

3. Other Land Uses. The service bases generally provide a radio mast suitable for the attachment of its clients' own aerials. The height of the mast required determines the amount of land to be set aside for the tower. A mast of 100 feet would require almost 1 acre while a tower of 200 feet would require almost 4 acres. Of course, the tower might be suitably located off the base on high ground which would serve to reduce the height of the mast, as well as eliminating the land use requirement on the base.

If a helicopter pad is required at the service base for occasional helicopter use, it will require a minimum of .5 acres of land. Despite the fact that the helicopter pad needs to be somewhat less than 65 feet by 65 feet (for a Sikorsky S61, for example), the slope of the approach/departure paths necessitates the commitment of this greater land area in a suitable location on the base.

If a base does not have ready access to workshop facilities (welding heavy machine shops), it will have to provide its own. It is assumed that during the exploration phase the items to be repaired, modified, or fabricated would be shipped to workshops in other locations. However, with the advent of large-scale exploration activities or development drilling, workshop facilities either on the base or within the community would undoubtedly be required.

In the Scottish sector of the North Sea, most of the custom-built service bases are located in or near communities with workshop capacity. These workshops are used rather than duplicating facilities on the service base. Two exceptions are the Norscot and Hudsons bases located on the remote Shetland Islands. The Hudsons base has no workshop; however, the large Norscot base has 5,800 square feet for this use.

Unlike some other land uses, the space requirement of a workshop do not conveniently submit to ratios based on berths or rigs. Since tubular stock of 40 feet or longer, anchors (which can effectively occupy over 1,000 cubic feet), or other large items fabricated from steel, are common items processed in the workshops, the initial workshop constructed on a service base would appear to require a minimum of approximately 5,000 square feet. Considering parking and staging areas, this facility would occupy no more than .25 acres.

Other possible uses include explosives storage (which requires a small, secured concrete bunker within a fenced area, appropriately located in a remote corner of the service base), transformer stations (which would also require small, fenced areas), ar possibly even electric generation plants (which would require relatively small, secured structures). These potential uses, along with others possibly required in response to offshore demands, require that sufficient land reserves be held by service bases.

A factor to be considered is the heavy precipitation in the form of rain and snow that this region normally receives. The heavy snowfall will require areas be set aside to store plowed snow, especially in the open storage areas distant from the quay. Also, the snowmelt and heavy rainfall may necessitate a drainage system that requires additional acreage. It is further assumed that during portions of the year, the quay apron and access roads would require sanding due to icy conditions. Areas for the stockpiling of sand would be required on the base under these conditions. It is estimated that the total additional acreage used because of the above factors associated with climate will be .25 to .5 acres per berth.

LABOR REQUIREMENTS - 5

In the wide range of industiral endeavors, the service base appears to offer employment opportunities closely related to the labor skills presently existing in the coastal communities. Aside from the engineering workshops with some specialized skills, such as oil field lathe operators and pipe welders, most of the task to be performed at service bases have been performed by large numbers of the Maine labor force.

A. Structure of Employment

Although there are a variety of employment structures on service bases devised by the firms operating the bases, employment is basically divided into three groups. There are materials and transport, purchasing, and administration. On the more sophisticated bases, a fourth group is added which is workshops.

An example of this structure of employment in the remote but well-utilized Norscot service base, presently employed in the exploration, construction, and development stages, is as follows:

Management	
General Management	5
Office Administration (Including stores)	9
Materials and Transport	5
Purchasing	2
Workshops	3
Labor Below the Rank of Foreman	
Materials and Transport	34
Purchasing	2
Workshops	21
	81

On some bases, there are distinct sections for electronics, ship-brokering, customs, and marketing. Nevertheless, the basic function of the base remains in materials handling and transportation.

The positions in the principal sector of base employment, materials and transport, are concerned with stevedoring, warehousing, and the operation of equipment, such as trucks, forklifts, and cranes.

Because the base operates 24 hours per day, 7 days per week, employees, or base operatives as they are commonly called in the North Sea, must be able to perform a number of jobs.

SHORESIDE CREW--TYPICAL

	Number	On Duty
Manager	1	1
Bookkeeper	1	1
Warehouseman	1	1
Crane/Forklift Operator	2	1
Truck Driver	2	1
Longshoreman	3	2
Roustabout	3	2
Radio Operator	2	1
Mud and Cement Service	2	1
Fuel Service	2	1
Rental Tool Service	2	1
	21	12

TABLE. 5.1

NOTE: Four to six company administrative and technical people will likely have permanent responsibilities for the offshore work, but they will perform most of their duties either on the drilling vessel, or in a home office.

Therefore, a Base Operative 1, for example, may essentially be a laborer. When he gains experience and learns to drive a pickup truck, he becomes a Base Operative 2, and performs both functions. A Base Operative 3 may perform as a laborer, pickup truck driver, and the driver of a forklift. Thus, as this labor force becomes more experienced, they are able to perform a number of jobs, so should a critical task or emergency occur, the base employees would be better able to respond. This is especially important during the evening shift since the division of the work force is generally two-thirds during the twelve-hour daylight shift, and one-third during the evening shift. Skeleton crews are maintained on the weekends, with a substantial portion of the work force being on call to respond to service requirements should they occur.

B. Seasonality

Since operations offshore may be reduced during the winter months (depending upon weather conditions), there may be some seasonality in service base employment. The extent of this seasonality will, in large part, depend upon the state of development, or the activities being supported.

Rigs during the exploration stage may be able to operate at a reasonably constant level of performance in all but the worst of the winter months. Fixed platforms will continue to drill production wells with little reduction in performance throughout the year. On the other hand, construction activities will probably be confined to the summer season when the best weather conditions occur.

Therefore, if the base is servicing exploration rigs, there will be moderate seasonality. The servicing of construction activities such as pipe-laying and platform installation will result in extreme seasonality with almost all pipe-laying and platform installation activities taking place during the summer season. Otherwise, during the development and production phases there should be little seasonality.

To compensate for seasonality in base employment, a number of bases in the North Sea operate with a relatively small permanent labor force during the winter months from October to March, supplementing this permanent labor force with temporary workers, such as students, during the summer.

However, one of the most efficient bases compensates for seasonality by working its permanent workforce overtime during the summer. In fact, there have been instances where employees have worked over 100 hours per week. Besides increased wages resulting from overtime, the base has guaranteed employees year-around full-time employment with liberal leave during the winter months. It is the philosophy at this service base that in terms of efficiency and community relations, it is more acceptable to guarantee stable year-round employment than to lay employees off in the fall and attempt to rehire them in the spring. In this particular case, their employment practices are popular with the local community and its governmental representatives in respect to their growth policies, since they result in reduced employment with less seasonality. However, this stability of employment within a service base often depends upon factors beyond the control of the base operating company, such as the absence or presence of unions, the organization of the unions, and the willingness of the labor force to work the prescribed hours.

C. General Service Base Requirements

Estimating service base employment becomes precarious because of the many variables attendant to the internal layout and operations of service bases, as well as the exogenous factors. Internal factors such as the availability of land, the service base design, the degree of skill and availability of a labor force, the structure of employment, the methods of operation of the service base operators, and the influence of unions, play a role in determining the total employment of individual bases. On the other hand, external factors such as the frequency of base resupply, special demands of offshore operators, the weather as it effects offshore operations, and the phases of offshore activity serviced play a similar role.

A review of selected service bases in the Scottish sector of the North Sea indicates an average employment of approximately 26 persons per berth. However, approximately 55 percent of this employment is not part of the base operations of the service base companies, but in the main offices. Although this other employment is essential to the offshore activities, it is not critical

EMPLOYMENT AND EMPLOYMENT PER BERTH,

SELECTED SERVICE BASES, SCOTTISH SECTOR, NORTH SEA

BASE	BERTHS (NUMBER)	TOTAL BASE EMPLOYMENT	PER BERTH	BASE OPERATIONS	PER BERTH	OTHER	PER BERTH
Dundee Petrosea (Dundee)	3	90	30	30	10	60	20
BP (Dundee)	3	100	33	60*	20	40	13
Norscot (Lerwick)	9	181	20	81	9	100	11
BOC (Peterhead)	7	150	21	90**	13	60	9
Aberdeen Service Co. (Peterhead)	7	220	31	72**	10	148	15
	29	741	26	333	11	408	14

* Estimate of base operatives and other employees in larger purchasing function for Scottish Sector.

** Trimble, N., The Pattern of Support Activity for North Sea Oil and Gas Exploitation, an unpublished report, 1975.

TABLE 5.2

to the operation of a service base. On the other hand, the remaining 45 percent, or an average of 11 persons per berth, are employed by the firms operating the bases to carry out the basic service base functions. It should also be noted that this basic employment ranges from a low of 9 persons per berth on a new, well-planned service base to a high of 20 persons per berth on an over-crowded make-shift base.

Llewellyn-Davies (who were consultants to the Shetland County Council) estimated 15 to 20 jobs per berth based upon the full range of experience on the Scottish mainland for estimating service base employment impact in the remote Shetland Islands. Based upon total employment at the Norscot base (181), their high estimate was accurate (20 x 9 = 180). On the other hand, G. A. Mackay of the University of Aberdeen more precisely defined service base employment as jobs in the basic service base functions, as follows:

> Briefly, most of the Shetland bases will be used as 'forward' bases, the main function of which will be storage and trans-shipment and in which there will be very little repair and engineering work of the type common on the Scottish mainland. An exception will be the Norscot base under construction in Lerwick which is intended to include a small engineering facility; but generally this will happen only on a small scale in Shetland. Consequently, the appropriate ratio to use will be much lower, probably in the range 6-8 jobs per berth...

If the workshop employment at the Norscot base is subtracted from the operator's total employment, the 6-8 jobs per berth range (81 - 24 = 57 ÷ 9 = 6.3 jobs per berth) applies at the Norscot base.

Obviously, economies of scale will be realized in this example with the addition of units offshore since it is obvious that the positions of manager, bookkeeper, radio operator, and perhaps others, need not be duplicated with the addition of each unit. However, if 4 non-recurring positions are deducted and only 2 rigs are assumed per berth, 11 employees would be required to be added per berth.

NERBC estimates are similar to those described by the Scottish economists. However, the group includes an adjustment ratio in Table 5.4 which should be considered. The following number of onshore employees per unit of offshore activity were used in calculating onshore impacts:

5 per exploratory rig:
9 per platform drilling:
3 per platform producing:
1 per 5 wells worked over.

Employment on boats and helicopters is assumed to be:

11 per supply boat:
6 per crew boat:
3 per helicopter.

The average annual salary of service base employees is assumed to be $17,000.

During the early stages of exploration, a large share of the service base employment is made up of experienced oil industry workers who are relocated from other areas. As time goes on, however, the resident labor force will become increasingly knowledgeable in oil industry operations and capture a larger share of the available jobs. Table 5.3 depicts the assumed percentage of total service base employment made up of members of the resident labor force over time.

PERCENT OF TOTAL SERVICE BASE EMPLOYMENT
FILLED BY RESIDENT WORKERS

Year After First Lease Sale	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th	18th..31st
Percent Resident Workers	50	51	53	56	60	63	66	68	70	72	74	75	76	77	78	79	80 ..80

Source: NERBC, 1976

Table 5.3

Resident employment will reach 80 percent 18 years after the initial lease sale and remains roughly at that level throughout the life of the service base.

Certain factors, such as supply boats, helicopters, and onshore employment, are affected by economies of scale. The following chart translates some calculations to take into account, the adjustments for non-recurring employment. Column 1 indicates the total employment and Column 2 describes the number of jobs that may not be needed. This means that for every 44 - 48 jobs predicted, the actual employment may be off by as many as 9.

ADJUSTMENTS FOR ECONOMIES OF SCALE

Onshore Employment

Total	Number Off
7 - 9	1
10 - 13	2
14 - 18	3
10 - 23	4
24 - 28	5
29 - 33	6
34 - 38	7
39 - 43	8
44 - 48	9

Source: NERBC, 1976

In the case of supply boats, economies were applied to the boat requirements as calculated for each of the industry interest areas.

