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Final Environmental Impact Statement

(Final Statement to FEA-DES 77-9)

STRATEGIC PETROLEUM RESERVE

Capline Group Salt Domes

Iberia, Napoleonville, Weeks Island Expansion
Bayou Choctaw Expansion, Chacahoula,

Iberia, Iberville, and Lafourche Parishes, Louisiana

U.S. DEPARTMENT OF ENERGY

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U.S. DEPARTMENT OF ENERGY
Washington, DC 20545

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DETAILED DESCRIPTION OF PROJECT

A.1 INTRODUCTION

A.1.1 Group Description

The Capline Group of five salt domes considered for the SPR program is located in Iberville, Iberia, Assumption, and Lafourche Parishes in southeast Louisiana (Figure A.1-1). The sites were selected for their engineering feasibility, convertible existing storage capacity, accessibility to pipeline and port facilities for crude oil distribution and their overall environmental suitability. For the purposes of this report, Capline salt domes are planned to have a total of approximately 300 million barrels (MMB) of crude oil storage capacity in existing salt mine space and existing and new solution-mined caverns. The group's expansion to an ultimate capacity of 500 MMB is also appraised. The oil would be distributed through the port facilities at St. James, Louisiana, and possibly the Nordix terminal at Sunshine, Louisiana. From these facilities, oil would be distributed to midwest refineries via the CAPLINE Pipeline system and to East Coast, Gulf Coast, and Caribbean refineries by transfer to tankers on the Mississippi River.

The potential storage sites are Napoleonville dome in Assumption Parish, Chacahoula dome in Lafourche Parish, Bayou Choctaw dome in Iberville Parish, and Weeks Island dome and Iberia dome in Iberia Parish. For the early storage phase of the project, up to 94 MMB of storage capacity could be developed in existing leached caverns at Bayou Choctaw, and an additional 89 MMB of estimated existing capacity could be developed in a conventional salt mine on Weeks Island, for a total storage of as much as 183 MMB. Also, the terminal facilities at St. James will be constructed for the early storage phase to accommodate increased oil distribution requirements, and crude oil pipelines will be constructed to the Weeks Island and Bayou Choctaw sites (Figure A.1-1).

Development of the Capline Group to a total storage capacity of approximately 300 MMB would require the further construction of 117 MMB of new storage at one site or at a combination of sites within the group. Four site combinations have been identified: one proposed grouping and three alternatives. Construction of a 150 MMB facility at Napoleonville,

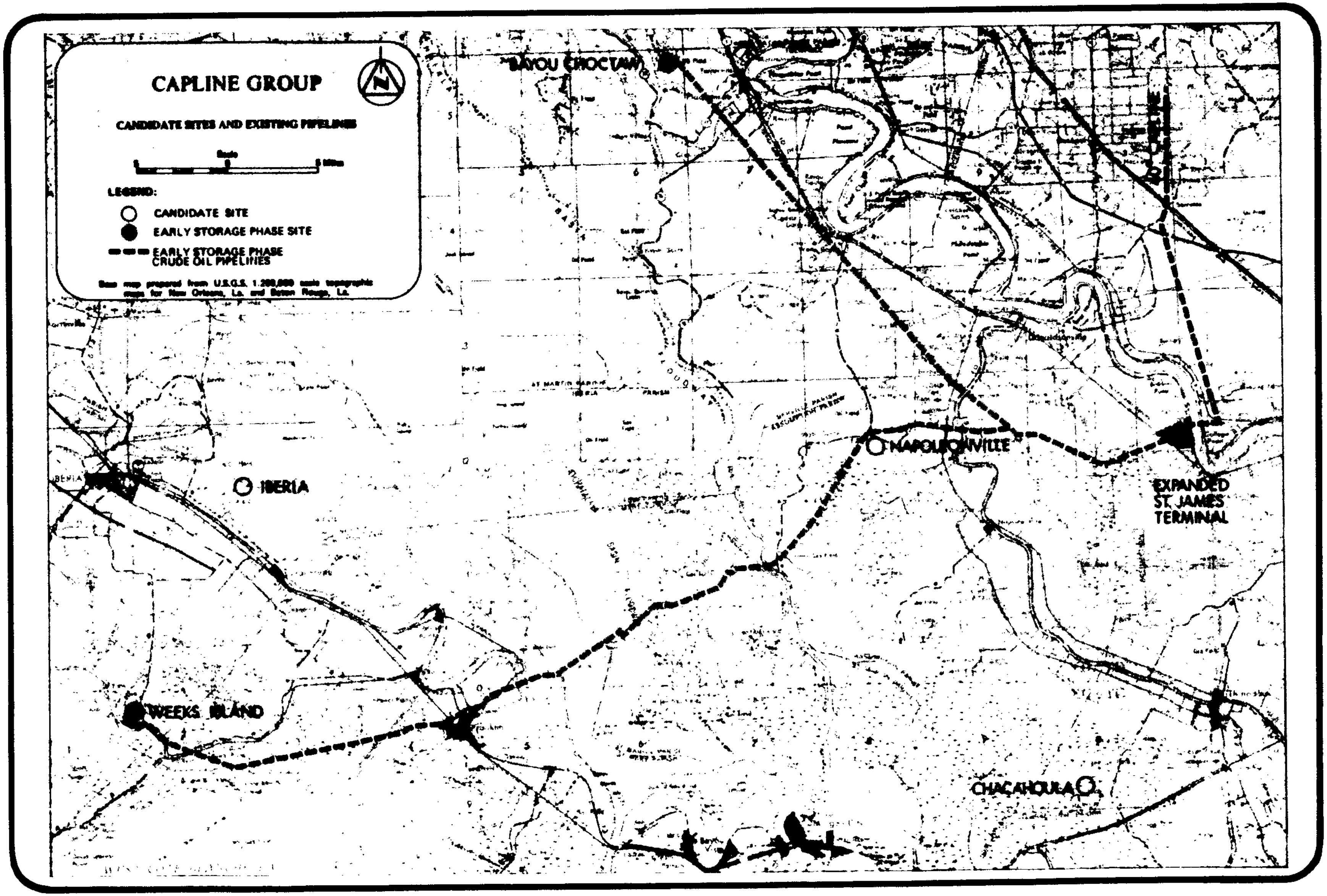


FIGURE A.1-1 Capline Group - alternative sites and existing pipelines.

together with early storage at Weeks Island and Bayou Choctaw is the proposed action, as shown in Table A.1-1. The alternatives are also shown therein. Specific site combinations for a 500 MMB ultimate group capacity have not been identified.

The proposed raw water source for three of the sites is the Mississippi River; Bayou Teche is a possible source for Iberia, and Weeks Island would obtain water from the Intracoastal Waterway. Alternatives include other local sources of surface water, ground water, and the Gulf of Mexico. Three sites would utilize deep-well injection for brine disposal, and the Gulf of Mexico would be the proposed location for brine disposal for Weeks Island and Chacahoula. The Gulf of Mexico is the alternative location for brine disposal for the other domes.

The terminal facilities at St. James would be expanded for the increased capacity of the Capline Group under the expanded SPR program. Expansion would primarily include increased tankage, pumping, and metering capability. An additional dock and surge tankage would also be constructed at another terminal to meet increased throughput requirements.

A.1.2 Presentation Format

Section A.4 of this appendix presents the proposed development of the Capline Group (early storage sites combined with Napoleonville dome) and details the construction and operation of proposed site facilities and their alternatives.

Development alternatives are provided in Sections A.5 through A.7, together with discussion of the proposed and alternative facilities for each development combination. A summary is provided in Section A.8.

Appendices B and C detail the existing environment and anticipated environmental impacts, respectively, for the Capline Group region for each individual site combination and for the 500-MMB ultimate group capacity. Impact discussions include both proposed and alternative facilities for each site combination.

TABLE A.1-1 Site combinations for Capline Group - 300 MMB development.

Combination[a]	Capacity Added (MMB)	System Capacity (MMB)	Report Section No.	Figure Reference No.
Proposed Development- Early Storage Sites plus Napoleonville Dome	150	333	A.4	A.4-1
Alternative No. 1- Early Storage sites plus expansion of Weeks Island Dome	91	274	A.5	A.5-1
Alternative No. 2- Early Storage sites plus expansion of Bayou Choctaw Dome plus Iberia Dome	106	289	A.6	A.6-1
Alternative No. 3- Early Storage sites plus Chacahoula Dome	200	383	A.7	A.7-1

[a]Early Storage sites include Weeks Island Dome (89 MMB) and Bayou Choctaw Dome (94 MMB) for a total of 183 MMB.

A.2 CONCEPT OF STORAGE IN SALT DOMES

It has long been recognized that caverns in salt domes are attractive storage sites for petroleum products due to both the relative low cost of bulk storage and the geological stability of deep rock salt masses. The formation of salt domes in the Gulf Coast region and the geological properties of the domes are discussed fully in the SPR Programmatic Environmental Impact Statement (FES-2). The single property of salt that makes it most attractive for crude oil storage is its in situ impermeability. No other common rock type could contain crude oil as safely. In addition, underground salt domes provide security from natural catastrophies or sabotage.

Salt domes are a major source of brine feedstock for the chemical and salt industries in the Gulf region. The salt in the domes is removed by conventional mining techniques or by solution mining. In the solution mining process, salt is dissolved by injecting raw water into the dome, and allowing the water to leach (or dissolve) the salt (Figure A.2-1). The resulting brine is then displaced by injecting more raw water. Solution mining of a salt dome requires that about 7 barrels of fresh water, or about 8 barrels of sea water, be used to leach one barrel of cavern space.

Caverns may be mined specifically for use as storage of petroleum products rather than as a by-product of obtaining brine feedstock. Expansion of the SPR Program storage capacity will use the same solution mining (leaching) method that has created many existing caverns except that the brine created will exceed the needs for feedstock and will be disposed of to the environment. To store petroleum products in the caverns formed by the leaching of the salt, the products would be injected into the dome to displace the brine (Figure A.2-2).

During an oil supply interruption, the oil would be withdrawn from the cavities (Figure A.2-3). The crude oil would be distributed to refineries by the CAPLINE Pipeline and tankers from the dock facilities on the Mississippi River. The raw (displacement) water would also dissolve the walls of the storage cavities, enlarging them somewhat.

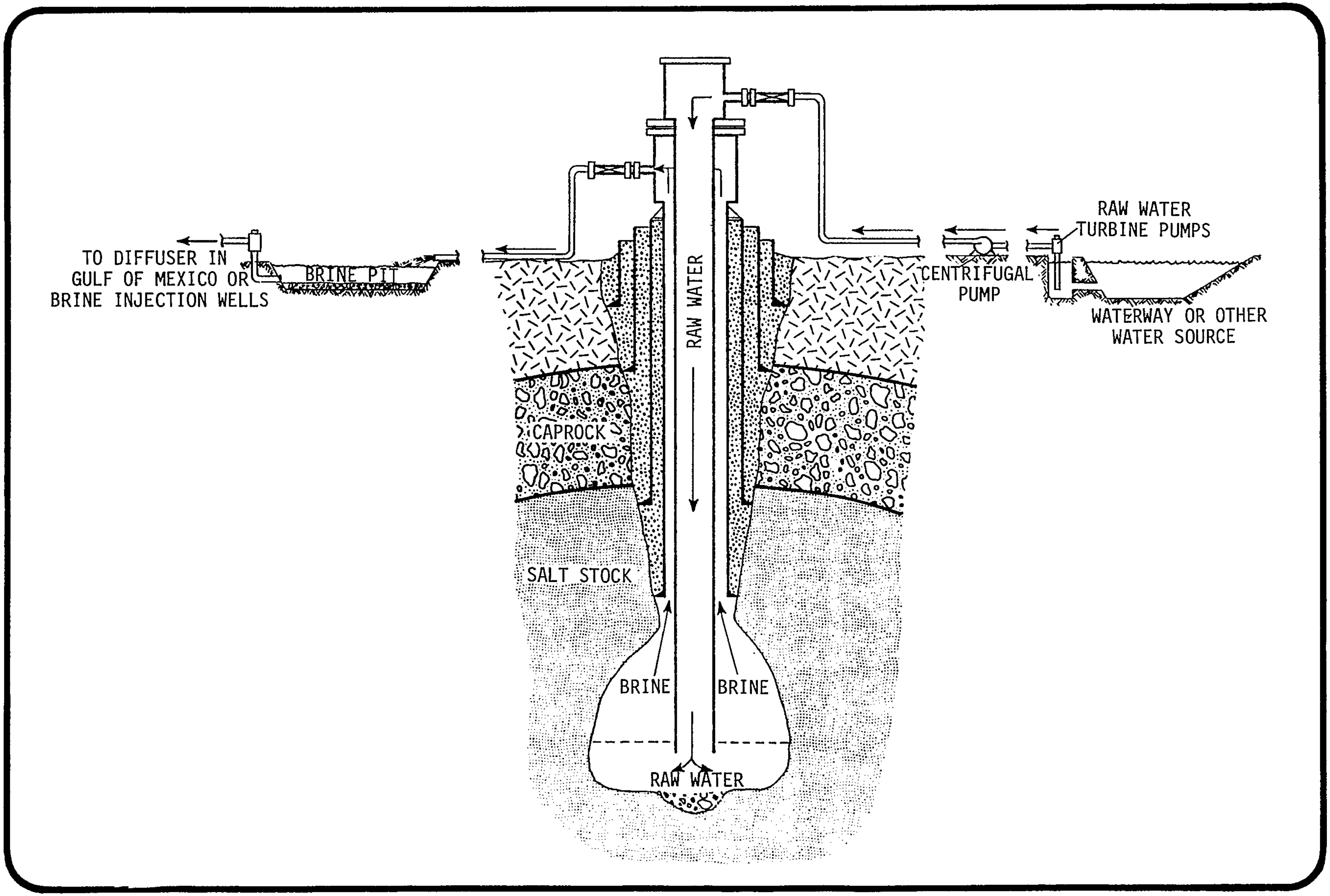


FIGURE A.2-1 Representation of solution mining cycle

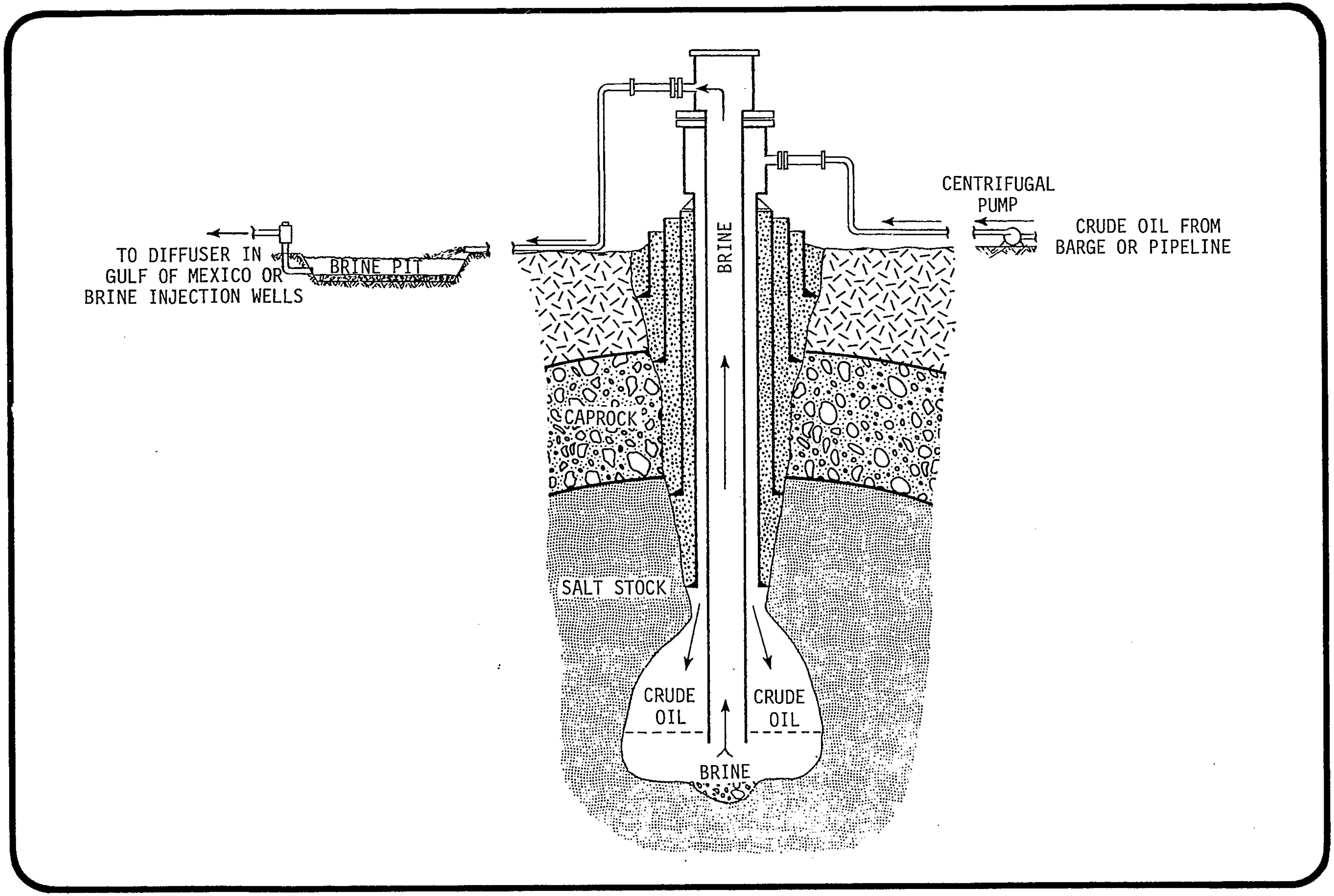


FIGURE A.2-2 Representation of oil storage cycle.

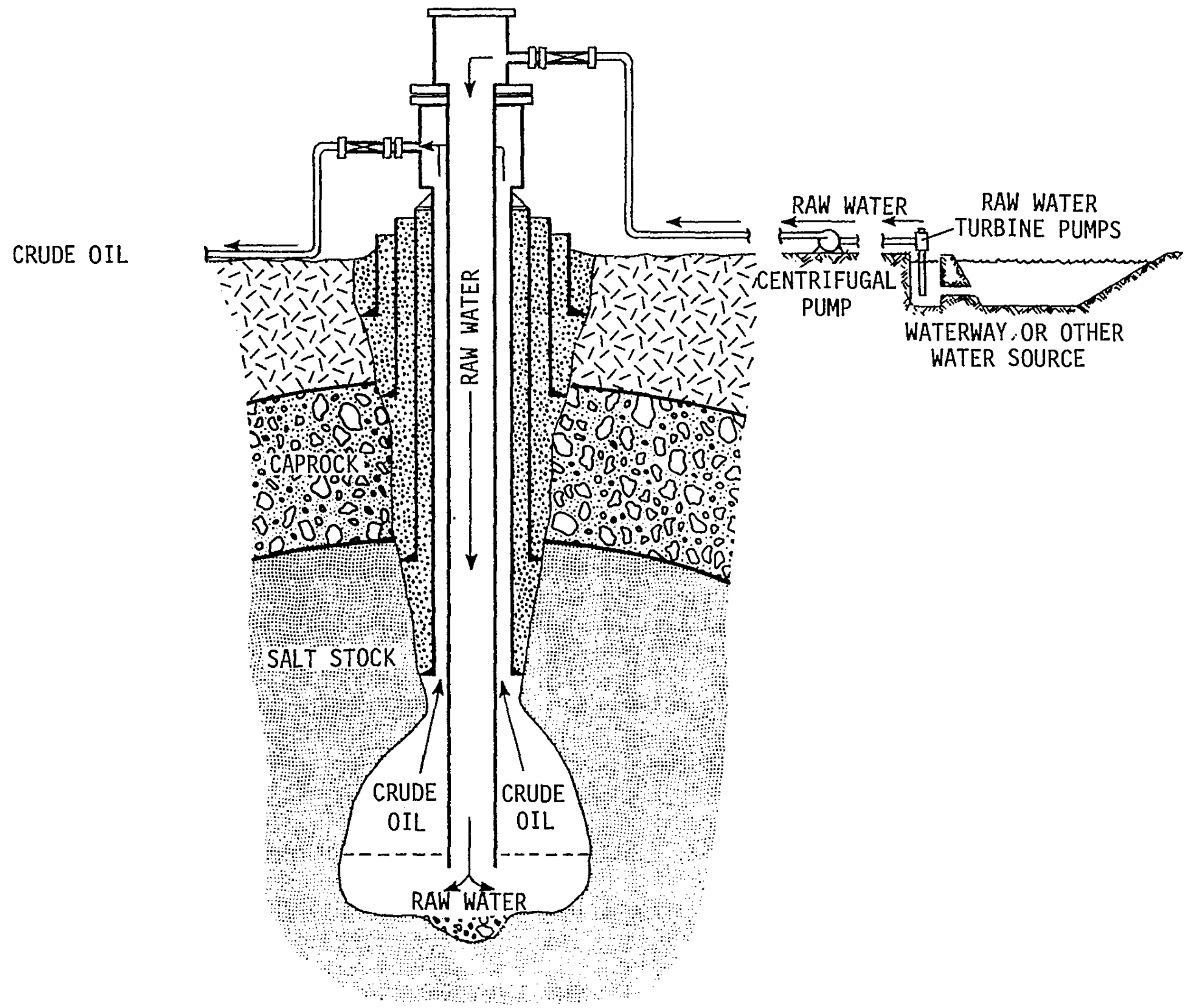


FIGURE A.2-3 Representation of oil withdrawal cycle.

Although crude oil storage in salt dome caverns does not present particular technical problems, the technique has been utilized primarily in other countries. In the United States, the products stored in salt dome caverns have largely been fuel oil and LPG products such as propane and ethylene.

A.3 GENERAL CONSTRUCTION AND OPERATION TECHNIQUES

This section describes those construction and operating procedures and methods that are common to all potential storage sites. Site-specific procedures and methods are described in Sections A.4 through A.7.

A.3.1 Generalized SPR Site Facilities

The storage system at each SPR site would consist of a series of caverns. New caverns would be leached to a capacity of approximately 10 million barrels. Existing caverns that would be converted for oil storage would be a combination of conventionally mined caverns or galleries and solution mined (leached) caverns that have been developed to obtain brine as feedstock for chemical plants. In the case of a solution mined facility, the oil storage cavern (basically a large subterranean pressure vessel connected to the surface by at least two vertical pipelines) usually contains both oil and brine. If oil is pumped into one of the pipelines, brine will come out of the other (or vice versa). Because oil will float on brine, the oil pipeline must connect to the top of the vessel and the brine line must connect to the bottom. In conventional mining, pumps are installed at the bottom of the mine to withdraw the oil.

Control of cavern construction and oil storage withdrawal operations would be established in a central pumping plant area, and each cavern would be linked to the central plant by electronically controlled valves and by oil pipelines plus water and brine lines as appropriate. All controlling, monitoring, and metering operations would be performed in the central plant area at the cavern storage sites. General operations associated with a storage site are shown in the schematic drawing in Figure A.3-1.

Where required, raw water for cavern leaching and for oil displacement during withdrawal would be supplied to each site from an off-site source. A pipeline would connect the water source to the plant area. Sources of raw water could include nearby streams or other bodies of relatively fresh water, subsurface aquifers containing either fresh or brackish water, or sea water from the Gulf of Mexico.

Both cavern leaching and crude oil storage in leached caverns require disposal of displaced brine. Brine would be piped to the Gulf of Mexico

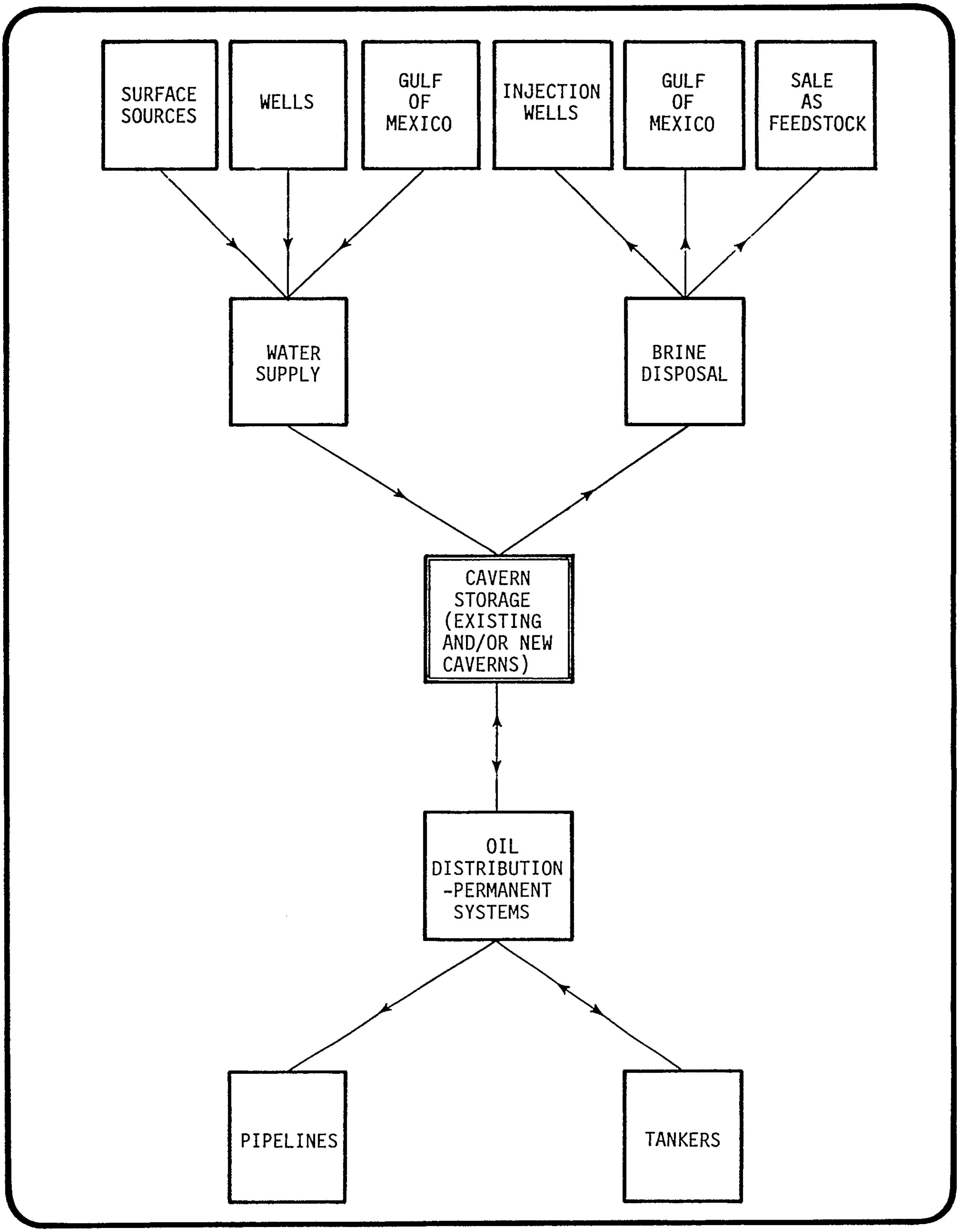


FIGURE A.3-1 Schematic of crude oil storage systems.

or to subsurface disposal injection wells. Depending on factors such as proximity to potential users, some brine could also be sold as feedstock to chemical plant operators.

Oil distribution would be handled through a regional facility and pumped via pipeline to each storage site. During withdrawal, oil would be pumped to the regional facility where transfer to tankers or pipeline would be made. Crude oil entering storage would be received from the regional facility.

A.3.2 Cavern Storage System

A.3.2.1 New Cavern Construction

A.3.2.1.1 General

As was stated previously, new caverns would be formed by solution mining the salt domes. This section describes the general techniques used in the construction of new caverns. Detailed descriptions of construction processes are presented in subsequent sections.

Prior to commencement of actual leaching activities, an entry well must be drilled. It is planned that conventional oil well drilling rigs would be used for this purpose. Well diameters are determined by the desired leaching or oil withdrawal rate, where the rate of oil withdrawal is based on emptying the cavern within 150 days.

During the drilling process, the casing string would be placed and grouted in the borehole to provide a sealed passage between the salt dome and the surface. Telescoping casing strings would be used, the largest casing being approximately 42 inches in diameter. Outer casings would use cement as the grouting material to prevent leakage into the caprock and to protect freshwater and brackish aquifers from contamination by brine or oil (Figure A.3-2). Cementing would also serve to stabilize the casing against possible movement and damage. After the drill hole penetrates through the dome caprock, a minimum additional five hundred feet would be drilled into the salt before the final casing would be placed and grouted. The bottom of the casing would be the location of the top of the cavern to be developed. Drilling then proceeds to the

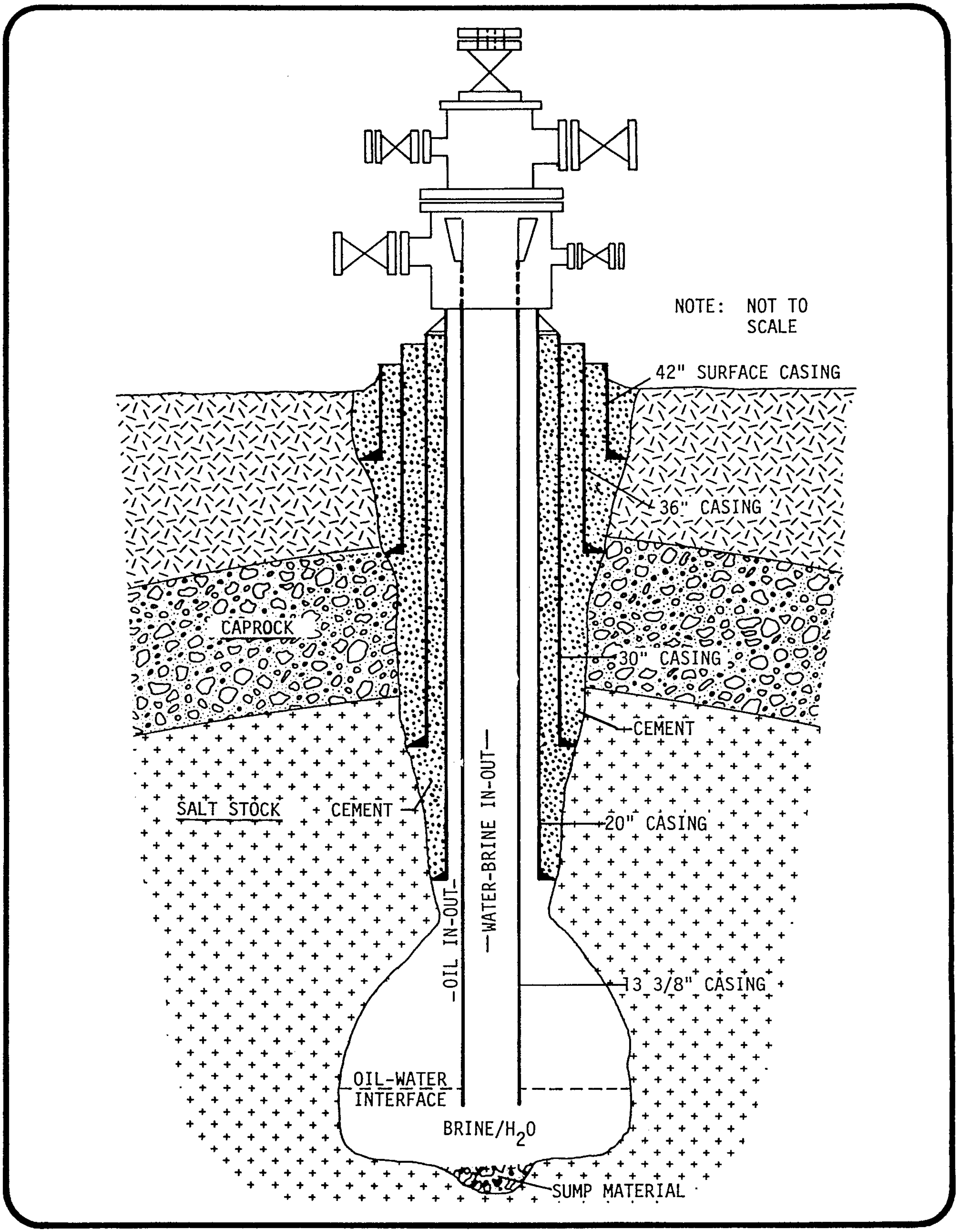


FIGURE A.3-2 Typical storage well casing diagram.

bottom of the sump. (A sump is an extension of the cavern that provides a place for insoluble material to stay in the cavity and not impair operation as a storage cavern.)

The drilling equipment would then be removed and the strings of pipe used for leaching inserted. Pipe strings for leaching would consist of two pipes of different diameters which would be placed concentrically in the well. The larger diameter pipe would extend just below the top of the proposed cavern ceiling. The smaller inner pipe would extend to the bottom of the drilled well. Each well would require 60 to 90 days of rig time for preparation for leaching. During leaching operations, a smaller, more portable workover rig would be used to adjust casings for proper leaching.

Leaching a storage cavity of the desired size and shape would be accomplished by varying the rate of raw water input and the positions of casings within the well. Blanket oil would be installed on the brine surface when necessary to restrict the ceiling of the cavity from further upward migration. The finished cavern would be approximately 1000 feet in height and 300 feet in diameter, with a conical sump about 400 feet deep at the bottom. Each cavern would require about 24 months to be leached to a 10 MMB capacity.

In an estimated 20 percent of the wells drilled, difficulty in drilling through the caprock overlying the salt is expected. Difficulty results when cavernous zones are encountered in the caprock. The cavernous zones derive from natural leaching of the anhydrite and gypsum layers during formation of the salt dome and may require the installation of a smaller casing to get through the caprock. The smaller casing would reduce the flow rates obtainable during oil withdrawal, and less oil could be removed during the 150-day withdrawal period. The cavern would therefore be leached only to the capacity which could be withdrawn in 150 days, or about 5 to 6 MMB.

Drilling muds utilized at each cavern site would be self-contained within each site using mud tanks or mud pits for storage. At completion of each well, the mud would be removed for reuse at other wells or hauled away for disposal. Mud pits would then be buried.

Newly developed caverns will have a design capacity of 10 MMB, although approximately 20 percent of the caverns will have reduced capacities resulting from drilling difficulties. With each oil fill and withdrawal cycle, up to five of which are anticipated over the life of the project, the capacity of the cavern will increase, resulting in an ultimate capacity of approximately 20 MMB. As discussed above, the entry well diameter and casing size are determining factors in the rate of oil fill and withdrawal. It is planned that each cavern will only be refilled to its original design capacity and that water introduced to force the oil out will remain in place to fill the excess capacity.

An 800-foot design spacing of storage cavities has been selected which for 300-foot diameter caverns, would allow a minimum of 500 feet between adjacent walls. A distance of 600 feet would be allowed from any cavity to the estimated extremity of the dome flanks. A minimum salt barrier of 500 vertical feet would be provided between the ceiling of each storage cavity and the caprock.

Existing leached caverns (i.e., Napoleonville) would potentially be utilized and would require inspection, testing, and conversion prior to inclusion in the storage program. Inspection and testing of existing caverns would include both the well apparatus and the cavern itself. Surface equipment and casing string integrity would be inspected using conventional techniques. Through these procedures, all equipment would be measured for wear and corrosion and checked for soundness and leakage. Casing strings would be pressure tested to an appropriate safety factor above working pressure. A sonar caliper survey would be performed on each cavity to record actual existing size and shape, and proximity to other existing and/or proposed caverns would be computed.

Conversion procedures would depend on the type and size of existing casing and surface equipment. Caverns with sound, adequately sized casing would require only installation of equipment for crude oil displacement and connection to water, brine, and oil pipelines. Other caverns would require more substantial conversions, possibly including the drilling of new entry wells to provide adequate flow rates.

A.3.2.1.2 Cavern Development

Underground caverns used for storage of crude oil can be of two basic types, solution-mined construction or conventionally mined. A solution-mined storage cavern is basically a large subterranean pressure vessel, connected to the surface by at least two vertical pipelines and usually contains both oil and brine. If oil is pumped into one of the pipelines, brine will come out of the other (or vice versa). Because oil will float on brine, the oil pipeline must connect to the top of the vessel and the brine line must connect to the bottom. To insure stability of the cavern, it is maintained in a continuously filled condition (either brine or oil or both), with the contents under an externally applied pressure.

A completed solution-mined cavern usually has a cased borehole terminating at the roof of the cavern and a suspended pipe terminating near the floor. Water or brine is inserted into the suspended pipe to displace oil upward through the borehole annulus during withdrawal of oil from storage. During filling, oil is pumped into the annulus forcing brine to surface through the suspended pipe (see Figure A.3-3). During withdrawal, fresh or saline water is injected into the cavern to displace the stored oil, as a result the cavern walls are dissolved and brine is formed.

Oil storage caverns constructed using conventional mining methods are designed with internal support provided by salt pillars, a technique not available with solution mining. The maintenance of a continuously filled condition is therefore not required for cavern stability. A single vertical pipeline extending to the bottom of the cavern is used as both the fill inlet and pump sump for withdrawal of oil. No brine is produced by conventional mined storage.

Size Relationship - Borehole Versus Cavern Size

Salt dome caverns are usually leached through single boreholes. The size of those boreholes has a significant effect on both the rate of cavern development and on the usefulness of the completed caverns. Many

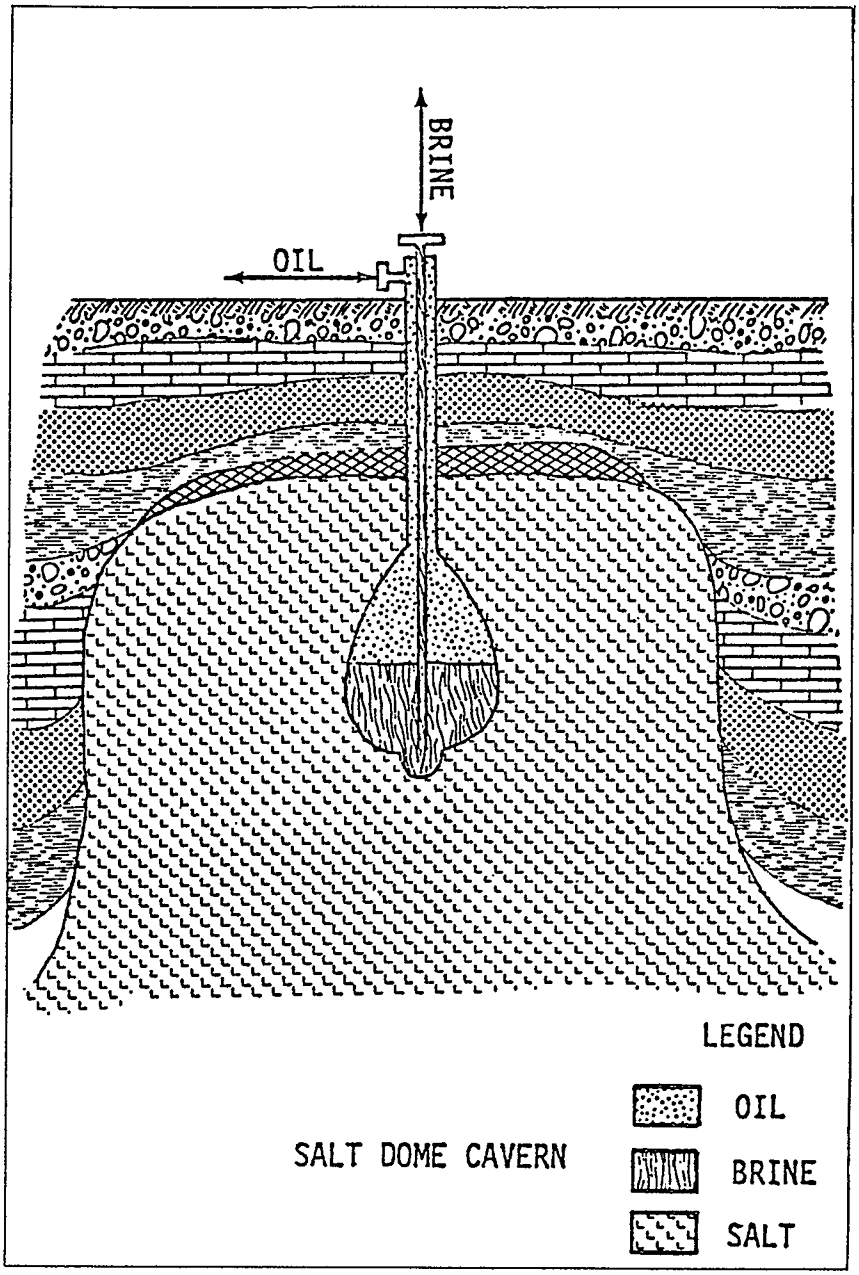


FIGURE A.3-3 A typical storage cavern.

commercial caverns storing LPG could meet operating requirements through cased boreholes as small as nine inches, yet have been developed through holes as large as 12-1/2 inches to facilitate rapid leaching.

The proposed strategic storage system presents a unique combination of criteria. Unlike commercial facilities, the stored product will rarely, if ever, be cycled. DOE has directed that caverns be designed to tolerate enlargement caused by fresh water displacement of oil during five cycles of storage. The basic objective is to develop the cheapest possible system capable of delivering its contents within a period of 150 days. Since solution mining is very sensitive to scale, this objective could be achieved by developing each cavern to the maximum capacity that could be emptied through its borehole during the prescribed period. There is, however, the consideration that to receive public acceptance and to expedite regulatory approval, the strategic storage cavern design must be based on proven technology.

A limit of 20 million barrels was selected for the final cavern, a size approximately equivalent to the largest salt dome caverns now used for brine production. The initial cavern size that would permit five cycles of storage without exceeding 20 million barrels was calculated and an initial volume of 10 million barrels was selected. A 10 million barrel cavern cycled five times with fresh water and refilled each time with 10 million barrels of oil would grow to a size of about 18.6 million barrels. If refilled to its maximum capacity after each cycle, it would grow to about 22.1 million barrels. Design criteria for these caverns is presented in Appendix F.

Because of the DOE criterion that a cavern would be refilled only to its original capacity after each storage cycle, the borehole delivery requirement would be only 10 million barrels in 150 days, regardless of how large the cavern grew. This objective can be achieved in most cases through a 15-inch cased borehole. The mining rate for solution-mined caverns would, however, require that 20-inch casing be used. If drilling difficulties are encountered in the often unpredictable caprock, it is sometimes necessary to set a string of 15-inch casing to complete the hole.

Thus even with the anticipated 20 percent likelihood of drilling difficulty, the oil withdrawal rate would not be altered. A related standardization adopted as part of the design is a maximum rate of brine discharge of 3000 gallons per minute for the 20-inch borehole, permitting a rate of cavern enlargement of approximately 15,000 barrels per day. This rate represents a point on the power consumption curve where the cost c accelerating flow may exceed the savings from accelerating leaching.

Leaching Well Design

Storage wells are drilled with "oil field" type rotary drilling procedures. A rotary bit is connected to surface by pipe. The bit supports the lower portion of the pipe, thereby deriving the downward thrust necessary to penetrate the rock. The lower portion of pipe - a series of drill collars - is very stiff, heavy, and resistant to buckling. The upper pipe - known as drill pipe - is kept in tension and consequently can be much more flexible.

Most drilling is done by rotating the bit with torque transmitted from the surface through the drill pipe and collars. Bits generally consist of three rolling cones, each serrated with short, husky teeth. As each tooth is presented against the bottom of the hole, a small chip is fractured away from the parent rock.

For drilling to proceed, chips must be transported from the face of the cutters to the surface. This is accomplished by pumping a fluid, known as mud, down the pipe to the bit where it exists, picking up the cuttings and carrying them to the surface through the borehole annulus. Besides transporting cuttings, the mud also cools the bit and supplies a stabilizing pressure to the borehole walls.

Many sedimentary rocks are so weak that they would cave if mud support were not available. Maintaining the proper composition and quality of mud is a critical factor in any drilling program. The wrong mud can cause hydration of shales, dissolve salt, slow drilling penetration, cause walls to fail and pipes to stick, and numerous other problems.

Regardless of how good the mud is, however, circulation must be maintained if the mud is to do its job. Many rocks are porous, permeable, and contain fluids existing at pressures less than that of the borehole mud. Consequently, the mud must be able to seal the walls of the hole or it will flow into the rock rather than back to the surface. Although the drilling industry has developed muds for almost every drilling condition, vugular or cavernous structures occasionally defy sealing, and circulation fails.

If the uncased borehole is composed of competent rocks when circulation is lost, the driller can utilize many materials including cement to seal the loss zone. In some instances, he may be able to proceed with drilling by sacrificing his mud and allowing cuttings to be deposited into the loss zone. If he can tolerate a reduction in hole size, he may choose to place steel casing across the zone.

The leaching well design established for this study is considered relatively conservative. Most of the problems encountered in drilling into salt domes have stemmed from the unpredictability of caprock. Adjacent holes in the same dome may behave quite differently from one another. One may permit strong circulation throughout drilling and cementing, while the other may prove so troublesome that an extra casing string must be set to achieve completion. The standard design must be conducive to successful completion, even under relatively difficult conditions. A possible design is shown in Figure A.3-2.

If circulation problems develop while drilling the caprock, the driller may choose from a number of options. He may try to reestablish good circulation by blending filler materials into the mud, attempt to advance to the projected casing point in the salt by drilling without fluid returns using brine injection, or try to seal the void with cement. If all else fails, he may attempt to set the 20-inch casing through the problem zone, and if successful, proceed to set 15-inch casing into the salt.

Regardless of his tactics, his drilling fluid, be it mud or brine, must be saturated with salt before penetrating the top of the salt mass. If the salt is drilled with unsaturated fluid the borehole will enlarge, causing problems in maintaining directional control, tool joint failures from buckling of the drill collars, and difficulties in obtaining good cementation of the product casing.

The cementing program should be designed to raise the cement column well into the 30-inch pipe. In most instances, it would be unadvisable to attempt cementation to surface in a primary stage. If full cementation is deemed imperative, a stage collar should be installed as the 20-inch casing is run to permit secondary cement placement after the primary stage has hydrated. If the hole has been completed without mud circulation, special nitrogen procedures may be required to achieve primary cementation into the 30-inch pipe.

Leach-Then-Fill Cavern Construction

The fundamental technique of cavern development is to expose the salt in a drilled hole, inject raw (fresh or low salinity) water into the hole, allow time for the water to dissolve the salt, and displace the resulting brine from the hole. The hole enlarges as the salt dissolves, eventually forming a cavern. In actual practice, the procedure for cavern development is somewhat more complex as described in the following paragraphs.

Raw water injected into a cavern makes contact with salt by circulation and diffusion. Circulation is the dominant factor, being caused by both density and pressure differentials. Being lighter than brine, injected raw water tends to rise, causing a "rolling" effect throughout the cavern. This agitation is responsible for the major portion of the dissolution. During the initial leaching effort, the pressure differential between points of fluid entry and exit establishes the direction of fluid movement across the salt face. As the cavern grows, the rolling effect may cause fluid at the salt face to move in the opposite direction.

Two basic washing methods - direct circulation and reverse circulation - are normally used. Direct circulation is more common, involving injection of raw water near the bottom of the cavern and withdrawal of brine through the casing annulus near the top of the cavern. In reverse circulation, water is injected down the casing annulus and enters near the top of the cavern, displacing brine into the tubing at the bottom of the cavern. Both methods employ the same drilling and casing procedures.

When direct circulation methods are used, the maximum diameter occurs near the bottom of the cavern interval and the minimum diameter forms near the top. The reverse circulation method causes development of a large diameter cavern roof, with the diameter decreasing toward the bottom of the cavern, resulting in the so-called "morning glory" type cavern.

To construct large caverns for most storage purposes, modified techniques using direct circulation initially, reverse circulation during primary leaching, and blanket material for control of upward growth are used. Casing strings would not be moved during cavern leaching.

Blanket material is any noncorrosive, lighter than water substance (gas, propane, butane, diesel oil, crude oil) which occupies the space in the topmost interval of the cavern. The purpose of blanket material is to prohibit leaching of salt from around the cemented casing. It also protects the casing from internal corrosion and can be used to initially depress leaching to the bottom of the borehole for construction of a sump.

The protective blanket is extremely important, requiring careful monitoring and maintenance. Protection of cemented casing serves the dual purpose of insuring a pressure-tight cavern and prohibiting development of high spots from which the stored product could not be retrieved.

Some insoluble material is present in most salt. As leaching proceeds, an accumulation of insoluble material builds up in the bottom of the cavern, sometimes plugging the wash pipe. This condition can be rectified if a small cavern is first leached below the storage interval. The pipe is then raised to wash the major cavern, allowing solids to accumulate in the sump.

The above techniques would be utilized for all caverns, using the casing configuration shown in Figure A.3-2, with an inner string of 8-5/8-inch casing installed for leaching. After approximately two years of leaching, the cavern would be fully formed, the 8-5/8-inch casings would be removed and the filling cycle begun. By sequencing the leaching and filling operations at a storage site, relatively uniform leach and fill could be achieved.

Leach/Fill Cavern Construction

A modified technique which permits the entire cavern interval to be leached without moving the tubing strings is proposed for the SPR program. The procedure involves setting blanket casing in the lower half of the cavern interval, maintaining the blanket at the final cavern roof elevation, and injecting raw water into the lower portion of the cavern. The entire interval would be leached simultaneously, yet saturated brine can be withdrawn from the bottom of the cavern. This method would be very efficient (see Figure A.3-4).

The modified leaching procedure would also permit the upper portion of the cavern to be used for cyclical storage while leaching continues. Stored product would be used as blanket material and the blanket level is lowered or raised as dictated by the storage cycle. During storage periods the lower portion of the cavern would continue to enlarge. The upper portion would be enlarged by removing the blanket material (crude oil). By introducing raw water at the correct depth, balanced cavern growth could be achieved.

To develop caverns by this method, conventional oil field techniques would be used to drill a hole to about 500 feet below the projected cavern floor. Casing would be cemented from the surface to the projected cavern roof, at least 500 feet below the top of the salt. Blanket casing would be suspended to the projected floor and concentric tubing suspended to the bottom of the hole. Oil would be placed in the hole around the blanket casing and raw water injected down the tubing. Brine would be withdrawn from the blanket casing, thereby leaching the lower portion of the sump. A few joints of tubing would then be removed and the direction of water/brine flow is reversed. Brine of increasing salinity would be produced until the sump is of sufficient size to handle anticipated insoluble material.

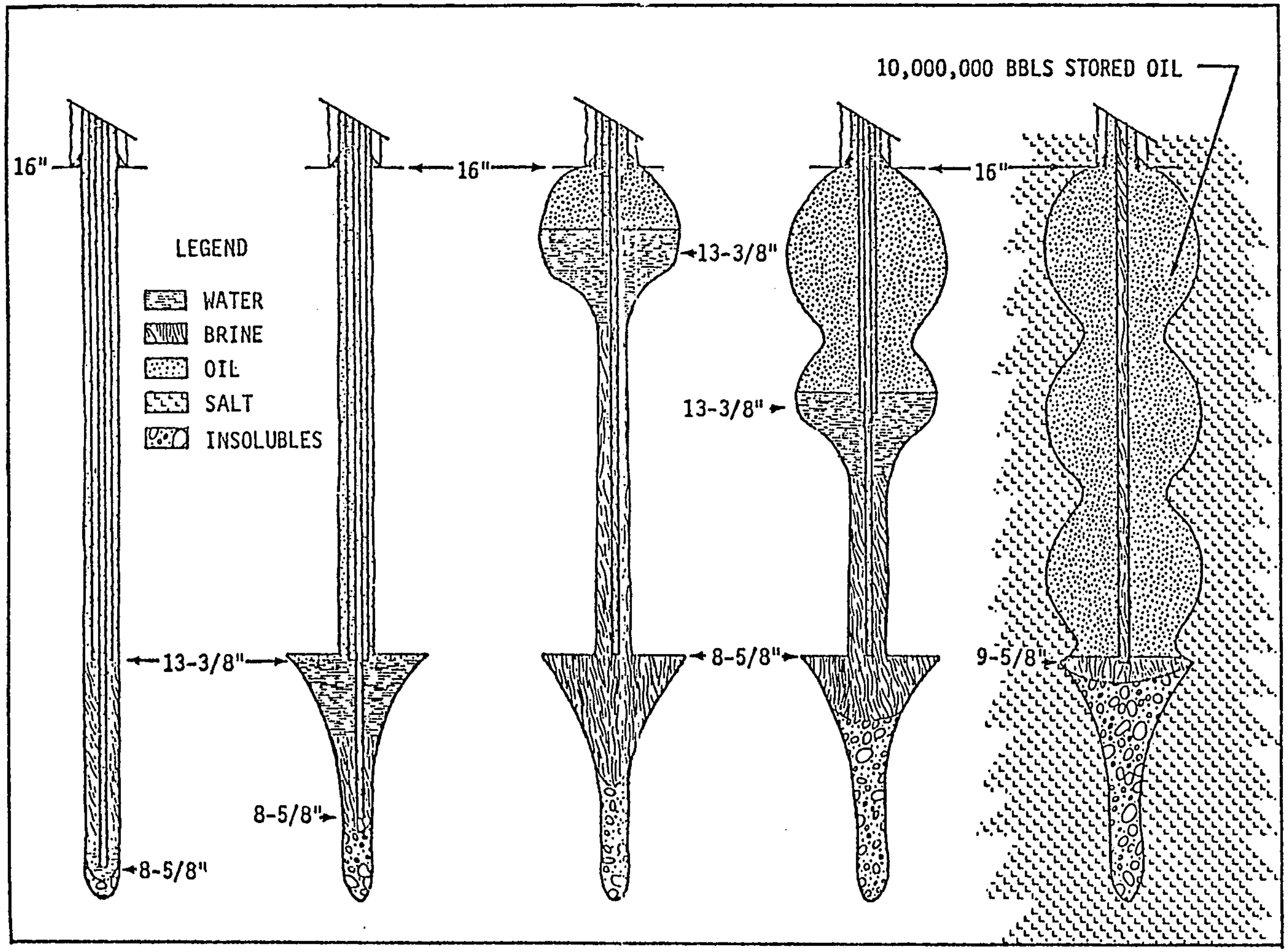


FIGURE A.3-4 Concept for commencing storage while leaching.

After completion of the sump, the oil (blanket material) is withdrawn to the elevation of the projected cavern roof and blanket casing relocated at a point about 170 feet below the oil. Tubing is relocated at the top of the sump. Raw water would be injected down the tubing and unsaturated brine withdrawn from the blanket casing until the borehole has been enlarged. Flow direction can then be reversed, causing raw water to enter the cavern at the base of the blanket casing and saturated brine to be withdrawn from the tubing. Blanket oil would be added as required until the cavern roof reaches a diameter of about 140 feet. The cavern would then be ready for acceptance of stored crude oil at a rate equal to the rate of cavern enlargement.

When the oil-water interface approaches the bottom of the blanket casing, the casing must be repositioned to a point about 500 feet below the roof of the cavern. When the oil-water interface approaches that point, casing would again be repositioned, this time to a point about 840 feet below the roof. Leaching would continue under that condition until the designed volume of 10 million barrels has been developed. The two suspended pipes are then replaced with a single string of 9-5/8-inch casing reaching to the top of the sump. The final increment of oil required to bring the total to 10 million barrels would be added and the cavern would be complete.

The cavern's actual shape would depend on the rate and regularity of oil additions, physical characteristics of the salt, and field decisions regarding leaching procedures. Assuming reasonably steady conditions, a trilobed cavern with a maximum diameter of about 330 feet would be expected. More lobes of smaller diameter could be developed if the suspended pipes were repositioned more frequently.

The preceding descriptions called for raw water to enter the cavern at a point below the oil-brine interface. Thus, gravity stratification of oil over water would not be disturbed and no significant agitation would occur to mix the oil with water. Since the types of crude that will be stored or their tendencies to emulsify with brine is not known, a standardized design that would minimize the risk of emulsification would be used.

A different procedure using fewer pipe movements and resulting in an almost cylindrical cavern might be possible with specific types of crude oil. If laboratory testing demonstrated that a particular crude did not tend to emulsify, or that an emulsion quickly broke under cavern conditions, it might be practical to allow the raw water to fall through the oil. Thus, the following procedure could be used to develop the configuration shown in Figure A.3-5.

The sump would be completed as described in the preceding technique. The oil blanket would then be withdrawn to the elevation of the projected cavern roof and blanket casing relocated to that point. Tubing would be repositioned to the top of the sump. Raw water would be injected down the tubing and unsaturated brine withdrawn from the blanket casing until the borehole has been enlarged. Flow direction would then be reversed, causing raw water to enter at the projected roof of the cavern and saturated brine to be withdrawn from the tubing. Blanket oil would be added as required until the cavern roof has reached a diameter of about 270 feet.

The cavern then would be ready for acceptance of stored crude oil at a rate equal to the rate of cavern enlargement. If oil were added at about the same rate that leaching occurs, a relatively cylindrical cavern should develop. Water would be moving rapidly enough down the blanket casing to keep oil from rising into that annulus and consequently, water injection pressure would be essentially the same as would be required in the earlier standardized design.

Startup pressure following any stoppage of water injection would be much higher, however, for oil would rise into the annulus during the lull. Following completion of leaching, the two suspended strings of pipe would be replaced with a single string of 9-5/8-inch casing run to the top of the sump.

Selected Cavern Development

Either the leach-then-fill or leach/fill cavern development technique could be used for the SPR program. However, the leach/fill design has

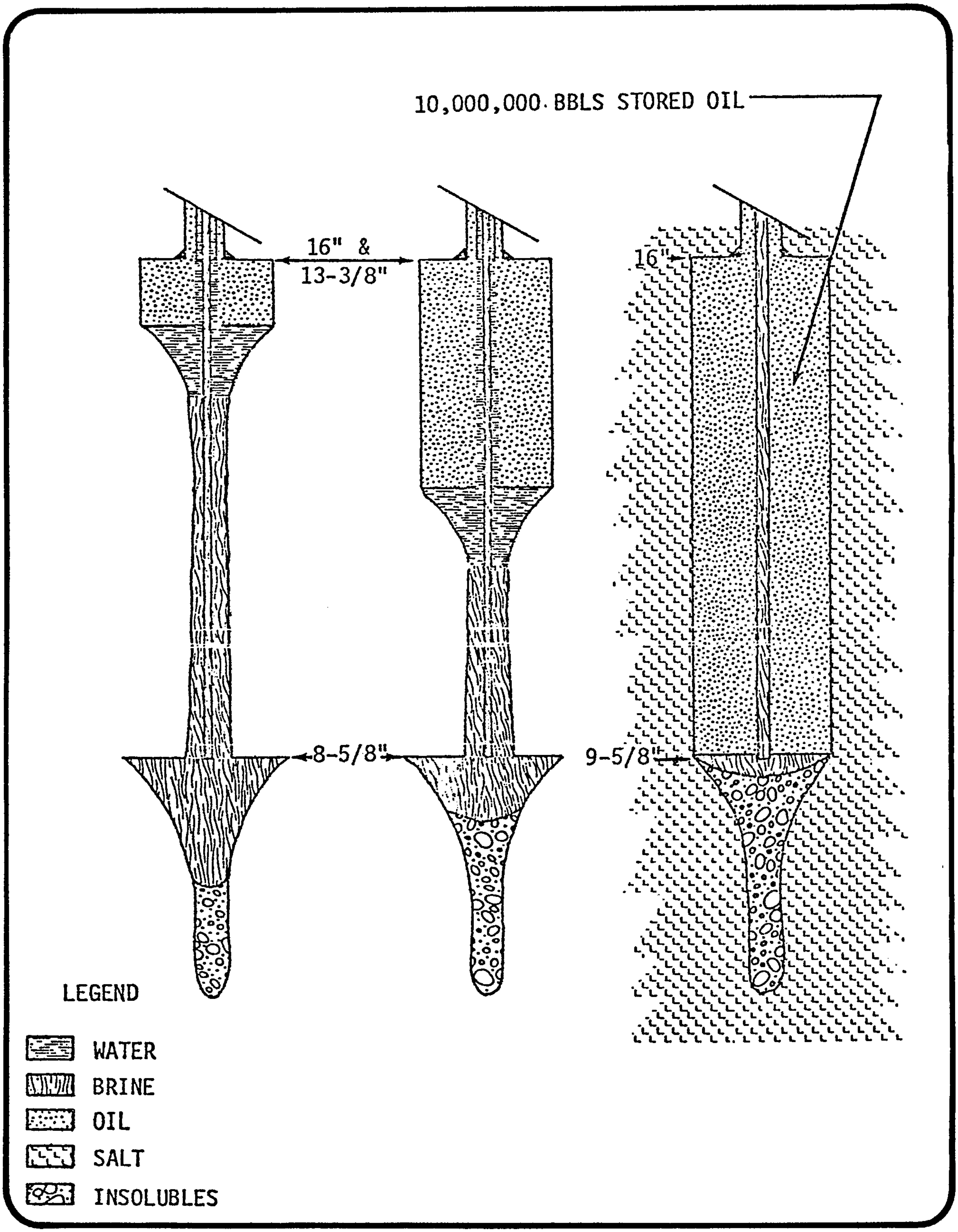


FIGURE A.3-5 Alternate concept for concurrent leaching and storage.

not been widely used for crude oil and would require special precautions. If crude oil is injected into a cavern during the period of cavern development, the oil-brine interface is always in reasonable proximity to the active leaching zones. Raw water dissolves the walls of the cavity, becomes brine, and is displaced out of the cavern. If crude oil becomes mixed with the brine due to the agitation caused by injection, it may be forced out of the cavern with the brine, resulting in the release of hydrocarbons to the environment. If the leach/fill method is used, it will first be tested to determine if hydrocarbon levels can be maintained at low levels that would not be harmful to the environment. It should be noted that leach/fill technology is being used successfully in West Germany for the creation of a storage facility.

Average oil injection and water supply rates over the course of the cavern construction phase for the simultaneous leach/fill process would be somewhat less than those required for the separate leach-then-fill process. Therefore, average brine disposal rates during cavern filling using the leach/fill process would be less than when using the leach-then-fill process. Average brine disposal rates for either process during cavern leaching would essentially be the same. Because of the higher exchange rates of raw water and brine, the separate leach-then-fill process would present the worst-case for environmental impact consideration, and it is this more extreme case which is assumed in the document for environmental impact assessment purposes.

Initial Fill

Crude oil to fill the SPR storage cavities will arrive at the Mississippi River terminals via tank ship. The terminal areas currently can handle ships up to 80,000 dead weight tons (DWT), about 450,000 barrels. It is presently anticipated that Very Large Crude Carrier (VLCC) tankships would transport oil from distant sources to the Gulf of Mexico. There, the oil would be lightered into 80,000 DWT tankers which would offload at the terminals. The oil would be pumped to the DOE terminal, from which it would be transported to the storage cavities. Surges in the oil distribution system would temporarily be stored in tanks at St. James. The oil would be metered at the dock and also at the storage site for discharge detection purposes. One of these measurements would provide data necessary for U.S. Customs requirements.

An automated crude oil sampling system would accumulate an approximate 20 gallon representative sample for each batch of crude oil off-loaded. These samples would be gathered proportionally through the entire batch, and would be analyzed for percentage content of basic sediment and water (BS & W). As a part of custody transfer procedure, the percentage of BS & W will be deducted from the temperature- and pressure-corrected batch volume (gross 60^{0}F volume) to yield a net volume for the crude oil batch. After gauging, the oil would be transferred from the surge tankage to storage caverns by pipeline. Use of the surge tanks would permit a smooth oil fill rate into the cavities.

Injection of crude oil into the cavities would displace brine into an on-site brine pit. After allowing time for solids to settle out, brine would be pumped through a pipeline to underground disposal or into the Gulf of Mexico. The brine disposal rate would equal the oil injection rate.

A.3.2.2 Cavern Operation

A.3.2.2.1 Oil Withdrawal

During an oil supply interruption, withdrawal of the oil would be accomplished by displacing it with water. The maximum oil displacement rate would be approximately 2 MMB per day for the Capline SPR site(s). This would be the total for both the early storage phase capacity at Bayou Choctaw and Weeks Island and new capacity at any of the five sites proposed for expansion. Injection of unsaturated water would cause additional leaching of the cavities. It is anticipated that the cavities would gain up to 86 percent of their original volume during five cycles of storage and withdrawal.

The crude oil would be distributed to the CAPLINE Pipeline at the tank farm at St. James, and to tankers at the terminal docks.

A.3.2.2.2 Subsequent Refills

Refills of the storage caverns would be operationally identical to the initial fill, but the brine displaced would have been exposed to the oil/brine interface and the oil in the cavern walls from the first storage cycle. Another source of hydrocarbons in brine would result from emulsions created at the brine/oil interface. Hydrocarbons in the displaced brine would contribute to emissions during the period it is in the brine pit and is a potential contaminant when injected into deep formations or diffused into the Gulf of Mexico. Hydrocarbon concentrations in the displaced brine are discussed in Appendix D.

A.3.3 Storage Site

A.3.3.1 Central Plant Area

The central plant area would contain all facilities necessary for operation and maintenance of the storage site. During construction, management activities and the fabrication and laydown yard would also be located in the plant area.

Central plant areas would typically be 10 to 12 acres in size, with about 5 to 6 of those acres required for construction and the remainder for permanent facilities. Included in the central plant area are a pump building, electrical equipment (transformer or generating station), tanks for water and blanket oil, a brine pond, and a support building for offices, laboratory, storage, and shops.

The pump building would house all pumps necessary to inject water into the storage caverns, transport brine to the disposal area, and transfer displaced crude oil into the pipeline to the regional distribution network. Appropriate piping and valving would be located in or adjacent to the pump building. Pumps and valves would be operated remotely in the pump building.

Electrical power for operating the storage sites would be either generated on-site or obtained from local utilities. A portion of the plant area would be required for the generating or transformer equipment.

Blanket oil would be used during cavern leaching to prevent unwanted upward migration of the cavern ceiling. The oil would be stored at the surface in a tank (from 5000 to 20,000 barrel capacity) and piped to the caverns or returned to the tank as required.

Raw water piped from a local supply would be stored in an on-site tank or pond to provide a reservoir for charging the cavity injection pumps and for fire protection. The tank level would be maintained automatically and would act to remove surges from the raw water injection pump lines.

Brine discharged from cavities would be directed through a lined brine pond for settling of solids prior to being pumped into the disposal system. The pond would relieve line surges and eliminate insoluble particles which could damage pumps or clog injection well screens.

The central plant area would contain a cluster of support buildings necessary for operation and maintenance of the facility. The support buildings would include an office, laboratory, warehouse, and shops.

A security fence would be constructed around the perimeter of each site to prevent casual trespassers by identifying the site as a restricted area. The fence would be of eight-foot chain link or similar construction.

A.3.3.2 Roadways, Levees, and Filled Areas

Substantial lengths of roadway and acreages of filled area would be required at some SPR sites, since these sites would be located in low-lying marshy areas. Several feet of fill would be required to provide permanent access to wellheads and along pipeline routes.

Roadways through marshy areas would be constructed directly on the existing vegetation, the fibrous nature of the vegetation and roots providing a base for the roadway fill. Crushed rock or shells would be used to cap the roads and provide an all-weather surface. In soft areas, felled trees, boards, or artificial mats might be utilized to support the roadway. Due to the soft subsoils, proper compaction of fill materials cannot be achieved, and all heavy structures such as bridges or plant facilities would therefore be supported on piles.

Levees would be required at some sites for flood protection. Depending on the degree of seepage integrity required, levees would be constructed either directly on existing vegetation, or the vegetation would be removed. Draglines would be used to construct levees, by digging a ditch alongside and using the spoil for levee fill. A capping of stone or shells would then be provided if the levee were to be used as a roadway.

A.3.4 Pipelines

Three basic techniques of construction would be used for pipeline construction: 1) conventional dry land method, 2) push-ditch method, and 3) flotation canal method.

Conventional dry land construction methods would be used through dry portions of pipeline routes where heavy construction equipment can be supported. The push-ditch method of construction would be used in freshwater swamp portions of pipeline routes where the ground can support marsh buggy-mounted excavating and backfilling equipment, but cannot support conventional dry land pipeline construction equipment. The flotation canal method of construction would be required in marshy portions of pipeline routes. The ground in marshy areas cannot support heavy construction equipment. Therefore, the work would have to be done on barges operating in the canal.

These methods, and procedures for construction of pipeline crossings, are summarized below.

A.3.4.1 Conventional Dry Land Pipeline Laying

With the conventional dry land method, a right-of-way width of approximately 80 feet is cleared. Excavation equipment then travels along the right-of-way digging the pipe ditch to a depth of approximately six feet so that the pipeline will have a minimum cover of three feet. The pipe joints are then strung along the pipe ditch, welded together, the required corrosion protection is applied, and the pipe is lowered into the ditch and tested.

Pipeline backfill equipment then travels along the right-of-way, backfilling the open ditch with the spoil removed in excavation.

Restoration of the right-of-way is made to permit continued agricultural use of the land.

A.3.4.2 Push-Ditch Method

In the push-ditch method of construction, a right-of-way width of approximately 80 feet is cleared. The push ditch is then excavated down the right-of-way by marsh buggy-mounted excavation and backfilling equipment. The excavated ditch is full of water. Several push sites are selected at convenient locations along the right-of-way on dry land. These sites are used to assemble the pipe joints into a completed pipeline and to push it into the ditch. The pipe in the ditch is then floated into position.

The fabrication and assembly of the pipeline consists of welding together joints of pipe (each pipe is about 40 feet long) on the push site. When operations on each joint at the push site are complete, the assembled pipeline is pushed forward into the push ditch by the length of another joint of pipe, and the assembly procedure is repeated. A marsh buggy, or similar equipment, travels along the right-of-way with the front end of the pipeline to guide the pipeline down the push ditch and to aid in starting and stopping the pipeline as the assembly continues.

After the pipeline is assembled and in its desired location, it is filled with water, causing the line to sink to its final position, and is then tested. Draglines, mounted on marsh buggies, then travel along the right-of-way, filling the ditch with the spoil that was stockpiled along the right-of-way.

A.3.4.3 Flotation Canal Method

In the flotation canal (or barge lay) method, a canal is dug along the surveyed pipeline route to accommodate construction barges. The canal is dredged to provide a water depth of approximately 7 feet. The canal may be 40 to 50 feet wide at the bottom and up to 75 feet wide at the top. The equipment needed for construction includes a dredge, a pipe lay barge, materials barges, personnel boats, and special equipment barges required for tie-ins and work at pipeline crossing. The required right-of-way is approximately 120 feet.

A pipe ditch is dug in each flotation canal to accommodate the proposed pipeline. The spoil removed in dredging the flotation canal and pipe ditch is placed alongside of the flotation canal until after the pipeline has been installed. The pipe lay barge travels along the flotation canal while the joints of pipe are being welded together. The completed pipeline is lowered off the stern of the barge into the pipe ditch. After hydrostatic testing, a barge-mounted dipper dredge travels along the flotation canal backfilling the canal behind it.

A.3.4.4 Modified Push Ditch Construction

A fourth mode of pipeline construction, termed the "modified push ditch" or "modified flotation canal," may be applicable in certain wetland terrain having constant or predictable water levels. This method employs shallow draft barges to excavate a canal which can be used to float the pipe into place. A larger push barge is then used to assemble the pipe and to push it into the canal, using flotation buoys to position the line before sinking. Under proper conditions, backfilling can be accomplished from the excavation barge.

Large diameter, concrete-coated pipelines, such as required for the SPR, must be pushed in relatively straight sections. The minimum bend radius may be 4000 feet; thus any bends requiring a smaller radius, and many crossings of other pipelines, would require installation of prefabricated bends. For such installation, barge access and new push sites must be provided.

The average volume of excavation is 30,000 cubic yards per mile. A 120-foot construction ROW and a 15 to 50-foot permanent access ROW are typical. Backfilling would minimize terrain alteration but a shallow canal normally results because of spoil compaction and erosion. Revegetation depends on final topography.

The modified push ditch method is most applicable to areas which have relatively constant, or predictable, water levels, such as coastal marshes. Possible advantages in some terrain may include reduced ROW width, reduced excavation volume, and less potential for drainage pattern alteration. Factors which make the method impractical for many pipelines include: (1) unpredictable and highly variable water levels could leave barges or pipelines stranded for weeks or months at a time; (2) the very liquid consistency of the silty substrate would prevent effective backfilling so that terrain would be altered in a manner similar to a flotation canal; (3) the logistics of supplying concrete-coated large diameter pipe to the push barge would be difficult and costly; (4) the timetable for initial crude oil fill of the SPR sites does not allow for indeterminate delays caused by weather or other unpredictable events; (5) the cost of mobilizing a second contractor to continue pipelaying in the event of a loss of water level is extreme (should this occur, a flotation canal would have to be constructed in the troublesome locations); (6) the shallow depth of the canal would create the danger of grounding if boat traffic is allowed access.

In summary, the modified push ditch can be a practical and technically feasible way of installing pipelines under certain conditions, but in many instances, those conditions are not met.

A.3.4.5 River Crossings

Pipeline river crossings require the pipe to be buried in a trench on the river bottom for protection from currents, floating debris, and river traffic. River crossings are located in protected locations away from hazards. An enlarged right-of-way is required at each end of the crossing.

Barge-mounted excavation equipment is used to dig the pipe trench from bank to bank, to a depth sufficient to completely bury the pipe and provide a soil cover. The pipe is assembled on shore and is floated to the desired location. The flotation devices are then removed or flooded, the pipe is positioned in the trench, and the trench is backfilled. Warnings of the pipeline crossing are posted at each bank.

A.3.4.6 Levee Crossings

Crossing of a levee with a pipeline requires that the water barrier provided by the levee is not lessened by the pipeline installation. Levee crossings are often constructed above grade for this reason. When below-grade construction is required, conventional pipeline lay methods are used with the exception that steps are taken to reduce seepage along the pipe and subsequent internal erosion of the levee. Clay or concrete seepage barriers are sometimes constructed at intervals along the pipeline through the levee crossing. An expanded right-of-way is required for crossing construction.

A.3.4.7 Highway Crossings

Pipelines crossing highways are constructed by ditching in the conventional method or by tunneling under the roadway. Sufficient soil cover or an outer casing is used to protect the pipeline from the weight of passing traffic. Construction right-of-way widths are wider at the highway crossing location.

A.4 PROPOSED DEVELOPMENT - EARLY STORAGE SITES PLUS NAPOLEONVILLE DOME

A.4.1 Introduction

Construction of a 150 MMB facility at Napoleonville together with early storage of up to 94 MMB at Bayou Choctaw and 89 MMB at Weeks Island is the proposed development for the Capline Group (see Figure A.4-1). The Napoleonville facility would utilize seven existing leached caverns and ten new leached caverns to obtain the 150 MMB design capacity. Included in the consideration of Napoleonville as the proposed site would be the interactions of Napoleonville facilities with those of Bayou Choctaw and Weeks Island. Principal interactions would be the cooperative use of terminal facilities for crude oil distribution, and mutual crude oil pipeline rights-of-way. To better relate the interactions within the group, the terminal facilities are discussed in Section A.4.2 and development of the Bayou Choctaw and Weeks Island sites is briefly treated in Sections A.4.3 and A.4.4, respectively. A detailed description of Bayou Choctaw and Weeks Island early storage sites has been presented in FES 76-5 and FES 76/77-8, respectively.

A.4.2 Capline Group - Oil Distribution Facilities

Crude oil to be stored in the proposed development would be imported in Very Large Crude Carriers (VLCCs) to the Gulf of Mexico. There, the crude would be loaded onto conventional tankers (up to 80,000 DWT light loaded) and transported up the Mississippi River to terminal systems which are, in turn, connected to the storage sites by pipeline. During withdrawal, the crude oil would be transfered from the storage sites to the terminal systems. From the terminal, about 60 percent would be shipped to inland refineries through the CAPLINE Pipeline and forty percent would be loaded into tankers for shipment to Gulf, Caribbean or Altantic Coast refineries.

Terminal systems would transfer the crude oil from conventional tankers. Tankers would moor at docks along the Mississippi River and transfer the crude oil through pipelines, valves, meters, etc. to surge tanks located near the docks. The combination of docks and tanks along with connecting pipelines and support facilities make up a terminal

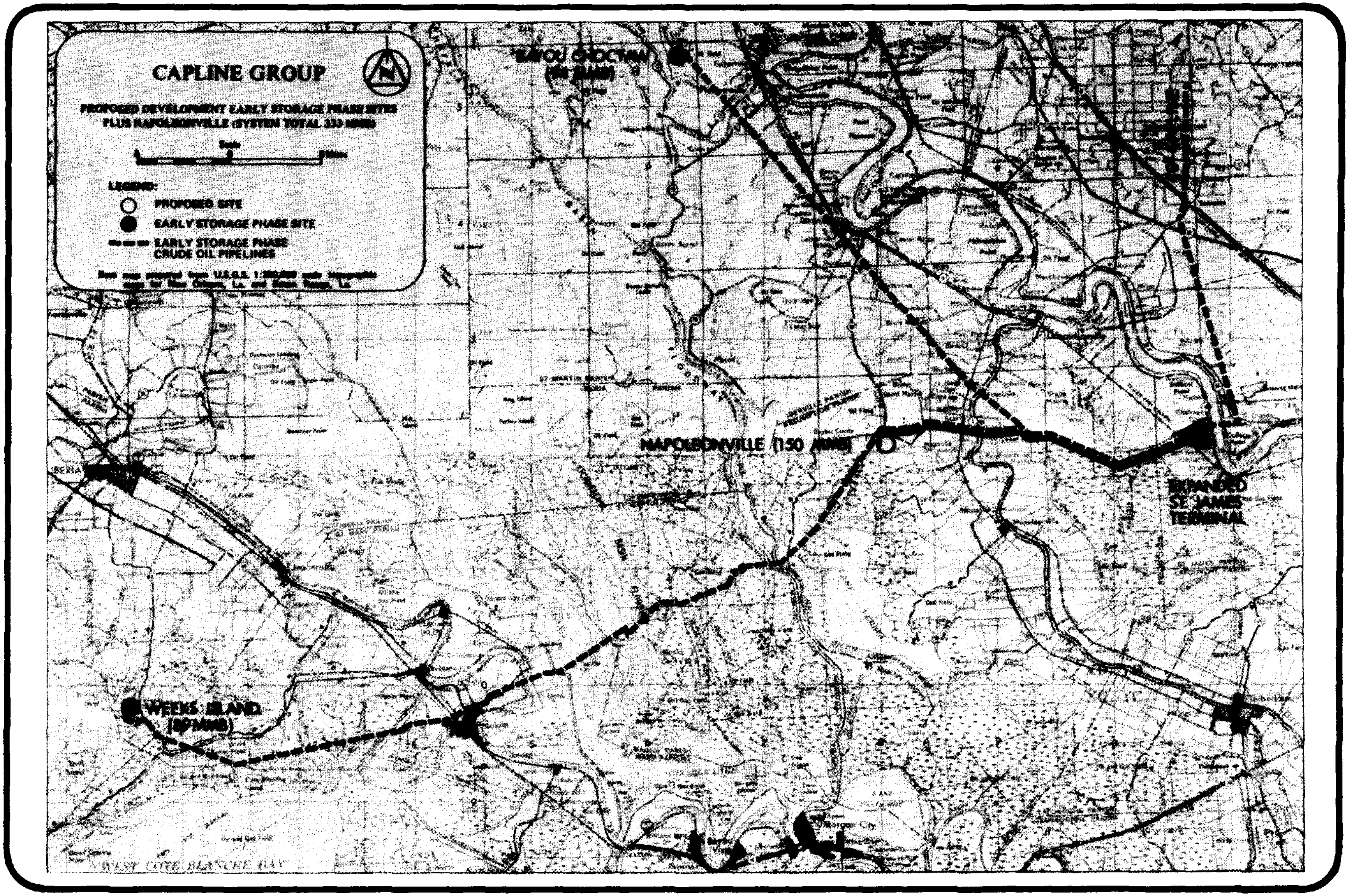


FIGURE A.4-1 Capline Group - primary development alternative - early storage sites plus Napoleonville.

system. DOE has made a decision to build an early storage phase terminal system on west bank of the Mississippi River immediately south of the CAPLINE Terminal at St. James, Louisiana (see Figures A.4-2 and A.4-3). However, to meet the increased oil handling requirements of the Capline Group expansion to approximately 300 MMB, the DOE terminal would be expanded and additional terminal facilities may be needed at either of two nearby commercial terminals. The two terminal systems available in addition to the DOE terminal are:

Terminal System	Location	Docks	Tanks
Koch	St. James, La	2[a]	3-500,000 bbl[b]
Nordix	Sunshine, La.	2[a]	10-150,000 bbl[b]

a) One existing dock available to DOE on a part-time basis plus one proposed dock.

b) All tanks are proposed.

A terminal system combination consisting of either DOE/Koch or DOE/Nordix would be utilized for the Capline system.

The facilities which will be constructed as part of the DOE terminal have been previously addressed in the EIS's and supplements for Bayou Choctaw, Cote Blanche and Weeks Island as part of early storage phase development. New facilities which would be constructed for the expansion of the Capline Group include one dock and three 500,000 barrel tanks constructed and operated by Koch Oil Company for DOE, or one dock and up to ten 150,000 barrel tanks constructed and operated by Nordix, Inc. for DOE. In addition, four more 200,000 barrel tanks would be constructed at the DOE terminal.

Expansion of either of these two commercial terminals as a result of SPR activity would depend on program needs and the ability to reach an agreement with the terminal owners. However, the construction and use of these facilities as part of the SPR Program is assessed in this EIS so that a worst-case analysis of the potential impacts is presented.

At this time, it is anticipated that terminal facilities constructed by DOE at St. James, would be reserved solely for SPR Program use. The surge tanks would be left partially full of oil and would be maintained

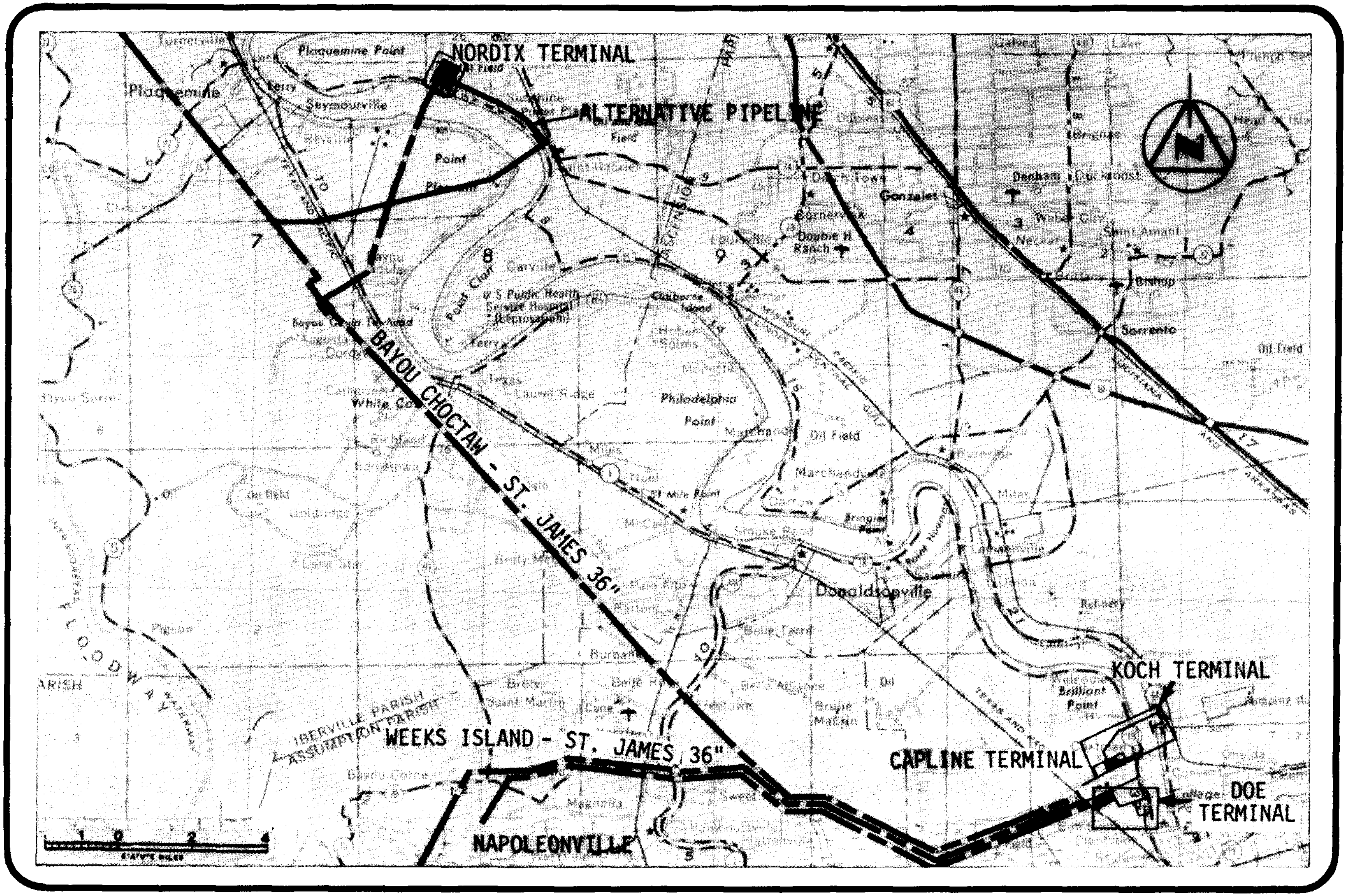
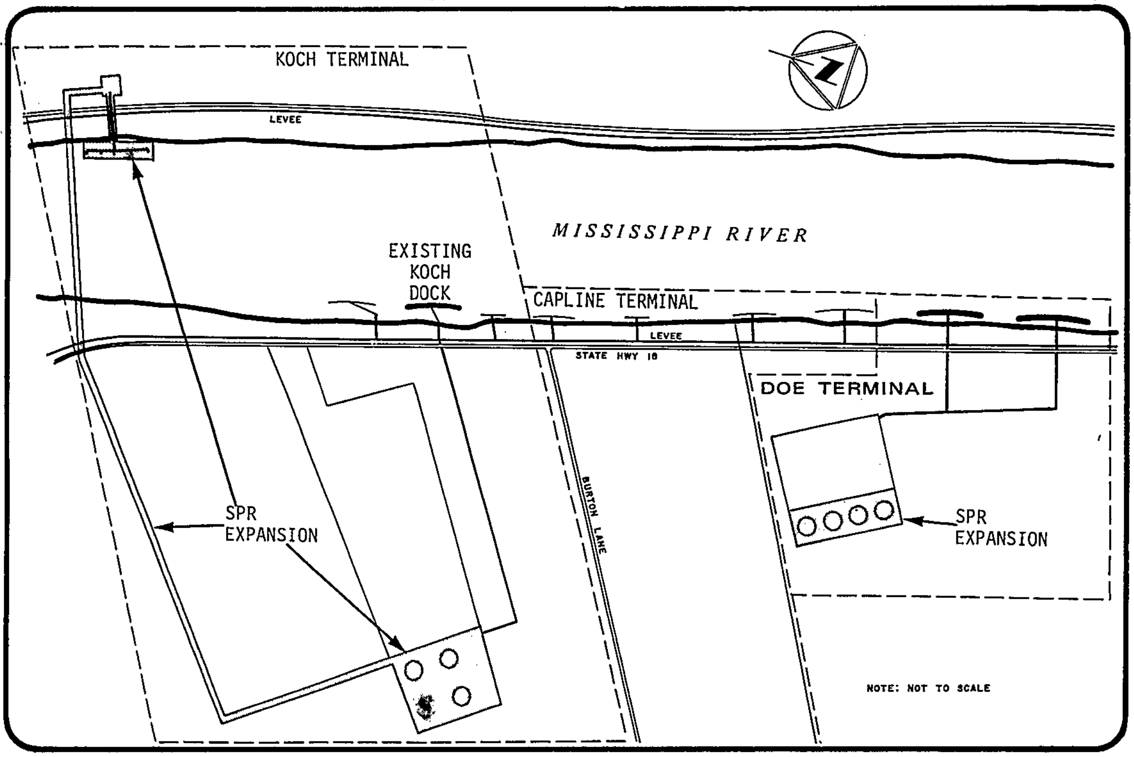
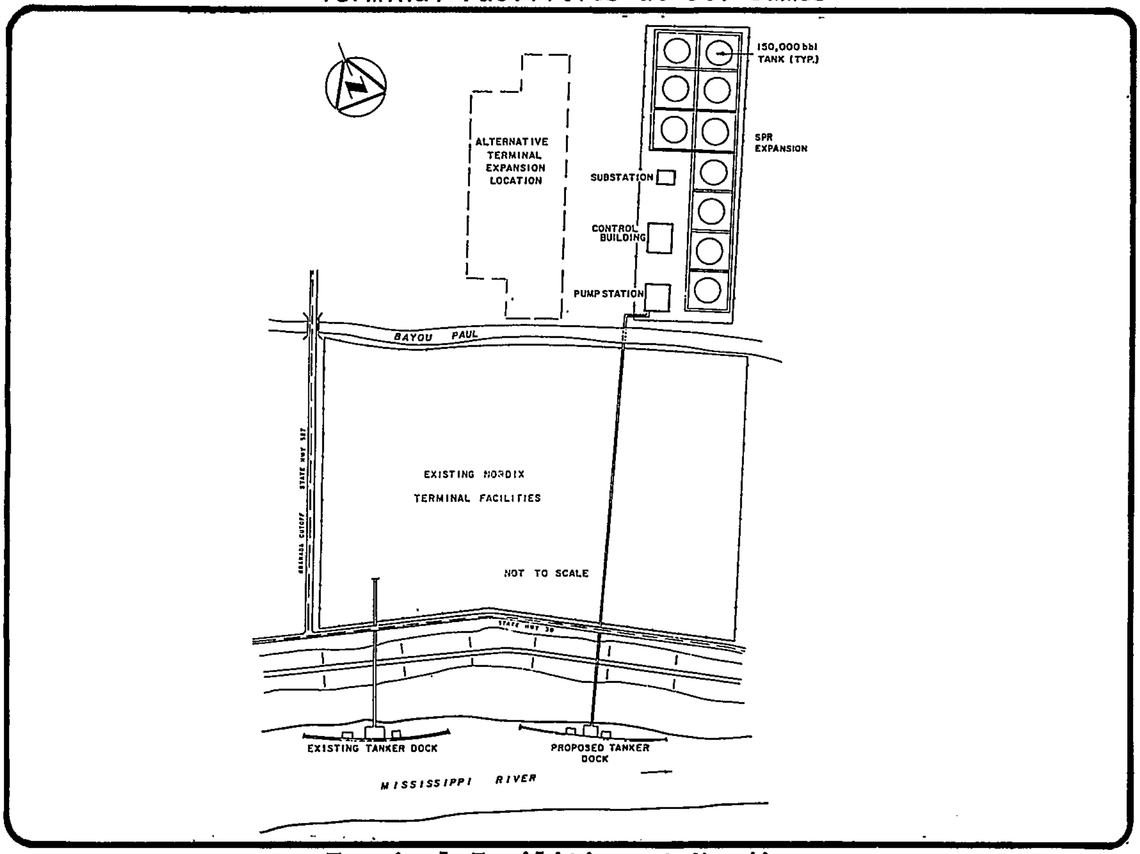


FIGURE A.4-2 Capline Group oil distribution terminal facilities.