Table 5.4

At the Davisville, R.I. service base, the total payroll for state residents was approximately $1 million. Table 5.5 summarizes the employment impact of that base during the eight to nine month period of operation. As shown, 38, or 70 percent, of the 54 onshore employees resided in Rhode Island; 45, or 37 percent, of the 122 offshore employees were Rhode Islanders.

COST HOLE SERVICE BASE IMPACTS
DAVISVILLE, R. I.

JOBS CREATED

FIRM	FUNCTION	ONSHORE PERSONNEL R.I. Employ.	ONSHORE PERSONNEL Total Employ.	OFFSHORE PERSONNEL R.I. Employ.	OFFSHORE PERSONNEL Total Employ.
Ocean Production Co.	Drilling Operator	0	3	0	4
IMCO Services	Drilling Fluids	15	16	0	2
Halliburton	Drilling Services	0	1	0	2
Analysts	Geophysical Testing	7	1	6	6
Southeastern Drilling Co. (SEDCO)	Drilling Contractors	3	3	28	39
Eura-Pirates	Boat Contractors (2 Boats)	13	5	-	-
Universal Services	Offshore Food and Living Conditions Services	0	1	11	4
	Totals	33	30	45	57

Source: Testimony of Jim Thomason, East Coast Manager, IMCO Services. Offshore Oil Workshop. Davisville, R.I., September 22-24, 1976, pp. 13-15.

Table 5.5

The total expenditure on diesel fuel in Rhode Island during the eight to nine month period was approximately $400,000. To determine additional economic impacts upon the local community the expenditure of one of the firms involved in the Davisville base is summarized in Table 5.6. As noted, IMCO Services spent a total of $338,000 in Rhode Island. Of this, 44 percent was spent on wages and salaries to Rhode Island residents.

IMCO SERVICES - COMMUNITY EXPENDITURE

DAVISVILLE, R.I.

Wages	$144,000
Construction	15,000
Small Equipment Rental	32,000
Crane Mill Rental	30,000
Crane Mill Labor	27,000
Harbor Rental	24,000
Maintenance	9,000
Utilities and Fuel	26,000
Miscellaneous	19,000
TOTAL	$338,000

Source: Testimony of Jim Thomason, East Coast Manager, IMCO Services, Offshore Oil Workshop, Davisville, R.I., September 22-24, 1976, pp. 13-15.

Table 5.6

Service bases exist to provide all the material and service requirements for the various offshore operations. It is obvious, but worth remembering, that everything required by the drilling or construction operations and for the men working must be carried out by boat.

The wide range of materials required are supplied by a wide range of companies, collectively referred to as "Ancillary Industries". These firms sell the equipment and supplies to the oil companies, and often have sites set up either on or near a service base. Where such companies locate depends on the state of development and the possible demand for a companies products or services.

The following list of materials and services should not be considered complete by any means. While the basics are indicated, a variety of factors may alter the requirements list. These factors include: contractual arrangements between oil companies and their suppliers, the stage of development, the presence and extent of any oil or gas finds, special conditions encountered in drilling, and the precise choice of technologies used in offshore operations.

1. Drilling Materials and Services

Drill Pipe (stem), including pipe joints and stem collars

Cement (cementing casings and plugging wells)

Mud (chemicals which act as well control fluids, which maintain pressure and act as a lubricant while carrying drill bits and cuttings to the surface)

Blow out preventors (valves which control pressure at the well head)

Hoses; for water, fuel, and bulk chemical transmission, circulating hoses, control hoses for hydraulic operation of control equipment, fire hoses, and general purpose hoses.

Wire, Synthetic Rope, and Manila Rope; for cranes, barge mooring system, drilling lines, guidance systems, tension system, diving and T.V. monitoring utility winch operations, vessel moorings, general purpose lashings, and catlines.

Cargo Handling Equipment; for onshore/offshore cargo operations, i.e., hooks, slings, shackles, nets, baskets, chains, pallets. waterproof covers, food containers, load binders, and transit tank for helicopter fuel.

Safety Clothing; for workers onshore and offshore, i.e., boots, gloves, goggles, helmets, arctic underware, O/MLS jackets, and foul weather clothing.

Safety Equipment; for firefighting, i.e., axes, hoses, extinguishers, stretchers, and asbestos blankets; and for other safety functions, i.e., gas detectors, breathing apparatus, resuscitators, flash lights, life rafts, lifeboats, life jackets, flares, lifelines, and scrambling nets.

Welding Equipment; for a range of welding tasks, including maintenance repairs, tool dressing, pipework, and fabrication, i.e., welding machines, rods, conductors and other equipment.

Pipe Fittings; unions, tees, nipples, couplings, and reducers of high and low pressure.

Valves Screwed, Flanged, and Welding; for all flow lines, manifolds, ballasting systems, mud and dry bulk chemical service, and other uses, i.e., gate, globe, check, butterfly, and diaphragm valves.

Flanges; for miscellaneous high and low pressure systems, i.e., screwed and welding flanges to A.P.I. standard.

Bolts, Nuts, and Studding; as above.

Risers (connections of drilling platform to seabed with tubular materials within which drill pipe can be run and casing strung)

Miscellaneous drilling tools: (reamers, hole openers)

Mud manifold systems (which control the use of mud)

Fishing tools (for retrieving equipment lost downhole)

Pipe cutting and underreaming equipment (for expanding or under-reaming or contracting a hole)

Logging and perforating services (measurement of the well and the formations being drilled and shooting holes through the cement casing through which the oil or gas may flow)

Inspection services (for tubular goods, pipe, structures, and equipment).

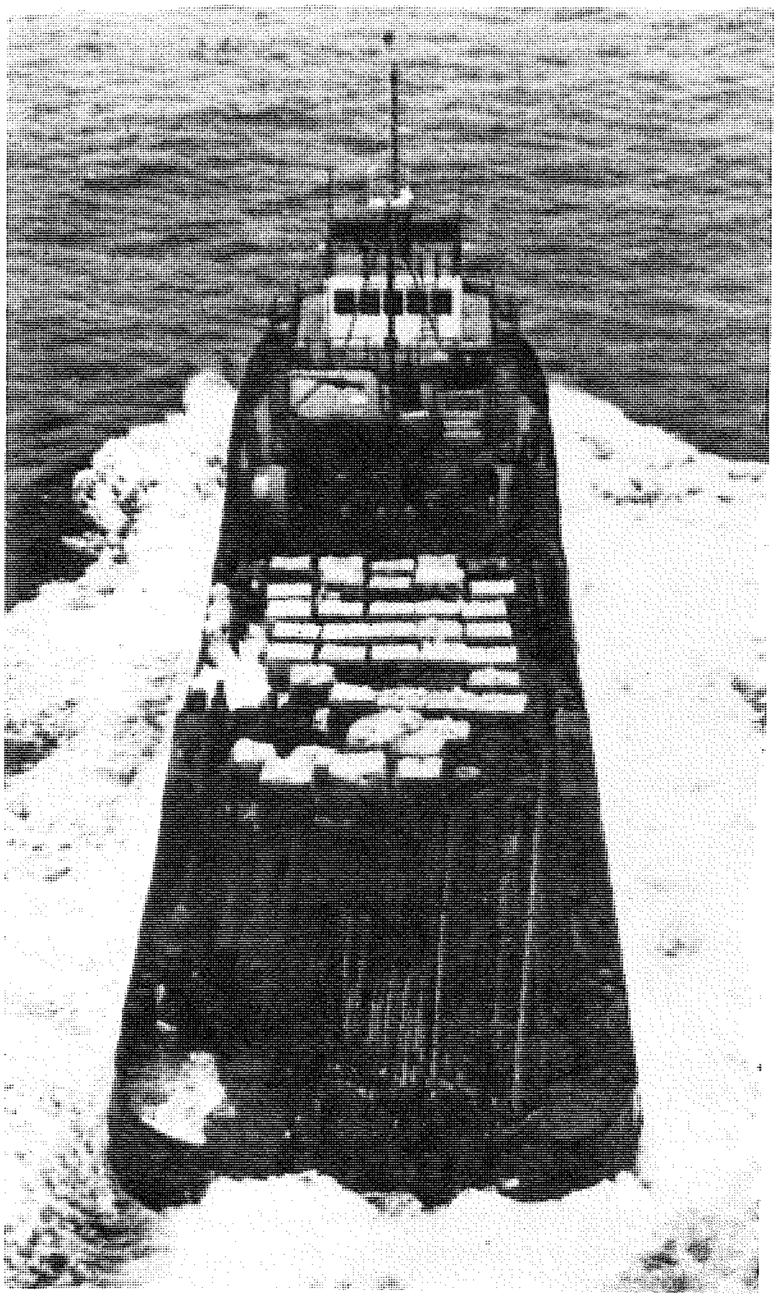


FIGURE 6.1

Service Boat

The arrangement of materials on the afterdeck of a Service Boat is illustrated in this photograph.

For all this equipment, repairs and service personnel are available for work either on or offshore, and a service base may provide operating space for the engineers and service technicians.

2. Miscellaneous equipment for rig operations.

Foodstuffs and Domestic, Laundry, and Medical Supplies; for fully comprehensive catering and accommodation facilities.

Films, Periodical, and Magazines; for recreation facilities.

Fuel; to operate power plants, vehicles, and helicopters.

Water; for domestic purposes (potable), and for drilling fluids and coolants.

Lubricants and Greases; for engines, pumps, generators, compressors, winches, motors, hydraulic systems, and other uses.

Paints; for interior and exterior structural maintenance, deck protection, plant maintenance, and other uses.

Gases; for diving, welding, and medical purposes.

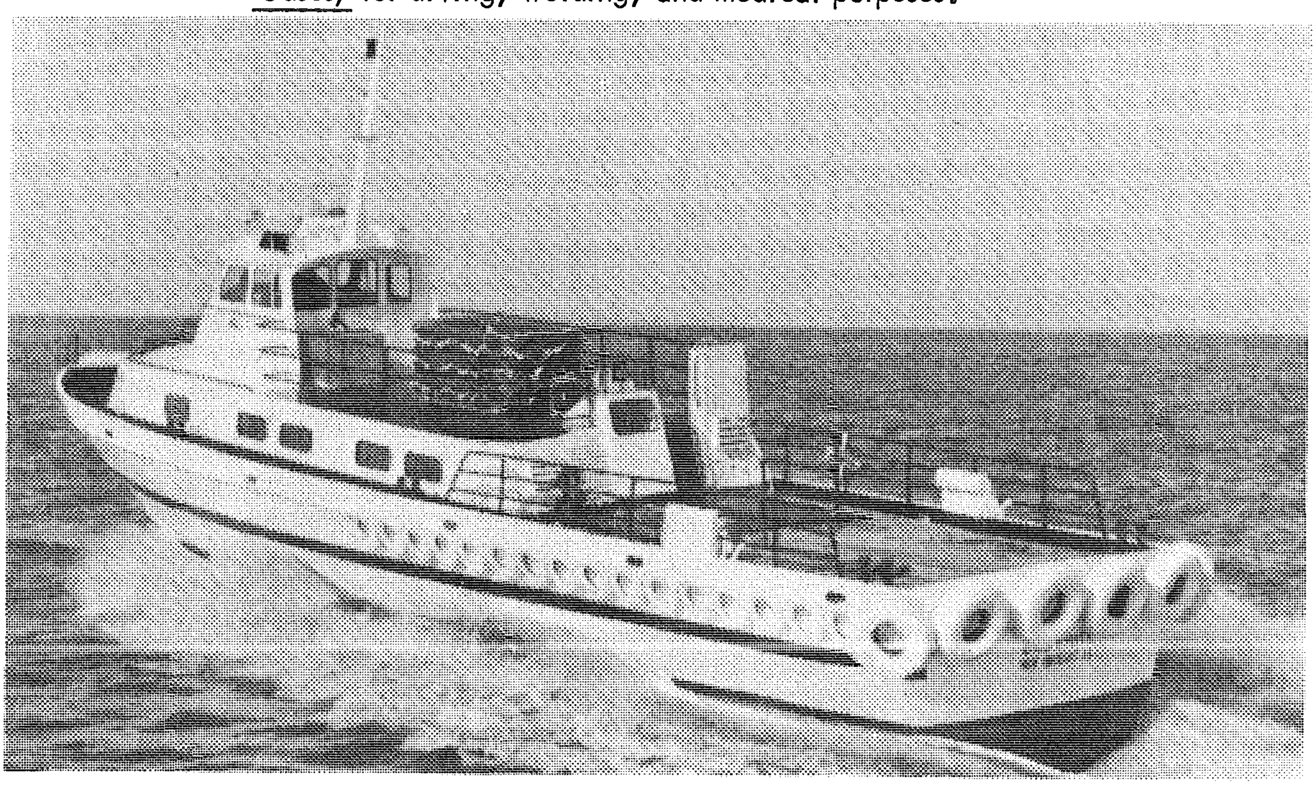


FIGURE 6.2 *Crew Boat*

This class of boat is used to ferry crews to and from offshore operations. It is most commonly used in the Gulf of Mexico. Helicopters are used for crew transport in the North Sea, and will probably be used on Georges Bank.

Joint Rings and Gaskets; as above.

Marine Equipment; for boats and offshore facilities, e.a., mooring anchors, buoys and chains, riser wires, miscellaneous cordage and terminal fittings, chain stoppers, barometers, chronometer, anemometer, wave recorder, portable radios, tension measuring equipment for main moaring system, and navigation charts.

Mobile Plant; for miscellaneous jobs onshore and offshore, i.e., welding equipment, generators, compressors, steam cleaners, and test pumps.

Engineering Tools; for interior and exterior uses on facilities and in engineering workshops, e.a., grinders, drills, chipping tools, impact wrenches, torque wrenches, sundry air operated tools, paint sprayers, bench drills, bench grinders, and small lathes.

Electrical; for interior and exterior uses on facilities, e.a., cables, trays, terminal fittings, lighting fittings, bulbs, tubes, switches, and conduits.

3. Pipe-laying Requirements

During the development state, if the service base is supporting the construction of pipelines buried in the ocean floor, the requirements (with the exception of some supplies related to materials offloading and onloading supply vessels, the mooring systems and some other nautical requirements, and some clothing and food catering supplies) will be different. Of course, there will be no drilling-related requirements, and the supplies related to general engineering will be quite different for the pipe-laying barges and the barges that bury the pipe in the ocean floor.

If the pipe for the sub-sea pipeline is supplied from the service base, then the base can expect to store large tonnages of 40- to 80-foot-long cement-coated pipe possibly up to 24 inches, or even 36 inches, in diameter for use by the pipe-laying barges.

FIGURE 6.3

Heavy Duty Ocean-going Tugboat

This class of vessel is used to tow large offshore structures, such as Concrete drilling platforms

4. Platform Installation Requirements

Some support from the service base would, in all probability, be required during the positioning and fitting out of the platforms, whether fixed or floating. In the main, this would probably mean the supply of fuel, water, and provisions to the tug and barge crews and platform assembly workers, and possibly minor items required in bringing a modularized platform to an operating condition. It is highly unlikely that any of the modular components for a fixed platform would be stored at the service base. However, there is a possibility that the barges carrying modulars for steel platforms and the cranes to lift them on their bases (jackets) might lay up in a protected service base harbor awaiting acceptable weather to assemble the platform, once the jacket has been positioned.

5. Specialized Services.

A. Diving

Diving for inspection of underwater equipment and in some cases for the construction of underwater equipment has become a major part of offshore operations. The technology and advances in medicine which enable diving at great depts of up to 1000 feet have made diving an essential part. Diving in support of offshore operations has become a major industry, with many

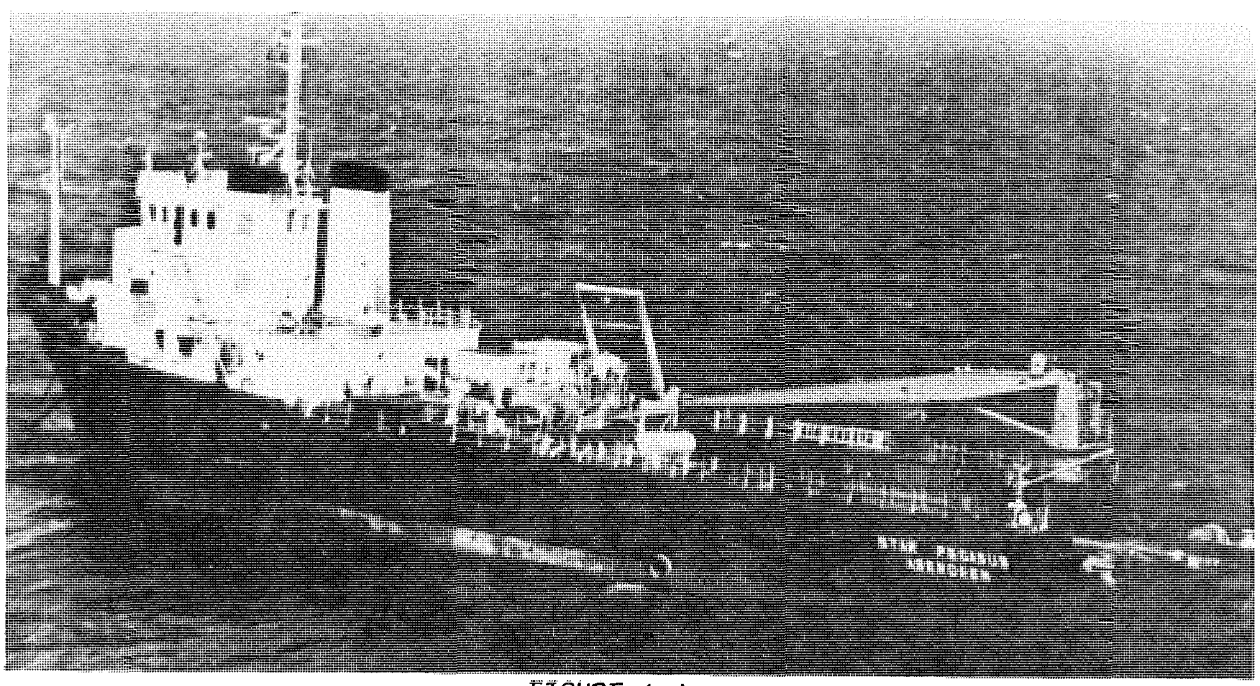


FIGURE 6.4

Diving Support Ship

This ship is typical of the specialized vessels used to support diving operations companies engaging in worldwide operations. Diving operations may be run from a service base or may be run from a specially built diving base. Again, this will depend on the amout and type of diving operations required.

Diving will tend to be most intense during development of a field, and less so during the exploration and production phases.

In addition to the gear used by the divers themselves (wetsuits, masks and helmets, air tanks, etc.) diving operations may require extensive equipment such as underwater welding and repair tools, compressors and special diving gases for deep dives. Bathyspheres and remote controlled underwater vehicles may also be used. Large diving companies may have their own ships for use, and these may occasionally use berthing space at a service base. If suitable arrangements could be made, such a boat could be berthed permanently at a service base.

B. Oil Spill Recovery

The technology to recover oil and chemical spills is a relatively recent development. Since the occurance of such spills is at random, and the equipment relatively expensive, oil spills recovery services will typically be located in ports which already handle a high volume of oil or chemical trans-shipment. Although such trans-shipments occur at a service base, unless the base is located in or near an oil handling port, the service would not be provided at the service base.

A service base may be required to use the recovery services from time to time, or a spill recovery service may be used to develop and maintain equipment on scene for use in a spill incident.

Repair and maintenance facilities are operated by many firms of varying capabilities, which provide services to the operators of vessels and equipment involved in outer continental shelf oil and gas development. They may or may not be located on or near service bases, but larger bases often have some repair facilities.

Second only to crew payroll, the money spent on repair and maintenance is the largest amount of money spent by the operators of OCS - support vessels. Fast, efficient service and highly skilled people are the primary needs for onshore repair and maintenance services required by the offshore oil industry.

The repair and maintenance industry presents what is perhaps one of the easist ways for indigenous enterprises in a frontier area to capitalize on the activity resulting from offshore oil and gas development. Repair and maintenance firms need only augment their existing capabilities to meet the repair and maintenance needs of the OCS - related vessels, rigs, fixed offshore platforms, and equipment in order to participate in the onshore economic growth.

OCS operations create a demand for a wide range of vessels and equipment which, in turn, require appropriate repair and maintenace capabilities.

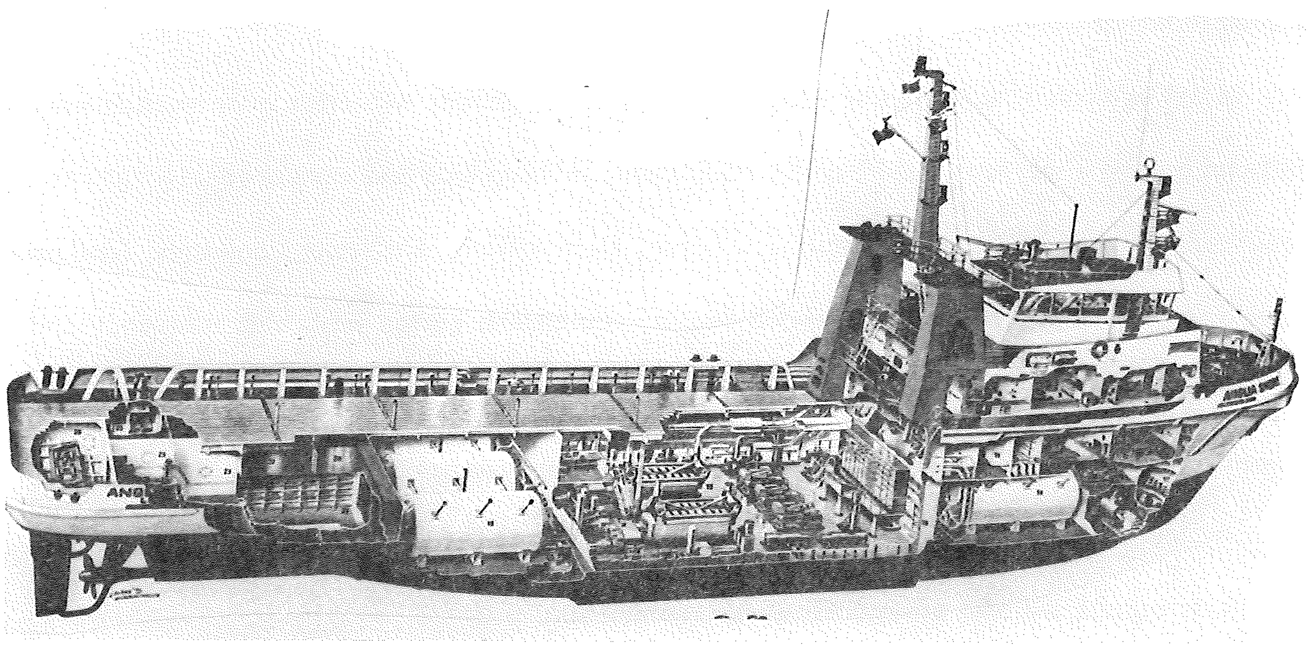


FIGURE 7.1 *Cross Section of a typical Supply Boat*

Vessels. Most of the vessels employed in the development of offshore oil and gas range between 60 and 200 feet in length. These include tug boats, crew boats, supply boats, production utility boats, ocean research and seismic vessels, and a variety of barges.