Terminal Facilities at St. James



Terminal Facilities at Nordix

FIGURE A.4-3 Schematic of terminal facilities at St. James and Nordix.

in a state of readiness in a manner similar to the pipeline. However, the tanker dock, and possibly the tank farm, could be leased to private industry if a sufficient demand should occur and if all applicable regulatory requirements were met.

The Koch or Nordix terminal facilities would be built by private industry and leased by the Federal government. During standby storage, Koch or Nordix would have full use of the dock and tank farm facilities, consistent with any Federal, state, and local requirements or restrictions which regulatory bodies would impose upon the use of any such new industrial facility.

A.4.2.1 DOE and CAPLINE Terminals

The main terminal at St. James, Louisiana constructed as part of the Capline Pipeline system has three existing tanker docks, one barge dock, and one tanker/barge dock. The associated tank farm of 6.4 million barrels of existing tankage occupies a tract of approximately 550 acres, which includes space for future expansion. The CAPLINE tank farm would not be directly utilized by DOE for the SPR program. During oil withdrawal, a portion of the crude oil removed from storage would be delivered to the CAPLINE pipeline.

The size of tankers docking at the CAPLINE terminal range from 30,000 to 80,000 DWT. The available draft in the Mississippi River is 40 feet, requiring some of the larger ships to lighten their loads prior to proceeding to St. James. The average rate of unloading at the CAPLINE terminal is 15,000 to 16,000 barrels per hour; some of the newer ships are capable of rates up to 30,000 barrels per hour. Turn around time for tanker unloading is about 30 hours. It is anticipated that similar rates would be experienced at the DOE terminal.

Early storage phase facilities which will be constructed for the DOE at St. James and which are addressed in the supplements to the Bayou Choctaw and Weeks Island EIS's include two tanker docks and a small tank farm to be constructed immediately south of existing CAPLINE docks and storage tanks (Figure A.4-3). Oil handling and metering facilities will be constructed within a 42-acre site and will consist of eight 200,000 barrel oil surge tanks, pumps, meters, and meter provers. Connections will be provided to existing CAPLINE facilities.

Expansion of Capline Group storage capacity for the SPR would require four additional 200,000 barrel tanks on 36 acres of land adjacent to the DOE's early storage phase tank farm. Approximately 112,000 cubic yards of fill would be moved during construction.

A.4.2.2 Koch Oil Terminal

The Koch Terminal is located to the north of the CAPLINE Terminal as shown on Figure A.4-3, and consists of a tank farm, a barge dock and a tanker dock (presently under construction).

Expansion of the terminal for the SPR would include construction of three-500,000 barrel tanks on 30 acres of land west of the existing tank farm and a tanker dock on the east side of the Mississippi River. Included in the utilization of the Koch terminal would be part-time usage of the existing tanker dock.

Construction of expanded facilities at the terminal would involve installation of 3.2 miles of pipeline, including a crossing of the Mississippi River. A total of 67 acres would be disturbed by the construction, with long-term maintenance of about 47 acres. Excavations, including dredging, would total about 760,000 cubic yards.

A.4.2.3 Nordix Terminal

The Nordix terminal at Sunshine, Louisiana, would be expanded by Nordix, Inc. for use by DOE (see Figure A.4-3). The terminal expansion would consist of a tanker/barge dock and ten-150,000 barrel tanks. Part-time usage would be made of an existing tanker/barge dock. A seven mile long pipeline (including a Mississippi River crossing) would connect the terminal to the Bayou Choctaw - St. James 36-inch oil distribution pipeline. This pipeline would either be a single 36-inch diameter pipe or dual, parallel 24-inch diameter pipelines. Construction of the terminal expansion would involve a total of 139 acres disturbed by the construction, excavation totalling 798,000 cubic yards (including dredging), and fill totalling 82,000 cubic yards.

An alternative route for the pipeline between the Nordix Terminal and the Bayou Choctaw-St. James pipeline would be an existing and unused 12-inch pipeline across the Mississippi River located approximately 16,900 feet downstream from the proposed pipeline crossing. Connecting the pipeline to the Nordix Terminal would be a 20-inch pipeline following State Highway 75 for 16,900 feet. The pipeline would be placed within or just outside the right-of-way for the highway. On the west side of the river, another 20-inch pipeline would connect the existing 12-inch pipeline with the Bayou Choctaw-St. James pipeline by following an existing electrical transmission and pipeline corridor a distance of 35,900 feet. The total length of this alternative pipeline would be approximately 10.7 miles and connect with the Bayou Choctaw-St. James pipeline approximately 2.5 miles northwest of the intersection of the proposed pipeline from the Nordix Terminal with the Bayou Choctaw-St. James pipeline.

A.4.2.4 CAPLINE Pipeline System

The CAPLINE Pipeline system transports crude oil for the CAPLINE terminal at St. James, to refineries in the upper midwest. Additional crude oil from other producing areas is transported to St. James by tankers and barges and is introduced into the 40-inch diameter pipeline. Expansions of the CAPLINE system now in progress will increase the carrying capacity of the system from its present 900,000 barrels per day to 1.2 million barrels a day. The proposed Louisiana Offshore Oil Port (LOOP) supertanker facility would connect with CAPLINE by construction of a large diameter pipeline to the CAPLINE terminal.

2.4.3 Bayou Choctaw Early Storage Site

Crude oil storage will be developed in existing solution-mined caverns at Bayou Choctaw as part of the initial phase of the SPR Program. The facilities required for this initial development and the associated environmental impact are described in FES 76-5 and FES Supplement of May 1977. A brief description of this site (which will provide up to 94 MMB of the planned capacity of the Capline Group) is provided in the following paragraphs.

A.4.3.1 Location

The Bayou Choctaw dome site is the northernmost site in the Capline Group, located 12 miles southwest of Baton Rouge, Louisiana, and about 4 miles west of the Mississippi River. Access to the dome by highway is good via local and state highways. Barge traffic can utilize the Intracoastal Waterway to within 2000 feet of the western edge of the dome. The site itself can be characterized as a swamp forest, with some cleared areas related to existing industrial development.

A.4.3.2 Capacity

The dome is presently leased by Allied Chemical Company for the production of brine feedstock by solution mining. A number of caverns have been developed, of which 12 can be made available for an estimated 94 MMB of crude oil storage. Details of the existing caverns are available in FES 76-5, Appendix H.

A.4.3.3 General System Description

Development of the early storage capacity at Bayou Choctaw will require conversion of the existing brine and product storage caverns to crude oil storage and construction of associated surface facilities. Initial crude oil fill will be via existing barge docks on Bull Bay, with concurrent construction of an oil pipeline to St. James for permanent use.

During operation of the facility, brine displaced by oil pumped into the caverns will be pumped to a system of injection wells located off the southern flank of the dome and dispersed by injection into deep saline water bearing sands. To withdraw the stored oil, fresh surface water will be taken from the Mississippi River, and injected into the cavities at sufficient pressure to displace the oil. (For further details, refer to Section 1.2 of FES 76-5).

A.4.3.4 Site Development

A.4.3.4.1 Site Layout

Twelve existing caverns presently used for brine production and storage of petroleum products will be converted for crude oil storage.

These caverns, Nos. 1, 2, 3, 8A, 11, 13, 15, 16, 17, 18, 19, and 20, have existing wellheads and connecting pipelines, some of which will require modification or drilling of new cavern entry wells for inclusion into the system. Present caverns are served by connecting roadways and are protected by dikes.

A.4.3.4.2 Plant Area

A centrally located plant area will be constructed to control the operations at the site. Pumping facilities for oil injection and the related control systems will be housed in a steel building. Raw water displacement pumps and brine injection pumps will be housed separately. Also contained within the plant area will be the offices, a laboratory, shops, and warehousing facilities. Existing buildings and facilities will be used where possible.

A.4.3.4.3 Raw Water Supply

Water for displacement of stored oil during withdrawal operations will be pumped from an intake at the on-site lake. This lake has a surface area of about 12 acres and is connected to Bayou Bourbeaux and the Intracoastal Waterway. Short pipelines will connect the pump at the intake structure and the plant area. Pumps will be sized to provide about 26,100 barrels of displacement water per hour.

A.4.3.4.4 Brine Disposal

The method for disposal of the saturated brine which is displaced during oil fill operations will be to inject it into subsurface saline strata off the southern flank of the dome. The brine disposal system has been designed to accommodate a maximum of 10,000 barrels per hour of displaced brine, and will consist of a well field of 10 disposal wells connected to the plant by a 6500-foot long, 30-inch diameter pipeline.

A.4.3.4.5 Crude Oil Distribution

For the initial storage fill operation, an existing barge dock on Bull Bay will be utilized. Barges will be used for filling until the completion of the Bayou Choctaw - St. James pipeline. The pipeline then will be solely utilized to complete the fill. Subsequent withdrawals and refills will be via pipeline system to St. James, the Bull Bay barge dock reverting to other uses.

A 36-inch diameter, 38-mile long reversible pipeline will be constructed for the early storage phase between the site at Bayou Choctaw and the CAPLINE terminal at St. James. The pipeline will be used for crude oil fill and withdrawal at the Bayou Choctaw site and will be constructed with pumping facilities at each terminus (no intermediate pump stations will be required). The route will parallel the west bank of the Mississippi River levee, passing near the towns of Plaquemine, White Castle, Annandale and Freetown, Louisiana (see Figure A.1-1). This pipeline is treated in the May 1977 Supplement to the Bayou Choctaw FES 76-5.

A.4.3.4.6 Land and Grading Requirements

Development of the main storage site will entail approximately 120 acres of land over the surface of the dome. This area will include about 8 acres for the central pump buildings, office buildings and other control and safety facilities. Construction of the brine holding pond within the plant area will utilize about 8.3 acres. The oil storage wells will be enclosed within containment dikes encircling an area of 104 acres. Most of the above area is cleared or otherwise presently utilized, and little grading will be required.

The barge dock on Bull Bay is located on a 6-acre plot and no significant alterations to land use will be necessary, however, some diking and regrading will be required. New construction will be required for the brine disposal well field, including 32 acres of land and 95,000 cubic yards of fill. The above land and grading requirements are discussed in detail in FES 76-5 (Sections 1.3.2 and 1.3.3).

The permanent oil distribution pipeline to St. James will require a 38-mile right-of-way 75 feet in width, and 40 acres at St. James, for a total of 408 acres of land. Total soil excavation will be approximately 383,000 cubic yards for the pipeline.

A.4.3.5 Development Timetable

Conversion of the Bayou Choctaw site is scheduled such that oil deliveries begin via barges at the existing Bull Bay terminal in mid-1977. Construction of the new oil distribution facilities to the FEA terminal will be completed by mid-1978. Oil fill would be complete in early 1981.

A.4.4 Weeks Island Mine Early Storage

Crude oil storage will be developed in the existing conventionally mined cavities at Weeks Island as a part of the initial phase of the SPR Program. The facilities required for this development and the associated environmental impacts are described in FES 76/77-8 and FES Supplement of July 1977. A brief description of this site (which will provide 89 MMB of the planned Capline Group capacity) is provided in the following paragraphs.

A.4.4.1 Location

The Weeks Island salt mine is a conventional underground mine located on Weeks Island in Iberia Parish, south central Louisiana, about 14 miles south of New Iberia, Louisiana. Access to the site is via State Highway 83, and a paved road into the mine area. Barge traffic utilizes the Intracoastal Waterway which passes immediately to the west of the mine site, and barge slips have been constructed to service the site. The project area consists of gently rolling slopes, situated above tidal levels. The Weeks Island site will be connected by a crude oil pipeline to the DOE terminal facility during development of the site for early storage.

A.4.4.2 Capacity

The existing salt mine is presently operated by Morton Salt Company using the room and pillar (dry) method at a depth of approximately 700 feet below mean sea level (msl). Earlier, abandoned workings are at a depth of about 536 feet msl. Due to the age of the mine (operating since 1903), large underground caverns have been excavated, and available capacity for crude oil storage is estimated at 89 MMB. Details of the existing mine operation are given in FES 76/77-8 (Section 2.0).

A.4.4.3 General System Description

The existing underground salt mine is operated dry and hence does not require a filling of liquid to remain stable as do leached caverns. Crude oil can therefore be stored or withdrawn without need for raw water supply or brine disposal facilities. Conversion of the existing mine primarily will involve the sinking of a new pump shaft, installation of oil pumps and casings, sealing of existing production and service shafts, and construction of the necessary oil distribution facilities. With the exception of off-site pipelines, construction will take place within or near the existing mine site area. The mine operation will be relocated.

A.4.4.4 Site Development

A.4.4.4.1 Underground Conversion

Access to the mine will be provided by converting the existing 10-foot diameter service shaft. Withdrawal pumps and casings for removing the oil from storage will be installed within this shaft, as will a dewatering line, a man-way opening, and a 20-inch fill casing.

Prior to beginning fill operations, the mine interior will be secured. Loose salt and other materials will be sealed off to prevent pump clogging and shallow ditches will be excavated to assure drainage of oil to the pump sump. The existing service and production shafts will then be sealed with concrete, leaving only an access manhole.

A.4.4.4.2 Aboveground Conversion

A pump station requiring about four acres of land will be constructed adjacent to the existing mine plant. Oil pumps will be connected via a pipeline to the DOE terminal. Oil fill is anticipated at an average of 190,000 barrels per day.

A.4.4.4.3 Crude Oil Distribution

Initial fill of the Weeks Island facility will be conducted using a pipeline connection to the DOE terminal. This pipeline is discussed in the supplement to the Weeks Island EIS. The route, as shown on Figure A.1-1, is about 65 miles in length and will extend east from Weeks Island to Franklin, then northeast to the terminal. The pipeline will cross within one mile of the Napoleonville dome.

A.4.4.4.4 Land and Grading Requirements

Development of the Weeks Island mine site will require minimal grading for the plant facilities. Approximately four acres of land will be graded for the main pump station.

A.4.4.4.5 Development Timetable

Construction and initial fill of the Weeks Island site is scheduled for the early portion of the SPR program. Construction of the facility is scheduled from late 1977 to mid-1978. Storage would then commence and is scheduled for completion in late 1979.

A.4.5 Proposed Site - Napoleonville

A.4.5.1 Location

A.4.5.1.1 Site Access

The Napoleonville salt dome is located near the north edge of Assumption Parish, Louisiana, about 30 miles south of Baton Rouge (see Figure A.4-1). The community of Napoleonville, for which the dome is named, is located seven miles to the southeast. The small village of Grand Bayou overlies the north-central portion of the dome.

Access to the site from Baton Rouge is by traveling south on State Highway 1, then west for about four miles on State Highway 70. A network of roads constructed by commercial interests is dispersed over the dome, providing access to within 3000 feet of any point on the dome. The north-south trending Grand Bayou bisects the western end of the site and development of the dome for the SPR program, for ease of construction, would be limited to areas east of the Bayou. Although Grand Bayou connects to Lake Verret, it is not considered commercially navigable, and is not connected to the Intracoastal Waterway.

The Napoleonville dome is 16.6 miles from the west boundary of the DOE terminal on the Mississippi River, about 26 miles by road. This terminal would distribute all crude oil fill and withdrawal at the site.

A.4.5.1.2 Site Description

Napoleonville dome is elliptically shaped with a surface area projected from the -2000 foot salt contour of about 1760 acres; the length and breadth of the surface area are 2.5 and 1.4 miles, respectively. At the storage site area approximately 437 acres would be enclosed by a fence. As shown on Figure A.4.4, the land overlying the dome is flat with an average elevation less than five feet above sea level. The dome has no surface expression. A mixture of farmlands, woods, and swamp describes the dome and vicinity.

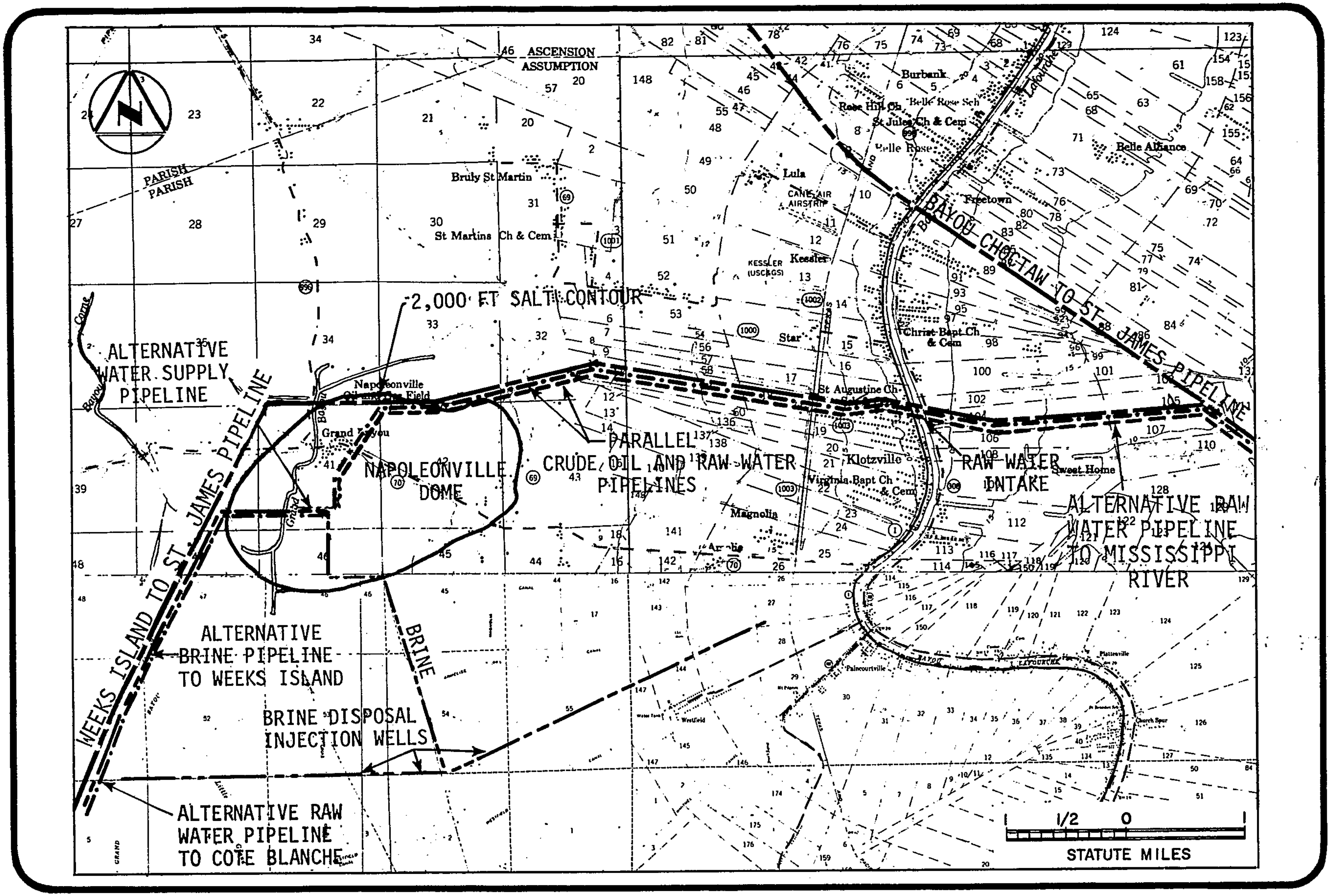


FIGURE A.4-4 Vicinity map - Napoleonville dome.

Since 1957, several companies have been active on the dome in solution mining for brine and sulfur recovery, and 26 caverns have been constructed. Some of the caverns now inactive for brine production are used for LPG storage purposes.

A.4.5.2 Capacity

Seven existing caverns in the south portion of Section 41 with an estimated total capacity of 30 to 45 MMB would be adapted for crude oil storage (see Figure A.4-5). Sonar surveying would be used to determine accurate cavern volumes and shapes. If the sonar sections indicate a volume less than 10 million barrels (MMB) of usable capacity per cavern, the caverns may be solution mined to a larger volume. The existing wellhead at each cavern would be inspected for structural integrity and flow rate capacity to determine if continued use is feasible or if new wellheads would be required.

Utilization of the dome to the design storage goal of 150 MMB would require the construction of a plant area, pipelines and related facilities, and the solution mining of ten new caverns in Sections 41 and 46 (see Figure A.4-5). It is anticipated that drilling difficulties or other considerations would result in 20 percent of the caverns not yielding a full 10 MMB capacity, and that caverns of six MMB capacity would be developed.

Planned development of the Napoleonville site would be limited to the area designated on Figure A.4-5. Estimates of the total storage capacity of the dome have not been prepared. It is likely, however, that the dome capacity would be significantly greater than the present design capacity.

A.4.5.3 General System Description

A.4.5.3.1 Proposed Systems

The Napoleonville dome would store 150 MMB of crude oil in 17 existing and new cavities. All new caverns would be of similar design for ease of construction. The use of existing caverns would enable storage of crude oil as soon as surface facilities are completed. Therefore, some of the seven existing caverns could be receiving crude

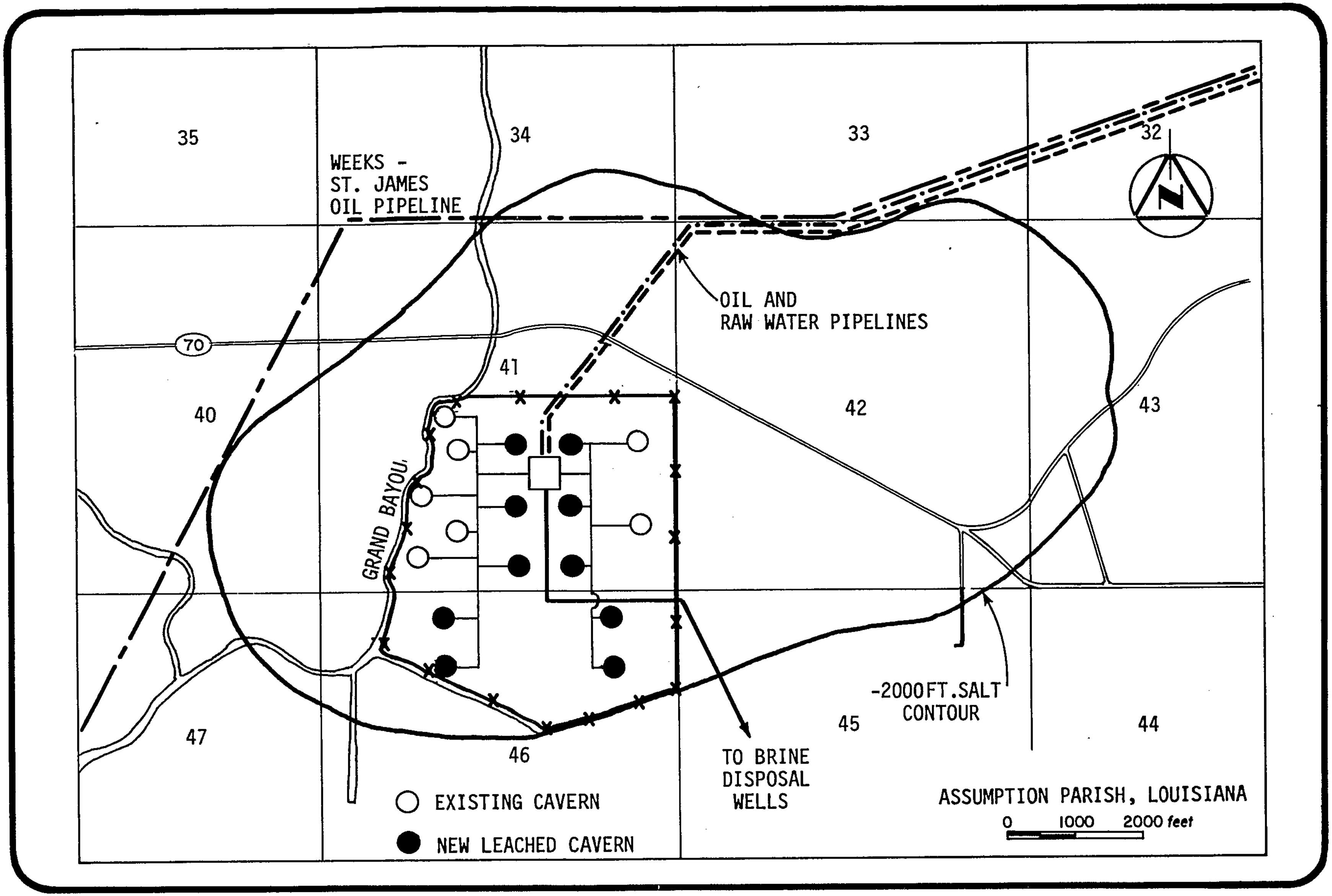


FIGURE A.4-5 Site map - Napoleonville dome.

oil for storage concurrently with the leaching of additional storage capacity.

Raw water required for the leaching of new caverns and displacement of stored crude oil is proposed to be supplied by a five-mile pipeline from Bayou Lafourche, which would in turn be supplied by additional water pumped from the Mississippi River at Donaldsonville. The proposed method to dispose of brine formed during cavern development or displaced during crude oil storage would be through deep well injection at a well field to be located about 2 miles southeast of the site. Oil supplies would be distributed by a new pipeline paralleling the Weeks Island pipeline connection to the CAPLINE terminal at St. James on the Mississippi River. These proposed systems are shown on Figure A.4-4.

A.4.5.3.2 Alternative Systems

Grand Bayou, located immediately to the west of the site, would be an alternative source of raw water. The ability of Grand Bayou to meet water demands has not been established. Another alternative source of raw water would be the Mississippi River. If nearby surface water sources could not be developed, alternative supplies include ground water from wells near the site, or water from the Gulf of Mexico via pipeline.

The Gulf of Mexico also would be an alternative method of brine disposal. The pipeline route would be identical to the alternative raw water pipeline to the Gulf.

A.4.5.4 Site Development

A.4.5.4.1 Proposed Physical Facilities

Site Layout

The tentative cavern layout for the site is shown on Figure A.4-5. In anticipation that much of the access road system and pipelines for the seven existing wells would require substantial modification prior to integration into the expanded system, existing surface facilities were not considered in deriving the layout scheme.

Each new cavity would be leached to an initial capacity of 10 MMB, where possible. A total of ten new caverns would be constructed, spaced on minimum 800-foot centers and located a minimum of 600 feet from the edge of the dome to assure a 400-foot wall around every cavern. Cavern wellheads would be connected to the central pumping plant by a series of roadways and pipelines (Figure A.4-5). A 12-foot access road to each pad would be required; all roads and drill pads would require several feet of fill. Pipelines are anticipated to be constructed above ground, adjacent to the roadways, on timber cribbing or piling. A small berm would be constructed around each wellhead to contain small operational oil spills.

Plant Area

The central pumping and control facilities area would be contained in a plant area about 350 feet by 250 feet in dimension. These facilities include the main pump building, control building, warehouses, laboratory, and office. The brine surge pond, blanket oil tank, raw water tank, and oil metering area would be located in adjacent areas (Figure A.4-6). A five to six acre materials and equipment yard would be located near the plant area.

Cavity injection and transport pumps would be housed in a prefabricated type steel structure on a concrete slab foundation. The pump building and other structures would be placed on fill at a suitable height above ground level for flood protection. As the existing ground may have poor load carrying capacity, the foundation slab may need to be pile supported. In addition to the main pump building, smaller structures of similar construction would be located nearby, containing instrumentation and electrical switchgear and house the office, lab, warehouse, and shop areas.

A brine settling and surge pond of 160,000 barrel capacity would be constructed near the plant area. The pond would have a surface area of about 2.1 acres and would be eight to ten feet deep. To provide additional operational flexibility, a second brine pond may be constructed; the two ponds would be used alternately. Raw water for charging the water injection pumps would be stored in a steel tank. A 5000 barrel blanket oil tank would also be constructed for use during cavern leaching and would be encircled by a spill containment dike.

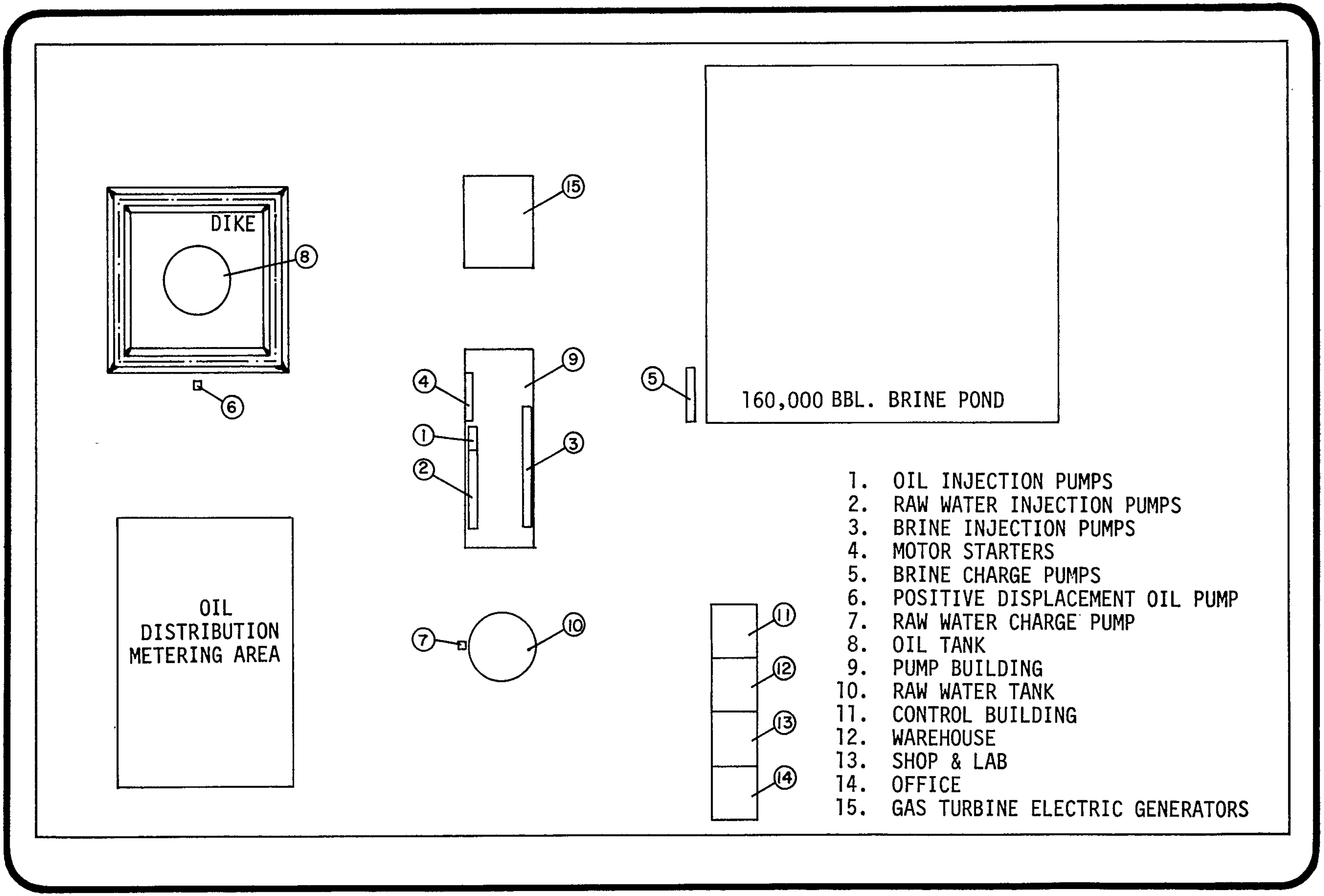


FIGURE A.4-6 Storage area layout - Napoleonville dome.

The power requirements of the facility are anticipated to be supplied by commercial sources through a new feeder line to the dome. A transformer bank at the storage site would be located adjacent to the electrical control building.

Raw Water Supply

Bayou Lafourche is the planned source of raw water for the enlargement of existing caverns and the initial leaching of the new storage cavities and for the subsequent displacement of the stored oil. It is a regulated stream which is supplied by a pumping station at Donaldsonville, Louisiana, on the Mississippi River. During cavern leaching, raw water would be required at the rate of 25,800 gallons per minute (GPM). The design water demand would be during crude oil withdrawal, when 29,200 GPM would be required. Cavern leaching would not take place concurrently with crude oil withdrawal.

Use of Bayou Lafourche would require the installation of an additional 33,000 GPM pumping capacity at the Donaldsonville pump station where water is lifted from the Mississippi River and discharged into the Bayou Lafourche channel. The intake structure would be sized to meet EPA intake design standards of a maximum velocity of 0.5 feet per second to reduce fish impingement on the intake screen.

Thus augmented, the Bayou could supply the required quantities of water, a maximum of 29,200 GPM. The increased flow would be picked up approximately 10 miles downstream of Donaldsonville through an intake structure and pump station and then would be pumped through a 36-inch diameter pipeline to injection pumps located at the main facility pump building. Of the 4.6 miles of right-of-way required for the raw water pipeline, 0.5 miles would utilize the Napoleonville to Weeks Island oil distribution pipeline connection right-of-way, and 4.1 miles would follow the Weeks Island-St. James pipeline right-of-way (Figure A.4-4).

In addition to supplying water directly to the injection pumps, the 36-inch diameter pipeline would be connected to a 3000 barrel raw water tank. Three charge pumps would be installed at the 3000 barrel tank. These pumps would enable the high pressure injection pumps to be started with water from the tank; after start up, the charge pumps would be shut down, and the injection pumps would take suction directly from the raw water supply pipeline. The raw water tank would also be used as a fire system reservoir.

Brine Disposal

Brine created by solution mining of new caverns and through displacement during crude oil storage is proposed to be disposed of utilizing deep injection wells. The wells would terminate in saline formations between the -5000 and -8000 foot elevations.

During cavern leaching, brine disposal would be at the maximum rate of 36,900 barrels per hour (BPH) (25,800 GPM). Oil storage would occur concurrently as shown in Figure A.4-8. Thus, the well field would be designed with spare capacity for a maximum loading of 40,000 BPH (28,000 GPM).

The disposal system as planned, would consist of 28 wells located about two miles off the southeast flank of the dome. The well field would be roughly tee-shaped with wells at 1000 foot intervals (see Figure A.4-4), serviced by pipelines to carry the brine from the caverns to surface brine settling and surge ponds and then to the disposal wells. Of the 6.7 miles of 80-foot right-of-way required for the disposal field, 1.6 would pass through agricultural land and 5.1 would cross freshwater swamp and require push-ditch pipelaying methods.

Crude Oil Distribution

The distribution of oil stored at Napoleonville is planned via a new 19.1 mile pipeline parallel to the Weeks Island-St. James pipeline, which passes near the west and north flanks of the Napoleonville dome. The connection to the dome would be approximately 0.5 mile in length and would cross freshwater swamps. The remainder of the pipeline would be located within the Weeks Island-St. James pipeline right-of-way and would cross 10.6 miles of agricultural land and 8.0 miles of freshwater swamp.

The pipeline connection would provide access to DOE terminal facilities, other oil distribution facilities, and to the CAPLINE Pipeline. During oil recovery operations, the maximum design flow rate of oil would be 29,000 GPM (1700 GPM per cavity), or a maximum of 1.0 million barrels per day for withdrawal.

Land Requirements

A total of approximately 589 acres of land at the Napoleonville site would be needed for the project as planned, of which 215 would be directly affected by site development, as shown in Table A.4-1 excluding terminal facilities which are detailed in Section A.4.2. The amount of acreage impacted for some of the pipelines constructed may only reflect incremental changes in a previously established right-of-way.

The storage facilities would be located on a fenced 437-acre tract of land lying directly over the western half of the salt dome. Much of this area (374 acres) would not be directly disturbed by site development.

The pumping station for raw water supply on Bayou Lafourche would require one to two acres. The required raw water pipeline connection would require about 13 acres of new right-of-way. Construction of the brine disposal well field would require 6.7 miles of roadway and 28 200-foot-square drill pads for a total of 76 acres. The oil distribution pipeline connection would require 62 acres of new right-of-way.

Road Construction and Other Grading

The proposed Napoleonville site lies in an area with an average elevation of less than five feet above sea level. Accordingly, it is anticipated that much of the plant area and pipeline roads would require four to five feet of fill for maintenance of all-weather roads.

Grading requirements, both within the storage site area and off-site, and the acreages affected by site development would be as presented in Table A.4-1.

A.4.5.4.2 Alternative Physical Facilities

The facilities associated with the alternative systems discussed below and in Section A.4.5.3.2 would have grading and land use requirements as detailed in Table A.4-2.

Raw water could be obtained from an intake structure on Grand Bayou, requiring a 0.4-mile pipeline to the west of the plant area. Another alternative source would be the use of ground water from wells

TABLE A.4-1 Proposed physical facilities - Napoleonville - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
A. SPR Facilities - Napoleonville - Fenced Area - 437 acres										
1) Storage Site										
a) Central Plant Area	---	---	80,000	---	---	10/10	---	---	---	10/10
b) Brine Surge Pond	---	---	28,000	---	---	4/4	---	---	---	4/4
c) Roadways to Cavern Wellheads (3 miles)	---	---	65,000	---	---	12/5	---	---	---	12/5
d) Cavern Wellhead Pads	---	---	74,000	---	7/4	3/2	---	---	---	10/6
e) Containment Dikes at Cavern Wellheads	---	---	12,000	---	5/2	3/1	---	---	---	8/3
f) Distribution Pipelines Within Plant Area	9.0	144,000	---	---	12/8	6/4	---	---	---	18/12
g) Blanket Oil Tank Containment Dike	---	---	2,000	---	---	1/1	---	---	---	1/1
2) Offsite										
a) Brine Disposal (Wells)										
1. Pipeline Excavation	6.7	106,000	---	16/10	---	49/31	---	---	---	65/41
2. Roadways to Brine Disposal Wellheads (5.1 mi)	---	---	110,000	---	---	---	---	---	---	---
3. Brine Disposal Wellhead Pads	---	---	85,000	---	---	11/7	---	---	---	11/7
b) Raw Water Supply (from Bayou Lafourche)										
1. Pump Station	---	---	5,000	1/1	---	---	---	---	---	1/1
2. Pipeline Excavation	4.6	74,000	---	10/6	---	2/1	---	2	1	13/7
c) Crude Oil Distribution (to Terminal)	19.1	300,000	---	39/24	---	22/14	---	4	1	62/38
3) St. James Terminal (DOE)										
a) 4 -200,000 bbl Tanks with Dikes	---	---	96,000	24/24	---	---	---	---	---	24/24
b) Roads and Miscellaneous	---	---	16,000	12/12	---	---	---	---	---	12/12
4) Koch Terminal	3.2	760,000	---	57/47	---	---	---	1	10	67/47
5) Nordix Terminal	7.0	798,000	82,000	68/53	55/25	---	---	15	16	139/78
Sub-Total (SPR Facilities-Napoleonville)	49.6	2,182,000	655,000	227/177	79/39	123/80	---	22	28	457/296
B. Early Storage Facilities										
1) Weeks Island										
a) Storage Site	---	---	---	4/4	---	---	---	---	---	4/4
b) Crude Oil Distribution	64.4	1,069,000	---	145/90	40/25	307/191	60/37	24	71	623/343
c) St. James Terminal	---	30,000	54,000	15/15	---	---	---	---	---	15/15
Sub-Total (Early Storage Weeks Island)	64.4	1,099,000	54,000	164/109	40/25	307/191	60/37	24	71	642/362

TABLE A.4-1 continued.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
2) Bayou Choctaw										
a) Storage Site	7.0	37,000	---	120/120	---	---	---	4	2	122/120
b) Brine Disposal	2.9	46,000	95,000	---	---	31/20	---	7	1	32/20
c) Raw Water Supply	---	---	5,000	---	---	---	---	---	---	---
d) Crude Oil Distribution	38.0	383,000	---	268/167	35/22	64/40	---	13	1	368/229
e) St. James Terminal	1.0	35,000	54,000	40/34	---	---	---	---	---	40/34
Sub-Total (Early Storage-Bayou Choctaw)	48.9	501,000	154,000	428/321	35/22	95/60	---	24	4	562/403
Sub-Total (Early Storage-Weeks Island plus Bayou Choctaw)	113.3	1,600,000	208,000	592/430	75/47	402/251	60/37	48	75	1204/765
Total (Early Storage at Weeks Island and Bayou Choctaw plus Napoleonville Dome)	162.9	3,782,000	863,000	819/607	154/86	525/331	60/37	70	103	1661/1061

TABLE A.4-2 Alternative physical facilities - Napoleonville - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
1) Brine Disposal										
a) Pipeline (Napoleonville dome to Gulf near Cote Blanche	74.4	1,129,000	---	17/11	5/3	45/28	25/15	25	849	941/57
b) Backup Brine Injection Wells	3.7	20,000	---	6/4	---	---	---	---	---	6/4
2) Raw Water Supply										
a) Grand Bayou	0.4	2,100	5,000	---	---	4/3	---	---	---	4/3
b) Wells (along oil line east of Napoleonville dome)	4.9	78,000	110,000	26/17	---	---	---	2	1	27/17
c) Gulf near Cote Blanche	44.3	653,000	5,000	17/11	5/3	45/28	25/15	25	120	212/57
d) Mississippi River at St. James	19.1	300,000	5,000	39/24	---	22/14	---	4	1	62/38
3) Nordix Terminal and alternative pipeline	10	123,300	82,000	74/56	21/15	---	---	4	1	96/71

located along the oil distribution pipeline. The well field would start 1.5 miles northeast of the central plant area and extend for a total length of 4.9 miles. Fifteen wells would be installed on well pads constructed adjacent to the right-of-way. To transport water from the Mississippi River to the site, a 19.1-mile pipeline would follow the crude oil pipeline from St. James. This system may also include a centrifugal desander for clearing excess sediment from the water. Effluent from the desander would be returned to the Mississippi River; a desilting pond may be constructed if needed to prevent silt buildup in the caverns.