These boats are often equipped with specialized gear, and are generally too large to be properly serviced in the yards which cater to pleasure craft. However, since the repair and maintenance capabilities at a major shipyard are geared for larger vessels, their rates are high. Therefore, because of the high rates and the time involved in servicing at a major shipyard, the intermediate-sized vessels assisting with oil and gas operations will seek appropriate repair and maintenance service at those harbors which customarily handle the larger fishing fleets.

Larger Vessels. Vessels, such as drill ships, semi-submersible drilling rigs, ships carrying general cargo and other materials, pipe lay and jet barges, pipe supply barges, and other large OCS-related carriers, must be serviced at major shipyards, which are usually involved with construction and conversion of vessels, in addition to repair and maintenance. Here, the largest boats can find dry dock facilities and most other services normally required by vessels of this size.

Vessel Equipment. Repair and maintenance yards also service boat equipment. This is usually accomplished at dockside.

Vessel equipment may include engines, compressors, pumps, reduction gear mechanisms, fuel and ballast water tanks, and transfer equipment, drilling mud and cement tanks, transfer equipment, towing and anchor handling winches, stern rollers, windlasses, capstans, food preparation equipment, air conditioning and heating equipment, radios (very high frequency and single side band), radars, fathometers, automatic pilot mechanisms, gyro compasses, Lorans (direction finders), refrigeration for bulk (often walk-in), cold storage, diving gear, on-board welders, and related items.

These repairs are also often done at service bases.

Although some of these items are unique to the offshore oil industry, and may require specialized repair facilities or skills, most are usually found on other ocean-going ships, as well. Therefore, the existing repair and maintenance companies, which cater primarily to ocean-going commerce, can expand as necessary to handle the new demands. It is also likely that new firms will enter the market to satisfy some of this increasing demand.

Oil Industry service vessels take a severe beating. The interior of the vessel gets damaged from the supplies being hauled. Working in high seas, in stormy weather and in extreme proximity to the offshore platforms, all take a toll on the vessel's exterior. Most boat repairs, including engine work, can be made most economically at dockside.

Work boat maintenance encompasses three basic types of repair: hull, mechanical and electronic.

Hull. Repair and maintenance of the hull refers mainly to the hull plates. This includes scraping and painting, replacement of damaged plates and repair to the hull super-structure. Other necessary underside repairs may involve the shaftings, propellers and steering mechanisms, including bow and stern thrusters. Hull maintenance requires that the vessel be partially or completely out of the water.

Mechanical. Mechanical repairs cover the main and auxiliary drive trains, diesel engines and reduction gear, in addition to auxiliary mechanisms such as generators, pumps, winches, anchorage gear, heating, ventilating and refrigeration equipment, etc.

Electronic. Electronic repairs cover radios (single side band and high frequency), radar, Lorans compasses, fathometers, automatic pilot mechanisms, gyro-compasses, etc. This type of equipment is usually repaired on board the vessel or removed from the vessel for shop work if extensive repairs are necessary.

In the Gulf Coast area, electronic repair jobs typically run from $100 to $500, averaging about $200. This work normally involves four to five hours labor and $60 to $70 in parts.

Inspections. The U.S. Coast Guard requires periodic inspections of all seagoing vessels registered in the United States. A walk-on inspection, to examine deck and safety conditions, is required every year. Every two years, vessels must be removed from water for hull, propeller, shaft, and drive train inspection. This type of Coast Guard inspection could tie up a boat for three or more days.

Since preventive maintenance can significantly reduce the number of repairs needed by a vessel, saving the operator time and money, heavy emphasis is placed on periodic inspections and maintenance beyond the licensing and certification of the U.S. Coast Guard.

Haul Out. When vessels must be taken out of the water for needed repairs or inspections, the 'haul out' method used depends on the extent of repair work to be done. The largest ocean-going carriers (those with a draft of 20 feet or more) must be hauled out for service at an existing dry dock in a major shipyard.

When the lighter crew boats need some bottom, shaft or propeller work, the flotation barge is a quick haul out technique. A crane on the dock hoists one end of the boat out of the water with straps, and the flotation barge is inserted underneath. Repairs can then be carried out without the continued support of the crane. Sometimes a mobile lift is used to haul out boats. This consists of a cable hoist arrangement which lifts the vessel and moves it to a temporary out-of-water position. Another haul out repair method used frequently in OCS operations involves marine railways, called 'slideways'. A work boat is winched out of the water on two rails which may run several hundred feet from the water onto the shore, where the repair work can be completed. Haul out repair jobs occur frequently in the Gulf Coast area where ports are shallow and often located on a river. Floating debris and a variety of submerged material can do substantial damage to a boat. Tree stumps, mooring lines and sunken debris can tear up propellers, bend shafts and rip up hull plates. A Gulf Coast work boat operator may need to have each of his vessels hauled out for necessary repairs as frequently as twice a month.

Other Areas. The need to haul out vessels for necessary repairs is greater in the Gulf Coast area than in regions where problems associated with shallow ports are less common. California, the Atlantic Coast and the North Sea, for example, have greater water depths close to shore, fewer riverine harbors and more coastal development.

Fixed Platforms and Rigs. Offshore platforms and rigs require extensive maintenance. Semi-submersible rigs are towed to shore for maintenance (normally to a qualified shipyard but any suitable shipyard will do). In the North Sea, concrete and steel platforms have required significantly more maintenance hours than expected.

Platform Equipment. Many of the specialized pieces of heavy equipment used on the platform (e.g., pumps, generators and compressors) require inspection, repair and maintenance. Inspection is usually done on the spot, while two alternatives exist for repair and maintenance:

- The equipment may be repaired on the spot, possibly causing a work delay on the platform, or
- The piece may be replaced immediately and removed to the local repair and maintenance yard for servicing.

Underwater Equipment. Since many repair and maintenance activities occur underwater, specialized diving support vessels with workshops on board are needed to service subsea completion units, pipes, hoses, etc. This service is extremely important. In 1976, North Sea drilling operations required over 20 such vessels. The crew on these vessels must be highly qualified in seamanship and diving, as well as maintenance.

All subsea completion units, pipes, hoses and single point mooring buoys require regular inspection.

When repair or maintenance work is necessary, specialized diving support vessels and crews service this equipment. The vessels equipped to provide these services generally carry a crew of 30 with up to eight divers and complete workshops for underwater repair. Primarily because of cost, oil companies are making arrangements to share these vessels, although they are wary of the possibility of breakdown while the vessel is being used by another company. These diving support vessels represent one of the largest growth markets in the North Sea.

SITING OF REPAIR FACILITIES

A repair and maintenance yard catering specifically to the needs of the petroleum industry is not likely to be newly sited in a frontier area. For the most part, these services already exist in ports where many of the OCS-related facilities requiring repairs and maintenance capabilities are likely to be sited. This fact sets repair and maintenance services apart from other oil and gas industry facilities, such as platform fabrication and pipe coating yards, because the repair operations are not uniquely associated with the petroleum industry.

Offshore activity can last for thirty years or more, and exploratory drilling, platform installation, development and production drilling and well workover may occur in overlapping periods. Existing marine repair capacities therefore, will have sufficient time to gear up and expand to handle increasing demands. New firms will also have ample opportunity to develop the necessary services for the repair and maintenance of boats, barges, helicopters, standardized equipment installed on the platforms and related specialized equipment.

The extent to which repair and maintenance services are augmented will be determined by the amount of exploration, the number of wells which go into production and the miles of marine pipe laid. In other words, the repair and maintenance services will expand in direct relation to the amount of offshore activity.

Pre-Lease Activity. During the continental offshore stratigraphic testing (COST) phase, a single base of operations is usually sufficient. Repairs can be handled by nearby repair facilities which cater to existing industry needs. The transition from no OCS activity to this initial phase of development creates no significant demand for repair and maintenance.

Post-Lease Activity. Following the lease sale, the demand for repair and maintenance capabilities in the region adjacent to the exploration site will increase significantly. Offshore activity may involve several exploratory rigs, all requiring onshore facilities. Trips between the service bases and the offshore sites will multiply with actual finds, especially if one or more are developed to production. The progression from exploration to development to production calls for progressively expanded repair and maintenance support onshore.

DEVELOPMENT OPTIONS

An oil company usually contracts for the initial fleet of boats serving a frontier area from an established boat chartering firm, frequently one of the major Gulf Coast area companies. (Any boat chartering operations located in the frontier area would, however, also be considered as potential contractors.) There are several options for repair and maintenance available to these boat chartering companies.

Branch Base. When the offshore development appears promising, the boat chartering company may decide to lease or purchase a branch office in the area. According to one industry source, four or more company boats operating in a frontier area may justify the establishment of a company-leased base for shoreside control. The branch site may be designed to simply berth the boats, locate crew quarters and office space and operate the chartering service. Or the company might decide to establish a small repair and maintenance area for its own boats, using other, more elaborate facilities only when necessary.

Expanded Local Facilities. If the boat chartering company decides not to site a branch base, however, the established local firms must absorb the repair and maintenance business from these boats. How this is handled depends on the needs of the petroleum industry and the capabilities of the existing repair and maintenance companies.

One possibility is for an established shipyard to develop an oil and gas industry work boat repair yard adjacent to their larger operations. The yard would be especially geared to service the vessels and equipment used in support of the offshore drilling operation.

An option common along the Gulf Coast, and in the North Sea operations, is for skilled mechanics from existing shipyards or related heavy industry to take advantage of the additional demand by opening smaller scale, independent repair and maintenance service operations, catering only to the specialized repair needs of the oil and gas industry.

Oil Industry Involvement. The petroleum industry itself does not become directly involved in the repair and maintenance process. As a rule, the industry does not want to bring in its own mechanics. However, two opportunities for direct input may occur:

- when a major industry imports one maintenance supervisor to oversee its entire operation; or
- when new or specialized equipment is introduced in a frontier area and industry or manufacturer's representatives are sent in to train key personnel.

OPERATIONS MODES FOR REPAIR SERVICES

The operators of OCS-related vessels work within a tight schedule and are always under the pressure of a deadline. Platform material has to be available when needed; pipe for the lay barges must be continuously supplied. It is the boat operator's responsibility to meet the agreed upon schedule. Otherwise, there is 'down time' for every one involved. Several hundred workers may become idled and millions of dollars lost if the industry schedule is not met. When a boat is laid up for repair work for more than 12 hours, there may be down time for many workers. By providing quick, efficient service and high quality skills to the oil industry, repair and maintenance firms help to minimize the down time of workers, vessels and related equipment.

Accessibility to road, rail and air transportation for delivery of parts from suppliers is necessary to ensure quick, efficient service to the boat operators. A repair company must keep its stock up and make sure that inventories include all needed items. Regardless of its size, the repair and maintenance company must be able to provide the required service within the 12-hour down time limit.

Round-the-Clock Service. Most repair and maintenance firms need to run on a 24-hour, seven days per week schedule. When the company cannot stay open, an alternative system for 'call out' will be required. 'Call out' means that a skilled repair crew is on call at any time (nights, weekends, holidays) to be sent out to dockside, to an offshore site or to another shoreside location. The cost of calling in a repair crew for one or two days mechanical work on a rig or platform, during non-work hours or offshore duty, can be $1,000 or more.

To avoid down time, boat operators will frequently radio in their problems. If necessary, a 'call out' crew can be ready at shoreside to begin the repair work as soon as the vessel comes into port. Normally, though, the operator merely arranges for an appointment with the repair yard over the radio, thereby cutting down on costly onshore waiting time.

Skill Categories. Depending on the type of work to be done, the repair and maintenance operation should be able to call upon the services of a wide range of skilled people. Certified welders and shipfitters, electricians, mechanics, machinists, riggers, carpenters, pipefitters, sandblasters and painters may all be needed.

SITING REQUIREMENTS

Repair and maintenance yards already exist as part of the indigenous industrial infrastructure of the area adjacent to the offshore site. They will probably be servicing local industry at the same time they are handling the repair and maintenance of oil industry vessels and equipment. This factor makes it unrealistic to discuss specific energy, land and waterfront requirements, as can be done with other OCS-related facilities.