Brackish water from the Gulf of Mexico could be pumped from an intake structure near Cote Blanche Island along a 44.3-mile pipeline. The majority of the pipeline route would utilize the Weeks Island-St. James pipeline right-of-way, with a short two-mile-long right-of-way required to connect the intake structure and a one-mile connection at the storage site. A similar route would be followed for the alternative brine disposal system to a diffuser in the Gulf of Mexico. The total 78.1-mile length of the diffuser and backup system would include a 32.1-mile offshore connection to the diffuser.

A.4.5.5 Construction Techniques

A.4.5.5.1 Cavern Construction

Existing wellheads would be inspected to determine their suitability for integration into the facility. The ten new cavern wellheads and any replacements for existing wellheads would be completed similarly, with telescoping upper casing strings and a lower brine/water casing string. Details of cavern construction are presented in Section A.3.2.

A.4.5.5.2 Roadways

A system of roadways would be required at the dome for access to cavern wellheads and other plant areas. Roadways would also be built for the construction and maintenance of the raw water intake and brine disposal system. The majority of the roadways and other filled areas would be located in low-lying areas and swamps. The fill material would be placed on a base of felled trees, boards, or other materials used to support the subgrade as discussed in Section A.3.4.

A.4.5.5.3 Pipelines

Pipeline routes for the oil distribution connection, brine disposal, and raw water lines would cross both freshwater swamp and agricultural land. Water depths and access to pipeline routes are not anticipated to be major problems. A combination of push-ditch and conventional pipe-laying techniques would be used (see Section A.3.5).

A.4.5.6 Development Timetable

While the facility would, in part, consist of existing storage caverns, the construction of the necessary pumps, raw water, and brine systems and laying the required pipelines would take an estimated five months following approval of the program and design of the facility. Approximately 21 months of cavern leaching would then precede the filling of existing caverns and new capacity. It is estimated that 150 million barrels of stored oil could be in place and the facility ready for emergency withdrawal within the time allotted by the SPR program (see Figures A.4-7 and A.4-8).

A.4.5.7 Operation

A.4.5.7.1 Storage Phase

When the storage facility has been completed and the design capacity is reached, there would be an interim period during which the only activities at the site would be security and maintenance checks. However, readiness for activation during an emergency would require keeping operations personnel available.

During that static storage period, all equipment would be serviced and tested on a regular basis to insure proper working order. Maintenance crews would be on duty on a 24-hour basis.

It is possible that certain national emergencies could occur before the planned total reserve capacity of the SPR program is met. In order to prepare for such a contingency, the Napoleonville facility design provides for oil return bypass valves to allow intermittent recovery of oil already stored.

A.4.5.7.2 Extraction Phase

The SPR program requirements plan for an emergency deliverability of stored oil at a system delivery rate of two million barrels per day. For the first 150 days of a withdrawal, oil would be removed from Napoleonville at the rate of 0.78 million barrels per day, the remainder (1.22

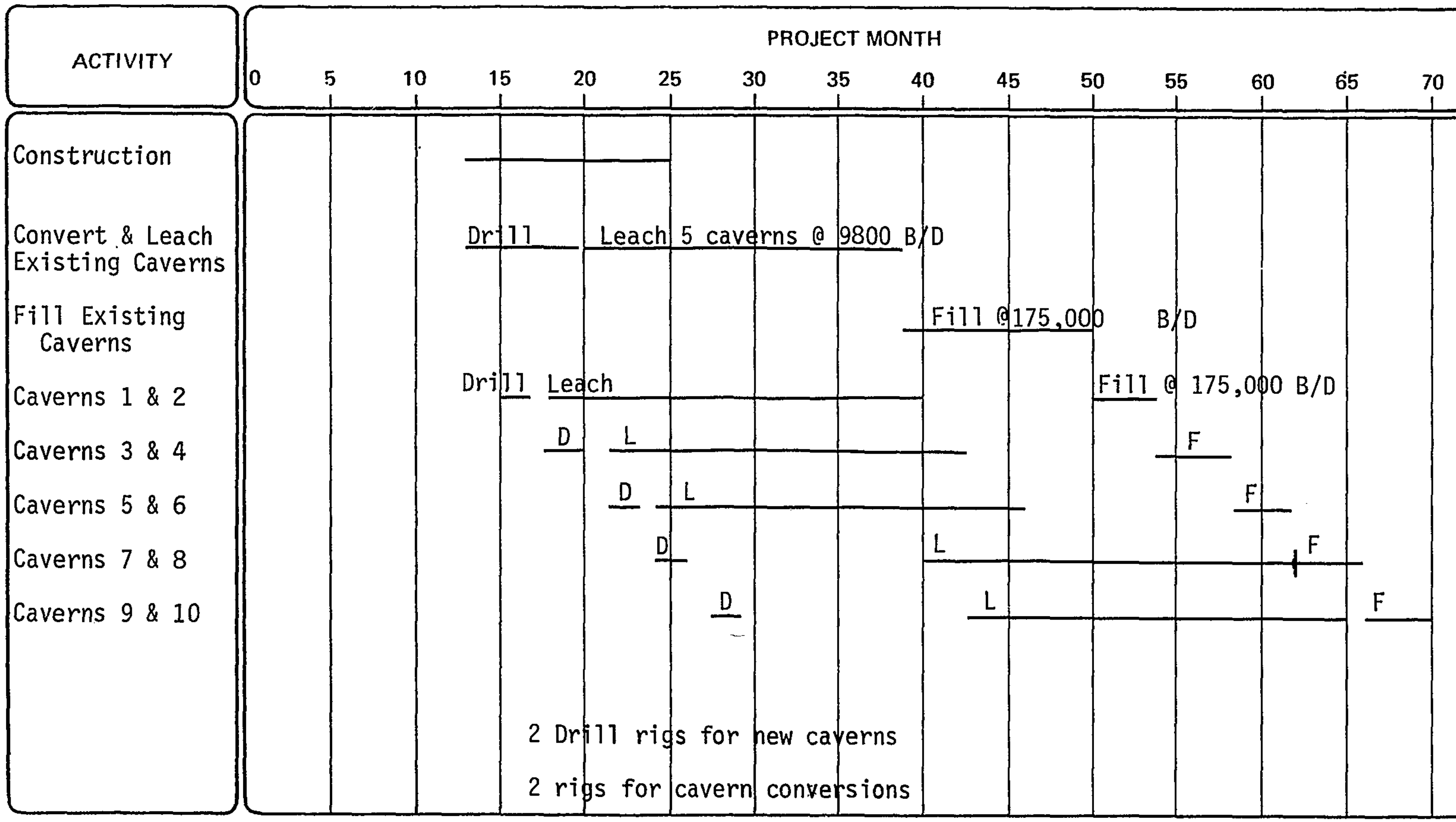


FIGURE A.4-7 Development timetable for Napoleonville dome.

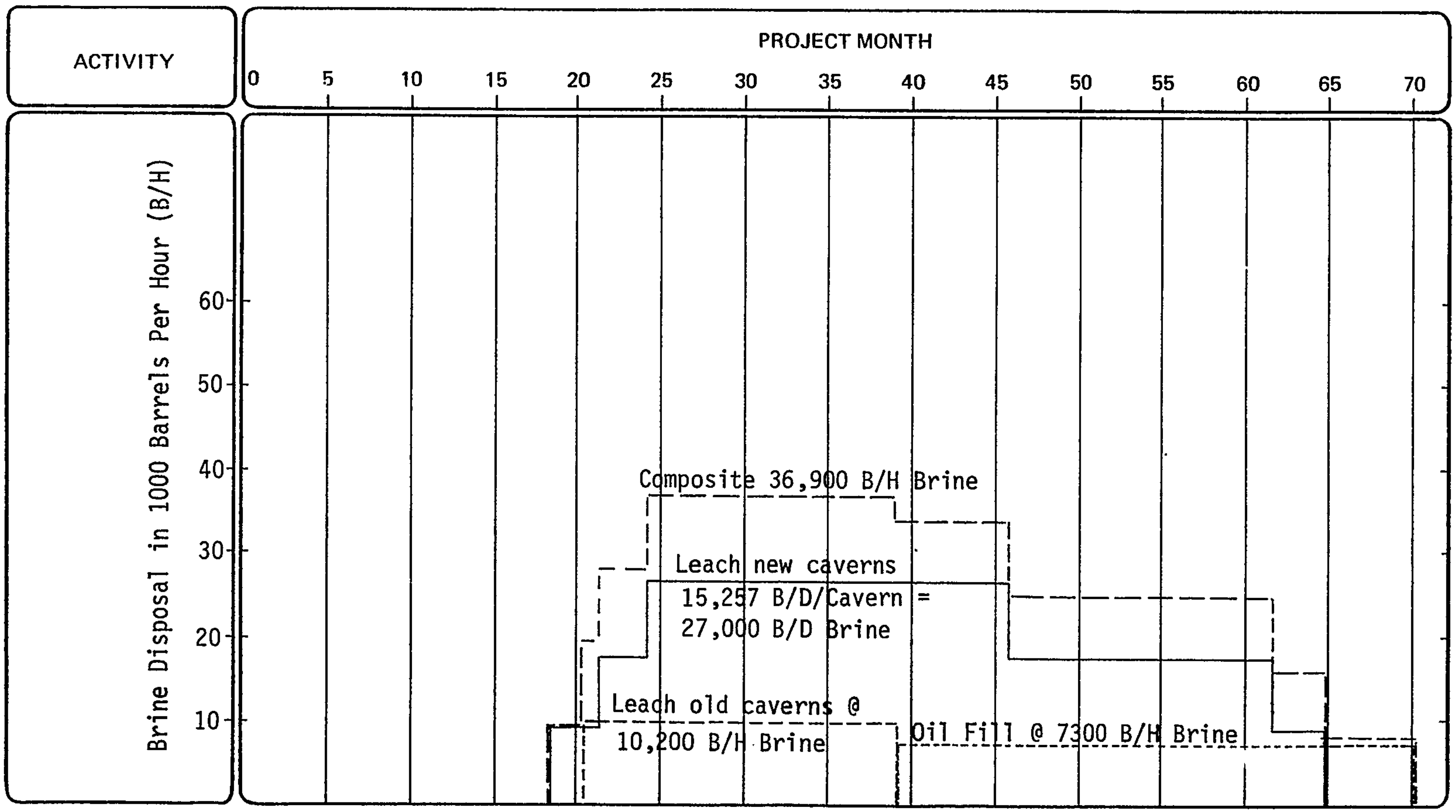


FIGURE A.4-8 Development timetable for Napoleonville brine disposal.

MMBPD) resulting from withdrawal of early storage phase storage at Bayou Choctaw and Weeks Island. The remaining oil would then be withdrawn from Napoleonville at the pipeline capacity of 1.0 MMBPD, for a total withdrawal period of 183 days.

Crude oil stored in each cavity would be recovered by pumping raw water into the bottom of the cavity, and displacing the oil through the annular space at the top of the cavity. The oil would leave each wellhead at a pressure capable of transporting the oil via pipeline to the distribution terminals.

A.4.5.7.3 Refill Phase

After an oil supply interruption has ended, refill of the SPR storage facility is planned. The rate of fill would depend on the availability of crude but is currently planned for fill over a 24-month period. Refill is assumed to begin six months after the end of the supply interruption.

Refill Process

The refill process is the reverse of the recovery process. The crude oil is injected into the top of the storage cavity, thus displacing the brine, which in turn goes to the disposal wells. The brine disposal system and distribution system are designed with excess capacity which would be available during refill periods.

Refill Capacity

Up to five fill and withdrawal cycles are included in the design considerations for the SPR program. Although for leached cavity facilities the cavern capacity enlarges during each cycle, due to the introduction of fresh water, only the original design capacity for each cavity would be refilled. The fact that a smaller percentage of fresh water would be introduced into the cavern during successive fill operation reduces somewhat the continued leaching process. Due to casing and pipeline limitations, total usage of the enlarged capacity would not allow total displacement within the required time during subsequent withdrawals.

A.4.5.8 Termination and Abandonment

When the oil storage capacity at Napoleonville dome would no longer be needed, it is intended that the facility continue to serve a beneficial use. Storage of light petroleum products, LPG, or other industrial products is a possibility. If no users could be found for the short term, the facility could be mothballed for later use.

Ultimately, the facility would be abandoned. Surface equipment would be removed and sold off-site. Brine injection wells and cavity access would be sealed with concrete, a common oil field procedure. No long-term surveillance or maintenance is anticipated.

A.5 ALTERNATIVE GROUPING NO. 1 - EARLY STORAGE SITES PLUS EXPANSION OF WEEKS ISLAND DOME

A.5.1 Introduction

Early storage for the Capline Group total as much as 183 MMB at the Bayou Choctaw dome and Weeks Island dome sites (see Sections A.4.3 and A.4.4). Development of the group to near the design goal of 300 MMB could be accomplished by the construction of 91 MMB of additional storage in leached caverns at the Weeks Island site (See Figures A.5-1 and A.5-2). The expanded capacity could be developed without construction of a new crude oil distribution pipeline to the DOE Terminal, as only increased usage of the existing Weeks Island - St. James Pipeline (early storage) would be necessary (see Section A.4.4.4.3).

The required construction and interaction with existing facilities necessary for the expansion of the Weeks Island site are presented in Section A.5.2.

A.5.2 Weeks Island Expansion Alternative

Development of the Weeks Island site would be in two stages. The existing underground salt mine operated by Morton Salt Company would be converted to crude oil storage during the early storage phase of the SPR Program (see Section A.4.4 and FES 76/77-8). Leached caverns would then be constructed to provide additional storage under the long-range provision of the program. This section describes the proposed expansion and relates it to previously existing and early storage facilities at the site.

A.5.2.1 Location

The Weeks Island salt mine site is located in Iberia Parish, south-central Louisiana, about 95 miles southwest of New Orleans and 14 miles south of New Iberia, Louisiana (see Figures A.5-1 and A.5-2). The former town of Weeks overlies a portion of the island.

A.5.2.1.1 Site Access

Vehicle access to the site is by State Highway 83 which crosses the east side of the island. Paved roads then lead into the remainder of the island. The Southern Pacific Railroad has a spur line to the island from the south.

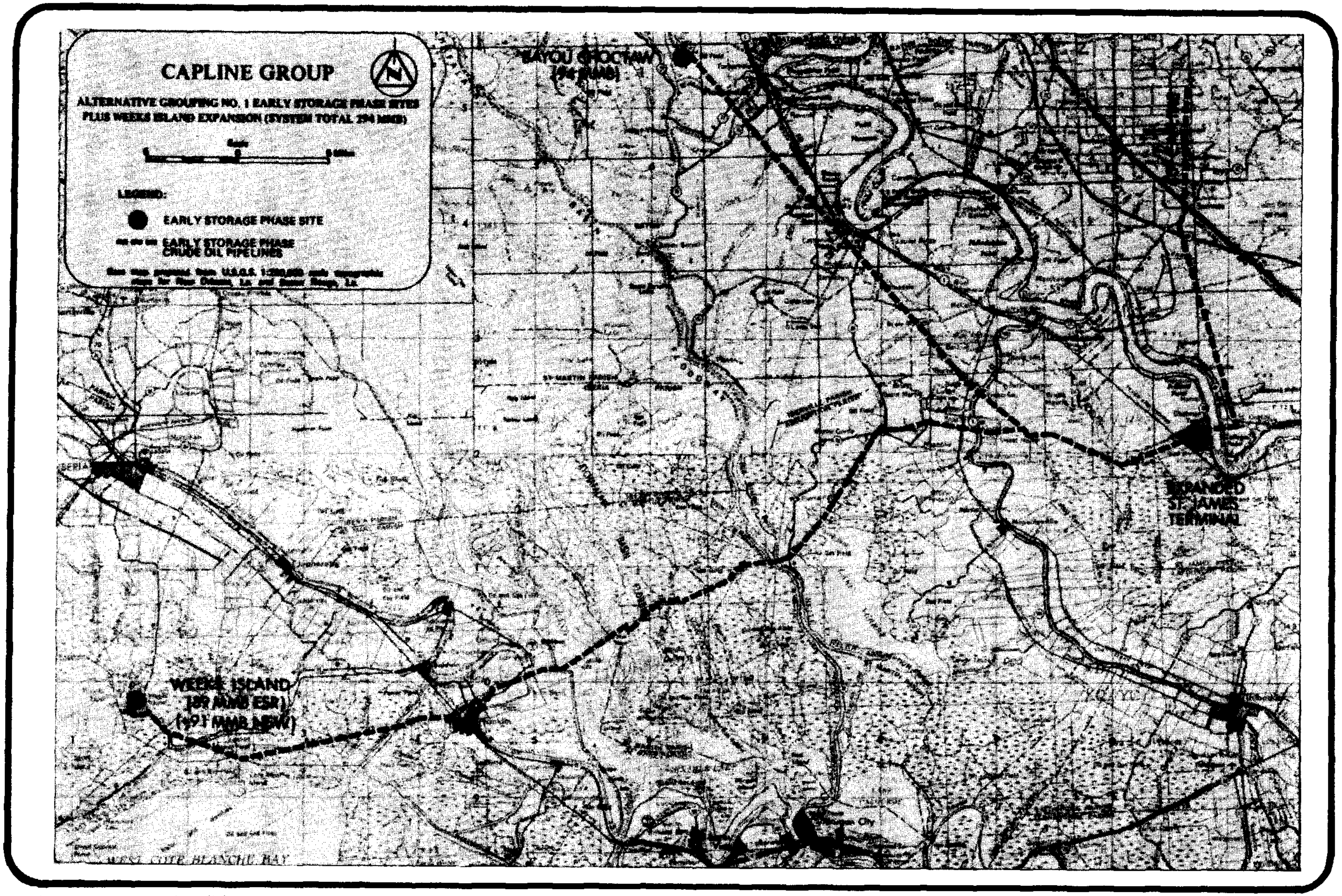


FIGURE A.5-1 Capline Group - alternative no. 1 - early storage sites plus Weeks Island expansion.

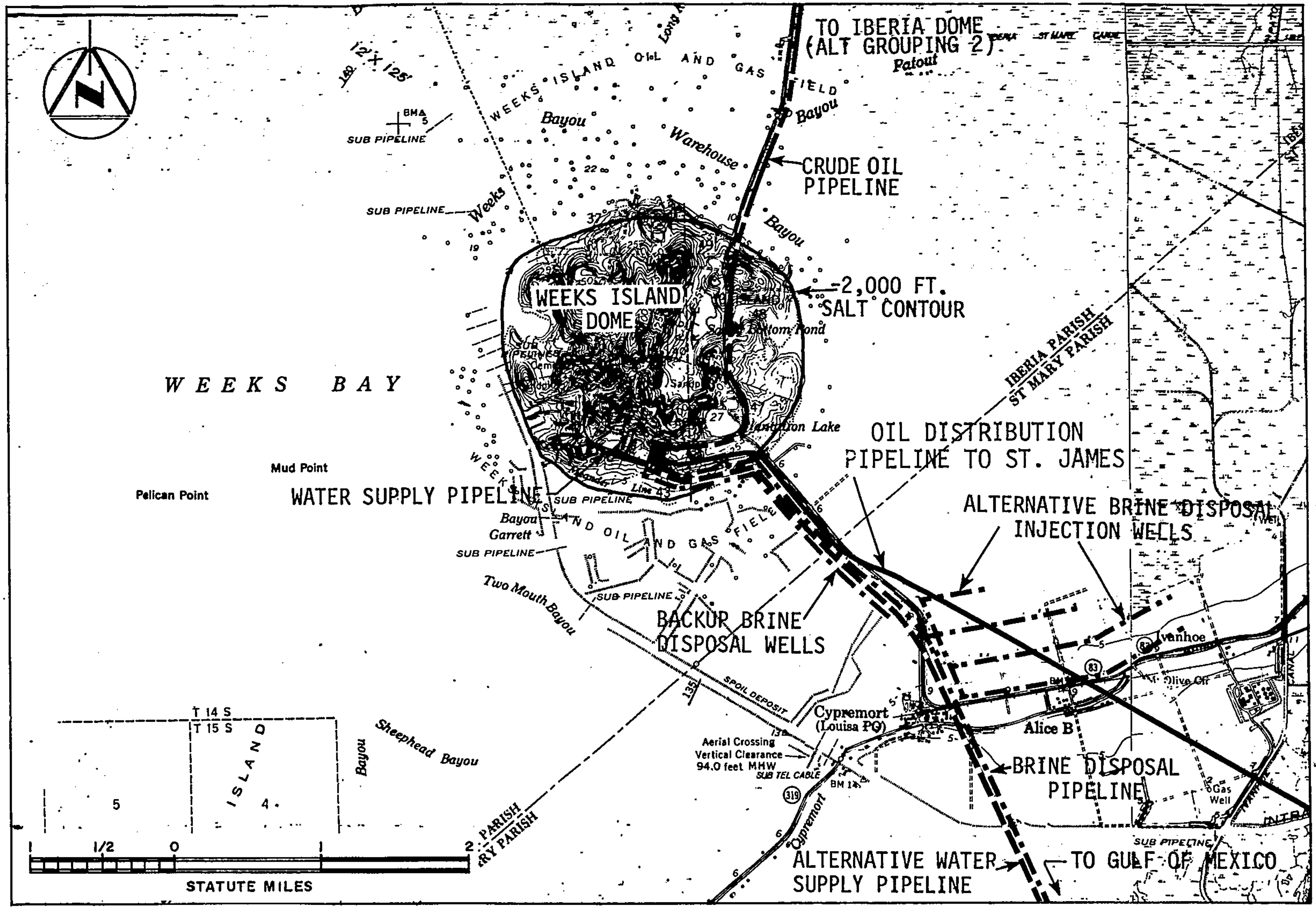


FIGURE A.5-2 Vicinity map - Weeks Island dome.

The island is surrounded by brackish and intermediate marsh and swamp forest; the Intracoastal Waterway passes just to the west. The eastern shore of Weeks Bay lies further to the west. The area has been extensively explored for oil and gas with numerous wells on all sides of the island. Small access channels have been dredged to many of the wellheads.

The Weeks Island site is located approximately 66 miles southwest of the DOE terminal on the Mississippi River. This would be the distribution terminal used for all crude oil fill and withdrawal at the site.

A.5.2.1.2 Site Description

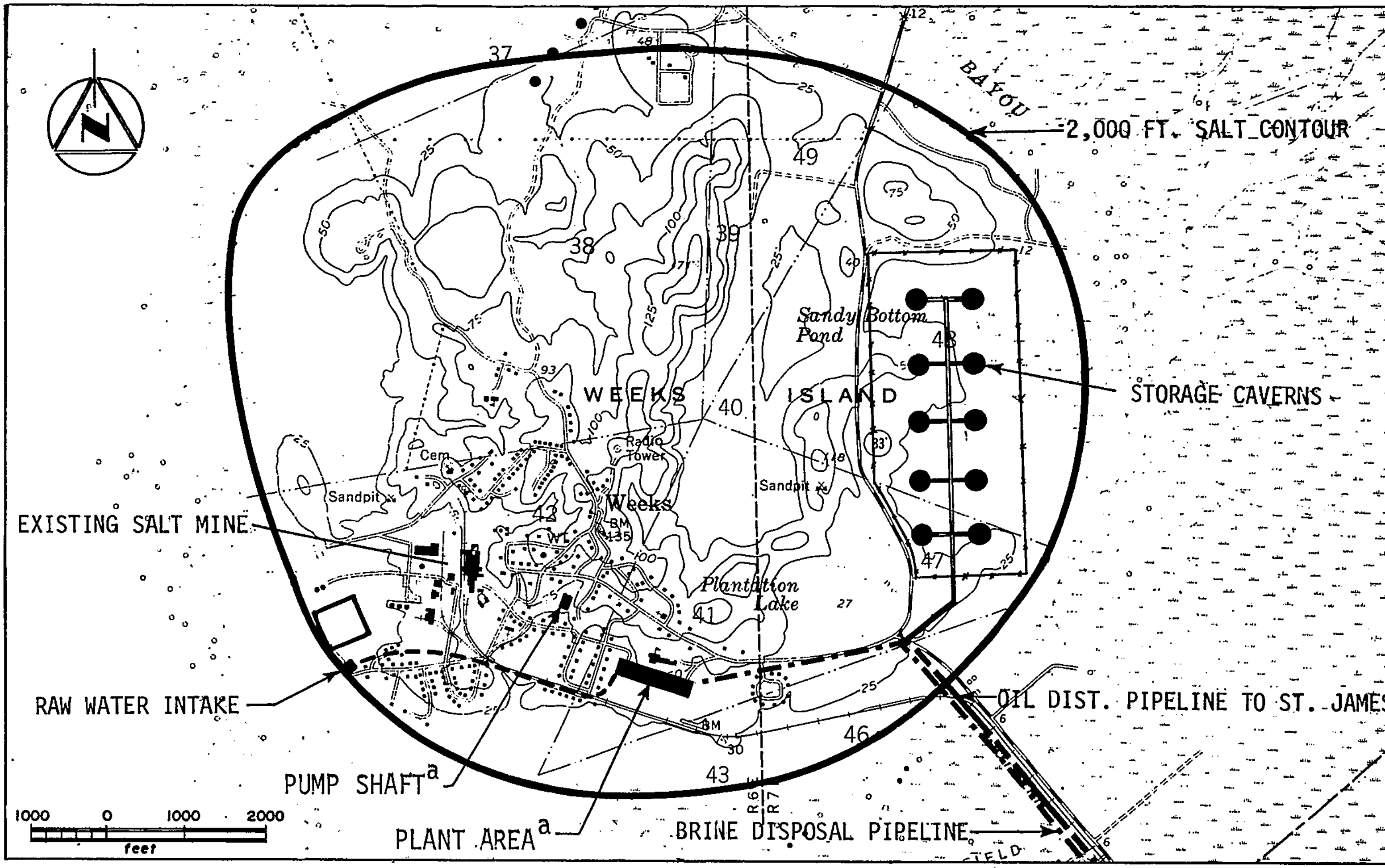
Weeks Island is the topographic expression of one of a series of salt domes on the Louisiana coast known as the Five Islands. It is approximately circular with a diameter of two miles; the highest point on the island is about 170 feet above mean sea level. About 2000 acres are located within the -2000 foot salt contour (Figure A.5-3), of which about 95 percent is dry land. Approximately 100 acres would be enclosed by a fence for the storage site.

The island is characterized by gently rolling slopes, covered with a second growth deciduous forest. Parts of the island have been cleared for sugar cane, and farming is limited to a few hundred acres leased from Morton Salt Company along State Highway 83 on the eastern flank of the island. A Shell Oil Company oil and gas production facility is located at the north edge of the island and the Morton Salt Company mine is confined to the Southwest corner of the island.

A.5.2.2 Capacity

The existing underground salt mine facilities operated by Morton Salt Company would be converted to storage of 89 million barrels of crude oil utilizing existing mine space only (early storage phase), and no expansion of that capacity by conventional mining methods would be anticipated for later stages of SPR.

Expansion of the Weeks Island site as part of alternative grouping No. 1 would consist of 6 solution mined cavities of 10 MMB capacity each, two each with a capacity of 7.3 MMB, and two 8.2 MMB caverns at



[a] early storage facilities

FIGURE A.5-3 . Site map - Weeks Island dome.

the tentative locations shown in Figure A.5-1. This 91 MMB of additional storage plus the 89 MMB of early storage would yield a design storage capacity at Weeks Island of approximately 180 MMB.

Preliminary estimates by the DOE indicate that the Weeks Island site would be suitable for a total of 35 leached caverns of 10 MMB capacity, including the 10 described above (Figure A.5-3). Therefore, 230 MMB of additional capacity could be leached, for a total capacity at the site of 439 MMB. If all caverns were developed to 20 MMB each, the ultimate capacity of the site would be 789 MMB.

A.5.2.3 General System Description

A.5.2.3.1 Proposed Systems

The proposed leached cavern storage area would be located away from existing mine works and early storage facilities but would utilize the existing, though expanded, plant area. The caverns would be constructed in the grid, as shown in Figure A.5-3. The caverns would be connected by pipeline to the main plant area, and all flows would be directed through the main plant. Leaching of the caverns would be accomplished by pumping fresh water through the central pumping facility into the salt. The brine which is formed when the salt enters into solution with the fresh water is displaced from the expanding cavity by the continued pumping of fresh water into the cavity. Displaced brine would then be piped to a disposal area.

Raw water is proposed to be provided through a short pipeline to the Intracoastal Waterway (see Figure A.5-3) west of the mine site. Brine disposal would be accomplished by construction of a pipeline to the Gulf of Mexico. The pipeline would extend about 37.6 miles south of the site.

Crude oil storage would commence with the completion of cavern leaching. Oil would be injected into the cavities, displacing brine for disposal. Oil supplies, withdrawals, and subsequent refills are planned utilizing a new pipeline connection to the DOE terminal on the Mississippi River (early storage) about 64.4 miles northeast of Weeks Island (see Figure A.5-1). Some additional tankage and other systems would be required at the terminals to accomodate the additional crude oil transfers to the expanded Weeks Island site, as discussed in Section A.4.2.1. Withdrawal of the stored oil would be accomplished by the injection of displacement water from the Intracoastal Waterway into the storage cavity through the well tubing. The displaced oil would be piped to surge tankage and mainline pumps (early storage) and through the pipeline to St. James.

A.5.2.3.2 Alternative Systems

An alternative raw water source would be the Gulf of Mexico. An alternative brine diffuser in the Gulf of Mexico would be 53.1 miles south of the site. The pipeline to the Gulf would parallel the proposed brine disposal line. Deep well injection could be utilized as an alternative brine disposal method. A possible well field is shown on Figure A.5-2.

An alternate method of crude oil distribution would be via pipeline to an offshore loading area in the Gulf of Mexico. This loading area would be constructed at a point in the Gulf with a minimum water depth of 60 feet.

A.5.2.4 Site Development

A.5.2.4.1 Proposed Physical Facilities

Site Layout

The 10 planned leached storage caverns would be located east of State Highway 83 on an 800-foot grid as shown in Figure A.5-3, on a site comprising about 100 acres in area. Each cavity would be leached to an initial capacity ranging from 7.3 to 10 million barrels each. As there is no identifiable caprock at the dome, drilling difficulties which would reduce effective cavern size are not anticipated. The 11 caverns are therefore expected to have a system capacity of 91 MMB.

Wellheads would be connected to the existing central plant (early storage) by a series of roadways and pipelines. A 12-foot access road would be required to each pad. On-site pipelines would be mounted above ground on pilings located beside the roadways. Some grading would be required for installation of roadways and for construction of a dike around each cavern wellhead to contain operational oil spills. The 100-acre main leached cavern storage area would be enclosed by a 9-foot-high chain link fence.

Plant Area

Plant facilities would consist of an expansion to the existing (early storage) plant at the mine site, as the existing facilities require only oil handling equipment. Existing equipment will include the main pump and control building, shops, warehouse, office, laboratory, oil metering yard, and laydown-fabrication yard (five to six acres), and would occupy a total of 8 to 10 acres. (See Section A.4.4.4 and Figure A.5-4).

Expansion of the site facilities to include leached caverns would require, in addition to upgrading oil handling equipment, the installation of raw water and brine disposal systems. Additional pumps and controls would be installed at the central plant to handle the water and brine systems. Also required at the plant would be a lined brine surge pond of about 120,000-barrel capacity, and a 112,000-barrel raw water surge pond. Each pond would cover 1.5 acres and be 8 to 10 feet deep. To provide additional operational flexibility, a second brine pond may be constructed; the two ponds would be used alternately.

For initial cavern leaching, a 20,000-barrel blanket oil tank enclosed in an adequate spill containment dike would be located near the pump building. This tank would also be used as a surge tank during oil withdrawal operations.

Power supply for all equipment would be an extension to existing commercially supplied power at the site.

Raw Water Supply

The Intracoastal Waterway (ICW) is the planned source of raw water for the initial leaching of the storage cavities, as well as for the subsequent displacement of stored oil. As the ICW is connected to the Gulf of Mexico at nearby locations, problems with adequate supplies would not be anticipated. A maximum of 28,000 barrels per hour (19,600 GPM) of raw water would be required.

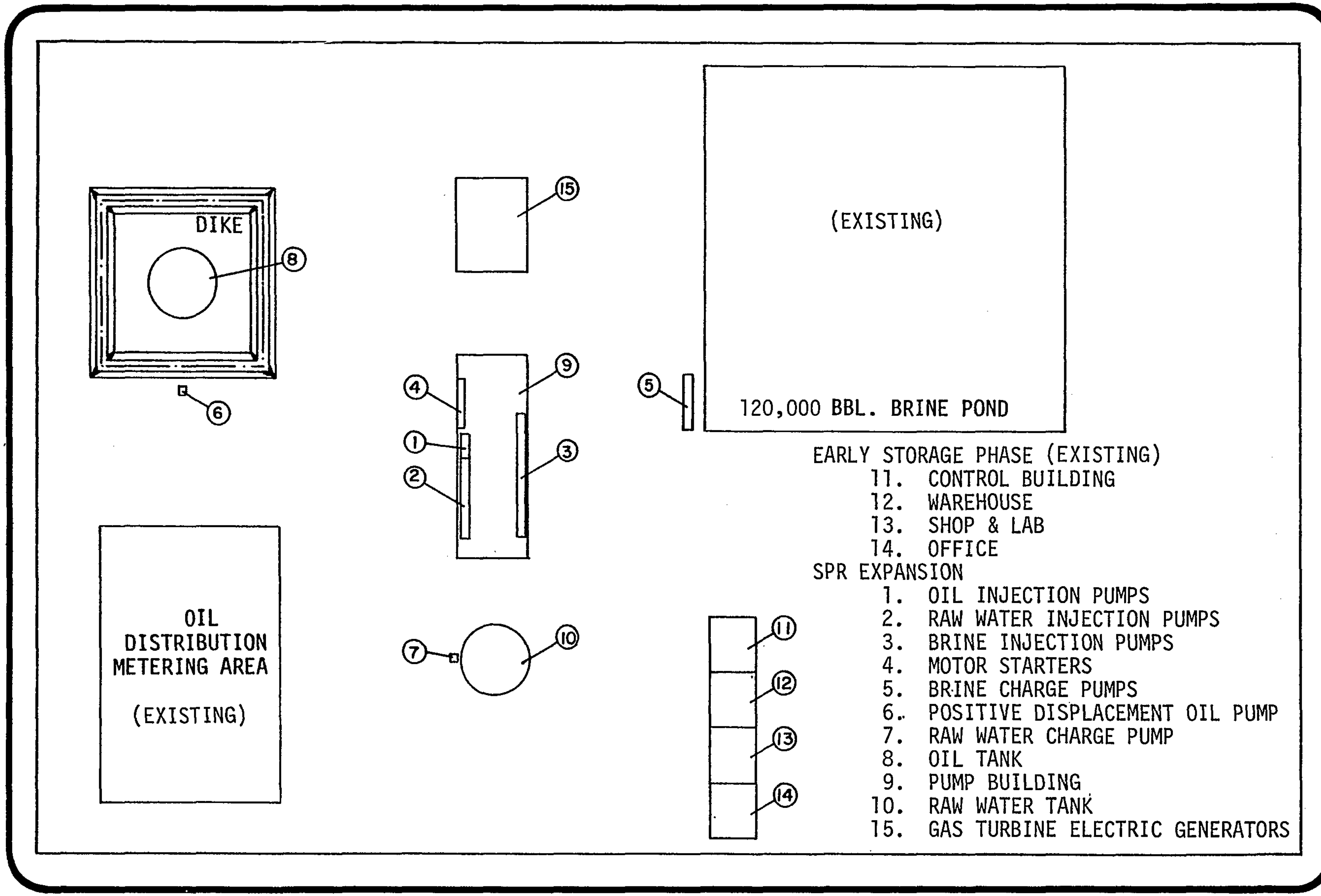


FIGURE A.5-4 Storage area layout - Weeks Island dome.

Use of the ICW as a raw water source would require the installation of a pump station at the location shown in Figure A.5-3. The intake structure at the pump station (Figure A.5-5) would be sized to meet EPA intake design standards of a maximum velocity of 0.5 feet per second, to reduce fish impingement on the intake screen and to assist in the removal of suspended solids. Raw water would then by piped along the location shown, to the central plant area for distribution to the storage cavities. The 0.9-mile-long pipeline would pass through previously industrialized land.

The pipeline from the water intake and pump station would terminate at a 112,000-barrel raw water surge pond, designed for a four hour retention period for solids settling. Automatic controls would be provided to maintain the level in the surge reservoir. Charge pumps would be installed at the reservoir. These pumps would enable the high pressure injection pumps to be started with water from the reservoir; after startup, the charge pumps would be shut down, and the injection pumps would take suction directly from the raw water supply pipeline. The raw water pond would also be used as a fire system reservoir.

Brine Disposal

Brine produced during leaching and crude oil fill operations would flow to a lined, 120,000-barrel settling and surge reservoir. Then, it would be transferred to the discharge pipeline by brine charge pumps and pressurized by the pipeline transport pumps. The proposed means of disposing of brine is via a pipeline to the Gulf of Mexico at the rate of 33,000 barrels per hour. The proposed 37.6-mile pipeline route (Figure A.5-6) runs onshore southeast of the plant area for 5.5 miles, then extends offshore across West Cote Blanche Bay in a southeasterly direction, then south across East Cote Blanche Bay and into the Gulf of Mexico. An underwater pipeline length of 32.1 miles would be required to extend to the 20-foot water depth. The final 2000 feet of the brine disposal pipeline would be constructed as a diffuser, which would consist of 34 3-inch risers stemming from the top of the buried pipeline. Risers would be spaced on 60-foot centers over the 2000-foot-long diffuser area. Each riser would be five feet above the mudline (see Figure A.5-7).

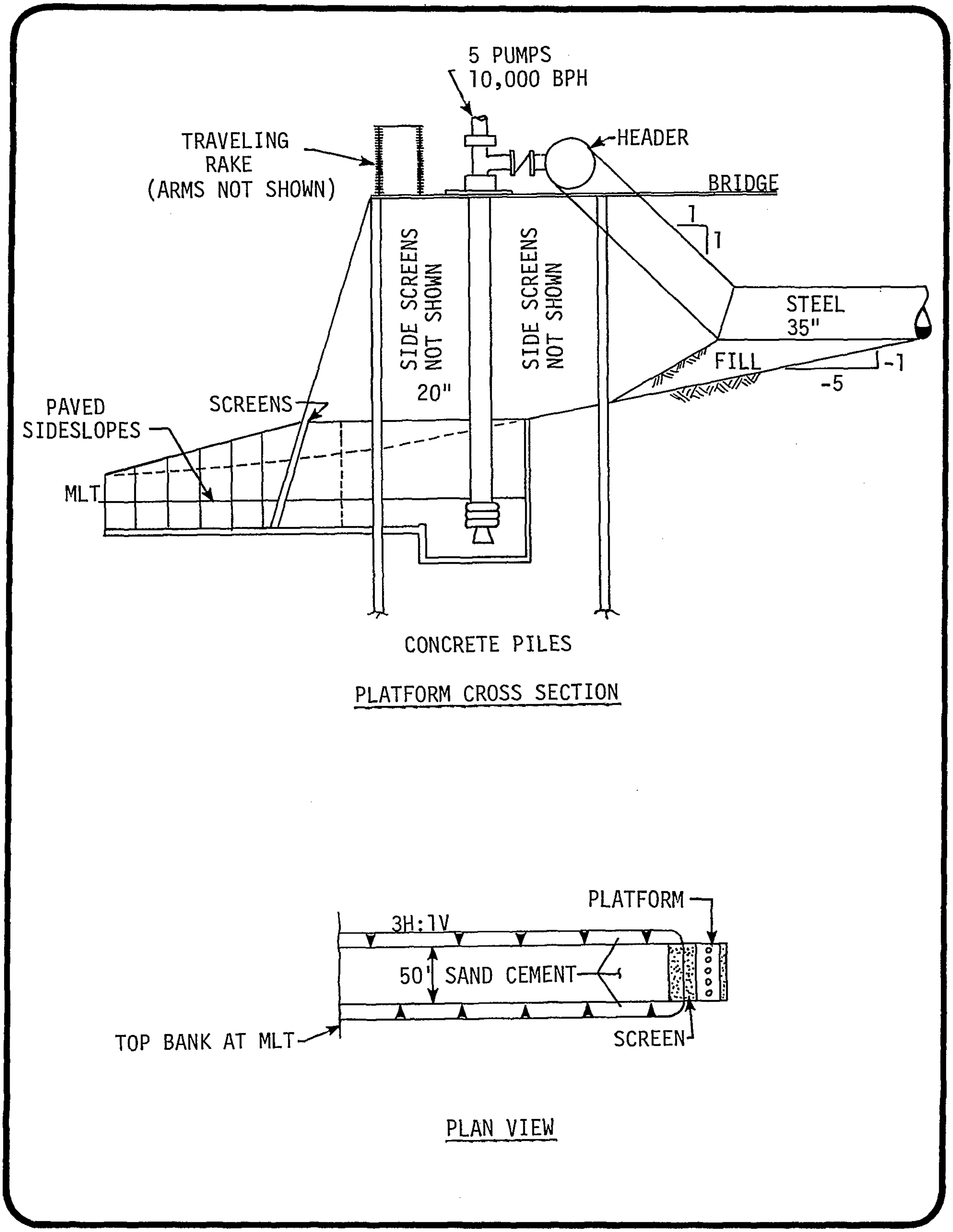


FIGURE A.5-5 Water intake platform and structure.