The repair industry must be prepared to service offshore vessels and equipment whenever - and wherever - the need arises. To provide this kind of service, then, the yards should be located near the service base and harbor. Significant changes in the repair and maintenance capabilities will occur, essentially, in terms of augmenting existing services.

ENVIRONMENTAL IMPACTS FROM SERVICE BASES -8

The Environmental impacts from service bases fall into two categories: from construction and from operation. This chapter presents a general discussion of the environmental impacts which result from construction of coastal industrial facilities. It also describes the generic impacts of service bases.

It is important to remember that actual impacts will be a function of the exact facility proposed and the site in which it will be located. The descriptions of impacts given in this section are intended only as a very general guide.

1. Construction Impacts:

Construction of facilities such as service bases alter the environment through changes in the land site and through changes in the wetlands and coastline areas. These areas are considered separately.

A. Land Site Development

Air Emissions

Two kinds of air emissions are generated by site alteration and construction activities:

- combustion emissions from machinery at the site; and
- fugitive dust from machinery moving over exposed topsoil.

Combustion Emissions:

Exhaust from heavy machinery operation at the site will contribute various pollutants to the surrounding environment, principally nitrogen oxide (from deisel-powered equipment) and carbon monoxide (from gasoline-powered equipment). Emission volumne will depend directly on the numbers and types of machinery used at the site.

Complete emmissions information for various pieces of heavy machinery is found in Tables 8-1 & 8-2. There are no current federal emmission standards on these off-highway sources.

Dust:

Dust will be generated at the construction site by heavy machinery moving over exposed topsoil. The quantity depends upon the size of the disturbed area, the types and levels of activities, local weather conditions, and soil characteristics. The higher the silt content of the soil, and the drier it is, the more dust will be generated. The Environmental Protection Agency has estimated dust emissions to be 12 tons/acre of construction/month of activity. (The construction area studied had a medium activity level, a moderate (30 percent) silt content, and a semi-arid climate). Dust emissions can have a substantial temporary impact on local air quality.

How severe an impact these air emissions will have on the surrounding area depends largely on the existing air quality of the area. In an area with good to excellent air quality, concentration of regulated air pollutants will be low. Although extensive site alteration may be necessary, requiring a lot of heavy machinery, it is unlikely that the volumes of air pollutants generated would increase beyond federally acceptable levels.

TABLE 8-1

EMMISSION FACTORS FOR HEAVY-DUTY DIESEL-POWERED CONSTRUCTION EQUIPMENT

Equipment	Carbon Monoxide		Exhaust hydrocarbons		Nitrogen oxides		Aldehydes		Sulfur oxides		Particulates	
	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons
Tracklaying tractor	0.386	87.5	0.110	25.1	1.47	332.0	0.027	6.22	0.137	31.1	0.112	25.3
Wheeled tractor	2.15	161.0	0.148	50.9	0.994	342.0	0.030	10.3	0.090	31.1	0.136	46.5
Wheeled dozer	0.739	65.9	0.234	20.7	5.05	450.0	0.065	5.76	0.348	31.2	0.165	14.8
Scraper	1.46	98.3	0.626	42.2	6.22	419.0	0.143	9.69	0.463	31.2	0.406	27.3
Motor grader	0.215	78.0	0.054	17.4	1.05	374.0	0.012	4.31	0.086	31.1	0.061	22.2
Wheeled loader	0.553	95.4	0.187	32.3	2.40	408.0	0.041	7.17	0.182	31.2	0.172	29.3
Tracklaying loader	0.160	65.9	0.32	13.2	0.594	240.0	0.009	3.66	0.076	31.2	0.058	24.0
Off-highway truck	1.34	92.2	0.437	30.0	7.63	524.0	0.112	7.74	0.454	31.2	0.256	17.7
Roller	0.184	114.0	0.054	24.3	1.04	488.0	0.016	6.10	0.067	31.1	0.080	24.2
Miscellaneous	0.414	94.2	0.157	34.7	2.27	494.0	0.031	6.78	0.143	31.1	0.139	30.1

Source: "Heavy-Duty Construction Equipment" in Compilation of Air Pollutant Emmission Factors, 2nd ed., U.S. EPA, 1976, pp. 3.2. 7-2 and 3.2. 7-3

TABLE 8-2

EMMISSION FACTORS FOR HEAVY-DUTY GASOLINE-POWERED CONSTRUCTION EQUIPMENT

Equipment	Carbon monoxide		Exhaust hydrocarbons		Evaporative - Crankcase hydrocarbons		Nitrogen oxides		Aldehydes		Sulfur oxides		Particulates	
	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons	lb/hr	lb/1000 gallons
Wheeled tractor	9.52	3250.0	0.362	122.0	0.0681	0.0718	0.430	146.0	0.0176	5.82	0.0155	5.20	0.024	8.27
Motor grader	12.1	3910.00	0.410	132.0	0.0661	0.0818	0.320	102.0	0.0194	6.02	0.0167	5.31	0.0207	6.86
Wheeled loader	15.6	3630.0	0.531	124.0	0.0655	0.106	0.516	121.0	0.0213	4.95	0.0234	5.31	0.0298	7.0
Roller	13.4	3840.0	0.611	176.0	0.0622	0.122	0.802	100.0	0.167	4.86	0.0185	5.28	0.026	7.47
Misc.	17.0	3960.0	0.560	130.0	0.056	0.112	0.412	95.8	0.0198	4.44	0.0234	5.28	0.0258	6.06

Source: "Heavy-Duty Construction Equipment" in Compilation of Air Pollutant Emission Factors, 2nd edition, U.S. EPA, 1976, pp. 3.2.7-4 and 3.2.7-5.

Table 8-3 presents noise levels and attenuation distances for the loudest machinery used during construction. Control methods currently available to lessen construction noise include mufflers, intake silencers, and engine enclosures. Noise levels can be reduced by 5 - 10 decibels, depending on the machinery involved and the control methods chosen. Table 8-4 presents uncontrolled and controlled noise levels of various construction equipment.

Runoff:

When a site is prepared for construction, it is cleared of vegetation, the topsoil is exposed, and the soil profile is altered by grading and levelling operations. The soil is compacted by the constant movement of heavy machinery. These modifications will alter water-retention properties of the soil, increasing runoff from the site, and reducing ground water replenishment.

Runoff and erosion patterns will also be altered in the area of the site -- both erosion and siltation will increase. Exposed soil is particularly sensitive to both water and wind erosion. The actual extent of erosion is determined by the soil type(s), the size of the disturbed area, local weather conditions, and the extent of heavy machinery use at the site.

Runoff from construction sites contains two major pollutants:

- suspended solids (organic and inorganic particles) from exposed soil at the site; and
- heavy metals from painting spills and metal finishing processes.

Sediments contained in runoff water have a twofold impact on the receiving water, and hence on aquatic organisms, especially plants. Since the increased particulate concentrations increase turbidity (cloudiness), less light will be available for

TABLE 8-3

NOISIEST EQUIPMENT OPERATIING AT CONSTRUCTION SITES

Construction Phase	Equipment and decibel level at 50 ft.	Attenuation Distance (ft.)* Rural Area (40 dB)	Metropolitant Area (70 dB)
Ground Clearing	Truck - 91	13,000	600
	Scraper - 88	10,000	400
Excavation	Rock drill - 98	25,600	1,200
	truck - 91	13,000	600
Foundations	jack hammer - 88	10,000	400
	concrete mixer - 85	6,400	300
Erection	derrick crane - 88	10,000	400
	jack hammer - 88	10,000	400
Finishing	rock drill - 98	25,600	1,200
	truck - 91	13,000	600

Source: Noise from Construction Equipment and Operations, Building Equipment and Home Appliances. US EPA. 12/31/71. p. 22

* These calculations do not take into account physical barriers, terrain, vegetation and other factors which lower sound levels within a shorter distance.

photosynthesis. This will reduce growth rates in plants. However, sediments may also contain nutrients which increase growth rates. As a result of these changes in the aquatic environment, those species capable of rapid nutrient utilization with lower-than-average light requirements will be favored. If the water was originally clear with low nutrient concentrations, the addition of sediments from runoff would alter the balance of the endemic plant population; the new dominant species would be those better suited to the new environmental conditions.

The impact of the heavy metals contained in runoff on receiving waters will depend upon their nature and concentrations, and the nature of local species. Some heavy metals are extremely toxic, even in very low concentrations. Others exert no direct initial effects on organisms which ingest them, but can accumulate in their tissues. Since concentration of a toxic substance in creases with each step up in the food chain, these metals may exhibit a toxic effect on higher consumer organisms.

The extent to which heavy metals and suspended solids contained in runoff water will affect the quality of receiving waters depends upon the original quality of the water and the extent of governmental control of pollutant discharges. Water quality standards, including those for heavy metals and suspended solids, are set by individual states, but must equal or exceed federal guidelines. These standards vary depending upon how the receiving water is used. Usage divisions include public water supplies, recreational bathing, irrigation, and fishing. Quality standards for water not used for drinking supplies are generally set to protect aquatic organisms.

TABLE 8-4

IMMEDIATE ABATEMENT POTENTIAL OF CONSTRUCTION EQUIPMENT

Equipment	Noise Level in dB(A) at 50 ft. Present	With Feasible Noise Control*
Earthmoving		
front loader	79	75
backhoes	85	75
dozers	80	75
tractors	80	75
scrapers	88	80
graders	85	75
truck	91	75
paver	89	80
Materials Handling		
concrete mixer	85	75
concrete pump	82	75
crane	83	75
derrick	88	75
Stationary		
pumps	76	75
generators	78	75
compressors	81	75
Impact		
pile drivers	101	95
jack hammers	88	75
rock drills	98	80
pneumatic tools	86	80
Other		
saws	78	75
vibrator	76	75

Source: <u>Noise from Construction Equipment and Operations, Building Equipment and Home Appliances.</u> U.S. EPA. 12/31/71. p. 26.

* Estimated levels obtainable by selecting quieter procedures or machines and implementing noise control features requiring no major redesign or extreme cost.

If runoff from a construction site enters receiving waters which are already highly polluted, water quality standards may be exceeded. In such a case, the developer may be required to provide some kind of containment and treatment facility (such as diking and settling ponds) to lower pollutant concentrations in the runoff water.

In an undeveloped location, water quality standards are likely to be higher than those of a highly developed area. However, in an area with relatively few pollution sources, large quantities of pollutants could be released from a construction site without exceeding permissible concentrations.

Solid Wastes:

Solid wastes generated during facility construction include packaging materials of wood, paper, metal and plastic, wire and metal scraps, cement, and concrete. Wood and paper may be burned at the site. Concrete and cement may be buried or used to improve the site. Wire and metal scraps may be reclaimed or sold. All of these wastes may be incinerated and/or buried in a sanitary landfill.

If hazardous substances, such as paint or fuel, are spilled, the contaminated soil should be removed and disposed of at a site specifically designed to handle hazardous solid wastes. Failure to clean up a large spill of this nature could result in contamination of ground water supplies and/or waters receiving runoff from the site.

Habitat Alteration:

Extensive site alteration is usually necessary to prepare a previously undeveloped location for construction. The site must be cleared of trees and brush, and access roads and utility rights-of-way must be prepared. Habitats of local organisms are often destroyed as a result.

If site preparation alters only a small part of a species' habitat, and the surrounding area is not at its peak carrying capacity, the displaced species may relocate nearby. However, if the disturbed area is large in relation to the total available habitat, or if a species' habitat requirements are specific for the area destroyed, the species may be eliminated from the area. However, site alteration may also create new habitats, which may be colonized by one or more species from outside the area. For example, if patches of a large hardwood forest were cleared, a new grassland environment would be created. A new community may evolve in this habitat containing small mammals such as woodchucks, field mice and rabbits, certain species of birds, and soft wood trees such as poplars and white pines.

The adverse impacts of site alteration and construction can be minimized by scheduling activities to avoid the most environmentally sensitive periods of the year, such as the breeding season for local animals, and the rainy season.