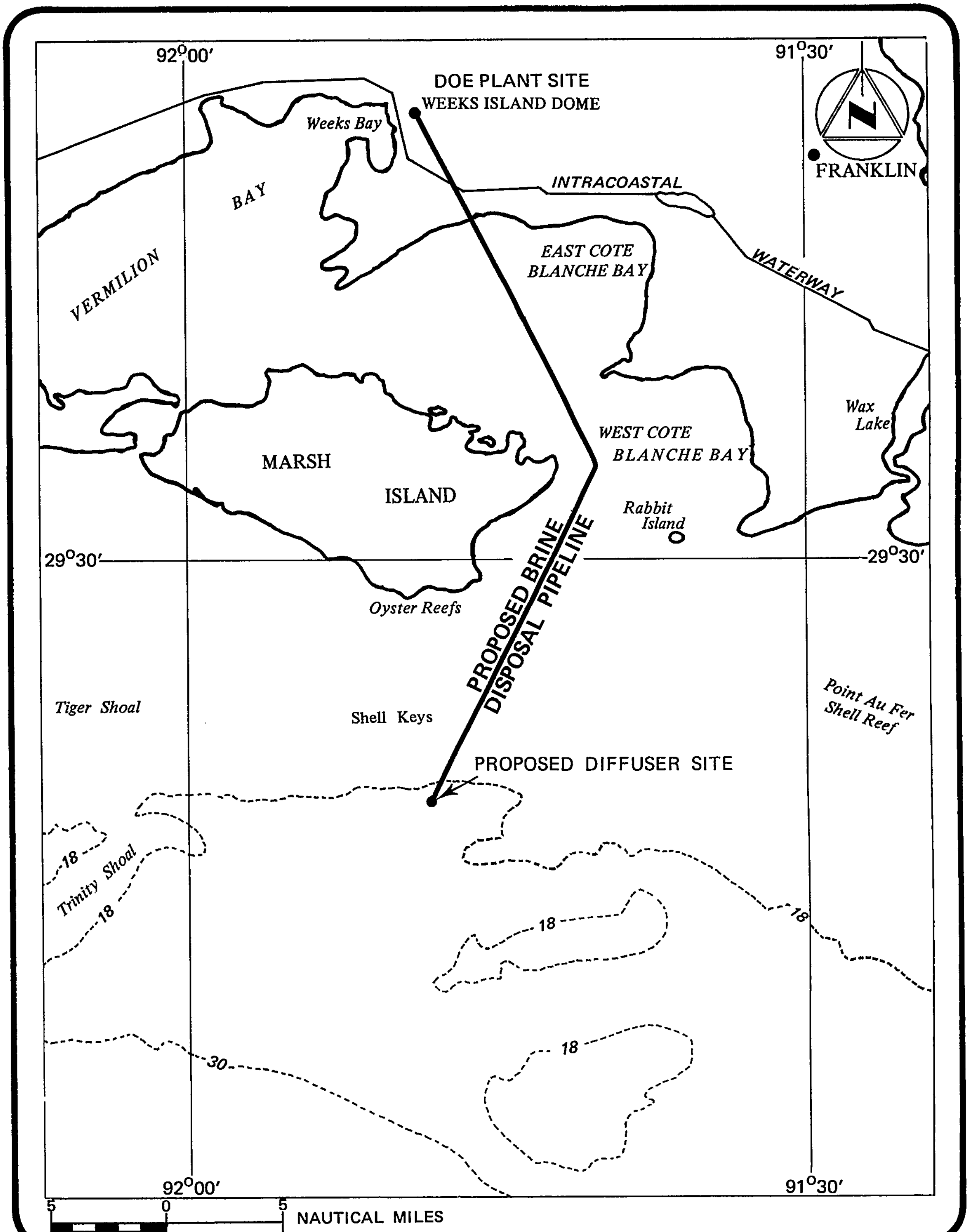


FIGURE A.5-6 Brine disposal pipeline route - Weeks Island dome.

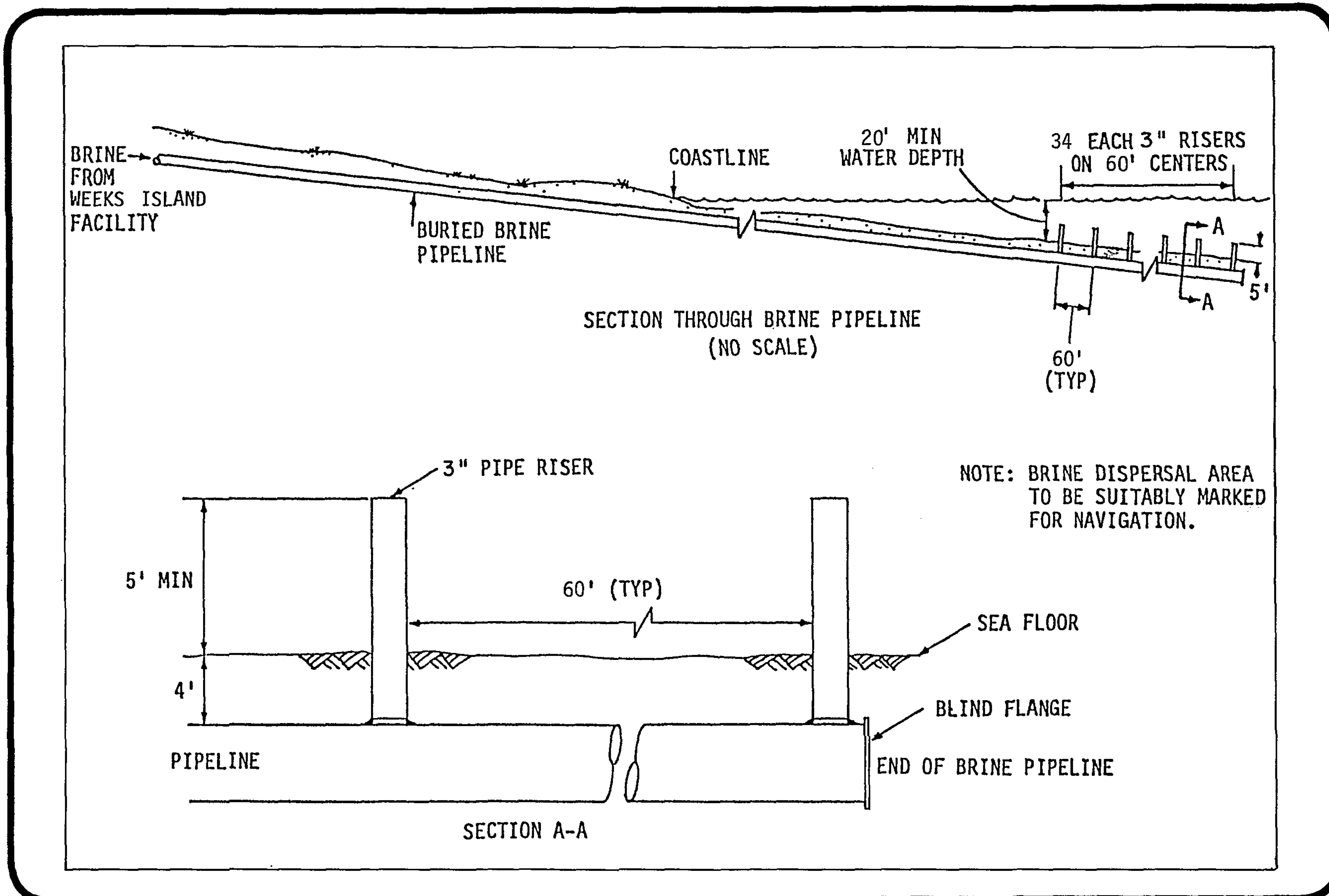


FIGURE A.5-7 Brine dispersal system - Weeks Island dome.

The on-land portion of the brine disposal pipeline would pass through 13 acres of marsh requiring a 120-foot right-of-way and flotation canal pipeline techniques, and 41 acres of dry land where an 80-foot right-of-way and conventional pipelay techniques would be used.

To supplement the offshore disposal system, a series of three deep injection wells would be constructed off the southeast flank of the dome, along the brine disposal pipeline. These wells would be valved into the pipeline and would be operated for brine disposal when conditions preclude disposal to the Gulf of Mexico.

Crude Oil Distribution

Initial crude oil fill as part of the early storage phase will be accomplished via a pipeline connection to the DOE Terminal on the Mississippi River. Increased usage of the pipeline and construction of additional valving and monitoring capacity at Weeks Island would be required to accommodate the 91 MMB storage increase over the 89 MMB early storage phase design.

During oil recovery operations, the maximum design flow rate of oil would be 1.0 MMB per day for withdrawal of 180 MMB of stored oil.

Land Requirements

Total land requirements for the expansion project as planned would be 168 acres on land plus 778 acres offshore (Table A.5-1).

The storage facilities would be located on a 100-acre tract of land lying east of State Highway No. 83. Development within this area would be confined to approximately 32 acres. Pipeline connections to the existing early storage facility would require a right-of-way approximately 6.6 miles long, an area of 7 acres. Other onsite facilities would be located in previously industrialized areas expanded under early storage construction.

The raw water pipeline and pumping facilities would be located at the converted mine site. The water pipeline from the plant to the storage caverns would be in the above described right-of-way; the pipeline from the water intake to the plant would require about nine acres.

TABLE A.5-1 Proposed physical facilities - Weeks Island - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
A. SPR Facilities - Weeks Island - Fenced Area - 100 acres										
1) Storage Site										
a) Brine Surge Pond	---	---	24,000	2/2	---	---	---	---	--	2/2
b) Roadways to Cavern Wellheads	---	---	16,000	2/2	1/1	---	1/1	---	---	4/4
c) Cavern Wellhead Drill Pads	---	---	60,000	2/2	1/1	---	1/1	---	---	4/4
d) Cavern Wellhead Containment Dikes	---	---	7,000	8/5	3/2	---	---	---	---	11/7
e) Blanket Oil Tank Containment Dike	---	---	6,000	1/1	---	---	---	---	---	1/1
f) Raw Water Surge Pond	---	---	23,000	2/2	---	---	---	---	---	2/2
g) Raw Water, Oil, and Brine Pipelines to Cavern Wellheads	6.6	35,000	---	5/3	2/1	---	---	---	---	7/4
h) Miscellaneous	---	---	1,000	1/1	---	---	---	---	---	1/1
2) Brine Disposal										
a) Pipeline to Gulf of Mexico	37.6	575,300	---	28/18	---	13/8	13/6	6	778	832/34
b) Back-up Brine Wells	2.3	12,000	13,300	3/2	---	2/1	---	---	---	5/3
3) Raw Water Supply (from ICW)	0.9	5,000	5,000	9/6	---	---	---	---	---	9/6
4) St. James Terminal										
a) 4 - 200,000 bbl tanks	---	---	96,000	24/24	---	---	---	---	---	24/24
b) Roads and Miscellaneous	---	---	16,000	12/12	---	---	---	---	---	12/12.
5) Koch Terminal	3.2	760,000	---	57/47	---	---	---	1	10	67/47
6) Nordix Terminal	7.0	798,000	82,000	68/53	55/25	---	---	15	16	139/78
Sub-Total (SPR Facilities-Weeks Island)	57.6	2,185,300	349,300	224/180	62/30	15/9	15/10	22	804	1120/229
B. Early Storage Facilities										
1) Weeks Island										
a) Storage Site	---	---	---	4/4	---	---	---	---	---	4/4
b) Crude Oil Distribution	64.4	1,069,000	---	145/90	40/25	307/191	60/37	24	71	623/343
c) St. James Terminal	---	30,000	54,000	15/15	---	---	---	---	---	15/15
Sub-Total (Early Storage-Weeks Island)	64.4	1,099,000	54,000	164/109	40/25	307/191	60/37	24	71	642/362

TABLE A.5-1 continued.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
2) Bayou Choctaw										
a) Storage Site	7.0	37,000	---	120/120	---	---	---	4	2	122/120
b) Brine Disposal	2.9	46,000	95,000	---	---	31/20	---	7	1	32/20
c) Raw Water Supply	---	---	5,000	---	---	---	---	---	--	---
d) Crude Oil Distribution	38.0	383,000	---	268/167	35/22	64/40	---	13	1	368/229
e) St. James Terminal	1.0	35,000	54,000	40/34	---	---	---	---	---	40/34
Sub-Total (Early Storage-Bayou Choctaw)	48.9	501,000	154,000	428/321	35/22	95/60	---	24	4	562/403
Sub-Total (Early Storage-Weeks Island plus Bayou Choctaw)	113.3	1,600,000	208,000	592/430	75/47	402/251	60/37	48	75	1204/765
Total (Early Storage at Weeks Island and Bayou Choctaw plus Expansion of Weeks Island)	170.9	3,785,300	557,300	816/610	137/77	417/260	75/47	70	879	2324/994

Brine produced during cavern leaching or crude oil storage would be transported via pipeline to the Gulf of Mexico. A new right-of-way would be required on land for 5.5 miles south of the cavern storage area, following State Highway No. 83 for about two miles, then south across marshes to the coast. The pipeline would cross the Intracoastal Waterway south of Cypremort. A right-of-way of from 80 to 120 feet would be required on land, or a total of about 54 acres. The 32.1 mile offshore portion of the pipeline would disturb a 200-foot-wide area, or a total of 778 acres.

Road Construction and Other Grading

Grading requirements for the proposed expansion would be limited to within the 100-acre leached cavern storage area, the pipeline corridor to the early storage central plant area and to the raw water supply intake, and construction of surge ponds and containment dikes within the plant area. The ground elevation at the cavern storage area ranges from less than 5 feet to 45 feet above mean sea level, and grading and diking would be required. Storm design considerations indicate that roadways and drill pads should be constructed to elevation 20. Four eastern drill pads plus connecting roads would require fill to that elevation.

Fill requirements for the expansion would include:

Drill Pads and Connecting Roads	76,000 cubic yards
Cavern Wellhead Containment Dikes	7,000 cubic yards
Raw Water Surge Pond	3,000 cubic yards
Brine Surge Pond	24,000 cubic yards
Blanket Oil Tank Containment Dike	6,000 cubic yards
Miscellaneous	1,000 cubic yards
Brine Disposal Back-up Wells	13,300 cubic yards
Raw Water Supply Intake Structure	5,000 cubic yards
Total Fill	155,300 cubic yards

Excavations would be required for crude oil, raw water and brine disposal pipeline installation. Assuming that all but minor segments of the pipelines would be buried, excavation quantities would be as follows:

Raw Water Intake to Plant Area, 0.9 mile	5,000 cubic yards
Back-up Brine Injection Wells	12,000 cubic yards
Raw Water, oil and Brine Pipelines to Cavern Wellheads, 6.6 miles	35,000 cubic yards
Brine Pipeline to Gulf of Mexico - on Land 5.5 miles	66,300 cubic yards
-offshore 32.1 miles	509,000 cubic yards
total on land	118,300 cubic yards
total offshore	509,000 cubic yards
total excavation	627,300 cubic yards

A.5.2.4.2 Alternative Physical Facilities

The facilities associated with the alternative systems discussed below and in Section A.5.2.3.2 are presented in Table A.5-2 for comparison with proposed facilities.

Brackish water from the Gulf of Mexico could be pumped from an intake structure on West Cote Blanche Bay through a 7.5-mile pipeline which would parallel the proposed brine disposal pipeline on land. The raw water pipeline would require only 13 acres on land and 49 acres offshore due to existing right-of-way.

An alternate method of brine disposal would be by deep well injection into saltwater-bearing sands. Twenty-five wells would be located as shown in Figure A.5-2. The well field and accompanying roadways and drill pads would require approximately 125 acres of right-of-way, with 106 acres through agricultural land and 19 acres through freshwater swamp land. An alternative brine diffuser site requiring a 53.1-mile pipeline would follow the proposed brine disposal pipeline right-of-way on land and would extend 47.6 miles offshore.

An alternate method of crude oil distribution would be via a pipeline to an offshore loading area in the Gulf of Mexico. The 61.5-mile pipeline would pass through 31 acres of forest and marsh, and would extend 56 miles into the Gulf to a point with minimum water depth of 60 feet. An offshore area of about 1428 acres would be affected by the pipeline excavation.

TABLE A.5-2 Alternative physical facilities - Weeks Island - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
1) Raw Water Supply (from Gulf of Mexico)	7.5	98,500	5,000	7/5	---	3/2	3/2	6	49	62/9
2) Brine Disposal (Wells)										
a) Pipeline Excavation	8.8	151,000	---	87/55	---	19/12	---	---	---	106/67
b) Roadways to Brine Disposal Wellheads	---	---	---	6/4	---	---	---	---	---	6/4
c) Brine Disposal Well-head Pads	---	---	---	13/9	---	---	---	---	---	13/9
3) Brine Disposal to Alternative Diffuser	53.1	820,800	---	28/18	---	13/8	13/8	6	1154	1208/34
4) Crude Oil Distribution To Gulf of Mexico (SPM)	61.5	1,027,500	---	---	16/10	---	15/9	1	1428	1459/19
5) Nordix Terminal and Alternative Pipeline	10.0	773,000	82,000	74/56	21/15	---	---	4	1	96/71

A.5.2.5 Construction Techniques

A.5.2.5.1 Cavern Construction

Cavern construction will consist of ten leached caverns spaced on 800-foot centers, with heights of up to 1000 feet and ultimate diameters up to 400 feet. As no previous cavern development or subsurface mining has been undertaken in this portion of the dome, and no caprock has been defined, no complications with developing the site are anticipated. Construction of the caverns would therefore be as described in Section A.3.2.

A.5.2.5.2 Roadways

The Weeks Island site ranges from less than five feet above mean sea level, with marshy areas along the eastern edge of the cavern storage area. Road construction should be relatively straightforward, consisting of conventional cut and fill operations. Extending roadways out into marshes a short distance should not present difficulties.

A.5.2.5.3 Pipelines

Pipelines connecting the leached cavern storage area and the central plant area would be located on high ground and conventional pipelaying techniques could be utilized. Pipelines within the cavern storage area would be found above ground on piers or piles alongside roadways.

The brine disposal pipeline to the Gulf of Mexico would cross swamp forest for approximately 1.3 miles, agricultural land for about 2.9 miles and lowlying marshes for about 1.3 miles. Barge lay techniques will be required for the marsh areas; the construction areas can be reached by water borne equipment via existing channels. Conventional methods would be used across agricultural land near Cypremort, and push-ditch construction would be used in areas of swamp forest.

Oceangoing equipment would be used for the 32.1 mile pipeline extending into the Gulf.

A.5.2.6 Development Timetable

According to present plans, the first 11 months of facility construction would involve the installation of the raw water system, brine disposal system and connecting pipelines to the early storage phase facility (see Figure A.5-8). Twenty-four months of cavern leaching would proceed the initial storage of crude oil in developed cavities, then leaching and storage would proceed concurrently at a fill rate of 120,000 to 175,000 barrels per day (See Figure A.5-9). It is estimated that the required 91 million barrels of cavity stored oil could be in place with the facility ready for emergency withdrawal, within the time allocated by the SPR program.

A.5.2.7 Operation

A.5.2.7.1 Storage Phase

The facility would become part of the SPR as soon as cavern filling was initiated. To cover the possibility that certain national emergencies could occur before the design capacity of the facility was met, the storage system would be equipped with oil return bypass valves to allow intermittent recovery of stored oil.

There would be an interim period from the time of facility completion until a need arises for emergency distribution of the stored oil. During this interim period, the only activities at the site would be security and maintenance activities. All equipment would be serviced and tested on a regular basis to ensure proper working order. Maintenance crews would be on duty on a 24-hour basis.

A.5.2.7.2 Extraction Phase

The SPR program plans for an emergency delivery of stored oil over a five month period. Withdrawal rates for the 180 million barrel facility at Weeks Island would be limited by the 1.0 million barrels per day capacity of the 36-inch Weeks Island - St. James pipeline, requiring 180 days for complete withdrawal.

Crude oil stored in each salt cavity would be recovered by pumping raw water into the bottom of the cavity. This would cause displacement

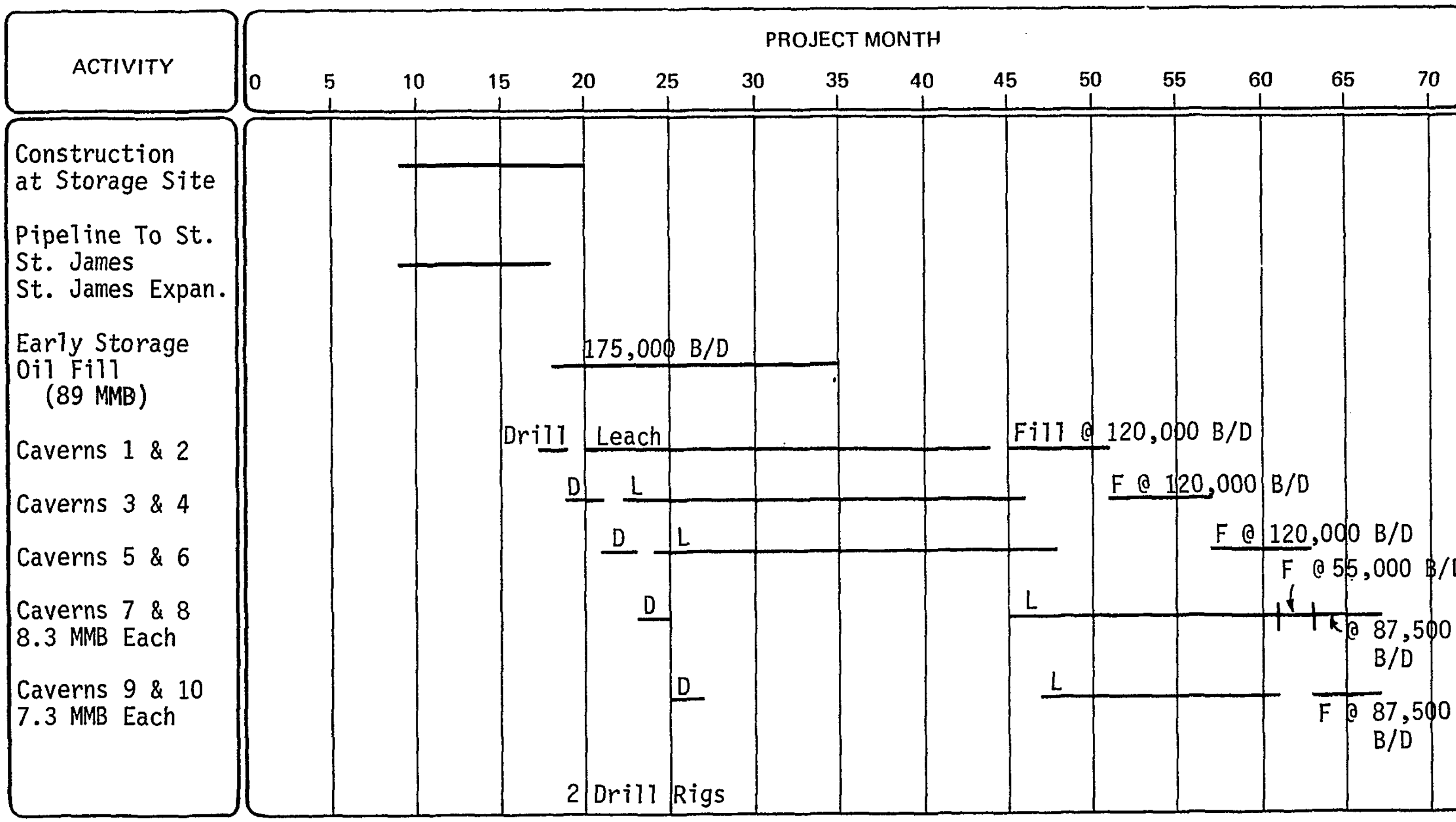


FIGURE A.5-8 Development timetable for Weeks Island expansion.

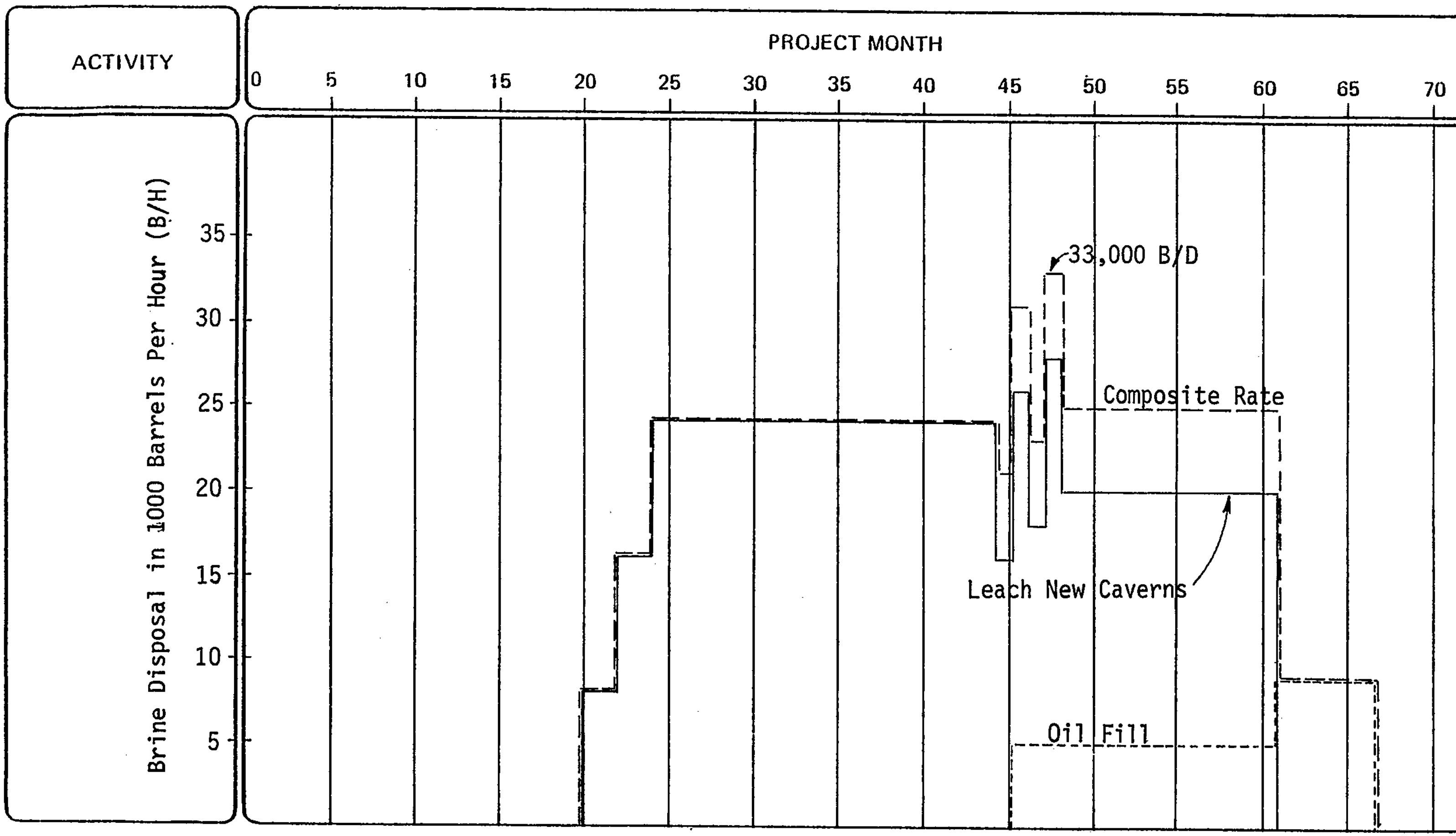


FIGURE A.5-9 Development timetable for Weeks Island brine disposal.

of the oil through the concentric tubing at the top of the cavity. Oil stored in the existing salt mine would be pumped out and to the distribution pipeline. The terminal facilities on the Mississippi River would be the distribution points for the Weeks Island strategic storage facility.

A.5.2.7.3 Refill Phase

After an oil supply crisis had ended and provided that supplies were stabilized and new imports were sufficient for additional storage reserves, refill of the SPR storage facility would be planned. The rate of fill would depend on the availability of surplus imports. Refills would be via the Weeks Island - St. James pipeline connection.

Refill Process

The refill process would be the reverse of the recovery process. For the cavern storage area, the crude oil would be injected into the top of the storage cavity, thus displacing the brine which in turn would go to the disposal system. The brine disposal systems and cavity injection system would have excess capacity available during refill periods. Mine sites would simply be refilled, with no brine displaced.

Refill Capacity

Up to five fill and withdrawal cycles are included in the design considerations for the SPR program. Although the leached cavern capacity would enlarge during each cycle, only the original design capacities for each cavity are planned for refill. The fact that a smaller percentage of fresh displacement water would be introduced into the cavern during successive displacement cycles reduces the continued leaching process from about 90 percent enlargment to about 62 percent. Furthermore, due to casing limitations, total usage of the enlarged capacity would not allow total displacement in 150 days during subsequent withdrawals. The capacity of the mine site storage would not change during refill-withdrawal cycles as no fresh water is introduced.

A.5.2.8 Termination and Abandonment

At a time when the oil storage capacity at Weeks Island would no longer be needed, it would be intended that the facility continue to serve a useful purpose through the commercial storage of other products. Mothballing could be utilized in anticipation of use at a later date.

The facility would ultimately be dismantled and abandoned, and surface equipment sold. Cavity access wells would be stripped of casing and sealed with concrete, a common oilfield procedure. No long-term surveillance or maintenance is anticipated.

A.6 ALTERNATIVE GROUPING NO. 2 EARLY STORAGE SITES PLUS EXPANSION OF BAYOU CHOCTAW DOME PLUS IBERIA DOME

A.6.1 Introduction

Early storage phase development of the Weeks Island dome site for the SPR will provide 89 MMB of crude oil storage capacity to the system. Bayou Choctaw dome early storage phase development would add as much as 94 MMB for a total of up to 183 MMB. The expansion of Bayou Choctaw to 150 MMB is an alternative; however, the total storage would increase only to 239 MMB, short of the desired 300 MMB total. The further addition of Iberia dome to the alternative grouping yields a total potential storage of 289 MMB, which approximates the 300 MMB goal. This alternative grouping, therefore, contains a combination of Bayou Choctaw early storage (see Section A.4.3), Weeks Island early storage (Section A.4.4), Bayou Choctaw expansion (Section A.6.2) and Iberia (Section A.6.3), to obtain the required total storage (Figure A.6-1).

Oil distribution for the Iberia site would, in part, utilize the Weeks Island - St. James Pipeline (Section A.4.4.4.3) constructed for early storage development of the Weeks Island site. The early storage pipeline between Bayou Choctaw and St. James (Section A.4.3.4.5) would accommodate expansion of the Bayou Choctaw site. The terminal facilities would be utilized for oil distribution for all sites, as discussed in Section A.4.2.

A.6.2 Bayou Choctaw Dome Expansion Alternative

A.6.2.1 Location

The Bayou Choctaw salt dome is located in the east central portion of Iberville Parish and extends slightly into West Baton Rouge Parish, Louisiana. The site is about 12 miles southwest of Baton Rouge, 3.4 miles southwest of the town of Addis (population about 730), and 4 miles northwest of Plaquemine (population about 7,800). The Mississippi River is located about 4 miles east of the dome. The Port Allen Canal, an extension of the Intracoastal Waterway, is a quarter mile to the west of the dome (see Figure A.6-2).

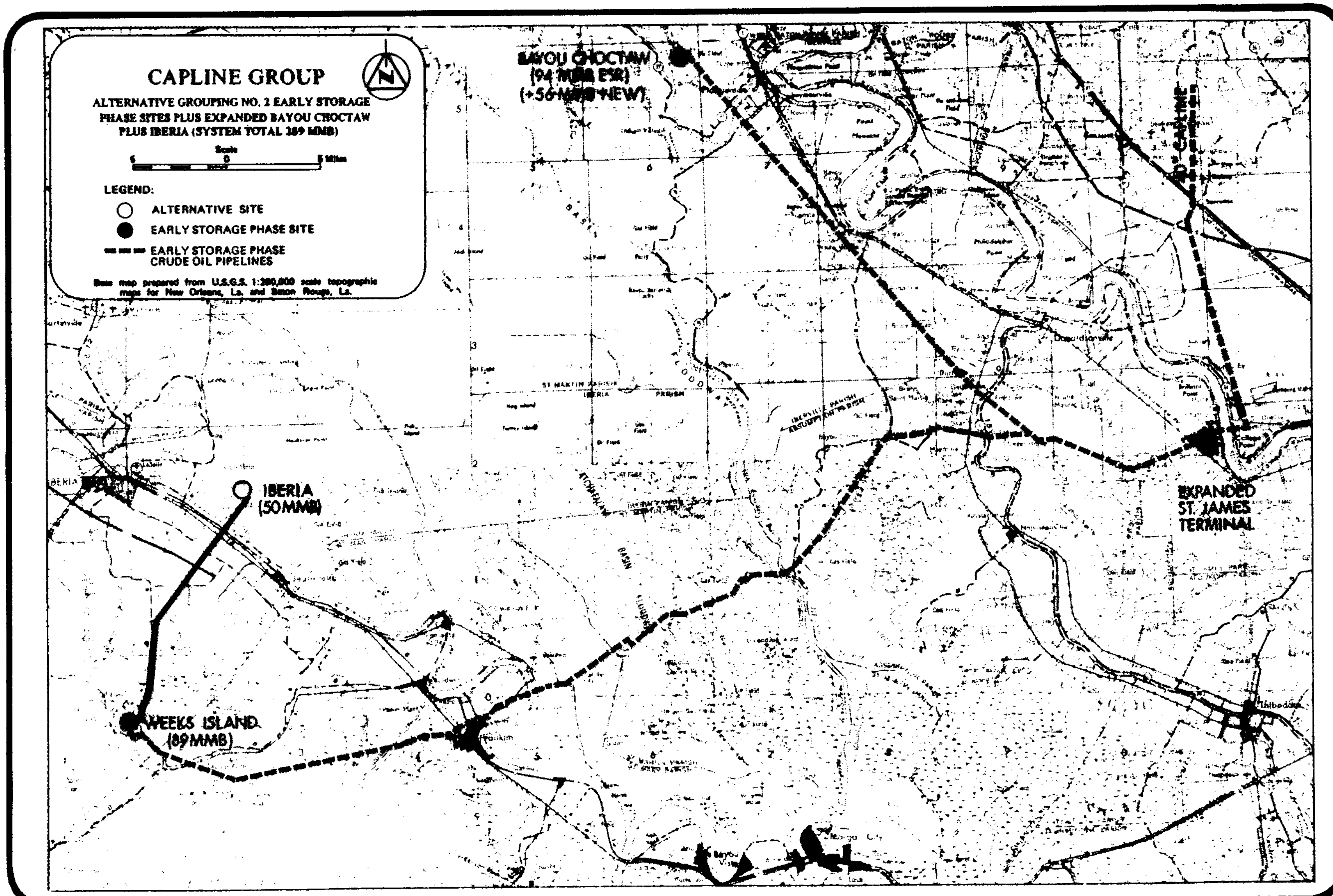


FIGURE A.6-1 Capline Group - alternative no. 2 - early storage sites plus expanded Bayou Choctaw plus Iberia.

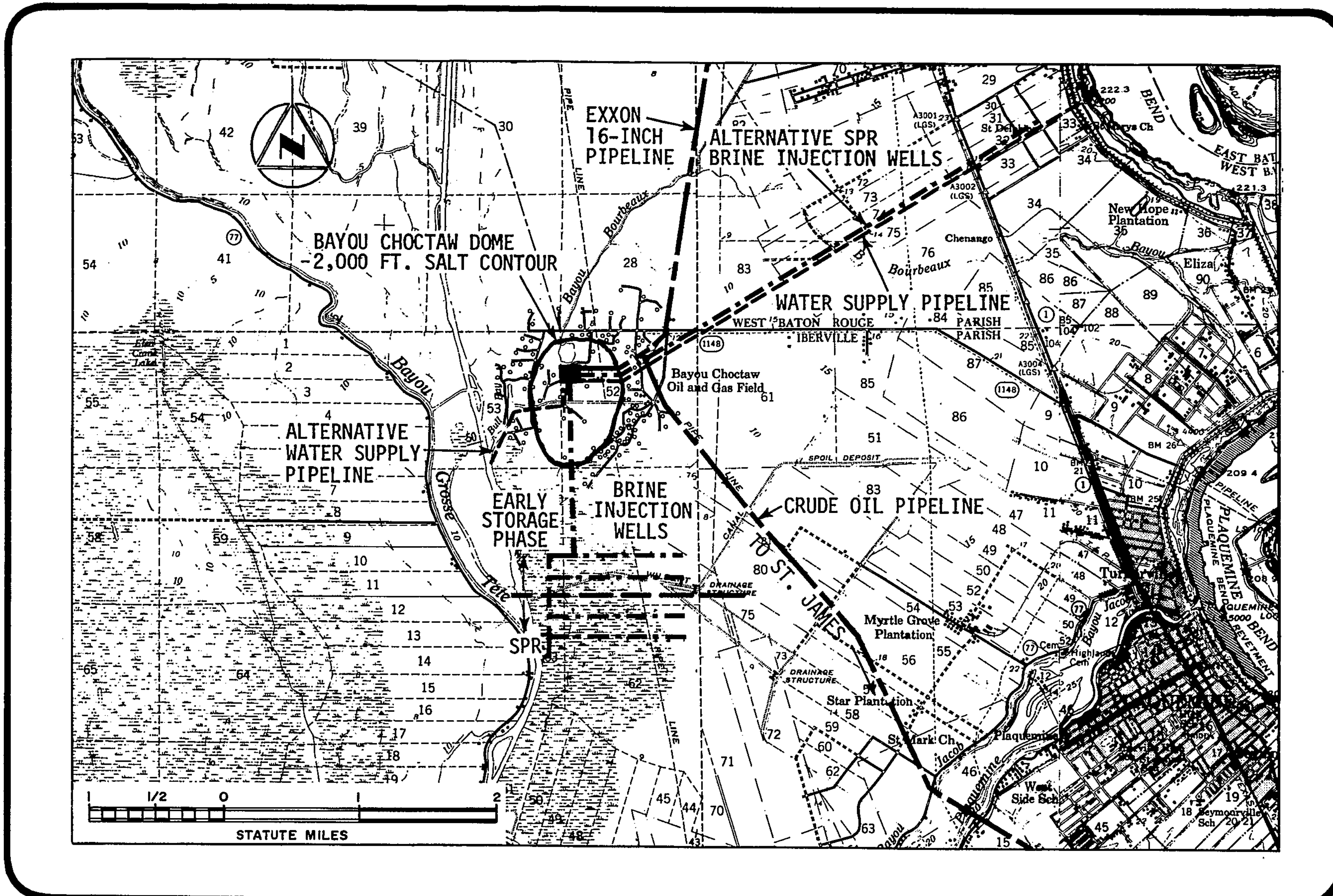


FIGURE A.6-2 Vicinity map - Bayou Choctaw dome.

A.6.2.1.1 Site Access

A 4-mile paved Parish road provides access to the northern edge of the dome from Louisiana State Highway No. 1. A network of improved gravel lease roads services the existing brine production and surrounding oil production wells.

The Bayou Plaquemine and Port Allen Canal portions of the Intracoastal Waterway provide a waterway over 100 feet wide and 9 feet deep to within 2000 feet of the western edge of the salt dome. The Intracoastal Waterway, Bull Bay, and an unnamed canal could provide barge access to the central, north, and eastern portions of the dome. A barge terminal is located adjacent to the site and would be used during construction.

Exxon operates two 16-inch crude oil pipelines within 1 mile of the dome, transporting crude oil from the port at St. James and from southern Louisiana to their refinery at Baton Rouge. Oil distribution from the site via a pipeline to St. James would parallel portions of the Exxon right-of-way.

A.6.2.1.2 Site Description

The general area surrounding the site is swampy, with an elevation ranging from less than 5 feet to more than 10 feet above mean sea level, with no clearly positive topographic expression of the Bayou Choctaw salt mass. Major surface subsidence has occurred, however, due to the collapse of a solution cavity in 1955 during uncontrolled leaching, resulting in the formation of a 12-acre lake (see Figure A.6-3).

The surface area within the -2000-foot salt contour is about 330 acres. In addition to the area already developed for early storage facilities, an area of about 27 acres would be fenced for the storage site. Portions not required by DOE are presently leased by Allied Chemical Corporation for the production of brine feedstock. Six of the existing caverns are subleased for hydrocarbon product storage. No sulfur mining has taken place in the caprock.

A.6.2.2 Capacity

The total capacity of the 12 existing available leached caverns in the Bayou Choctaw dome could total as much as 94 million barrels (or less depending upon the number of caverns which have been determined to be completely unavailable or unsuitable). Use of this available

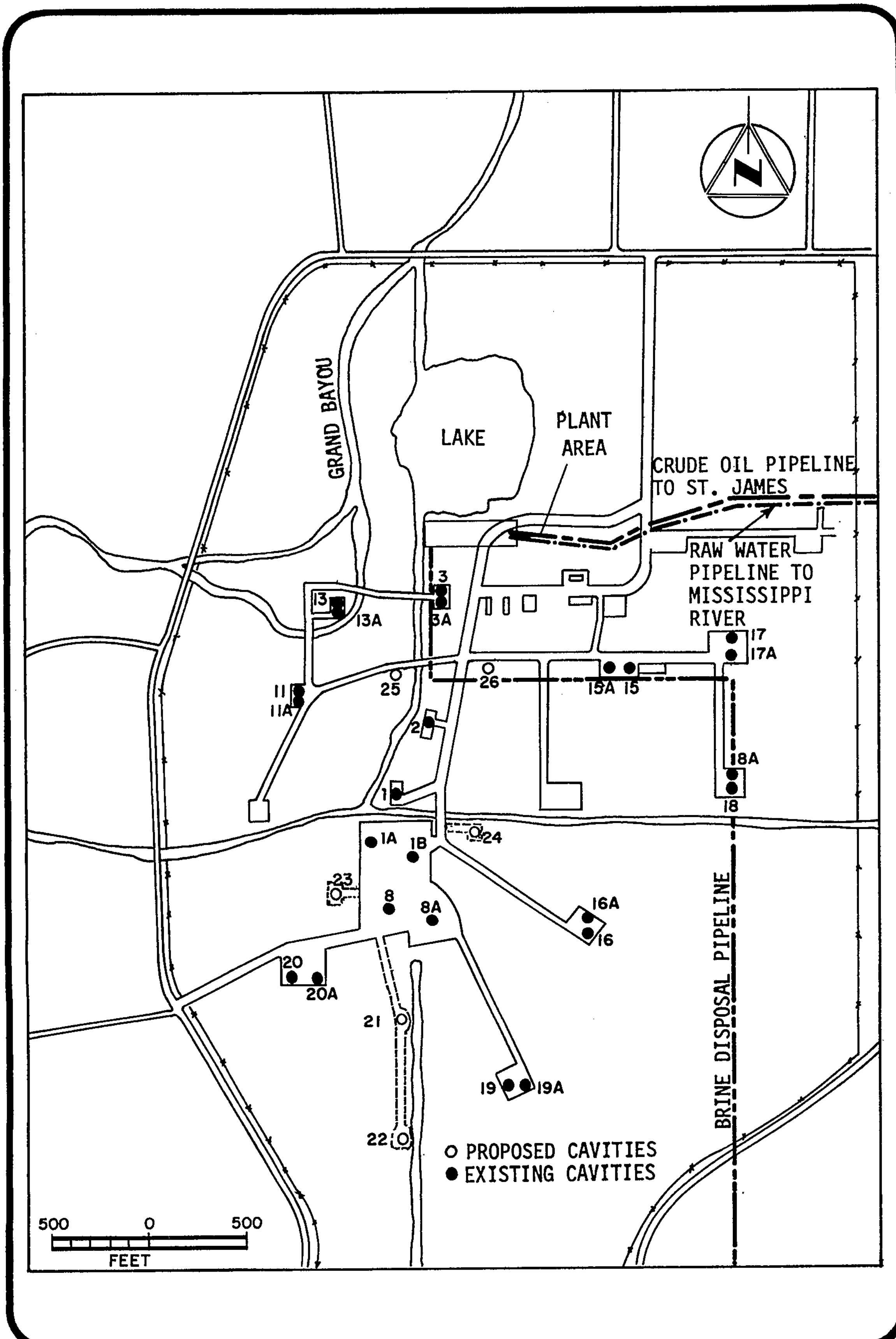


FIGURE A.6-3 Site map - Bayou Choctaw dome.

capacity presently occupied by Allied Chemical Corporation is planned for the early storage phase at the site (see Section A.4.3).