Construction during a breeding season usually disrupts breeding activities of local animals. Even if construction alters only a small part of the breeding area, the resultant noise and air pollution may be severe enough to disrupt breeding within a wide radius of the site. When construction occurs during a non-breeding season, the local habitat may have sufficient time to recover and thus to provide adequate natural conditions for the following breeding season.

Rainfall patterns are another index of environmental sensitivity. During a rainy season, dust emissions from construction are low, but runoff is high. During a dry season, runoff is lower, but dust emissions increase. Dust emissions are more easily controlled (by watering techniques) than is runoff, which may require a system of diking and settling ponds. For this reason, construction in a dry season usually results in fewer impacts. The fact that the rainy season often coincides with the local breeding season further increases its environmental sensitivity.

B. Development of Wetlands and Coastal Areas

Construction Activities

Adverse environmental impacts resulting from development of a coastal area can be minimized by scheduling construction activities to avoid the most environmentally sensitive times of the year. Such scheduling is particularly important when the affected area includes either the water column or beaches separating wetlands from the ocean.

Plankton blooms -- periods of intensive planktonic growth -- are the most critical periods in the water column biome. Blooms follow a set developmental pattern: phytoplankton (free-floating plants) normally bloom first, followed by rapid growth of zooplankton (free-floating animals, including many larval forms of crustaceans and fish), which graze on the phytoplankton. Enrichment of the water column with nutrients from disturbed sediments may disrupt this relationship, thus lowering annual productivity. The addition of nutrients just prior to a bloom may cause it to begin early; nutrients added during a bloom may maintain high phytoplankton concentrations for a longer time than usual. Either of these phase disruptions will upset the annual cycle and alter the area's productivity. Nutrients added after a bloom has occurred will have very little effect, since phytoplankton concentrations drop to very low levels at this point.

Scheduling of construction activities is also important so that disturbed beaches, especially those separating wetlands from the ocean, can recover. Terrain recovery proceeds more rapidly in the summer, when erosion rates are lowest and sedimentation rates are highest. Destroyed vegetation, needed to protect against winter beach erosion, also regenerates faster during the summer. Hence, construction should be scheduled to end just prior to the summer months.

Dredging:

Dredging a previously undisturbed estuary or harbor may have long term and/or severe impacts on the local aquatic environment. These impacts include:

- alteration of water circulation patterns and salinity gradients as a result of alterations of shoreline and bottom topography;
- alteration or destruction of intertidal and benthic habitats; and
- addition of nutrients and particulates to the water column.

These changes in the aquatic environment may result in a partial or total change in the species composition of the estuary or harbor.

Topography Alteration:

Dredging alters both shoreline and bottom topography, and hence affects water circulation patterns. When a coastline is changed from natural and irregular to straight and unobstructed, it offers less resistance to the flow of surface currents. As a result, the speed of tidal flow past the area and the possibility of eddy formation are both increased. Dredging the bottom of a harbor makes it straighter and deeper, and results in new salt water distribution patterns. The salt wedge may move up the estuary or harbor more easily due to lowered bottom resistance. As a result of this movement of salt water into previously freshwater zones, horizontal and vertical salinity profiles in the area will also be changed.

Alteration of circulation patterns and salinity gradients in the estuary or harbor will seriously affect populations of indigenous organisms. Planktonic species may be displaced by altered surface currents. Changed salinity profiles may selectively inhibit species with a narrow salinity tolerance range, such as the larval forms of shrimp and oysters. The disturbed area may also be colonized by additional species adopted to the new conditions.

Habitat Alteration:

Shoreline dredging will reduce the size of the intertidal zone and change it from a gradual, natural slope to a vertical, man-made surface. This will alter the species composition of the disturbed area. Sea grasses will be replaced by attached seaweed species, such as Fucus. Populations of animals, such as clams, which burrow in the intertidal mud will be replaced by species which attach themselves to surfaces, such as mussels and barnacles.

Dredging will remove benthic organisms from the site, and the disturbed sediments may smother eggs and non-mobile organisms in the area. Indigenous benthic species unable to adopt to the new substrate conditions will also be eliminated; new species may colonize the area. If any larval forms of indigenous species were unable to tolerate the changed bottom conditions, this segment of the species' life cycle would be eliminated, thus reducing its population size.

Alteration of the Water Column:

Dredging disburbs sediments and thus increases the concentrations of organic and inorganic particles and dissolved substances in the affected water. As a result, both turbidity (cloudiness) and nutrient content of the water will increase.

The combination of increased nutrients and increased turbidity which results from dredging may alter the balance within the indigenous phytoplankton population. Under natural conditions, some species are dominant during only one phase of an annual cycle; others are present year-round in low concentrations. Increased nutrient concentrations will tend to increase the growth rates of all species. The increased turbidity, however, will limit growth rates, since a certain amount of light is necessary for optimal photosynthesis. As a result, species more efficient at utilizing high nutrient concentrations with lower-than-average light requirements may exhibit dominance. If dredging has altered the nature of the water significantly, these species may be different from the original dominant species.

Since the phytoplankton population comprises the lowest level of the area's food chain, such a shift in balance will have impacts on all levels of the chain, with possible long term effects throughout the entire estuarine biome -- the intertidal zone, the estuarine floor, and the water column. Impacts will be especially severe when one or more species in the food chain are adapted to feed only on one other indigenous species. If this food species is eliminated from the area, and its consumer is ill-equipped to feed on species which replace it, then the higher species will be reduced or eliminated. In this manner, alteration of the lowest level of the food chain can set off a chain reaction with impacts felt at every level. Ultimately, yields of commercially harvested fish and/or shellfish may decrease.

These alterations in the food chain may cause an initial reduction in overall productivity in the area as the chain is reorganized. Stabilization of a new estuarine community may ultimately result in a new trophic structure containing few species from the original population.

Dredging in Industrial Areas:

Dredging may be unnecessary if a facility is to be built in a developed port or harbor. If it is necessary, environmental responses would be minimal compared to those of an undeveloped area, since productivity and diversity of indigenous species are usually low in a developed harbor. This is due to the continual turbidity resulting from maintenance dredging, and the constant influx of toxic substances, such as oil discharges from boats and heavy metals from industrial discharges. Since only species adapted to these conditions will be present in the area, further dredging will not elicit significant environmental response.

The most significant impact of dredging in an industrial area will result from disposal of the dredge spoils, which may contain high concentrations of petroleum products and heavy metals. Some of these compounds, such as aromatic hydrocarbons, are extremely toxic to marine life. Others, such as lead, may be concentrated in the tissues of lower organisms, such as filter feeders, and passed up the food chain with lethal effects at higher levels. Disposal of these highly contaminated dredge spoils is carefully regulated and monitored to avoid polluting coastal waters.

Factors Affecting Impact Magnitude:

The preceding sections have described the most extensive impacts which can result from dredging operations. The actual impacts may be considerably less extensive, depending upon:

- characteristics of the dredged materials;
- the ratio of the size of the dredged (or spoils disposal) zone to the volume of water (mixing zone) available for dilution and dispersion of the sediments; and
- characteristics of the indigenous populations.

The size of the particles in the dredged sediments will affect the concentration of suspended particles in the water. The smaller the particles are, the more of them will be suspended in the water, resulting in increased turbidity.

In an area with restricted water circulation, the magnitude of environmental impacts will depend upon the size of the dredged area. The larger it is, the more extensive the impacts will be, especially if the area has a slow flushing rate.

Noise:

Heavy machinery used during the site alteration and construction will raise noise levels around the site. Figure 8-1 presents typical noise levels of construction equipment.

The impact of construction noise on the surrounding area will largely be determined by existing community noise levels. The effects would be much greater in a rural area, with an average level of 40 decibels, than in a metropolitan area, which has an average level of 70 decibels.

If a new source of noise is louder than the surrounding area, the ambient level will increase, if the noise level of a new source equals the ambient level at the site, the ambient level will increase only minimally (by approximately three decibels for each new source added). If the new source is quieter than its surroundings, there will be no net noise increase. Therefore, any source generating less than 70 decibels will have little impact on an urban area. In a rural area, any source generating more than 40 decibels will increase ambient levels.

The attenuation distance (the distance at which noise from a source reaches ambient levels) also depends on community noise levels. In an idealized situation, noise levels decrease by six decibels each time the distance from the source is doubled. The attenuation distance for construction noise is much shorter in a noisy metropolitan area than in a quieter non-metropolitan area.

The complexity of the area's food web and the species diversity will also influence the magnitude of dredging impacts. Elimination of one species will have a much greater effect on a simple, linear food chain, in which each level depends directly on another, than on a complex food web, in which each species consumes a number of different organisms from various trophic levels.

In an industrial or agricultural area, where species are already adapted to high concentrations of particulates and/or nutrients, dredging impacts will be less extensive.

2. Operations Impacts

Air Emissions

The magnitude of air emissions, and other environmental impacts from a service base, will depend upon the volume of delivery, storage, and transfer of fuel, supplies, and wastes associated with the offshore oil and gas operations. Sources of air emissions at a service base include:

- evaporation from fuel storage tanks;
- evaporation from transfer of fuel;
- combustion from machinery and vehicles; and
- accidental spills, breakage, etc.

The magnitude of impacts from these sources will depend on the number of storage tanks and vehicles, as well as the ambient air conditions. Impacts would be much greater in a rural area than in an industrially developed port.

Fuel Storage Tank Emissions. Diesel and other fuels are stored in large amounts at service bases for use by both the vessels and the drilling rigs. The volume of evaporative losses by hydrocarbons from storage tanks at a base depends on the following factors:

tank design

- type of roof
- diameter and capacity
- color of surface paint
- mechanical condition of tank

tank location and usage patterns

- diurnal changes in tank vapor space
- schedule of emptying and filling
- height of vapor space
- vapor pressure of stored liquids.

As shown in Figure 8-6 the three basic tank designs now in use vary primarily by roof type -- fixed roof, floating roof, and variable vapor space. A fixed roof tank is the least expensive to construct; it is equipped with a pressure/vacuum vent which responds to deviations in pressure.

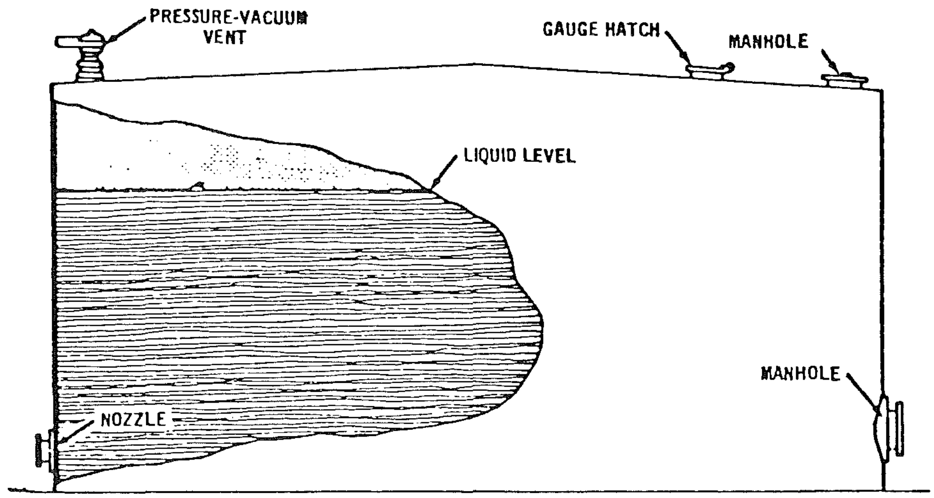
A floating roof tank has a roof which "floats" up and down in response to changing amounts of vapor present. The floating roof prevents the formation of vapor above the liquid surface, which would otherwise escape as emissions during filling and emptying. The tank is equipped with mechanical seals to seal the space between the roof and the walls. Floating roofs are sometimes covered with fixed roofs to further reduce vapor losses.