Bayou Choctaw dome has a moderate potential for development to larger total capacities. Preliminary engineering studies have determined that four 10-million barrel and two 6-million barrel caverns can be constructed in the 2300 to 4300 ft. depth range, within the area of present development. By constructing this additional capacity, the facility would have a total storage volume of about 150 million barrels for the SPR program. Further significant development beyond a capacity of 150 MMB is not likely.

A.6.2.3 General System Description

A.6.2.3.1 Proposed Systems

The planned expansion of the Bayou Choctaw site would principally include the leaching of six new cavities and construction of access roads, pads, protective diking and pipelines for connection of the new cavities to existing facilities. As part of the initial storage phase, existing brine cavities will be converted to crude oil storage, and construction of oil distribution systems, a displacement water source and a brine field will be completed. Modifications to existing systems would be required to handle increased oil, water, and brine flows resulting from the approximately 60 percent enlargement of crude oil storage capacity. The principal addition to the existing facilities would be the construction of a water supply pipeline to a new intake on the Mississippi River.

A.6.2.3.2 Alternative Systems

The Port Allen Canal/Intracoastal Waterway (ICW) connects the Mississippi River near Baton Rouge with the Atchafalaya Basin Floodway at Bayou Sorrel, passing within one mile of the Bayou Choctaw Dome. As an alternative to construction of a pipeline to the Mississippi River, a pump station would be established on the ICW to provide the necessary raw water for cavern leaching and oil displacement.

Shallow subsurface aquifers are also an alternative water source. A well field would be located in the same pipeline right-of-way as the early storage brine disposal pipeline. The wells would tap the Plaquemine aquifer at depths between 100 and 450 feet. The aquifer is considered capable of providing the water quantities required during oil removal.

Development of the Gulf of Mexico as a raw water source would likely require that brine be removed to the Gulf as well. To provide the necessary economies in pipelaying, the right-of-way would extend southeast to near the Chacahoula Dome, then southwest the remaining 40 miles directly to the Gulf.

A.6.2.4 Site Development

A.6.2.4.1 Proposed Physical Facilities

Modifications and expansions to most subsystems will be necessary to incorporate the additional capacity into the existing site facilities (presently existing and early storage phase.) Those changes are detailed in the following sections.

Site Layout

To the extent that they are found to be suitable for storage, caverns 1, 2, 3, 8A, 11, 13, 15, 17, 18, 19, and 20 could be converted for the initial storage phase. The locations of these 12 caverns, together with planned re-entry wells required for providing sufficient flow are shown on Figure A.6-3. New cavities, Nos. 21 through 26, would be located within the site area previously established. Short roadway and pipeline connections would be made to existing facilities. The perimeter dike (early storage phase) would be enlarged to include the new caverns.

Plant Area

The early storage phase pumping and control buildings as shown schematically in Figure A.6-4 would be expanded for use with the additional capacity. Increased pumping and metering capability would be required, together with corresponding upgrading of other facilities to reflect the approximately 60 percent increase in flow rate during withdrawal. It is anticipated that essentially all expansion can be accommodated within the early storage plant area, without clearing or filling additional land.

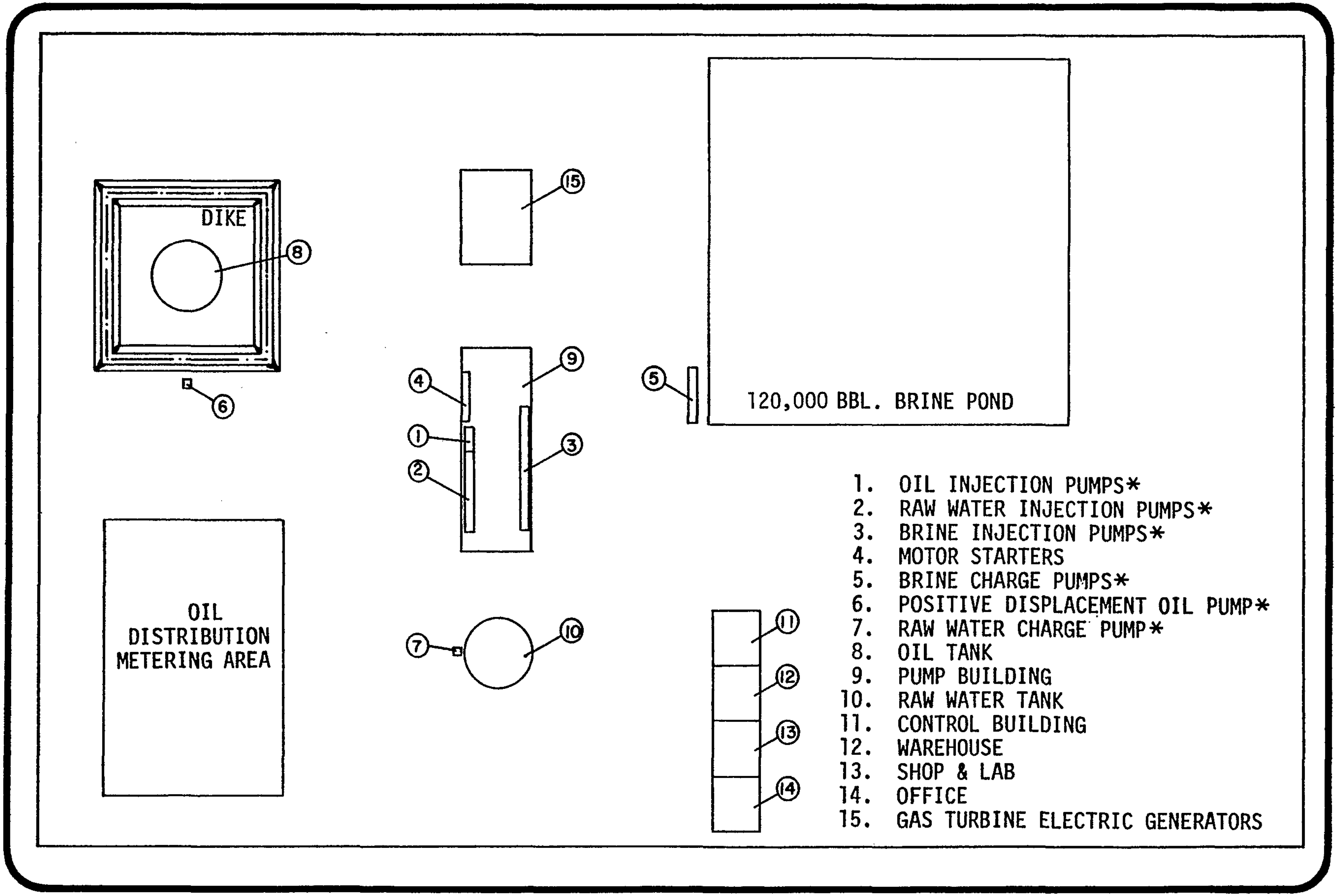


FIGURE A.6-4 Storage area layout - Bayou Choctaw dome.

Raw Water Supply

The Mississippi River would provide displacement water for expansion requirements, through a 5.4 mile pipeline to an intake east of the site. The early storage system drawing from the on-site lake is designed for withdrawal of water at the rate of 627,000 barrels per day (18,300 GPM), providing the same rate of crude oil displacement. At the increased storage capacity of 150 MMB, the required rate of water inflow would increase to one million barrels per day (29,200 GPM) to allow displacement of the oil in 150 days. (Maximum raw water requirements during cavern leaching would be 18,700 GPM). The Mississippi River pumps and pipeline would be sized to provide the total raw water requirement. The intake structure on the Mississippi would be sized to meet EPA intake design standards of a maximum velocity of 0.5 feet per second to reduce fish impingement of the intake screen.

Brine Disposal

A system of deep injection wells will be used for brine disposal during early storage operations. A brine disposal rate of 10,000 barrels per hour would be required, or 10 wells.

During the latter stages of the expansion, oil fill operations would be concurrent with leaching of new caverns. The combined brine disposal rate resulting from both oil fill and leaching would be on the order of 29,550 barrels per hour (20,700 GPM). The existing early storage well field located south of the plant area would be expanded to a total of 23 brine disposal wells (see Figure A.6-2).

Crude Oil Distribution

The terminals at St. James or the Nordix Terminal would be used for oil distribution during withdrawals from the Bayou Choctaw storage site. Plans for the Bayou Choctaw facility as part of the early storage phase include a pipeline to St. James capable of handling a delivery rate of 1,000,000 barrels per day.

Expansion of the Bayou Choctaw facility to a total storage of 150 MMB would utilize the crude oil pipeline capability of 1,000,000 barrels per day to deliver 150 MMB in 150 days via the pipeline to St. James or to Nordix.

Land Requirements

Most facilities proposed for the expansion at Bayou Choctaw would be located within or adjacent to early storage facilities, therefore, land requirements would be small. Total land area directly affected would be 117 acres for the expansion as planned. A summary of grading requirements is provided on Table A.6-1.

Caverns 23, 25, and 26 would be located essentially within the existing containment dikes which surround the present plant, and would require no additional land. Caverns 21, 22, and 24 would be located outside the dike. The land requirement for the three drill pads and connecting road, plus the perimeter dike and onsite pipelines would be about 27 acres.

Construction of the proposed raw water supply pipeline to the Mississippi River would require 5.4 miles of 80-foot right-of-way to the intake point and one to two acres of land for the intake structure, for a total of 54 acres.

Expansion of the brine disposal well field would require 13 wellhead pads 200 feet square and approximately 3.9 miles of connecting roadways, for a total area of about 36 acres.

Road Construction and Other Grading

Cavern pad construction would require 6 pads, 200-feet square each; the fill needed would be about 62,400 cubic yards including perimeter containment dikes. The containment dikes would be constructed by use of a dragline and would need only a thin cap of fill material. The raw water intake pipeline would not require a permanent roadway. Drill pads and roadways for the brine disposal well field expansion would require about 111,000 cubic yards of fill material.

In total, about 178,400 cubic yards of fill would be required for the expansion.

A.6.2.4.2 Alternative Physical Facilities

The facilities associated with the alternative systems discussed in Section A.6.2.3.2 are presented in Table A.6-2 for comparison with the proposed systems.

TABLE A.6-1 Proposed physical facilities - Bayou Choctaw and Iberia - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
I. SPR Facilities										
A. Bayou Choctaw - Fenced Area - 27 acres										
1) Storage Site										
a) Expansion of Cavern Wellhead Containment Dike	---	---	11,000	---	---	6/6	---	---	---	6/6
b) Roadways to New Cavern Wellheads	---	---	6,400	---	---	6/3	---	---	---	6/3
c) Cavern Wellhead Drill Pads	---	---	45,000	---	---	6/4	---	---	---	6/4
d) Distribution of Raw Water, Crude Oil, and Brine	2	19,000	---	8/5	---	---	---	1	1	9/5
2) Brine Disposal (Wells)										
a) Pipeline Excavation	3.9	70,000	---	3/2	---	25/18	---	4	1	29/20
b) Roadways to Brine Disposal Wellheads	---	---	53,000	---	---	---	---		---	---
c) Brine Disposal Wellhead Pads	---	---	58,000	---	---	7/5	---	---	---	7/5
3) Raw Water Supply (from Mississippi River)	5.4	29,000	5,000	53/33	---	---	---	1	1	54/33
4) St. James Terminal										
a) 4-200,000 bbl tanks	---	---	96,000	24/24	---	---	---	---	---	24/24
b) Roads and Miscellaneous	---	---	16,000	12/12	---	---	---	---	---	12/12
5) Koch Terminal	3.2	760,000	---	57/47	---	---	---	1	10	67/47
6) Nordix Terminal	7.0	798,000	82,000	68/53	55/25	---	---	15	16	139/78
Sub-Total (SPR Facilities-Bayou Choctaw)	21.5	1,676,000	372,400	225/176	55/25	50/36	0	16	29	359/237
B. Iberia										
1) Storage Site - Fenced Area - 160 acres										
a) Central Plant Area (excludes acreage for brine surge pond and blanket oil tank)	---	---	26,000	6/6	1/1	---	---	---	---	7/7
b) Brine Surge Pond	---	---	23,300	2/2	---	---	---	---	---	2/2
c) Roadways to Cavern Wellheads (1 mile)	---	---	13,000	3/2	---	---	---	---	---	3/2
d) Cavern Wellhead Pads	---	---	11,000	4/3	---	---	---	---	---	4/3
e) Containment Dikes at Cavern Wellheads	---	---	4,200	3/2	---	---	---	---	---	3/2
f) Distribution within Plant Area	3.0	16,000	---	29/18	---	---	---	---	---	29/18
g) Blanket Oil Tank Containment Dike	---	---	2,000	1/1	---	---	---	---	---	1/1

TABLE A.6-1 continued.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
2) Offsite										
a) Brine Disposal (Wells)										
1. Pipeline Excavation	4.4	23,000	---	38/24	5/3	---	---	---	---	43/27
2. Roadways to Wellheads	---	---	26,000	---	---	---	---	---	---	---
3. Wellhead Pads	---	---	37,000	10/7	2/2	---	---	---	---	12/9
b) Raw Water Supply										
1. Pipeline from Bayou Teche	1.5	8,000	---	15/10	---	---	---	---	---	15/10
2. Pumping Station	---	---	5,000	1/1	---	---	---	---	---	1/1
c) Crude Oil Distribution (to Weeks Island)	14.6	324,000	---	90/56	---	40/25	39/25	7	1	170/106
Sub-Total (SPR Facilities-Iberia)	23.5	371,000	147,500	202/132	8/6	40/25	39/25	7	1	290/188
Sub-Total (SPR Facilities-Bayou Choctaw plus Iberia)	45.0	2,047,000	519,900	427/308	63/31	90/61	39/25	23	30	649/425
II. Early Storage Facilities										
A. Weeks Island										
1) Storage Site	---	---	---	4/4	---	---	---	---	---	4/4
2) Crude Oil Distribution	64.4	1,069,000	---	145/90	40/25	307/191	60/37	24	71	623/343
3) St. James Terminal	---	30,000	54,000	15/15	---	---	---	---	---	15/15
Sub-Total (Early Storage-Weeks Island)	64.4	1,099,000	54,000	169/109	40/25	307/191	60/37	24	71	642/362
B. Bayou Choctaw										
1) Storage Site	7.0	37,000	---	120/120	---	---	---	4	2	122/120
2) Brine Disposal	2.9	46,000	95,000	---	---	31/20	---	7	1	32/20
3) Raw Water Supply	---	---	5,000	---	---	---	---	---	---	---
4) Crude Oil Distribution	38.0	383,000	---	268/167	35/22	64/40	---	13	1	368/229
5) St. James Terminal	1.0	35,000	54,000	40/34	---	---	---	---	---	40/34
Sub-Total (Early Storage-Bayou Choctaw)	48.9	501,000	154,000	428/321	35/22	95/60	---	24	4	562/403
Sub-Total (Early Storage-Weeks Island plus Bayou Choctaw)	113.3	1,600,000	208,000	592/430	75/47	402/251	60/37	48	75	1204/765
Total (Early storage at Weeks Island and Bayou Choctaw plus Expansion of Bayou Choctaw plus Iberia)	158.3	3,647,000	727,900	1019/738	138/78	492/312	99/62	71	105	1853/1190

TABLE A.6-2 Alternative physical facilities - Bayou Choctaw - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage				Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
				Cleared Land Constr/Maint	Bottomland Forest Constr/Maint	Deciduous Swamp Constr/Maint	Marsh Constr/Maint			
1) Brine Disposal										
a) To Gulf of Mexico via Chacahoula										
1. Pipeline to Gulf	119.9	1,643,100	---	133/85	9/6	232/145	298/186	49	574	1246/422
2. Back-up Brine Wells	2.2	11,500	---	6/4	---	---	---	---	---	6/4
b) Brine Well Field along Raw Water Pipeline from Mississippi River										
1. Pipeline Excavation	2.6	13,600	---	6/4	---	---	---	---	---	6/4
2. Roadways to Brine Disposal Wellheads		---	---	4/3	---	---	---	---	---	4/3
2) Raw Water Supply										
a) From Gulf of Mexico via Chacahoula	98.3	1,301,000	5,000	133/85	9/6	232/145	298/186	49	51	723/422
b) From ICW near Bayou Choctaw	1.0	5,300	5,000	8/6	---	---	---	---	---	8/6
c) Ground Water Wells along Crude Oil Pipeline	4.7	25,000	---	12/8	---	---	---	2	1	13/8
3) Nordix Terminal and Alternative Pipeline	10.0	773,300	82,000	74/56	21/15	---	---	4	1	96/71

As an alternative raw water supply source, brackish water from the Gulf of Mexico could be pumped from an intake structure on Caillou Bay approximately 98.3 miles to the Bayou Choctaw site. Pipeline right-of-way requirements on land for this alternative would include 133 acres of agricultural land, 9 acres of forest land, 232 acres of swamp land, and 298 acres of marsh land. In addition, approximately 51 acres of open water area would be affected.

A second raw water supply alternative source would be the Intracoastal Waterway near Bayou Choctaw. A pump station could be established on the ICW, and a 1.0 mile pipeline constructed to the Bayou Choctaw site. Approximately 8 acres of agricultural land right-of-way would be required.

A third raw water supply alternative source would be a series of groundwater wells drilled into the Plaquemine aquifer at depths between 100 and 450 feet. The well field would be located along the primary brine disposal pipeline right-of-way, through 4.7 miles of agricultural land.

An alternative for brine disposal would be a pipeline to the Gulf of Mexico via Chacahoula. This pipeline would parallel the alternative raw water supply pipeline on land to the Gulf. It would then extend 23.6 miles further into the Gulf, terminating at a diffuser.

Brine disposal could also be accomplished by an injection well field along the primary raw water supply pipeline to the Mississippi River. The well field would extend 2.6 miles from the site through agricultural land (requiring approximately 10 acres of additional right-of-way).

A.6.2.5 Construction Techniques

A.6.2.5.1 Cavern Construction

Cavern construction would consist of six new cavities leached in the 2300-foot to 4300-foot depth interval as shown in Table A.6-3. The cavities would be spaced to fit between the existing caverns at the site, while maintaining safe horizontal and vertical clearances between cavities. Cavern construction will otherwise be as described in Section A.3.2.

TABLE A.6-3 New leached caverns - Bayou Choctaw.

Expansion Cavern Number	Initial Diameter	Final Diameter (5 cycles)	Cavern Interval	Volume
21	330'	400'	2500' - 3500'	10 MMB
22	330'	400'	2500' - 3500'	10 MMB
23	250'	300'	2500' - 3600'	6 MMB
24	330'	400'	2500' - 3500'	10 MMB
25	200'	240'	2500' - 4300'	6 MMB
26	250'	300'	2300' - 4100'	10 MMB

A.6.2.5.2 Roadways and Filled Areas

The site lies at the northern edge of a large swamp area and would be considered a swamp for construction planning purposes. Four to five feet of fill would be required for road and pad construction and additional fill might be required in some areas. Road construction techniques are described in general in Section A.3.3.

A.6.2.5.3 Pipelines

Principal pipelines for oil distribution and brine disposal would be constructed as part of the early storage phase development. Expansion of the storage capacity would require short pipelines from each of the six new oil storage caverns, 13 new brine injection wells and a raw water pipeline to the Mississippi River to connect with existing facilities. The oil and brine pipelines would be buried by conventional pipelaying methods along the filled access roads constructed to each wellhead.

Additional pipeline capacity would be required between the storage area and the brine disposal field. Due to the increase in flow rates, a second line may be added adjacent to the existing line. This line and lines within the disposal field would either be buried or supported above ground by pilings or piers.

Raw water pipelines would be constructed either along roadways or through agricultural land and conventional pipelay methods would be used.

A.6.2.6 Development Timetable

As the proposed activity is an expansion to an existing oil storage site, development of the required facilities would take less time than at other sites. One drill rig would be employed for drilling cavern wells, and caverns could be drilled at the rate of one every three months. Brine disposal well field expansion would occur concurrently, with about one month required per well.

Development of the site is summarized in Figures A.6-5 and A.6-6.

A.6.2.7 Operation

A.6.2.7.1 Storage Phase

When the storage facility has been completed and design capacity is reached, there would be an interim period during which the only activities at the site would be security and maintenance checks. However, readiness for activation during an oil supply interruption requires keeping operations personnel available. During the static storage period, all equipment would be serviced and tested on a regular basis to ensure proper working order. Maintenance crews would be on duty on a 24-hour basis. It is possible that certain national emergencies could occur before the planned total capacity of the SPR is met. In order to prepare for such a contingency, the Bayou Choctaw facility design provides for oil return bypass valves to allow intermittent recovery of stored oil at any time.

A.6.2.7.2 Extraction Phase

The SPR program requirements plan for an emergency deliverability of stored oil over a 5-month period. Thus, delivery rates for a 150-million-barrel facility are one million barrels per day. The facility's systems would be designed to handle this maximum capacity. The 36" crude oil pipeline constructed between Bayou Choctaw and St. James for the early storage phase would have a capacity of one million barrels per day.

Crude oil stored in each salt cavity would be recovered by pumping raw water into the bottom of the cavity, thus displacing the oil through the annular space at the top of the cavity. The oil would leave each wellhead at a pressure capable of transporting the oil via pipeline to the distribution facility. The facilities at St. James on the Mississippi River and the Nordix Terminal at Sunshine are the distribution points for the Bayou Choctaw strategic storage facility.

A.6.2.7.3 Refill Phase

After an oil supply interruption has ended, refill of the SPR storage facility is planned. The rate of fill would depend on the availability of crude, but is currently planned for fill over a 24-month

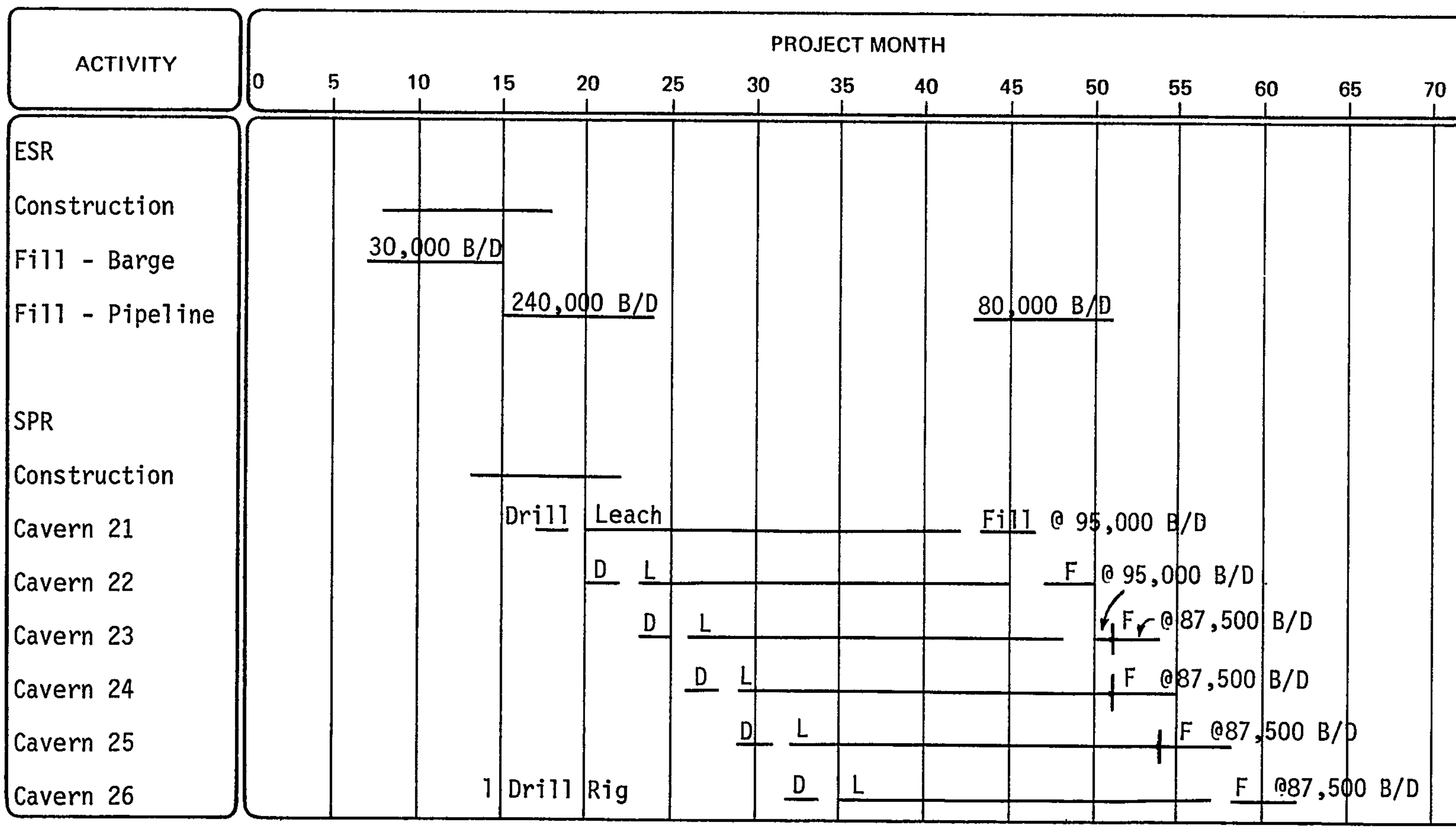


FIGURE A.6-5 Development timetable for Bayou Choctaw dome.

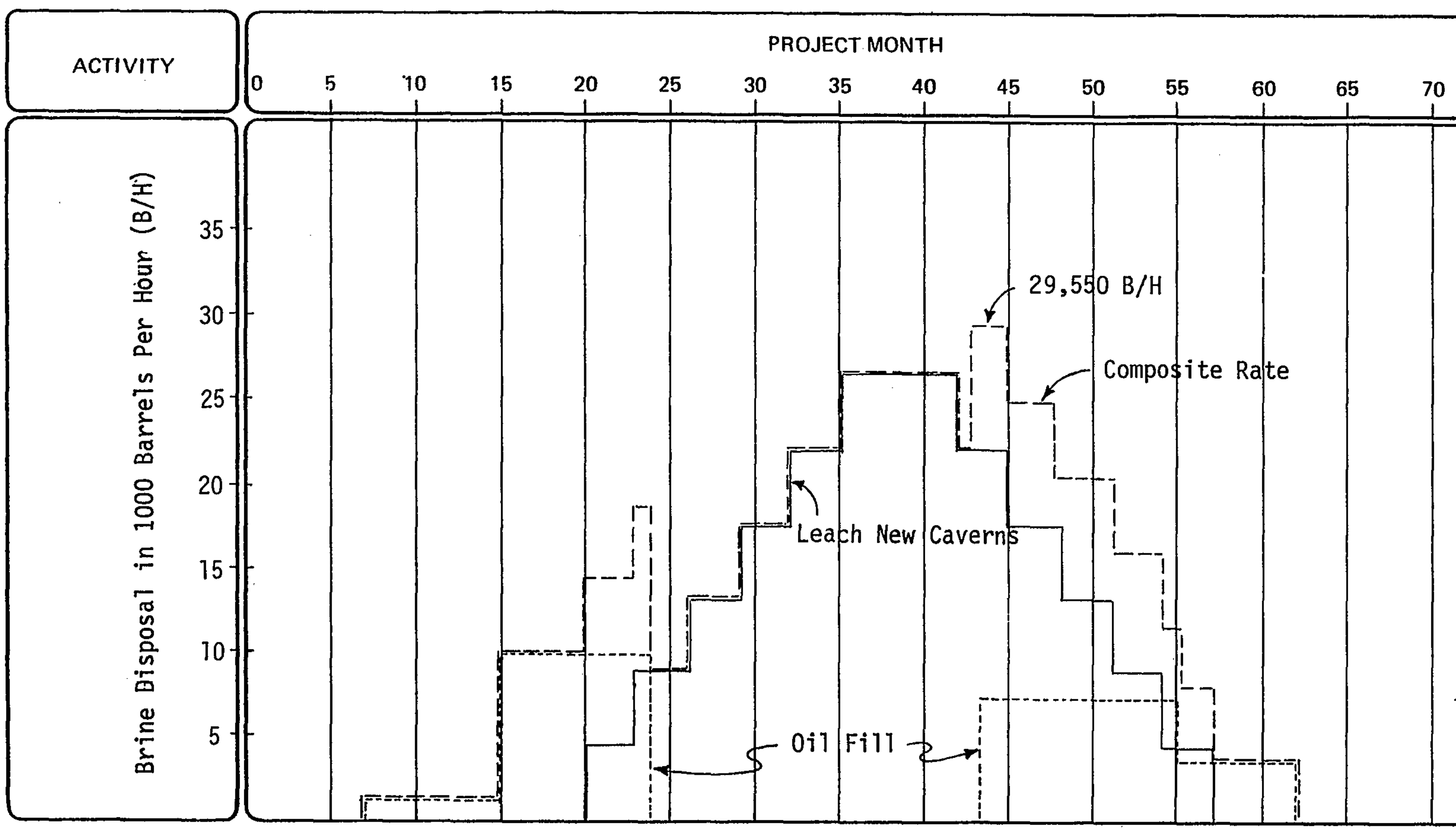


FIGURE A.6-6 Development timetable for Bayou Choctaw brine disposal.

period. Refill is assumed to begin six months after the end of the supply interruption.

Refill Capacity

Five fill and withdrawal cycles are designed for the SPR. Although the cavern capacity enlarges during each cycle, (due to the intr duction of fresh water) only the original design capacity for each cavit would be refilled. A smaller percentage of fresh water would be introduced into the cavern during successive fill operations, reducing somewhat the continued leaching process. Due to casing limitations, total usage of the enlarged capacity would not allow total displacement in 150 days during subsequent withdrawals.

A.6.2.8 Termination and Abandonment

When the the oil storage capacity at Bayou Choctaw dome would no longer be needed, it is intended that the facility continue to serve a beneficial use. Storage of light petroleum products, LPG, or other industrial products is a possibility. If no users can be found for the short term, the facility could be mothballed for later use.

Ultimately, the facility would be abandoned. Surface equipment would be removed and sold offsite. Brine injection wells and cavity accesses would be sealed with concrete, a common oil field procedure. No long-term surveillance or maintenance is anticipated.

A.6.3 Iberia Dome Alternative Site

A.6.3.1 Location

The Iberia dome is located in central Iberia Parish, Louisiana, in an agricultural area 5 miles east of New Iberia, and 22 miles southeast of Lafayette, Louisiana. (see Figure A.6-1 and A.6-7). Vermilion Bay and West Cote Blanche Bay lie 15 and 20 miles to the south, respectively.

A.6.3.1.1 Site Access

The site is accessible via Highway 87/182 from New Iberia, or U.S. 90 from Lafayette, Louisiana. It is 1.5 miles northeast of State Route 182 (formerly U.S. 90) and the paralleling Southern Pacific Railroad Line. The site may be reached by existing roads serving the petroleum activity which skirts the edge of the dome. Agricultural roads cross the site.

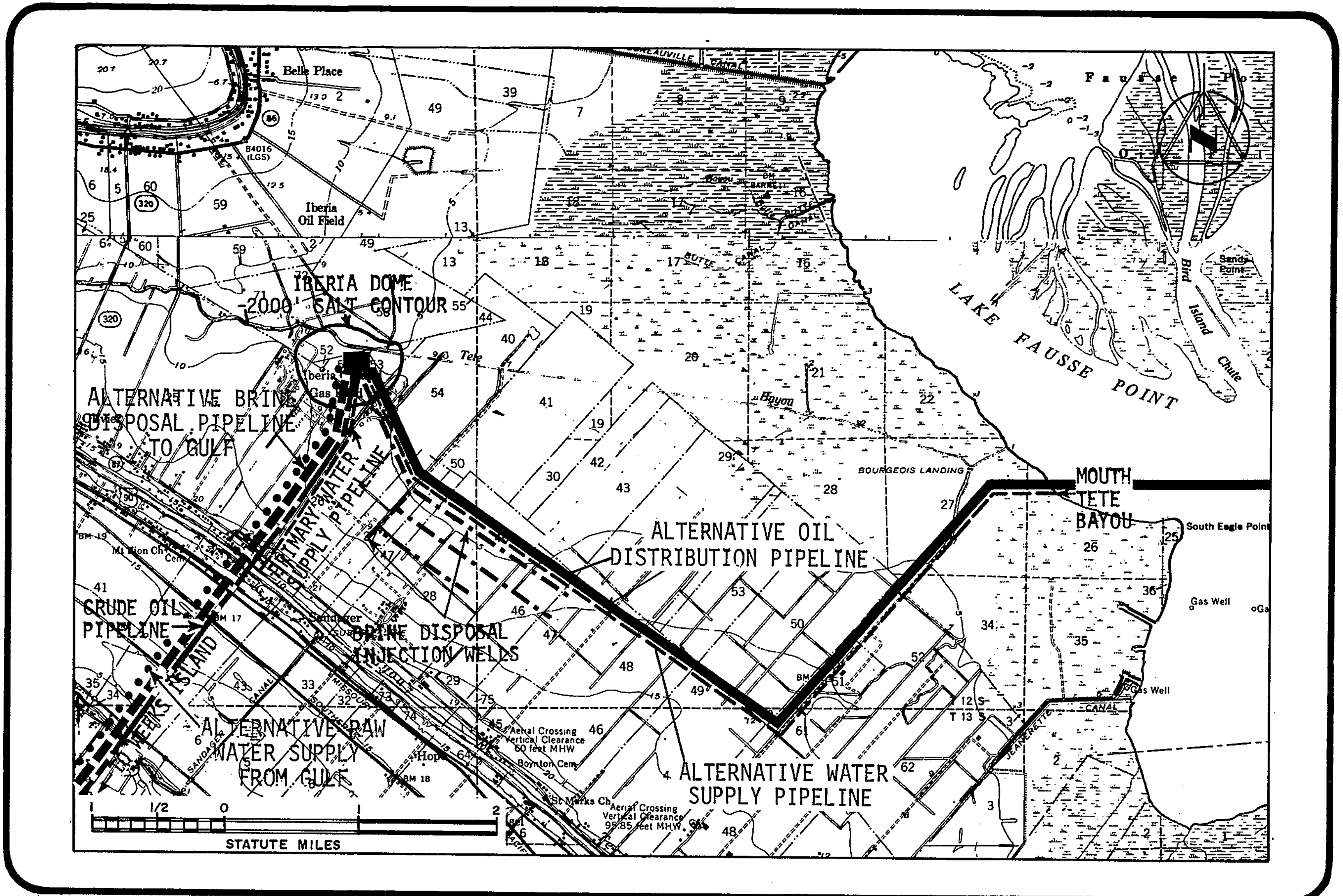


FIGURE A.6-7 Vicinity map - Iberia dome.

A meander of Bayou Teche, the proposed raw water source for the site, lies approximately 1.5 miles to the south, and a similar distance to the north. The smaller, 50-foot-wide Bayou Tete crosses the site from west to east, and connects with Lake Fausse Pointe 4.2 miles east of the dome. Lake Fausse Pointe opens onto the Gulf of Mexico 50 miles south of the confluence of Bayou Tete and Lake Fausse Pointe.

A.6.3.1.2 Site Description

The land area overlying the dome is small; about 160 acres are within the -2000 foot salt contour. Approximately 160 acres would be fenced in around the storage site. Elevation of the surface area overlying the -2000 foot depth salt contour ranges from under five feet to about 10 feet above mean sea level. The southeast one-third of the dome is tree covered and the remaining area is mostly agricultural (pasture) land. There is little marshy area or ponded water at the site and no surface expression of the dome. Development of the site will be limited to the area south of Bayou Tete (see Figure A.6-8).

Oil and gas production has been in progress at the site for many years. The greatest drilling activity has been on the south and west flanks of the dome.

A.6.3.2 Capacity

The dome's salt resources are presently undeveloped, with no commercial activity other than agriculture within the -2000 foot salt contour. As indicated on Figure A.6-8, the proposed development of the dome would have six caverns in two rows of three each. Four 10 MMB and two 5 MMB caverns would be leached for a total capacity of 50 MMB. The spacing of the caverns is scaled for a 5-cycle capacity of 20 MMB each, to allow for cavern expansion during subsequent withdrawal-refill cycles. At the 800-foot minimum cavern spacing, a total of 8 caverns could be constructed within the -2000 foot salt depth contour. Assuming an 80 percent completion rate, the ultimate capacity of the site would be on the order of 70 MMB.

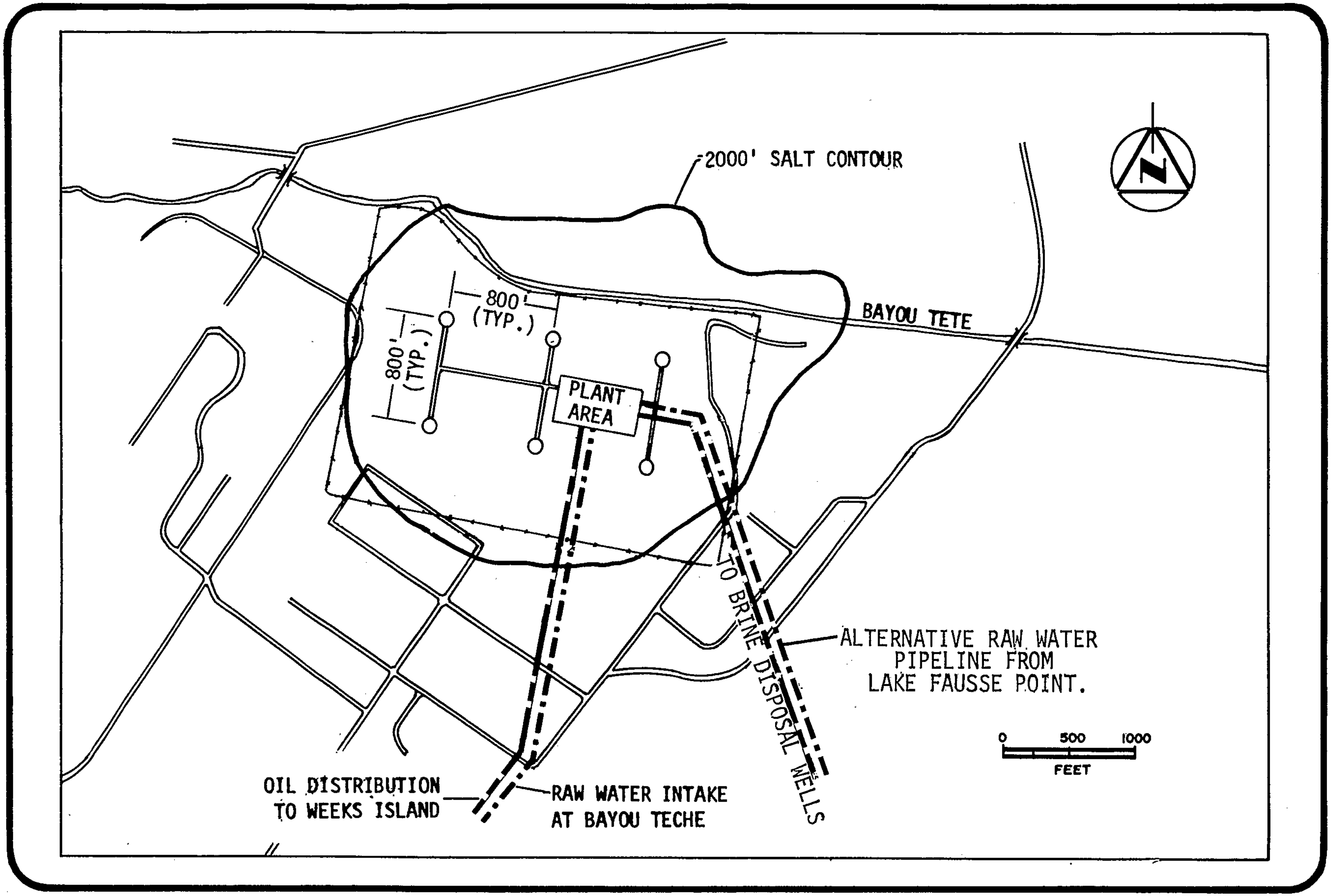


FIGURE A.6-8 Site map - Iberia dome.

A.6.3.3 General System Description

A.6.3.3.1 Proposed Systems

The Iberia dome site is planned for the storage of 50 million barrels of crude oil in six new salt caverns leached in the -2000 foot to -3000 foot depth interval. The physical system at the site is schematically illustrated in Figure A.6-9. The cavities would be formed by pumping fresh water through a central pumping facility into the salt. The brine, formed when the salt enters into solution with the fresh water would be displaced from the expanding cavity by the continued pumping of fresh water into the cavity. Displaced brine would then be piped to a disposal area.

Raw water for the site would be supplied via a 1.5 mile pipeline from Bayou Teche, at an intake point south of the dome. The proposed method of brine disposal is deep well injection at an area located southeast of the dome.

Initial crude oil storage would be initiated 23 months following the beginning stages of the cavern leaching process (see Section A.3.2.1). The proposed route for oil distribution from the Iberia site would be through increased utilization of an existing early storage phase crude oil pipeline from Weeks Island to St. James. This would require 14.6 miles of new pipeline to connect Iberia and Weeks Island.

Withdrawal of the stored oil would be accomplished by the injection of displacement water from Bayou Teche into the storage cavity through the well casing at sufficient pressure to push the crude oil out and through new pipeline to the Weeks Island site. The oil would then be transferred through the existing pipeline to the terminal·facilities.

A.6.3.3.2 Alternative Systems

The proposed system for oil distribution is through a new pipeline to Weeks Island and then through an existing pipeline to the DOE Terminal facilities. An alternative would involve the construction of a new 39-mile pipeline directly to connect the Weeks Island - St. James pipeline near Napoleonville.