A variable vapor space tank is equipped with a diaphragm or "lifter" roof, which responds to the expansion and contraction of the vapor above the liquid surf ce

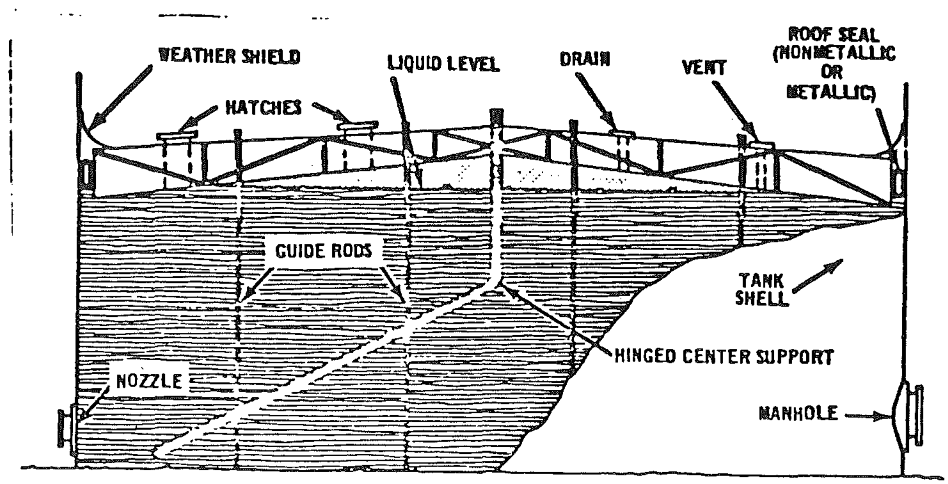
Emmissions from fuel storage tanks fall into three categories. Breathing losses, caused by temperature and pressure changes in the tank, are found only with fixed roof tanks. Working losses from filling and emptying are found with both fixed roof and variable vapor space tanks. Standing storage losses, due to improper fits between seal and tank walls, are found with floating roof tanks.

Figure 8.6
Fuel Storage Tanks

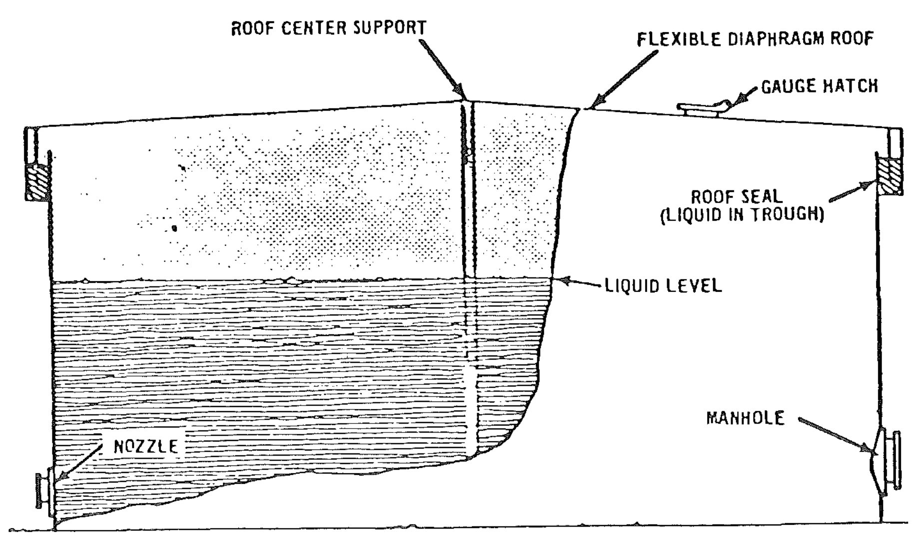
Fixed roof storage tank.



floating roof storage tank



Variable vapor storage tank



Source: EPA, Compilation of Air Pollutant Emissions Factors, 2nd edition, 1976, p. 4.3-1, 4.3-2, and 4.3-3

Table 8.7 shows average emission factors for fixed roof, floating roof, and variable vapor space tanks.

TABLE 8.7

TYPICAL FUEL STORAGE TANK EMMISSIONS

Tank Type	Kerosene Emmissions[a] lbs/day --- 1,000 gals.
fixed roof	
breathing loss	0.036
working loss	
(lbs/1,000 gals. tranferred)	1.00
floating roof	
(standing storage loss)	0.005
variable vapor space	
(working loss)	1.000

[a] figures for kerosene used due to unavailability of figures for diesel oil and the similarity of the two fuels. storage temperature: 63°F

Source: Compilation of Air Pollutant Emmission Factors, 2nd edition, U.S., EPA, 1976, pp. 4.3-8 and 4.3-9.

The color of paint on the tank surface has a significant effect on emmission quantity, due to the heat transfer properties of various colors. The use of white paint, which reflects the most light and heat, results in the least emissions; gray paint can result in 50 percent more emissions than white.

The American Petroleum Institute has developed a formula which can be used to calculate these various types of tank losses. The following is a sample caculation to determine the hydrocarbon breathing loss for a hypothetical fixed roof tank containing kerosene.

Fixed roof breathing losses can be estimated from the formula:

$$B = \frac{2.74\,WK}{V_c} \frac{P}{14.7-P}^{0.68} D^{1.73} H^{0.51} T^{0.50} F_p C$$

where:

B = Breathing loss, lb/day-10^3 gal. capacity
P = True vapor pressure at bulk liquid temperature, psia (0.4)
D = Tank diameter, feet (90)
H = Average vapor space height, including correction for roof volume, feet (11)
T = Average daily ambient temperature change, °F (15)
F_p = Paint factor (1.00)
C = Adjustment factor for tanks smaller than 20 feet in diameter
V_c = Capacity of tank, barrels (50,000)
K = Factor dependent on liquid stored (0.014)
W = Density of liquid at storage conditions, lbs/gal. (6.76)

Hydrocarbon breathing loss emissions for a hypothetical fixed roof tank containing kerosene were found to be 1.11 lbs/day/1000 gallon capacity.

Various methods are available to minimize storage tank evaporative losses. The U.S. Environmental Protection Agency has summarized some of these methods:

> The control methods most commonly used with fixed roof tanks are vapor recovery systems, which collect emissions from storage vessels and send them to gas recovery plants. The four recovery methods used are liquid absorption, vapor compression, vapor condensation, and adsorption in activated charcoal or silica gel. Overall control efficiencies of vapor recover systems vary from 90 - 95 percent, depending on the methods used, the design of the unit, the organic compounds recovered, and the mechanical condition of the system. In addition, water sprays, mechanical cooling, underground liquid storage, and optimum scheduling of tank turnover (e.g., avoidance of filling and emptying during the hottest parts of the day) are amoung the techniques used to minimize evaporative losses by reducing tank heat input.

Fuel Transfer Emissions. The transfer of fuel from the vehicles used to deliver it into the storage tanks at the base results in evaporative emissions. Fuel transfer from storage tanks to boats (which consume fuel as well as deliver large amounts to offshore sites) also causes emissions. The quantity of these vapor losses depends directly upon the temperature, density, and vapor pressure of the fuel, and how saturated the vapor space is at the time of unloading. While the fuel is being transported to the offshore sites, vapor losses en route from the tanks on the boats can be substantial.

Typical emissions from these sources are presented in Table 8.5.

TABLE 8.5.

TYPICAL FUEL TRANSFER EMISSIONS *

Operation	Emissions
Tank car unloading	0.23 lb/1000 gal. transferred
Boat unloading	0.24 lb/1000 gal. transferred
Boat loading	0.27 lb/1000 gal. transferred
Boat transit	0.32 lb/week per 1000 gal. load

* assumed temperature: 63°F
assumed vapor space saturation: 20 percent
assumed fuel: kerosene (very similar to diesel)

Source: Compilation of Air Pollutant Emission Factors, 2nd edition, 1976, U.S. Environmental Protection Agency, pp. 4.4-6.

Combustion Emissions: Combustion emissions from trucks, trains, boats and helicopters will contribute hydrocarbons, carbon monoxide, and nitrogen oxides to the air.

Dust Emissions: The major sources of dust emissions are the storage and transfer facilities for dry-pumped cement and mud. Large dust clouds can form from accidental spillage or a hose blowout. This is a major source of air emission and possibly the most visible.

Spills and Breakage: Occasional accidental spills of fuel and other stored materials, and similar daily operational losses will constitute a relatively minor source of air pollution at a service base.

Wastewater

The operation of a service base results in four sources of wastewater:

- sewage
- bilge water
- ballast water
- cooling water

Sewage: The boats that use service bases generate approximately 30 gallons per capita of sewage daily. Wastewater from sources such as galleys, sinks, showers, and laundry comes to about the same amount. Federal controls have focused primarily on sewage discharges; however, vessels which have installed Coast Guard-approved sanitary waste devices (fecal coliform count of less than 1000 per 100 ml, and no visible floating solids) prior to

January 30, 1978 can continue to use those devices as long as they are functioning properly. Any sanitary devices installed after this date must meet a higher effluent standard (fecal coliform count of less than 200 per 100 ml and suspended solid concentration less than 140 mg per liter) or contain holding tanks for sewage as of January 30, 1980. If porper treatment and discharge procedures are followed, little enviromental damage is expected.

Bilge and Ballast Water: Bilge water, which collects in the lower portion of boats, often contains petroleum products and metalic compounds leaked from machinery. The quantity of bilge water per boat can be calculated from the following equation:

$$Q = 0.004T$$

Where Q - average bilge water generation rate (gals/min)

T = dead weight tonnage of vessel.

For example, a 200 foot supply boat weights approximately 100 tons. According to the above equation, this boat would generate 0.4 gallons per minute of bilge water, or nearly 600 gallons per 24 hours of operation.

Ballast water is taken in by an empty cargo or supply boat after unloading to improve the handling of the vessel. Most of the ballast water used by vessels at service bases would be non-oily. (Oily ballast water is found mostly in oil tankers.) The composition of non-oily ballast water depends on the products transported, but it is often a mixture of pollutants which were contained in the vessel, and the polluted harbor water which was added as ballast. The final composition of the ballast water is further influenced by how long and under what conditions it remains in the vessel.

Ballast water often has a high biological oxygen demand, and contains high concentrations of fecal bacteria and heavy metals. These substances can be toxic to aquatic organisms and often contaminate recreational waters. It is anticipated, however, that most of the ballast water used at service bases will be taken on by the vessels delivering products; only small quantities will be discharged at the base site.

Section 311 (3) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) prohibits "the discharge of oil or hazardous substances into or upon the navigable waters of the United States, adjoining shorelines or into or upon the waters of the contiguous zone, where permitted under Article IV of the International Convention for the Prevention of the Pollution of the Sea by Oil, 1954, as amended and (B) where permitted in quantities and at times and locations or under such circumstances or conditions as the President may, by regulation, determine not to be harmful".

The Oil Pollution Control Act of 1961, which ratifies applicable sections of the 1954 International Convention for the Prevention of the Pollution of the Sea by Oil, states that discharges of oily mixtures from bilges containing lube oil drained and/or leaked from marine machinery spaces are permitted. The Oil Pollution Act also allows the discharge of ballast water from vessels other than tankers when proceeding to ports with inadequate reception facilities. Title 33, Part 153 of the Code of Federal Regulations, classifies the discharge of oil from properly functioning vessel engines as not harmful and, therefore, not prohibited.

Under these circumstances, it appears that vessels using service bases will regularly discharge ballast water, bilge water, and engine oil into coastal waters.

In Scotland, however, discharge of engine oil is prohibited. Generally, it is pumped into a road vehicle onboard, to be disposed of onshore.

Cooling Water: Cooling water, which circulates through vessels while their engines are in operation, is either discharged to the surrounding water or is recirculated and air cooled. Because of their small volume, boat engine cooling water discharges are not expected to cause serious environmental impacts.

Noise

Because a service base is in operation 24 hours a day, noise is generated continually. Sources of noise from a service base include pneumatic power tools, air compressors, pumps, compressed air machinery for painting and cleaning, industrial trucks, and cranes. In addition, auxiliary generators, or harbor sets, which may be present at the base, "can be very noisy unless operators are encouraged to dampen the sound." The noise levels and various controls are presented in Table 8.6.

TABLE 8.6

SOURCES OF NOISE AT SERVICE BASES

SOURCE	DECIBEL LEVEL AT OPERATOR'S POSITION	CONTROL TECHNOLOGY
Pneumatic power tools	90-115	sound absorbers
air compressors	92-100	mufflers enclosure of equipment
generators (at 6 feet)	90	not available
pumps	80 - 90	enclosure
compressed air machinery (painting and cleaning)	91-104	mufflers
industrial trucks	90	mufflers
cranes	75-85	muffler

SOURCE: Noise from Industrial Plants, prep. by LS goodfriend Associates for the EPA Office of Noise Abatement and Control, (1971), p. 12

If a service base is located in a relatively quiet inhabited area, the noise which it generates will present a problem. Typically, a noise level increase of 30 decibels or more will result in complaints from local residents.

Runoff

Because of the large volume of materials moving through service bases, frequent small spills of stored substances will occur. Drainage waters from portions of the yard where hazardous products are stored are often diked and the materials collected for treatment and off-site disposal. Any runoff which does leave the site and reach the surface or subsurface waters will likely be industrial in nature, and will contaminate the waters.

Solid Wastes

Two types of solid wastes are dealt with at a service base: those generated by offshore oil operations, and those generated by the service base itself. Offshore wastes are the more significant in terms of both quantity and environmental impacts.

During drilling operations, approximately six tons per day of solid wastes will be generated per well. This includes drilling wastes, such as mud, mud additives, bit cuttings, sand and sludges collected in separation vessels and tanks; galley garbage; oily sludges; lubrication oils and waxes; rags, cloth, and packaging wastes; drums, spools, cables, and scrap metals; and human wastes. Some of this material is treated and disposed of at sea, but a large quantity is returned to shore through the service bases.

Offshore operators are not permitted to dispose of any oiled drilling mud and drill bit cuttings at the platform. These waste materials come in two forms: oilbase drilling mud (a specialty mud, rarely used), and a standard mud and cuttings, which become mixed with oil while drilling. Since these materials cannot be economically reclaimed, they must be returned to shore (usually in barrels) and buried. Some oilbased mud must be transported "back to the mainland for centrifuging, if the rig itself does not have this particular equipment on board." A recent estimate for a 10,000 foot well in California indicates that 15,799 and 10,096 cubic feet of drilling mud and bit cuttings, respectively, were expected to be returned to land for disposal. The discharge from non-oiled drilling mud and cuttings are permitted in Federal waters.

Since drilling wastes often contain hazardous materials, such as oil, acids or heavy metals, they must be disposed of in a special landfill site where there is no danger of penetraing the ground water, running off into surface waters, or evaporating. Private industries have been established in Europe to convert some of the hazardous OCS solid wastes, such as oiled materials, acids and heavy metal sludges, into less harmful products, with special incineration procedures, thus allowing easier disposal.

Less hazardous offshore wastes, such as scrap metal, paper, or wood products, are either recycled or treated at the service base before disposal in an incinerator or sanitary landfill.

Solid wastes generated by service base operation include dunnage (material used to protect cargo), collected during boat unloading, garbage from supply and crew boats (approximately 6.5 lbs per person per day), and garbage/refuse from service base employees. These wastes can be incinerated, disinfected and used as landfill or, in the case of garbage, ground up and disposed of with the sewage. Little adverse environmental impact is anticipated if these materials are disposed of in accordance with existing regulations.

Aesthetic Impact

The aesthetic impact of a service base will depend largely upon the area in which it is located. In an industrial port, for example, the impact would be relatively minimal. In an undeveloped port, however, a 24-hour lighted storage facility, with heavy machinery in continual operation, and trucks, trains, and boats constantly arriving and leaving would have a much greater aesthetic impact. Some type of buffer zone around the base could mitigate these impacts, and might be required as a means of minimizing the hazards involved in fuel storage at the base, as well.

ESTIMATES OF SERVICE BASE ACTIVITY FOR GEORGES BANK 9

This chapter presents estimates/levels of service base activities which might be expected in connection with offshore oil development on Georges Bank. It considers levels of activity in the aggregate, since it is not known exactly where service bases will be located (the abandoned Naval facilities at Quonset Point in Davisville, Rhode Island, will almost certainly be a service base location, but other sites are unknown).

Estimates are based on three "find" scenarios developed by the New England River Basins Commission. The scenarios contain the following assumptions:

High Find: 2.4 billion barrels of oil
12.4 trillion cubic feet of natural gas

Medium Find: 900 million barrels of oil
4.2 trillion cubic feet of natural gas

No find of either oil or natural gas

Table 9.1 indicates the materials required by one drilling rig in one year to drill four 15,000 foot wells.

TABLE 9.1
One rig drilling four 15,000' wells in one year

Materials Needed	Cargo Capacity* of Service Boats
Mud= 19,363 cubic ft.	Bulk Dry Cargo = 6,275 cubic ft.
Cement = 12,852 cubic ft.	Drilling Water = 3,425 bbls.
Water = 5, 200,000 gal.	Potable Water = 625 bbls.
Drilling fuel =13,272 bbls.	Fuel = 3,060 bbls.
Tubular goods = 1,820	Cargo Deadweight = 1,125 tons
	Deck Cargo = 500 tons

Table 9.2 presents the trips per year and per month a service base of the type of boat in common use today. Sucha a boat is depicted in Table 9.1, it's prinicpal dimensions are: LOA: 209 feet, Beam: 43 feet, Draft: 16 feet. Table 9.2

Table 9.3 presents the number of drilling rigs expected to work on Georges Bank under the various scenarious. This data is combined with the data in Table 9.1 to yield Tables 9.4 and 9.5, which estimate the materials per year transported to support activity under the three scenarious.

Table 9.2

	Trips/Year	Trips/Month
Potable Water -	17.6	1.5
Drilling Water -	33.0	2.7
Fuel -	4.3	.4
Tubular Goods -	18.2	1.5
Mud -) Cement -)	5.1	.4

Table 9.3

OFFSHORE RIG ACTIVITY OF GEORGES BANK

Scenario of Finds	Years After Lease Sale 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
High Find															
Exploratory Rigs	7	9	11	11	12	12	12	11	10	10	8	6	4	3	3
Development Rigs					6	14	30	44	56	60	60	56	48	28	12
Producing Platforms								3	7	15	25	35	45	55	63
Supply Boats	17	23	28	27	38	51	72	96	107	116	116	110	90	65	51
Medium Find															
Exploratory Rigs	7	9	11	11	12	12	12	11	10	10	8	6	4	3	3
Development Rigs						3	5	14	18	17	11	4	3		
Producing Platforms									3	5	14	21	22	25	25
Supply Boats	17	23	28	27	28	32	34	62	70	68	52	25	21	14	14
No Find															
Exploratory Rigs	7	5	4	2	1										
Supply Boats	17	13	10	5	2										

Source: NERBC, 1976

Exploration Phase - 1 berth can service 2.5 rigs
1 berth usually needs 6-9 acres for every 2.5 rigs

Development Phase - 1 berth can service 1 single-rigged platform
1 berth needs 6 acres for every single-rigged platform

Production Phase - 1 berth can service 7 production platforms
Production Phase needs considerably less space than development phase

Table 9.4

Exploration Wells Drilled, Materials Required Offshore

Exploration Phase

	Year After First Lease Sale	2nd	3rd	4th	5th	6th
High						
	Number of wells drilled	28	36	44	44	48
	Mud in 1000 tons	18.0	23.1	28.2	28.2	43.4
	Cement (1000 tons)	8.8	11.3	13.9	13.9	22.0
	Steel Tubulars (1000 tons)	12.7	16.4	20.0	20.0	33.3
	Diesel Fuel (In 1000 bbls.)	92.9	119.4	146.0	146.0	247
	Fresh Water (In Million Gal.)	33.3	42.8	52.4	52.4	80
Medium						
	Number of wells drilled	28	36	44	44	48
	Mud (In 1000 tons)	18.0	23.1	28.2	28.2	30.8
	Cement (In 1000 Tons)	8.8	11.3	13.9	13.9	15.1
	Steel Tubulars (1000 Tons)	12.7	16.4	20.0	20.0	21.8
	Diesel Fuel (In 1000 bbls)	93	119	146	146	159
	Fresh Water (In Million Gal.)	33.3	42.7	52.1	52.1	57.1
No						
	Number of wells drilled	28	20	16	8	4
	Mud (in 1000 tons)	18.0	12.8	10.3	5.1	2.6
	Cement (in 1000 tons)	8.8	6.3	5.0	2.5	1.3
	Steel Tubulars (in 1000 tons)	12.7	9.1	7.3	3.6	1.8
	Diesel Fuel (in 1000 tons)	92.9	66.4	53.1	26.5	13.3
	Fresh Water (in million gals)	32.2	23.7	19.0	9.5	4.7

TABLE 9.5

BERTH REQUIREMENTS

YEARS	2	3	4	5	6	7	8	9	10	11	12	13	14
High Find													
Berths	7	9	11	11	16	21	34	45	54	58	58	54	50
Linear Wharf (ft.)	1,400	1,800	2,200	2,200	3,000	3,800	5,400	7,200	9,000	11,000	12,600	13,800	14,600
Medium Find													
Berths	7	9	11	11	12	16	19	32	38	36	27	16	13
Linear Wharf (ft.)	1,400	1,800	2,200	2,200	2,400	3,000	3,400	5,000	6,200	6,400	6,600	6,200	5,800
No Find													
Berths	7	5	4	2	1								
Linear Wharf (ft.)	1,400	1,000	800	400	200								

TABLE 9.6

Wells Drilled, Materials Required For development Wells

	Year After First Lease Sale	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
High											
	Exploratory Wells Drilled	48	48	44	40	40	32	24	16	12	12
	Development Wells Drilled	56	120	176	224	240	240	224	192	112	48
	Mud (In 1000 Tons)	60.2	93.8	120.6	143.3	151.7	146.5	133.0	111.4	67.2	34.6
	Cement (1000 Tons)	31.1	49.5	64.2	76.7	81.3	78.8	71.6	60.1	36.1	18.5
	Steel Tubulars (1000 Tons)	48.6	79.1	103.9	125.1	132.7	129.0	117.8	98.9	58.9	28.4
	Diesel Fuel (In 1000 bbls.)	361	591	777	935	992	965	882	754	469	294
	Fresh Water (In million Gal.)	111	174	223	265	280	271	246	209	130	82
Medium											
	Exploratory Wells Drilled	48	48	44	40	40	32	24	16	12	12
	Development Wells Drilled	24	40	112	144	136	88	32	24		
	Mud (In 1000 Tons)	43.4	51.8	87.0	101.3	97.1	66.7	32.2	22.9	7.7	8.3
	Cement (In 1000 Tons)	22.0	26.6	45.9	53.8	51.5	35.2	16.7	11.9	3.8	4.1
	Steel Tubulars (1000 Tons)	33.2	40.8	73.4	86.9	83.1	56.5	26.2	18.7	5.5	5.5
	Diesel Fuel (In 1000 bbls.)	245	302	546	647	618	420	194	139	40	68
	Fresh Water (In million Gal.)	80.4	95.9	161.0	187.3	179.5	123.4	59.6	42.3	14.3	21.6
No											

Table 9.5 indicates the berth requirements for boats needed to deliver the supplies estimated in Tables 9.3 and 9.4.

The production phase sees a substantial dropoff in activity relative to the development and exploration phases. The principal material requirements are those required for rig operations and for well workover, when the wells are redrilled to maintain pressure and the flow of oil and gas. Well workover will require the following materials:

Drilling Materials Required For Workover Of One 15,000
Foot Well

Mud	41 tons
Cement	25 tons
Steel Tubulars	2 tons
Diesel Fuels	2000 barrels
Freish Water	.52 million gallons

Table 9.7