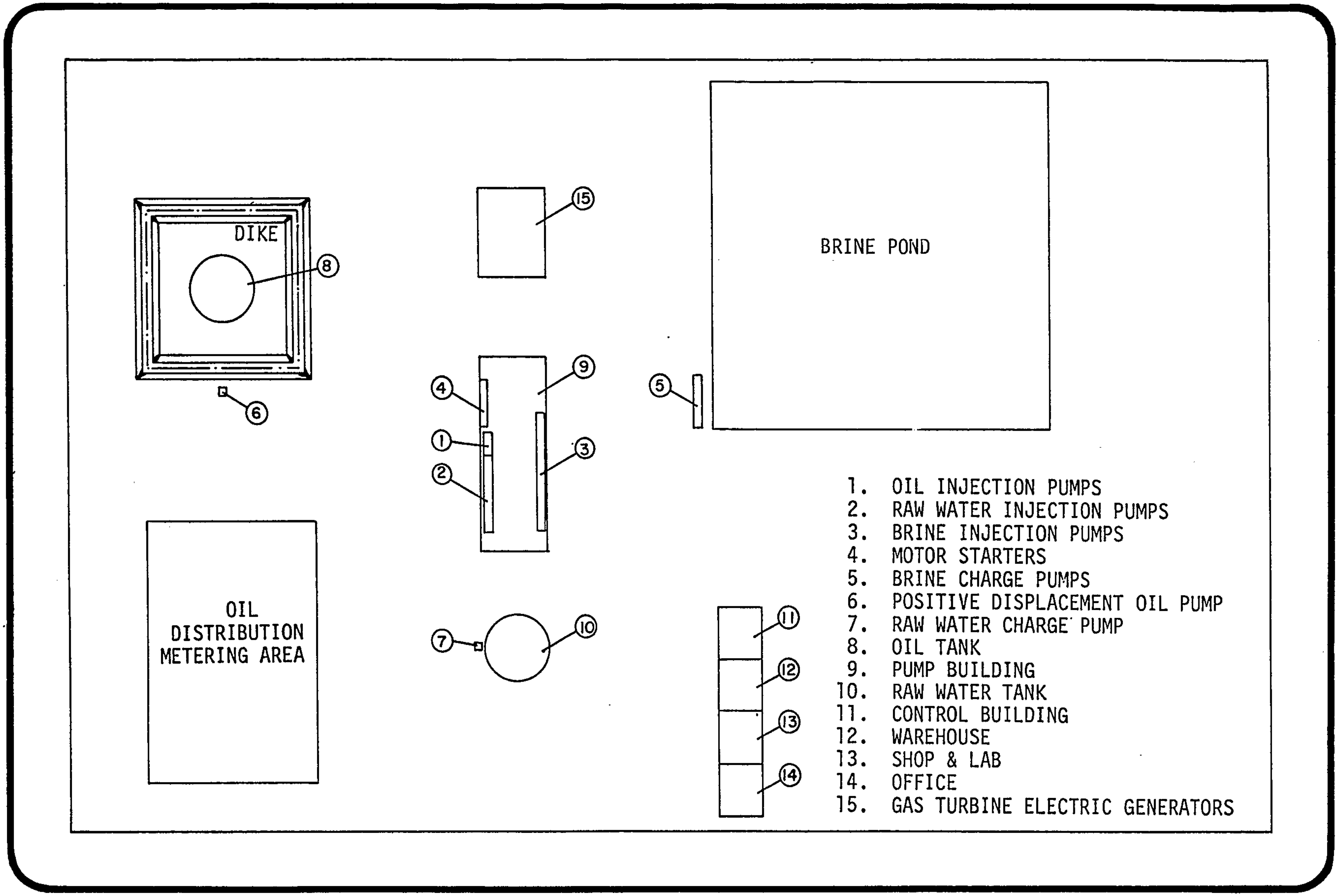


FIGURE A.6-9 Storage area layout - Iberia dome.

Alternative surface sources of raw water for displacement purposes would be Lake Fausse Pointe via a 7.3 mile pipeline, or via a pipeline from the Gulf of Mexico. Deep wells along the oil distribution pipeline route for providing a ground-water source could also be considered.

Disposal of brine to the Gulf of Mexico and an accompanying backup system is an alternative to deep well injection. The brine pipeline to the Gulf of Mexico would parallel the alternative water supply pipeline.

A.6.3.4 Site Development

A.6.3.4.1 Proposed Physical Facilities

Site Layout

The six planned storage caverns, along with the central pumping and control facilities would be located on an approximately 160-acre tract. An 800-foot spacing would be maintained between adjacent wells. Each cavity would be leached to an initial capacity of 10 MMB, and the six caverns would be leached to a total capacity of 50 MMB, assuming completion to only 5 MMB for two caverns.

Wellheads would be connected to the central pumping plant by a series of roadways and pipelines (see Figure A.6-8). A 12-foot-wide access road to each well pad would be required; roadway length would total about 1 mile. On-site pipelines would be buried by conventional pipelaying methods along the access roads connected to each wellhead. Each wellhead would be enclosed within a small berm to contain small operational oil spills. Grading requirements are not expected to be severe due to the relative firmness and higher elevation of the land at the site; fill depths of one to two feet would be required in some areas. The 160-acre facility would be enclosed by a 9-foot-high chain link fence. Other fencing would be needed around high-voltage areas or other dangerous or sensitive areas.

Plant Area

The central pumping and control facilities, as shown in Figure A.6-8, would be located on an 8 to 10 acre tract near the center of the storage area. The plant area would contain the pump building, control building, offices, laboratory, warehouse, brine surge ponds, a blanket oil tank, raw water tank, the oil metering equipment and a 5 to 6 acre material and equipment yard.

All cavity injection and transport pumps would be housed in a central pump building, approximately 30 feet by 100 feet. It would be a prefabricated steel structure on a concrete slab foundation. The buildings would require one to two feet of fill. Special foundation treatment may be required for both the building and heavy equipment. Smaller buildings would house instrumentation and electrical switchgear, the office, lab, warehouse, and shops.

A lined brine surge pond, having a capacity of 110,000 barrels, would be constructed within the plant area, and would be used for brine settling and as a surge pond for the brine disposal pumps. The brine pond would cover about 1.5 acres at a depth from 8 to 10 feet deep. To provide additional operational flexibility, a second brine pond may be constructed; the two ponds would be used alternately. A 10,000 barrel tank would be used as a raw water surge reservoir.

For initial cavern leaching, a 5000-barrel blanket oil tank, enclosed in an adequate spill containment dike, would be located near the pump building. Metering for permanent oil distribution would be located in a central, one-half acre area, and would handle oil delivered to and from the DOE Terminal.

Power for the facility would be supplied by a transmission line from local commercial sources.

Raw Water Supply

Bayou Teche is the planned source of raw water for the initial leaching of storage cavities and, later, displacement of stored oil. A 1.5 mile pipeline located in the oil distribution pipeline right-of-way would be constructed from the bayou to the site and would supply 18,700 GPM of water to the plant area. The intake structure at the bayou would incorporate EPA intake design standards for a maximum velocity of 0.5 feet per second to reduce fish impingement on the intake screen.

The pipeline (see Figure A.6-7) would be connected to a 10,000 barrel raw water tank. Charge pumps would be installed at the 10,000 barrel tanks. These pumps would enable the high pressure injection pumps to be started with water from the tank; after start up, the charge pumps would be shut down, and the injection pumps would take suction directly from the raw water supply pipeline. The raw water tank would also be used as a fire system reservoir.

Brine Disposal

The proposed method of disposal for the saturated brine disposal during cavern leaching and crude oil fill operations is injection into deep wells located off the southern flank of the dome. During periods of leaching and crude oil storage, the maximum rate of brine displacement from leaching would be 26,700 barrels per hour (18,700 GPM), (see Figures A.6-10 and A.6-11). The disposal system, designed to meet the maximum rate, would consist of 21 injection wells, each with a capacity of 1000 GPM. The wells would be constructed in the 5000 to 7000 foot depth interval, in a linear well field as shown in Figure A.6-7. An 80-foot right-of-way, 4.4 miles long, would be required through the well field and a 200-foot square drill pad would be constructed at each well site. The right-of-way would pass through 0.5 miles of wooded land, and 3.9 miles of agricultural land.

The brine displaced from the storage caverns would be collected in a lined surge pond. The pond, about 250 feet by 250 feet by 10 feet deep, would provide temporary brine storage in the event of a breakdown of injection well facilities and also act to settle out any insolubles which could damage pumps or clog the disposal wells.

Crude Oil Distribution

Oil distribution is planned via a new pipeline connection with the early storage phase facility at Weeks Island, 14.6 miles southwest of the site (Figures A.6-1 and A.6-7). The oil would then be transferred to an existing pipeline and transported to the terminal facilities on the Mississippi River, 64.4 miles east of Weeks Island.

Land Requirements

The oil storage facilities at Iberia would require approximately 160 acres of fenced land in an area overlying the salt dome, and 241

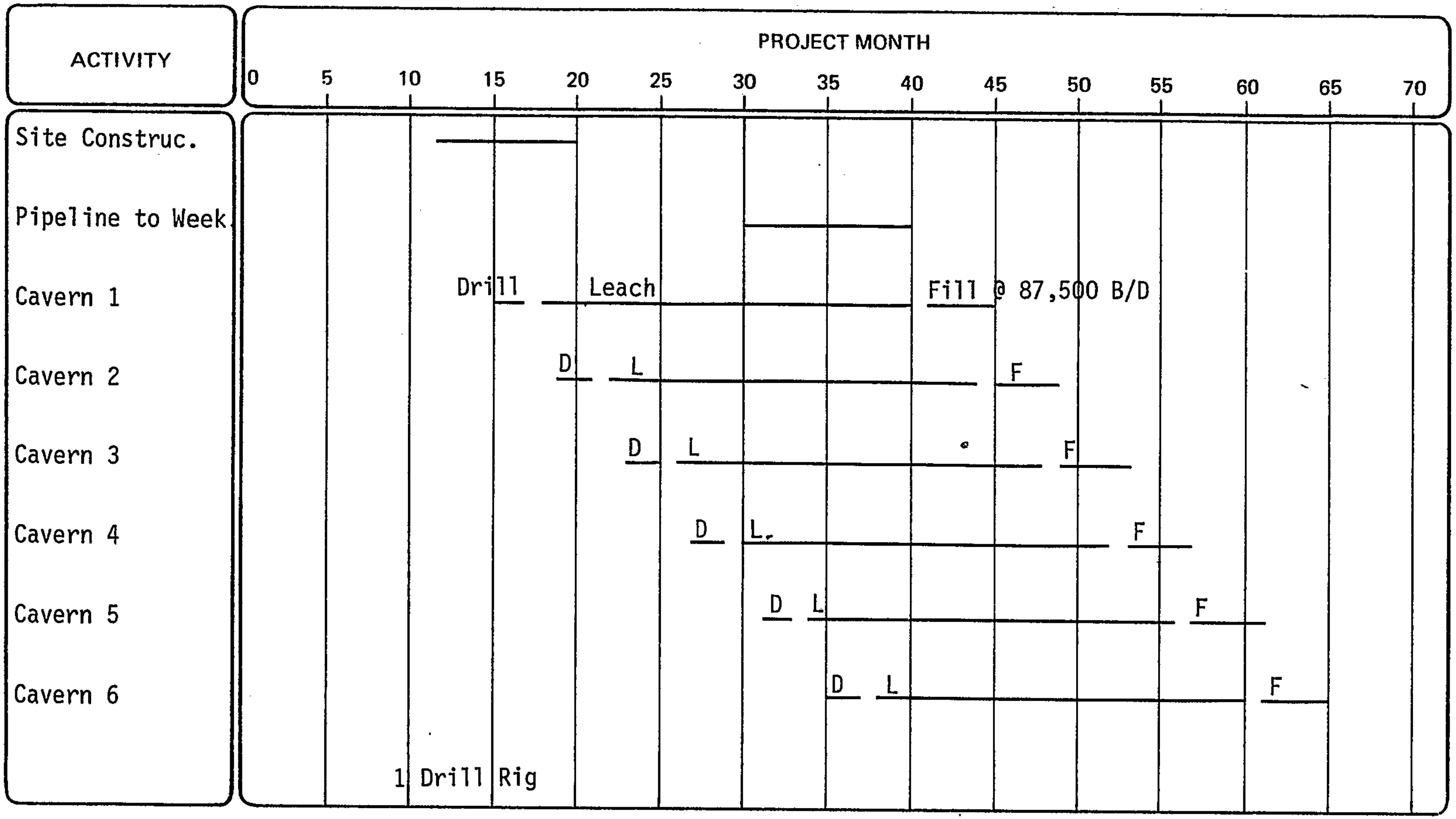


FIGURE A.6-10 Development timetable for Iberia dome.

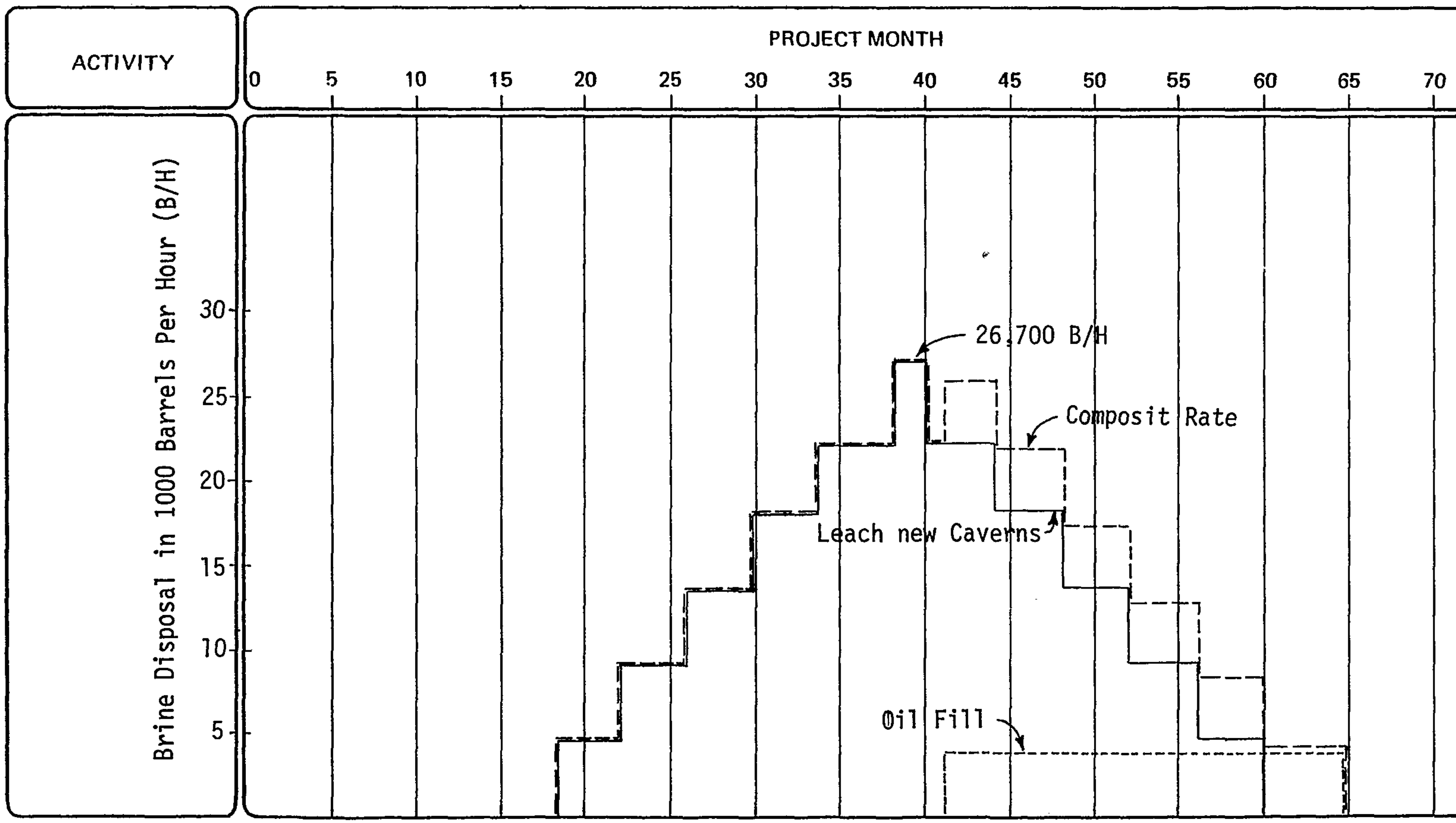


FIGURE A.6-11 Development timetable for Iberia brine disposal.

acres of offsite land, a total of about 401 acres for the project as planned. Only 49 acres would be directly affected by grading and excavation within the 160-acre fenced area onsite (see Table A.6-1).

The pumping station for the raw water supply on Bayou Teche will require about one acre. The pipeline connection from Bayou Teche to the storage site would share the oil distribution pipeline right-of-way.

Pipeline requirements for the brine disposal well field will total about 0.8 mile from the plant area to the field and 3.6 miles within the field, for a total of about 4.4 miles. Assuming a right-of-way width of 80 feet, and, for 21 drill pads 200 feet square, acreage required will be 55 acres; all but 7 acres would be agricultural land.

The proposed route for the oil distribution pipeline would extend about 7.4 miles southwest of the site to intersect the alignment of State Highway 83, then south through 5.4 miles of marsh and 1.8 miles of dry land to the Weeks Island early development facility. Agricultural land would be crossed for the first 7.4 miles and the last 1.8 miles of the route and, assuming an 80 foot wide right-of-way, approximately 90 acres of land would be required. Much of this land could be reestablished for agricultural use following construction of the pipelines. Construction of oil pipeline for the remaining 5.4 miles to Weeks Island will cross areas of swamp and low-lying marsh and open water requiring right-of-way of 80 acres. Total acreages for the crude oil pipeline would be 170 acres.

Road Construction and Other Grading

Both the on-site pipelines and the pipeline extending through the brine disposal field would require a twelve-foot roadway to be constructed and maintained throughout their length. Construction of the raw water and brine pipelines will not require permanent roadways, as existing roads can be used for access to the raw water intake and brine well field.

Permanent roads will require one to two feet of fill and a gravel or shell topping for all-weather use. About 1.0 mile of on-site roadway and 4.4 miles of brine well field roadway will be required, for a total of about 39,000 cubic yards of fill. The 21 drill pads at the brine injection wells will require an additional 37,000 cubic yards of fill.

Plant area construction would include about two acres of filled area for plant facilities plus 5 to 6 acres for the equipment and materials storage yard, or about 26,000 cubic yards. Construction of containment dikes, wellhead pads, and surge ponds would require about 40,500 cubic yards.

Total fill requirements for the facility as planned would be approximately 147,500 cubic yards. Actual volumes could be more or less depending on conditions encountered. A total of 23.5 miles of pipeline excavations would be required, with trench excavation totalling 371,000 cubic yards.

A.6.3.4.2 Alternative Physical Facilities

The facilities associated with the alternaive systems discussed below and in Section A.6.3.3.2 are presented in Table A.6-4 for comparison with primary alternatives.

An alternative source of raw water would be Lake Fausse Pointe via a 7.3 mile pipeline. Right-of-way required would include 7.0 miles through agricultural land (68 acres), and 0.3 miles through swamp forest (3 acres).

A second alternative raw water source would be via a pipeline to the Gulf of Mexico. This 22.1 mile pipeline would require right-of-way of approximately 117 acres of agricultural land, and 79 acres of swamp and marsh land. The pipeline would extend two miles into the Gulf of Mexico, affecting an offshore area of approximately 49 acres.

Deep wells along the oil distribution pipeline would also be a possible alternative raw water source. Pipeline excavation for these wells would pass through approximately 3.7 miles of agricultural land, requiring additional right-of-way of 10 acres.

Brine disposal to the Gulf of Mexico is an alternative to deep well injection. The brine disposal pipeline would parallel the alternative raw water pipeline on land (20.1 miles) and would then extend 32.1 miles into the Gulf and terminate at a diffuser. An offshore area of approximately 778 acres would be affected by the pipeline excavation.

TABLE A.6-4 Alternative physical facilities - Iberia - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
1) Brine Disposal (to Gulf of Mexico)										
a) Pipeline Excavation	52.2	742,000	---	117/74	---	66/41	13/8	8	778	974/123
b) Back-up Brine Wells	1.9	10,000	---	5/3	---	---	---	---	---	5/3
2) Raw Water Supply										
a) From Lake Fausse Point										
1. Pipeline Excavation	7.3	42,000	---	68/42	3/2	---	----	---	---	71/44
2. Pump Station	---	---	5,000	1/1	---	---	---	---	---	1/1
b) From Gulf of Mexico										
1. Pipeline Excavation	22.1	265,000	---	117/74	---	66/91	13/8	8	49	245/123
2. Pump Station	---	---	5,000	---	---	---	1/1	---	---	1/1
c) Groundwater Wells	3.7	19,500	---	9/6	---	---	---	1	1	10/6
3) Crude Oil Distribution (to St. James via Napoleonville)	39.0	449,000	---	68/42	87/54	177/111	---	26	116	448/207

An alternative to the proposed new oil distribution pipeline to Weeks Island would be the construction of a new pipeline from the Iberia site to connect to the Weeks Island - St. James pipeline near Napoleonville. This pipeline would follow the alternative raw water pipeline right-of-way to Lake Fausse Pointe (7.3 miles). It would then cross Lake Fausse Pointe and the Atchafalaya Basin Channel (4.5 miles under water), 3 miles of bottomland forest, and 3.2 miles of swamp forest to reach an existing crude oil pipeline right-of-way near Little Pigeon Bayou. The new pipeline would parallel the existing pipeline to Napoleonville, through 9.7 miles of swamp forest and 6 miles of bottomland forest. Total right-of-way required for this alternative crude oil pipeline would include 68 acres of agricultural land, 87 acres of bottomland forest, and 177 acres of swamp forest. Open water affected would total 116 acres.

A.6.3.5 Construction Techniques

A.6.3.5.1 Cavern Construction

Cavern construction will consist of six cavities leached in the -2000 to -3000 foot depth interval. The cavities would be spaced on 300-foot centers, with a height of 1000 feet and an ultimate diameter of 400 feet. As no previous cavern development has occurred within the salt at the dome, interfacing with existing facilities or caverns will not be necessary. Cavern construction would be based on the design parameters in Section A.3.2.

A.6.3.5.2 Roadways

The proposed facility lies in an agricultural area which would be accessible to vehicles much of the year. However, to assure all-weather travel within the site, one to two feet of fill or other grading would be required. Conventional road building techniques would be utilized.

A.6.3.5.3 Pipelines

The raw water and brine disposal pipelines and the initial 7.4 miles and final 1.8 miles of the crude oil pipeline will be constructed across agricultural land. It is anticipated that conventional pipelaying methods can be used in these areas (see Section A.3.4.1). No streams of significance would be crossed.

The remainder of the crude oil pipeline would cross marshes and swamps of varying vegetation and water depth. Flotation canal methods would be used in the marsh areas and push-ditch construction would be used in the swamp areas. Waterborne equipment would be used as necessary (see Section A.3.4.3 and A.3.4.4) and access could be provided without difficulty.

A.6.3.6 Development Timetable

According to present plans, the first eight months of facility construction would involve the installation of the raw water and brine disposal systems and crude oil supply facilities, and laying the required pipelines (see Figure A.6-10 and A.6-11). Up to 23 months of initial cavern leaching must take place before the initial fill operation. Oil fill operations are planned for at a design fill rate of 87,500 barrels per day. It is estimated that the 50 million barrels of stored oil could be in place, with the facility ready for emergency withdrawal, within the time allocated by the SPR program.

A.6.3.7 Operation

A.6.3.7.1 Storage Phase

When the storage facility construction has been completed and the design capacity is reached, there may be an interim period during which the only on-site activities would be security and maintenance checks. Readiness for activation during an emergency, however, requires that operations personnel be kept available. During this static storage period, all equipment would be serviced and tested on a regular basis to ensure proper working order. Maintenance crews would be on duty on a 24-hour basis.

It is possible that certain national emergencies could occur before the planned total reserve capacity of the SPR is met. To prepare for such a contingency, the Iberia facility design provides for oil return bypass valves to allow intermittent recovery of stored oil.

A.6.3.7.2 Extraction Phase

The SPR program requirements plan for an emergency deliverability of stored oil over a 5-month period. Thus, delivery rates for a 50-million-barrel facility are 333,000 barrels per day. The Iberia facility's systems would handle this maximum capacity. The 36-inch pipeline constructed for the early storage phase between Weeks Island and St. James would have sufficient capacity to withdraw both Iberia and Weeks Island crude oil storage in 150 days.

Crude oil stored in each salt cavity is recovered by pumping raw water into the bottom of the cavity, thus displacing the oil through the annular space at the top of the cavity. The oil leaves each wellhead at a pressure capable of transporting the oil via pipeline to Weeks Island. Pumps at Weeks Island would provide the pressure to deliver the oil to St. James for distribution.

A.6.3.7.3 Refill Phase

After an oil supply interruption has ended, refill of the SPR storage facility is planned. The rate of fill would depend on the availability of crude, but is currently planned for fill over a 24-month period.

Refill Process

The refill process is the reverse of the recovery process. The crude oil is injected into the top of the storage cavity, thus displacing the brine, which in turn goes to the disposal wells. The brine disposal system and oil distribution system would have excess capacity available during refill.

Refill Capacity

Five fill and withdrawal cycles are designed for the SPR. Although for leached cavity facilities the cavern capacity enlarges during each cycle (due to the introduction of fresh water) only the original design capacity for each cavity would be refilled. The fact that a smaller percentage of fresh water would be introduced into the cavern during successive fill operation reduces somewhat the continued leaching process. Due to casing limitations, total usage of the enlarged capacity would not allow total displacement in 150 days during subsequent withdrawals.

A.6.3.8 Termination and Abandonment

When the oil storage capacity at Iberia dome would no longer be needed, it is intended that the facility continue to serve a beneficial use. Storage of light petroleum products, LPG, or other industrial products is a possibility. If no users can be found for the short term, the facility could be mothballed for later use.

Ultimately, the facility would be abandoned. Surface equipment would be removed and sold offsite. Brine injection wells and cavity access wells would be sealed with concrete, a common oil field procedure. No long-term surveillance or maintenance is anticipated.

A.7 ALTERNATIVE GROUPING NO.3 - EARLY STORAGE SITES PLUS CHACAHOULA DOME

A.7.1 Introduction

Development of Bayou Choctaw and Weeks Island storage reserves will contribute as much as 183 MMB of crude oil storage to the Capline Group (see Sections A.4.3 and A.4.4). To accomplish the design goal of 300 MMB of total storage, the Chacahoula salt dome could be utilized for 200 MMB of additional storage in leached caverns (see Figure A.7-1). A new pipeline connection for crude oil distribution would be required between Chacahoula and the DOE terminal, to supplement pipelines constructed in connection with the early development sites. Cooperative use of terminal facilities would be the only interaction between the three sites. Data specific to the Chacahoula site is presented in Section A.7.2.

A.7.2 Chacahoula Dome Alternative Site

A.7.2.1 Location

A.7.2.1.1 Site Access

The Chacahoula dome lies under a swamp area approximately 72 miles south of Baton Rouge, Louisiana, via State Highway 1 and 66 miles west of New Orleans, Louisiana, via U.S. Highway 90, (see Figure A.7-1). The Atchafalaya embayment of the Gulf of Mexico is 28 miles to the southwest.

The site is located off of State Highway 309, a paved road. From Thibodaux, the site is three miles west on State Highway 1 and 7 miles south on State Highway 309. From Chacahoula, a small unincorporated town, the site is north two miles on State Highway 30.

Well-maintained lease roads service the oil operations on the south and northwest flanks of the dome. The only roads over the dome itself were built by Freeport Sulphur Company, which ceased operations in 1962. Freeport has also constructed numerous ditches and levees to restrain the swamp in the dome area.

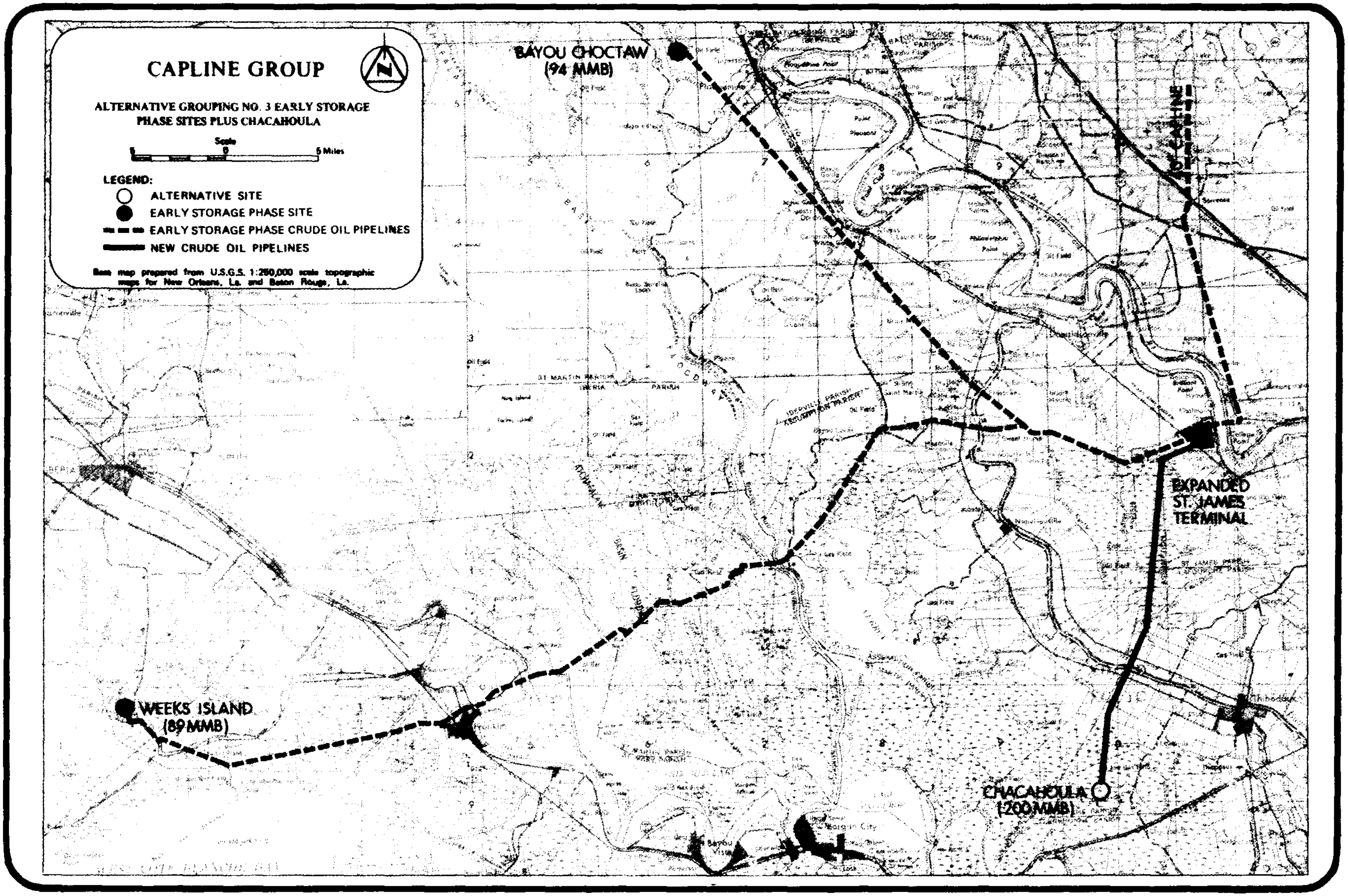


FIGURE A.7-1 Capline Group - alternative no. 3 - early storage sites plus Chacahoula.

Terrebone-Lafourche drainage canal, which runs north-south about two miles east of the dome site, connects with Phillips canal to the north and Southern Pacific Railroad at a point approximately three miles southeast of the site. A similar north-south canal, Donner Canal, is located immediately west of the proposed storage facility. This canal can bring barge traffic to the Southern Pacific Railroad at a point about two miles to the southwest. The Donner Canal also connects with Bayou Black, an important local waterway. Bayou Lafourche lies approximately seven miles northeast of the site. Its water supply is regulated by a pumping station at Donaldsonville on the Mississippi River. The Bayou is navigable from the Gulf of Mexico as far north as Thibodaux, but due to a dam upstream, the Bayou is not commercially navigable from Thibodaux to Donaldsonville.

Exxon operates two 16-inch pipelines within 14 miles of the Chacahoula dome which transport crude oil from St. James and southern Louisiana to their Baton Rouge refinery. Shell pipeline No. 258 crosses over the Chacahoula dome and carries oil from offshore oil production in the Gulf of Mexico to St. James.

A.7.2.1.2 Site Description

There is no surface expression of the salt mass at Chacahoula. The site and surrounding area are uniformly swampy with an elevation about 6 to 7 feet above mean sea level. Ponded swamp water is present in the entire area and several feet of fill will be required for construction of roads and drill pads.

A surface area of about 2 square miles could be utilized within the -2000 foot depth salt contour (see Figure A.7-2). Of that area, about 700 acres were exploited by Freeport Sulfur Company in Frasch sulfur production in the caprock. Sulfur production ceased in 1962. Most of the remainder of the dome area can be utilized without affecting the Freeport property.

A.7.2.2 Capacity

The dome's salt resources are presently undeveloped, the Freeport Sulfur operation being limited to the caprock. As indicated on Figure A.7-3, the facility would be designed as 24 cavities within an area

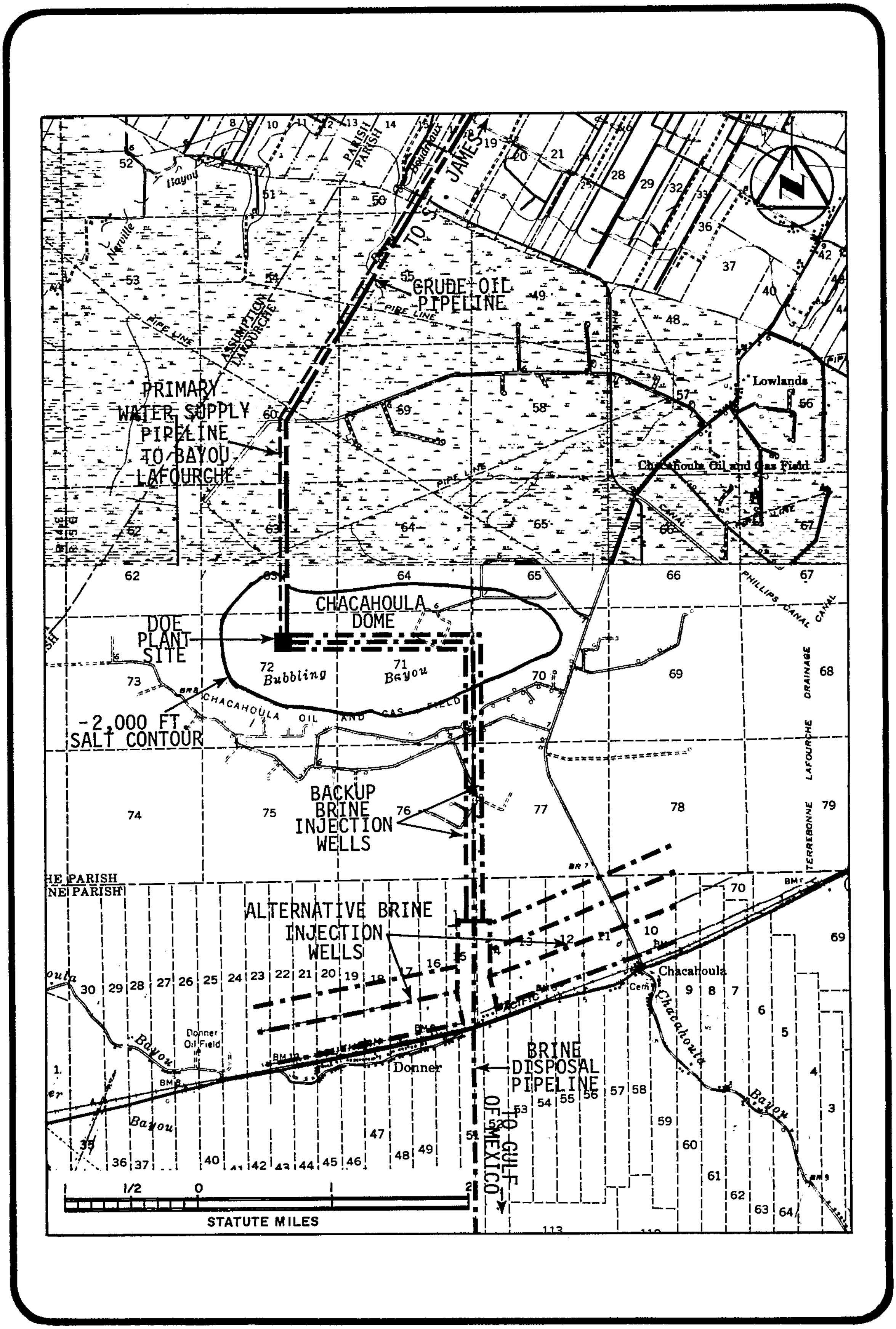


FIGURE A.7-2 Vicinity map - Chacahoula dome.

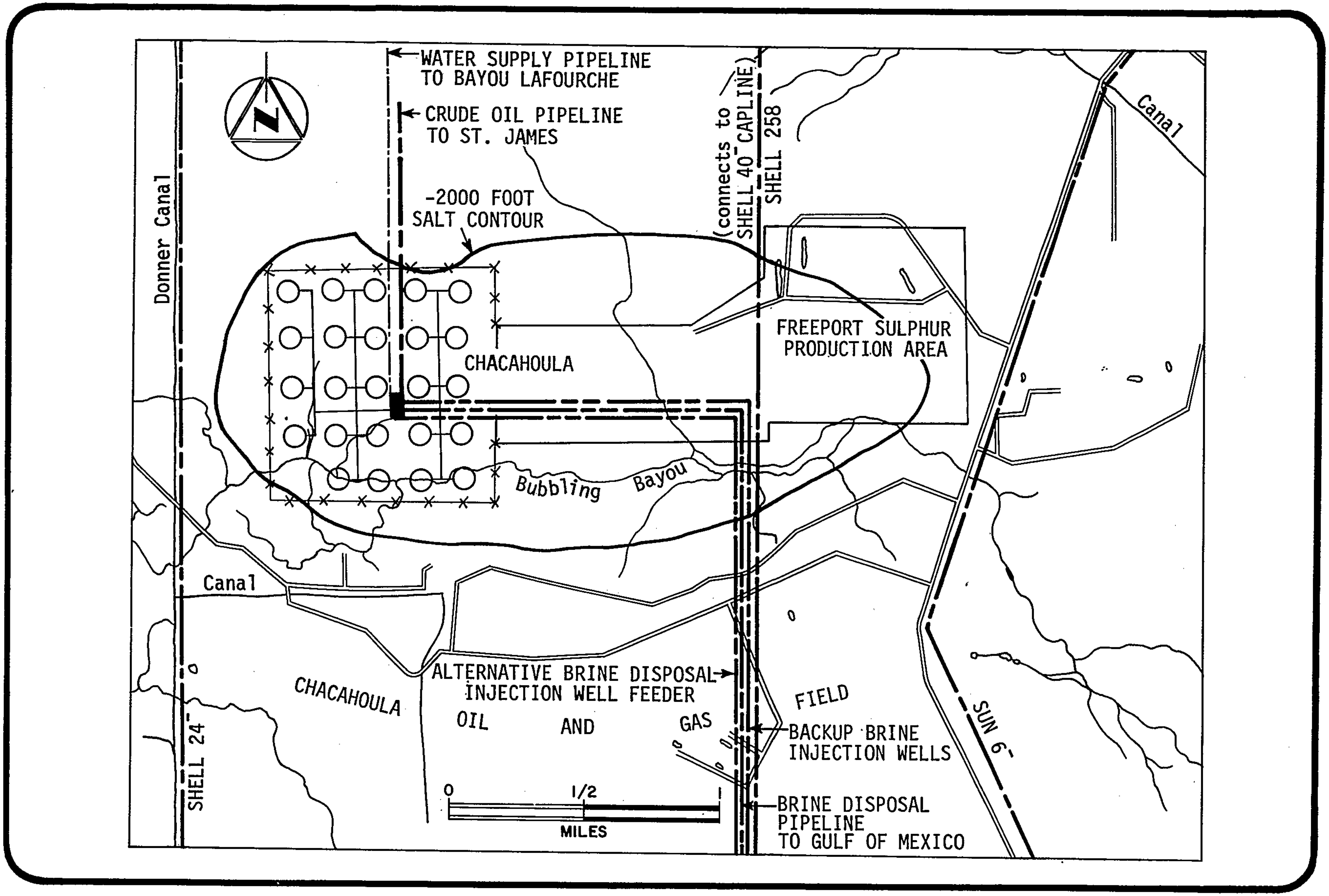


FIGURE A.7-3 Site map - Chacahoula dome.

extending from the Freeport property to the western edge of the dome. The development of a 450-acre fenced site would provide 200 million barrels of the Capline region storage requirement. Twenty-four caverns would consist of sixteen 10 MMB caverns and eight 5 MMB caverns.

At an 800-foot cavern spacing, about 50 cavities of 10 MMB each could be constructed without using the Freeport property. Assuming an 80 percent completion rate, the ultimate capacity of the site would be on the order of 450 MMB.

A.7.2.3 General System Description

A.7.2.3.1 Proposed Systems

The Chacahoula Dome site is currently planned for the storage of 200 million barrels of crude oil in 24 new salt cavities which would be leached in the -2500 feet to -3500 feet depth interval. The general physical system requirements are illustrated in Figure A.7-2. Cavities are formed by pumping fresh water through a central pumping facility into the salt. The brine which is formed when the salt enters into solution with the fresh water, is pumped out of the expanding cavity. The process of pumping fresh water into the dome and pumping the brine out of the dome, occurs simultaneously.

Raw water is proposed to be supplied via a 6.5-mile pipeline from Bayou Lafourche, which in turn would be supplied by additional lift pumps from the Mississippi River at Donaldsonville. The proposed method of brine disposal is to construct a pipeline which would traverse 40 miles on land and 25.8 miles into the Gulf to attain a sufficient depth of 20 feet for direct offshore disposal.

As outlined in the discussion of cavity construction procedures (see Section A.3.2.1), initial crude oil storage would be concurrent with all but the beginning stages of the leaching process. Oil supplies are planned via a new pipeline connection with the CAPLINE terminal at the St. James port facilities on the Mississippi River, about 21 miles northeast of the site.

Withdrawal of the stored oil would be accomplished by the injection of displacement water from Bayou Lafourche into the storage cavity through the well tubing at sufficient pressure to push the crude oil out and through the pipeline to the distribution terminals on the Mississippi River. Distribution of the stored oil is planned via a CAPLINE pipeline or tankers from the terminal facilities.

A.7.2.3.2 Alternative Systems

Oil distribution via the St. James, Koch, Nordix, and CAPLINE facilities are coproposals for the proposed system. Other alternative systems have been identified in previous EIS's.

Bayou Lafourche, augmented by increased pumpage from the Mississippi River would be the proposed raw water source for the site. Alternative sources would be wells in shallow aquifers near the site or the Gulf of Mexico.

Brine disposal is proposed via a 64-mile pipeline extending into the Gulf. The alternative raw water pipeline from the Gulf would parallel this line. Saline water-bearing sands are located at rather deep levels in areas surrounding the site and could be utilized for brine disposal through deep well injection.

A.7.2.4 Site Development

A.7.2.4.1 Proposed Physical Facilities

Site Layout

The 24 planned storage cavities, which would be placed on an 800-foot grid would, along with the associated central pumping and control facilities be located on an approximately 450-acre fenced site just west of the Freeport Sulphur property (see Figure A.7-3). Each cavity would be leached to an initial capacity of 10 million barrels each, except where difficulties in drilling through the caprock at a particular well location would force a reduction in borehole size. An 80 percent success rate in completing full-size wells is assumed. This would result in a probability that 8 of the 24 wells would only be developed to a 5-million barrel capacity, with flow rates equal to half of those planned for a

10 million barrel cavity. The projected site capacity for 24 wells is 200 million barrels with 16 wells storing 160 million barrels and 8 wells storing 40 million barrels.

Wellheads would be connected to the central pumping plant by a series of roadways and pipelines. A 12-foot access road to each well pad would be required. On-site pipelines (sizes varying from 30-inches at the pumps to 10-inches at the wells) would be mounted above ground on pilings located beside the roadways. All roads and pads would require several feet of fill. Each wellhead would be enclosed within a berm to contain operational oil spills. The 450-acre main storage facility would be enclosed by a 9-foot-high chain link fence. Other fencing would be needed around high-voltage areas or other dangerous or security zones.

Plant Area

The central pumping and control facilities shown in Figure A.7-4 would be located on an 8 to 10 acre tract near the center of the storage site. This area would contain the pump building, control building, offices, laboratory, warehouse, surge ponds, a blanket oil tank, the oil metering center, and a 5 to 6 acre material and equipment yard.

All cavity injection and transport pumps would be housed in a central pump building, approximately 30 feet by 200 feet in size. It would be a prefabricated type steel structure on a concrete slab foundation. The building area would be placed on 4 to 5 feet of fill, and because the existing ground is expected to have poor load-carrying capabilities, the slab may need to be supported by pilings. In addition to the pump building, two smaller buildings of similar construction would be located nearby to house instrumentation and electrical switchgear, and the office, laboratory, warehouse, and equipment repair area.

Two surge reservoirs are planned within the plant area. One 3.6-acre lined pond of 280,000 BBL capacity (water depth 10 feet) would be used for brine settling and as a surge pond for the brine disposal pumps. The other reservoir would be 40,000 BBL capacity tank used for raw water surge. To provide additional operational flexibility, a second brine pond may be constructed; the two ponds would be used alternately.

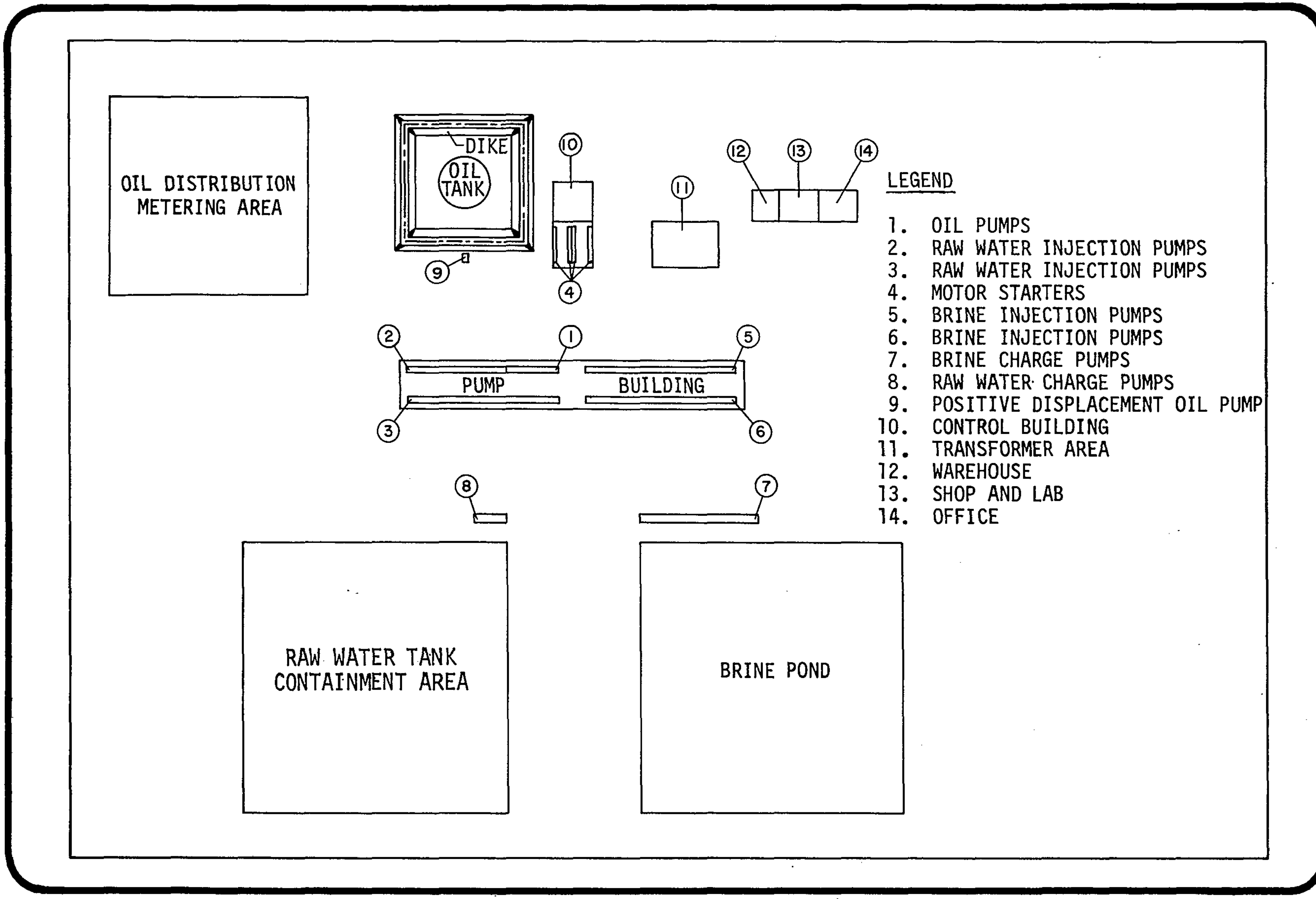


FIGURE A.7-4 Storage area layout - Chacahoula dome.

For initial cavern leaching, a 5000-barrel blanket oil tank, enclosed in an adequate spill containment dike, would be located near the pump building. For permanent oil distribution, the metering center at the central plant, comprising approximately one-half acre, would handle the oil piped to and from the terminal facilities.

Power requirements for all pumps would be provided by a new 5-mile line connecting to Louisiana Power and Light Company's main feeder line now under construction east of Chacahoula. A transformer bank at the storage site would be located adjacent to the electrical control building.

Raw Water Supply

Bayou Lafourche is the proposed source of water for the initial leaching of the storage cavities, as well as for the subsequent displacement of the stored oil. It is a regulated stream which is supplied by a pumping station at Donaldsonville, Louisiana, on the Mississippi River.

Use of Bayou Lafourche requires the installation of an additional 54,000 gallons per minute of pumping capacity at the Donaldsonville pump station where water is lifted from the Mississippi River and discharged into the bayou channel. The intake structure would be sized to meet EPA intake design standards of a maximum velocity of 0.5 feet per second, to reduce fish impingement on the intake screen. The increased flow would be picked up approximately 25 miles downstream through an intake structure and pump station, then pumped through a 42-inch, 6.5 mile-long pipeline to injection pumps located at the main facility pump building. Thus augmented, the bayou can supply the required quantities of water, a maximum of 49,000 gallons per minute. The proposed pipeline route parallels the oil distribution line running from the plant site to the DOE terminal (see Figure A.7-2).

In addition to supplying water directly to the injection pumps, the 42-inch pipeline would be connected to an 40,000 barrel raw water reservoir. Controls would be provided so that raw water would flow into the reservoir only if the water level in the reservoir is low and the pipeline pressure is high. Three charge pumps at the reservoir would enable high pressure injection pumps to be started with water from the reservoir. After start up, the charge pumps would be shut down, and the injection pumps would take suction directly from the raw water supply pipeline.

Brine Disposal

The proposed means of disposing of brine from the Chacahoula facility is via pipeline to the Gulf of Mexico at the rate of 70,000 barrels per hour (49,000 gallons per minute). A three-well backup injection field would be constructed south of the site, along the proposed brine disposal pipeline to the Gulf. The proposed route for the Gulf pipeline runs along to an existing pipeline, Shell No. 258, through some 40.4 miles of marshland to the coast (see Figures A.7-2 and A.7-5).

The line then proceeds offshore for a distance of roughly 23.6 miles and terminates at a diffuser, which consists of 58 3-inch risers stemming from the top of the buried 40-inch pipeline. Risers are spaced on 60-foot centers, creating a 3420-foot-long diffuser area. Minimum water depth in the diffuser area is 30 feet, and each riser would be 5 feet above the mudline (see Figure A.7-6). To mark the area for navigation, signal lights would be mounted atop a line of pilings stationed at 50-foot intervals. Signs attached to a cable strung between the pilings would provide visual daytime warnings.

As brine is produced, during leaching and subsequent fill operations, it would flow to a 280,000 barrel settling and surge reservoir. From the reservoir, it would be withdrawn by brine charge pumps and delivered to the pipeline transport pumps. During leaching, the flow rates may be maintained to hold a brine concentration at about 230 parts per thousand, or slightly less than saturation to prevent precipitation of salt out of solution at the cooler surface temperatures. During displacement operations, a near saturation solution of around 265 parts per thousand is expected.

Crude Oil Distribution

Oil distribution is planned via a new pipeline connection to the CAPLINE terminal at St. James port facilities on the Mississippi River,

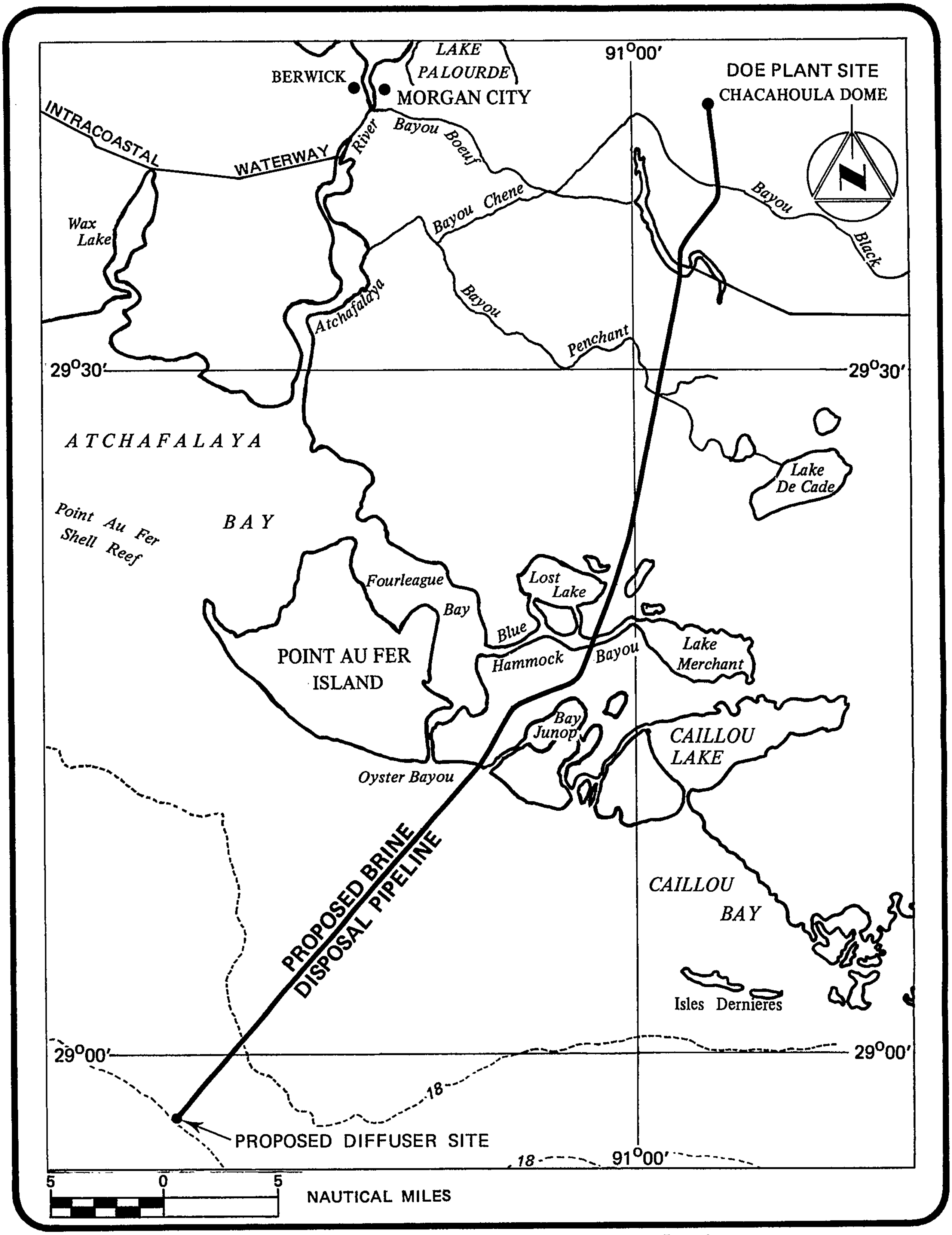


FIGURE A.7-5 Brine disposal pipeline route - Chacahoula dome.

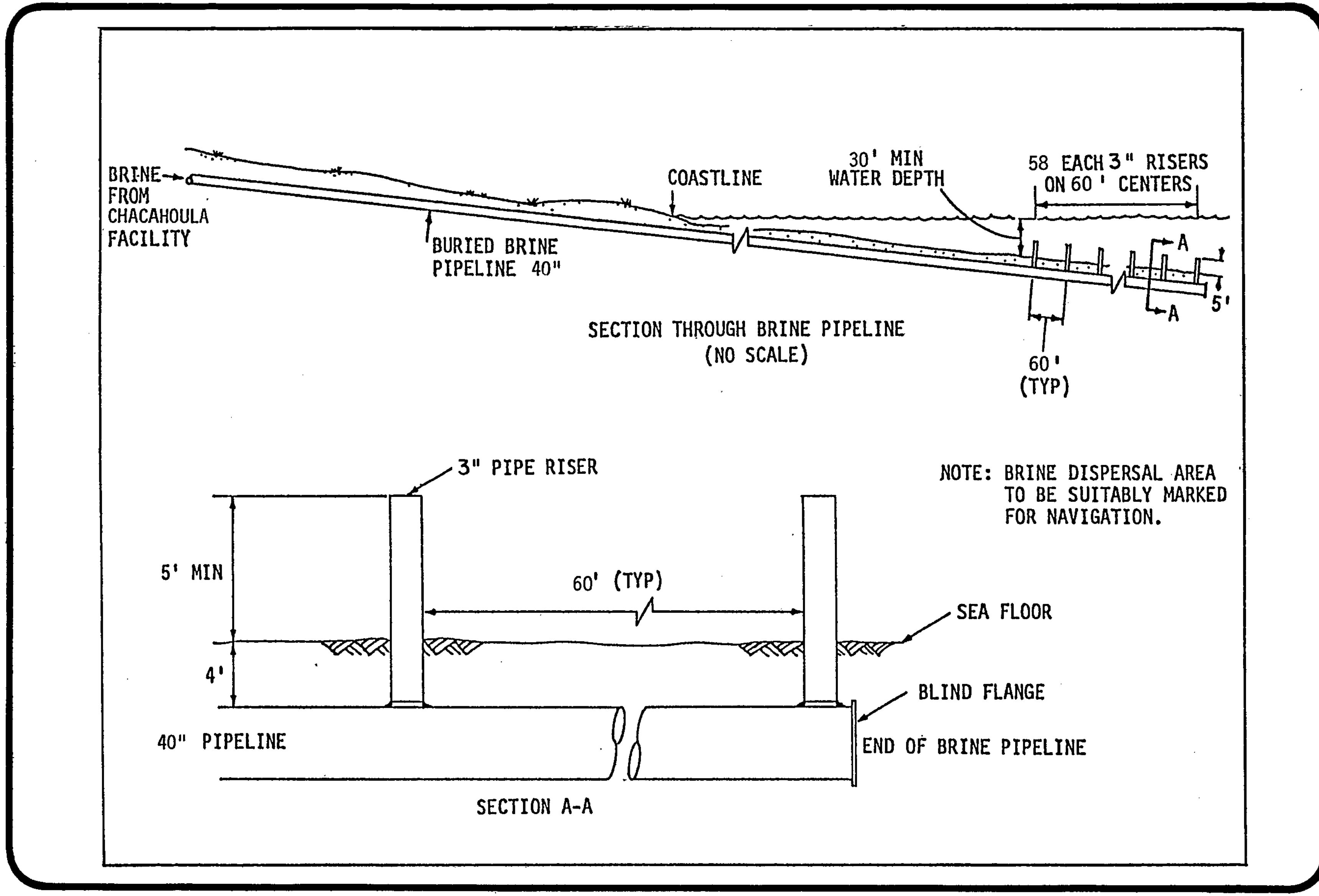


FIGURE A.7-6 Brine dispersal system - Chacahoula dome.

21.9 miles northeast of the proposed site. Presently, a 16-inch pipeline (Shell No. 258) crosses the Chacahoula dome and connects the CAPLINE terminal with offshore production wells. Because of limited available capacity, the need for reverse flow capability, a new pipeline for the proposed facility would be constructed near the existing pipeline right-of-way (see Figure A.7-2).

Land Requirements

Total land requirements for the Chacahoula facility, as planned, would be 1653 acres, including 574 acres in open water. The storage facilities would be located on a 450-acre fenced tract of land lying directly over the western half of the salt dome, just west of the Freeport Sulphur property.

The pumping station for raw water supply on Bayou Lafourche will require one to two acres. The required pipeline connection from Bayou Lafourche to the storage site would utilize the oil distribution pipeline right-of-way. The crude oil distribution line would require 21.9 miles of 80 foot right-of-way or approximately 214 acres (see Table A.7-1). This acreage would consist of 40 percent agricultural land and 60 percent swamp forest.

The present design for brine disposal would require a 40.4 mile pipeline from Chacahoula to the Gulf of Mexico and an additional 23.6 miles into the Gulf for direct offshore disposal. This line would follow an 80-foot right-of-way through 6 acres of cleared land, 88 acres of swamp land, and 298 acres of marsh land for a total on land of 392 acres. The route would follow an existing pipeline right-of-way (Shell No. 258) which would minimize the amount of land which would be disturbed. The 23.6-mile offshore portion of the pipeline would disturb a 200-foot wide area, totaling 572 acres.

Road Construction and Other Grading

The Chacahoula site is swamp with elevations ranging from six to seven feet above mean sea level. Accordingly, it is anticipated that much of the plant area and pipeline roads would require four to five feet of fill.

A.7-15

TABLE A.7-1 Proposed physical facilities - Chacahoula - grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
A. SPR Facilities - Chacahoula - Fenced Area - 450 acres										
1) Storage Site										
a) Central Plant Area	---	---	80,000	---	---	10/10	---	---	---	10/10
b) Brine Surge Pond	---	---	50,000	---	---	5/5	---	---	---	5/5
c) Roadways to Cavern Wellheads	---	---	98,000	---	---	18/7	---	---	---	18/7
d) Cavern Wellhead Containment Dikes	---	---	17,000	---	---	13/13	---	---	---	13/13
e) Cavern Wellhead Drill Pads	---	---	107,000	---	---	13/9	---	---	---	13/9
f) Distribution Within Plant Area	13.5	71,000	---	---	---	131/82	---	---	---	131/82
g) Blanket Oil Tank Containment Dike	---	---	2,000	---	---	1/1	---	---	---	1/1
2) Offsite										
a) Crude Oil Distribution (to Terminal)	21.9	255,000	---	85/54	---	128/80	---	10	1	214/134
b) Brine Disposal										
1. Pipeline to Gulf of Mexico	64.0	1,009,700	---	6/4	---	88/55	290/186	26	572	964/245
2. Back-up Brine Wells	1.9	30,000	55,000	---	--	5/3	---	---	---	5/3
c) Raw Water Supply										
1. Pipeline to Bayou Lafourche	6.5	76,000	---	7/4	---	10/6	---	3	1	18/10
2. Pump Station at Bayou Lafourche	---	---	5,000	2/2	---	---	---	---	---	2/2
3) St. James Terminal										
a) 4-200,000 bbl tanks	---	---	96,000	24/24	---	---	---	---	---	24/24
b) Roads and Miscellaneous	---	---	16,000	12/12	---	---	---	---	---	12/12
4) Koch Terminal	3.2	760,000	---	57/47	---	---	---	1	10	67/47
5) Nordix Terminal	7.0	798,000	82,000	68/53	55/25	---	---	15	16	139/78
Sub-Total (SPR Facilities-Chacahoula)	118.0	2,999,700	608,000	261/200	55/25	422/271	298/186	55	600	1636/682
B. Early Storage Facilities										
1) Weeks Island										
a) Storage Site	---	---	---	4/4	---	---	---	---	---	4/4
b) Crude Oil Distribution	64.4	1,069,000	---	145/90	40/25	307/191	60/37	24	71	623/343
c) St. James Terminal	---	30,000	54,000	15/15	---	---	---	---	---	15/15
Sub-Total (Early Storage-Weeks Island)	64.4	1,099,000	54,000	164/109	40/25	307/191	60/37	24	71	642/362

TABLE A.7-1 continued.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Bottomland Forest Constr/Maint	Deciduous Swamp Constr/Maint	Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
2) Bayou Choctaw										
a) Storage Site	7.0	37,000	---	120/120	---	---	---	4	2	122/120
b) Brine Disposal	2.9	46,000	95,000	---	---	31/20	---	7	1	32/20
c) Raw Water Supply	---	---	5,000	---	---	---	---	---	---	---
d) Crude Oil Distribution	38.0	383,000	---	268/167	35/22	64/40	---	13	1	368/229
e) St. James Terminal	1.0	35,000	54,000	40/34	---	---	---	---	---	40/34
Sub-Total (Early Storage-Bayou Choctaw)	48.9	501,000	154,000	428/321	35/22	95/60	---	24	4	562/403
Sub-Total (Early Storage-Weeks Island plus Bayou Choctaw)	113.3	1,600,000	208,000	592/430	75/47	402/251	60/37	48	75	1204/765
Total (Early Storage at Weeks Island and Bayou Choctaw plus Chacahoula Dome)	231.3	4,599,700	816,000	853/630	130/72	824/522	358/223	103	675	2840/1447

Grading requirements, both within the storage site area and offsite would be as follows:

Storage Site

Central Plant area, 10 acres	80,000 cubic yards
Brine Surge Pond	50,000 cubic yards
Blanket Oil Tank Containment Dike	2,000 cubic yards
Roadways to Cavern Wellheads, 4.5 miles	98,000 cubic yards
Cavern Wellhead Pads and Containment Dikes	124,000 cubic yards
	354,000 cubic yards

Offsite

Raw Water Pump Station		5,000 cubic yards
Back-up Brine Injection Wellpads		55,000 cubic yards
	Total Fill	414,000 cubic yards

Oil distribution, brine disposal and raw water supply pipelines would require approximately 107.8 miles of excavation, including:

Oil Distribution	21.9 mi	255,000 cubic yards
Brine Disposal - Onland	40.4 mi	635,900 cubic yards
Brine Disposal Back-up Wells	1.9 mi	30,000 cubic yards
- Offshore	23.6 mi	373,800 cubic yards
Raw Water Supply	6.5 mi	76,000 cubic yards
Distribution within Plant Area	13.5 mi	71,000 cubic yards
	107.8 mi	1,441,700 cubic yards

A.7.2.4.2 Alternative Physical Facilities

Alternatives to proposed systems discussed below and in Section A.7.2.3.2 are detailed in Table A.7-2, for comparison to the proposed systems.

An alternative raw water source would be the Gulf of Mexico. A 42.4-mile raw water pipeline could be constructed parallel to the proposed brine disposal pipeline to the Gulf. The pipeline would require additional right-of-way of 22 acres of swamp, 75 acres of marsh, and 2 acres of cleared land.

A second alternative raw water source would be shallow aquifers near the site. Wells could be drilled along the right-of-way of the

TABLE A.7-2 Alternative physical facilities - Chaca~~houla -~~ grading requirements and land use.

	Total Miles Pipeline	Excavation (c.y.)	Fill (c.y.)	Habitat Acreage: Cleared Land Constr/Maint	Habitat Acreage: Bottomland Forest Constr/Maint	Habitat Acreage: Deciduous Swamp Constr/Maint	Habitat Acreage: Marsh Constr/Maint	Water Crossings	Open Water Acreage	Total Acreage Impacted Constr/Maint
1) Brine Disposal (Deep Well Injection)										
a) Pipeline Excavation	18.1	287,000	---	---	---	176/110	---	4	1	177/110
b) Roadways to Brine Disposal Wellheads	---	---	392,000	---	---	---	---		---	---
c) Brine Disposal Wellhead Pads	---	---	365,000	---	---	45/30	---	---	---	45/30
2) Brine Disposal to Alternative Diffuser	62.7	989,100	---	6/4	---	88/55	298/186	26	541	933/245
3) Raw Water Supply										
a) Wells (Shallow Aquifers)										
1. Pipeline Excavation	10.2	103,000	---	14/9	---	11/7	---	2	1	26/16
2. Roadways to Drill Pads	---	---	100,000	22/8	---	18/7	---			40/15
3. Drill Pads	---	---	45,000	17/12	---	5/3	---	---	---	22/15
b) Gulf of Mexico Pipeline	42.4	667,600	5,000	2/1	---	22/14	75/47	26	49	148/62
c) Mississippi River at St. James	21.9	255,000	5,000	22/14	---	32/20	---	10	1	55/34
4) Nordix Terminal and Alternative Pipeline	10.0	773,300	82,000	74/56	21/15	---	---	4	1	96/71

crude oil pipeline to St. James. Excavation of 10.2 miles of pipeline would require 14 acres of additional right-of-way on agricultural land, and 11 acres of additional right-of-way in swamp forest. Another alternative raw water source would be directly from the Mississippi River at St. James through a 21.9-mile pipeline following the crude oil distribution pipeline right-of-way. This system may also include a centrifugal desander for clearing excess sediment from the water. Effluent from the desander would be returned to the Mississippi River; a desilting pond may be constructed if needed to prevent buildup in the caverns.

Brine disposal could alternatively be accomplished through deep well injection. A well field (55 wells) could be constructed south of the site (see Figure A.7-2), requiring approximately 18.1 miles of pipeline excavation and 177 acres of right-of-way on swamp land. An alternative brine diffuser site requiring a 62.7-mile pipeline would follow the proposed brine disposal pipeline right-of-way on land and would extend 22.3 miles offshore.

A.7.2.5 Construction Techniques

Cavern construction would consist of 24 cavities leached in the -2500 to -3500 foot depth interval. The cavities would be spaced on 800-foot centers, with heights of 1000 feet and ultimate diameters of 400. As no previous cavern development has occurred within the salt at the dome, interfacing with existing facilities or caverns would not be necessary. Construction of the caverns would therefore be as described in Section A.3.2.

A.7.2.5.2 Roadways

The proposed Chacahoula salt dome site lies beneath a swamp area which is covered with several feet of standing water. Four to five feet of fill would be required for all road and pad construction, and additional fill may be necessary in some areas. Section A.3.4 describes general road construction technqiues.

A.7.2.5.3 Pipelines

The raw water pipeline and crude oil line would be constructed on the same right-of-way from the site to Bayou Lafourche, the oil pipeline then continuing to St. James. Agricultural land will be crossed for a distance of about three miles on each side of the Bayou Lafourche and for about one mile near the DOE terminal. It is anticipated that conventional pipelaying methods can be used in these areas (see Section A.3.4.1). No difficulties are expected in crossing Bayou Lafourche. The remainder of the raw water and oil pipelines and the brine disposal line would cross swamps and marshes of varying vegetation and water depth. Flotation canal and push-ditch methods would be used in these areas and for the line extending into the Gulf of Mexico. Access can be provided to all locations for waterborne equipment.

A.7.2.6 Development Timetable

According to present plans, the first nine months of facility construction would involve the installation of the brine disposal and raw water systems, and laying the required pipelines (see Figures A.7-7 and A.7-8). Up to 24 months of initial cavern leaching must take place before the beginning fill operations. Leaching and oil fill are planned for 58 months at a design fill rate of 350,000 barrels per day. It is estimated that the 200 million barrels of stored oil could be in place with the facility ready for emergency withdrawal within the time allocated by the SPR program.

A.7.2.7 Operation

A.7.2.7.1 Storage Phase

The facility will become part of the SPR as soon as cavern filling is initiated. To cover the possibility that certain national emergencies could occur before the design capacity of the facility is met, the storage system would be equipped with oil return bypass valves to allow intermittent recovery of stored oil.

There would be an interim period from the time of facility completion until a need arises for emergency distribution of the stored oil. During this interim period, the only activities at the site would be security and maintenance activities. During the storage period, all equipment would be serviced and tested on a regular basis to ensure proper working order. Maintenance crews would be on duty on a 24-hour basis.

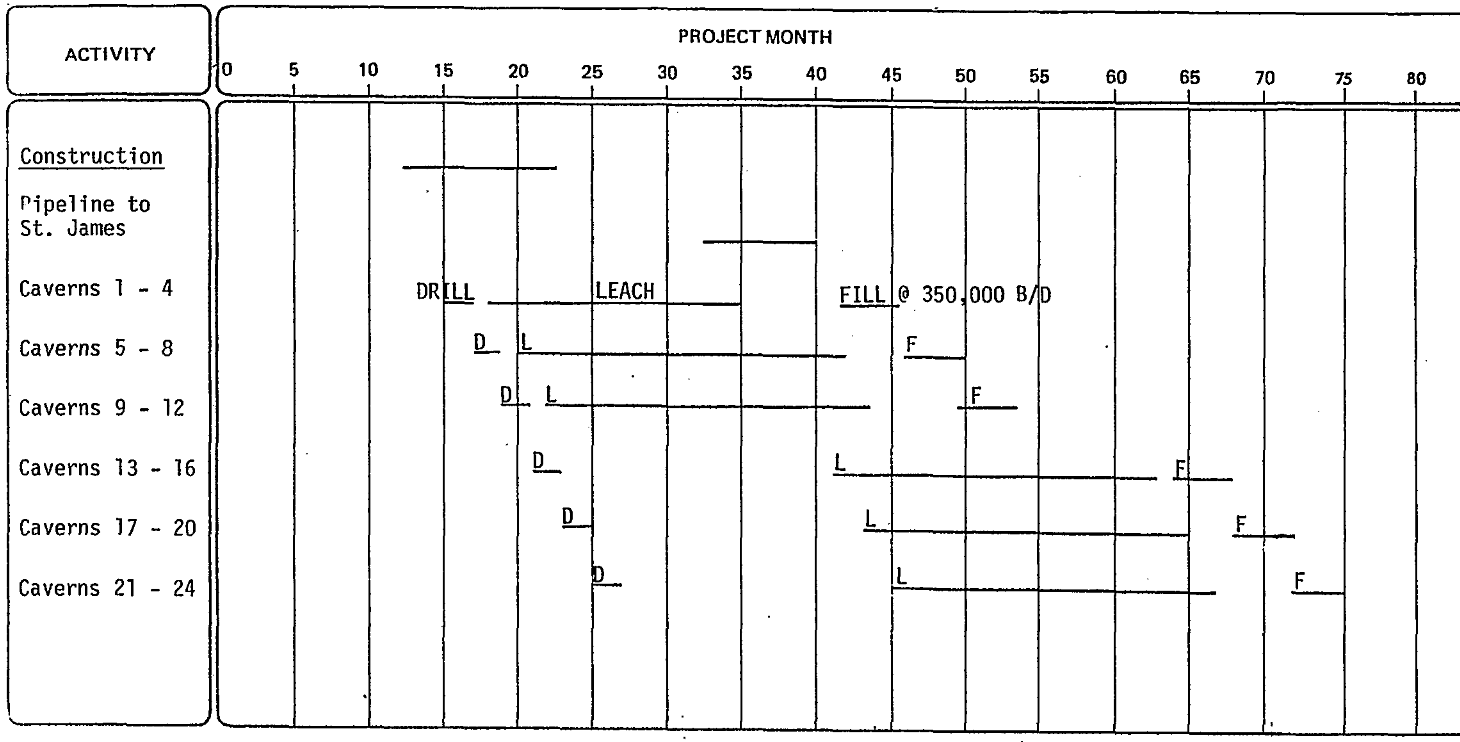


FIGURE A.7-7 Development timetable for Chacahoula dome.

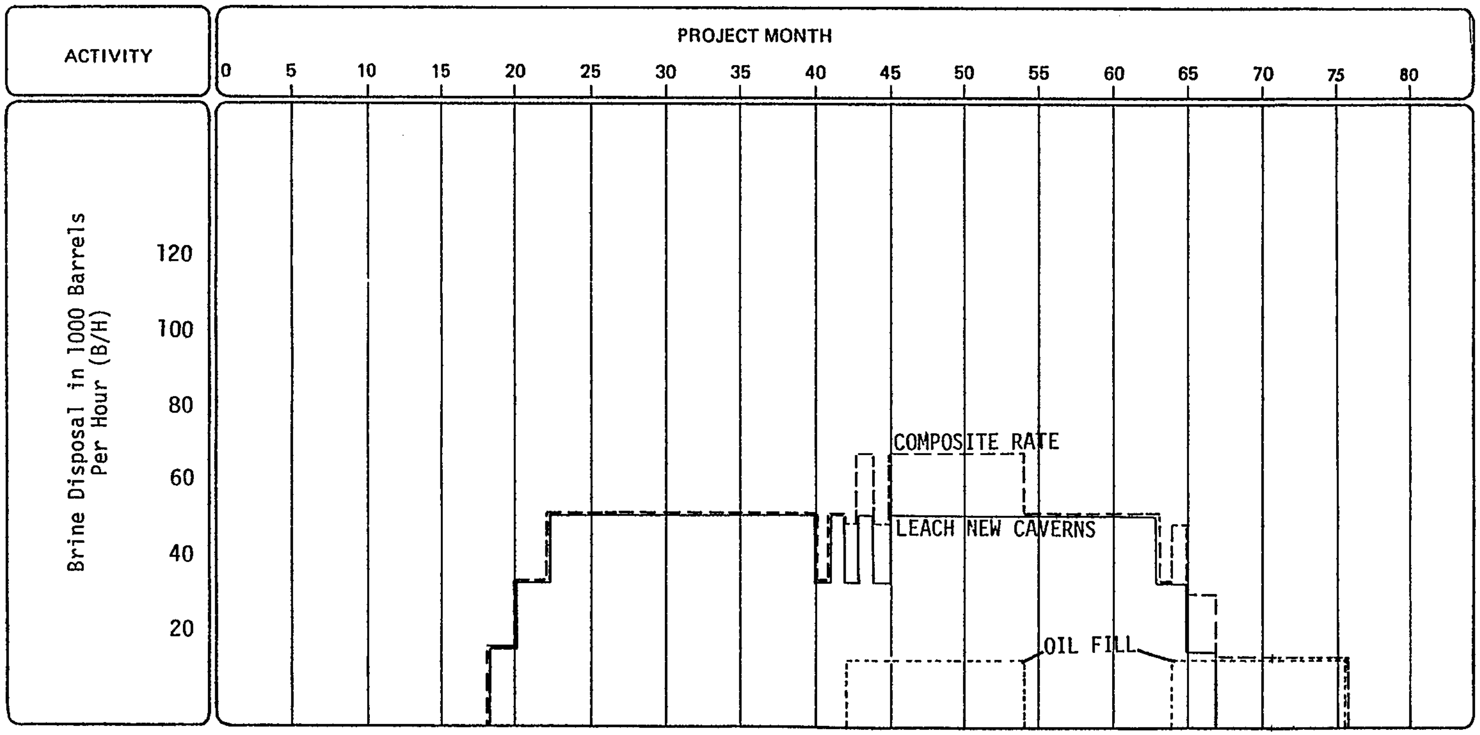


FIGURE A.7-8 Development timetable for Chacahoula brine disposal.

A.7.2.7.2 Extraction Phase

Delivery of stored oil from the Capline Group would be at a rate of 2.0 million barrels per day (MMBPD) for the group. The combined withdrawal rates to empty the Bayou Choctaw and Weeks Island early storage phase sites over a 150-day period would be 1.22 MMBPD. During this 150-day period, oil would be withdrawn from the Chacahoula facility at 0.78 MMBPD (2.00-1.22) or 117 MMB. The remaining 83 MMB at the facility would be withdrawn in 69 days at the 1.2 MMBPD capacity of the 40-inch oil distribution pipeline, for a total withdrawal period of 219 days. Raw water would be supplied for oil displacement at the maximum rate of 1.2 MMBPD (35,000 6PM).

Crude oil stored in each salt cavity would be recovered by pumping raw water into the bottom of the cavity. This would cause displacement of the oil through the concentric tubing at the top of the cavity. The oil would leave each wellhead at a pressure capable of transporting the oil via pipeline to the distribution facility. The DOE terminal on the Mississippi River would be the distribution point for the Chacahoula strategic storage facility.

A.7.2.7.3 Refill Phase

After an oil supply crisis has ended and provided that supplies are stabilized and new imports are sufficient for additional storage reserves, refill of the SPR storage facility is planned. The rate of fill would depend on the availability of crude, but is currently planned for fill over a 24-month period.

Refill Process

The refill process is the reverse of the recovery process. The crude oil is injected into the top of the storage cavity, thus displacing the brine which, in turn, goes to the disposal system. The brine disposal system and cavity injection system would have excess capacity available during refill.

Refill Capacity

Five fill and withdrawal cycles are assumed for the SPR system. Although the cavern capacity would enlarge during each cycle, only the original design capacities for each cavity are planned for refill. The fact that a smaller percentage of fresh displacement water would be introduced into the cavern during successive displacement cycles reduces the continued leaching process from about 90 percent enlargement to about 62 percent. Due to casing limitations, total usage of the enlarged capacity would not allow total displacement during subsequent withdrawals.

A.7.2.8 Termination and Abandonment

At a time when the oil storage capacity at Chacahoula will no longer be needed, it is intended that the facility continue to serve a useful purpose through the commercial storage of other products. Mothballing could be utilized in anticipation of use at a later date.

The facility will ultimately be dismantled and abandoned, and surface equipment sold. Cavity access wells would be stripped of casing and sealed with concrete, a common oilfield procedure. No long-term surveillance or maintenance is anticipated.

APPENDIX B

DESCRIPTION OF THE ENVIRONMENT

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APPENDIX B

DETAILED DESCRIPTION OF THE ENVIRONMENT

B.1 INTRODUCTION

This Appendix presents descriptions of the environment, both natural and manmade, in the region of the proposed project and in the immediate vicinity of the sites.

The regional environment, discussed in Section B.2, includes information on the "region" as it pertains to the specific disciplines discussed. For land features, the region can be considered to include much of southern Louisiana; for surface water, the region comprises the nearshore Gulf of Mexico, the Atchafalaya Basin and adjoining portions of the Mississippi River and Vermilion River basins; and for socioeconomics, the region is the eleven parish area extending from Baton Rouge to the Gulf of Mexico.

Sections B.3 through B.6 detail the environment of the terminal sites and each of the five candidate sites, Napoleonville dome, Weeks Island dome, Bayou Choctaw dome, Iberia dome and Chacahoula dome. Since there are many environmental characteristics which are similar at two or more sites, when a description first appears in the text it is most complete, and other occurrences are more abbreviated and cross-referenced. References cited are included in Section B.7.

Additional physical, chemical, and biological oceanographic data describing the Gulf of Mexico, from a supplemental study, are included in Appendix G and incorporated, in part, in this Appendix.

B.2 REGIONAL ENVIRONMENT

B.2.1 Land Features

B.2.1.1 Geology

B.2.1.1.1 Regional Geology

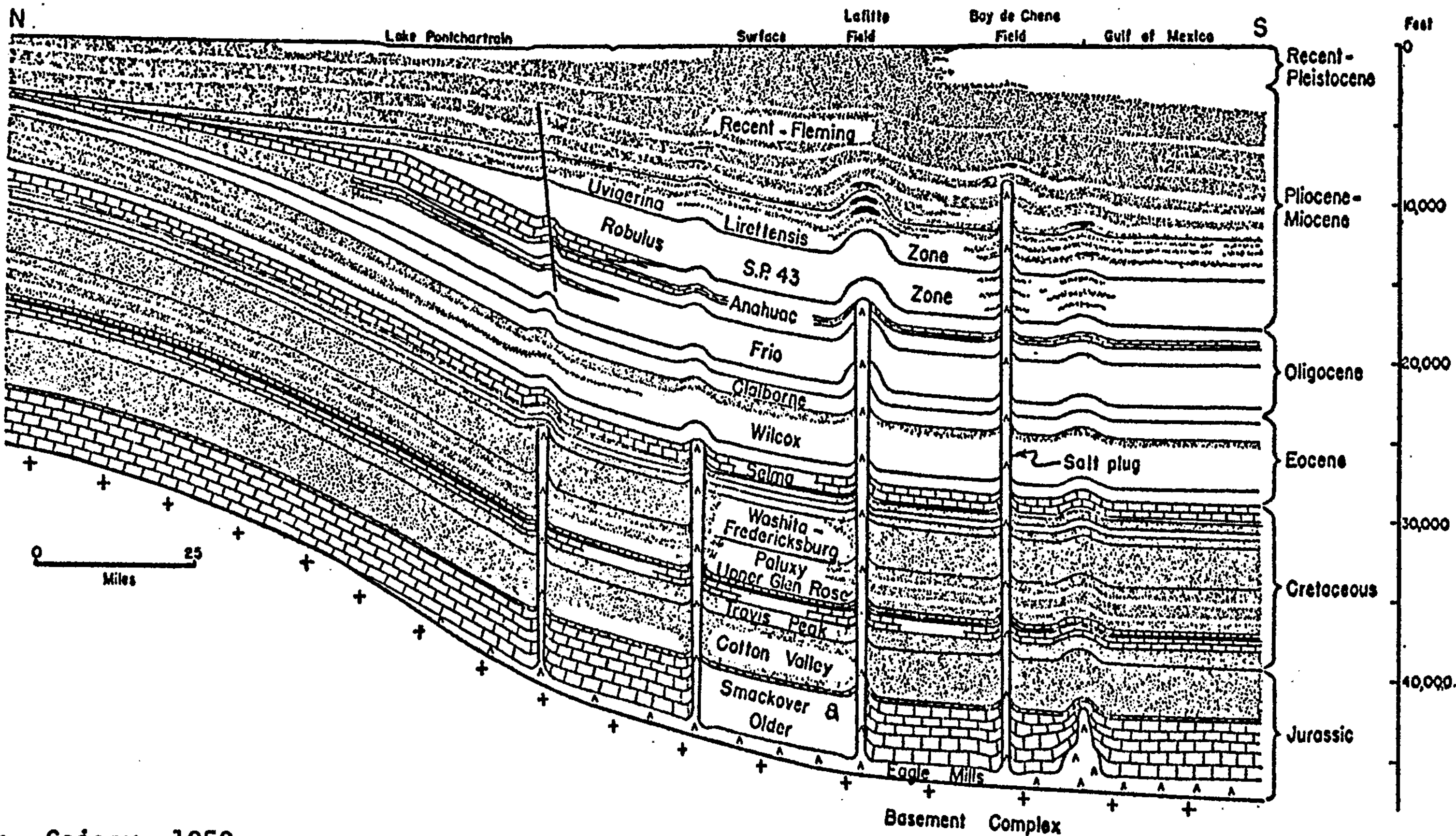
The dominant geologic feature of southern Louisiana is the Gulf Coast Geosyncline. The axis of this geosyncline generally corresponds with the present coastlines of Texas, Louisiana, Mississippi, Alabama, and Florida. The stratigraphic record indicates that the geosyncline has been slowly subsiding since the Cretaceous. The area of subsidence has received voluminous deltaic accumulations of sediments derived from broad portions of central North America. These accumulations are expressed as a large wedge of Mesozoic and Cenozoic sediments that progressively thickens toward the south (Figure B.2-1). In the vicinity of the coast, the wedge is reported to be about 50,000 feet thick (Figure B.2-2).

Physiography

The region lies within the Western Gulf Coastal Plain physiographic province. Four natural regions may be distinguished: the coastal marsh-lands, the Mississippi River floodplain, the Pleistocene terraces, and the hills (Figure B.2-3). (The Red River Valley region shown on Figure B.2-3 is largely outside of the project region).

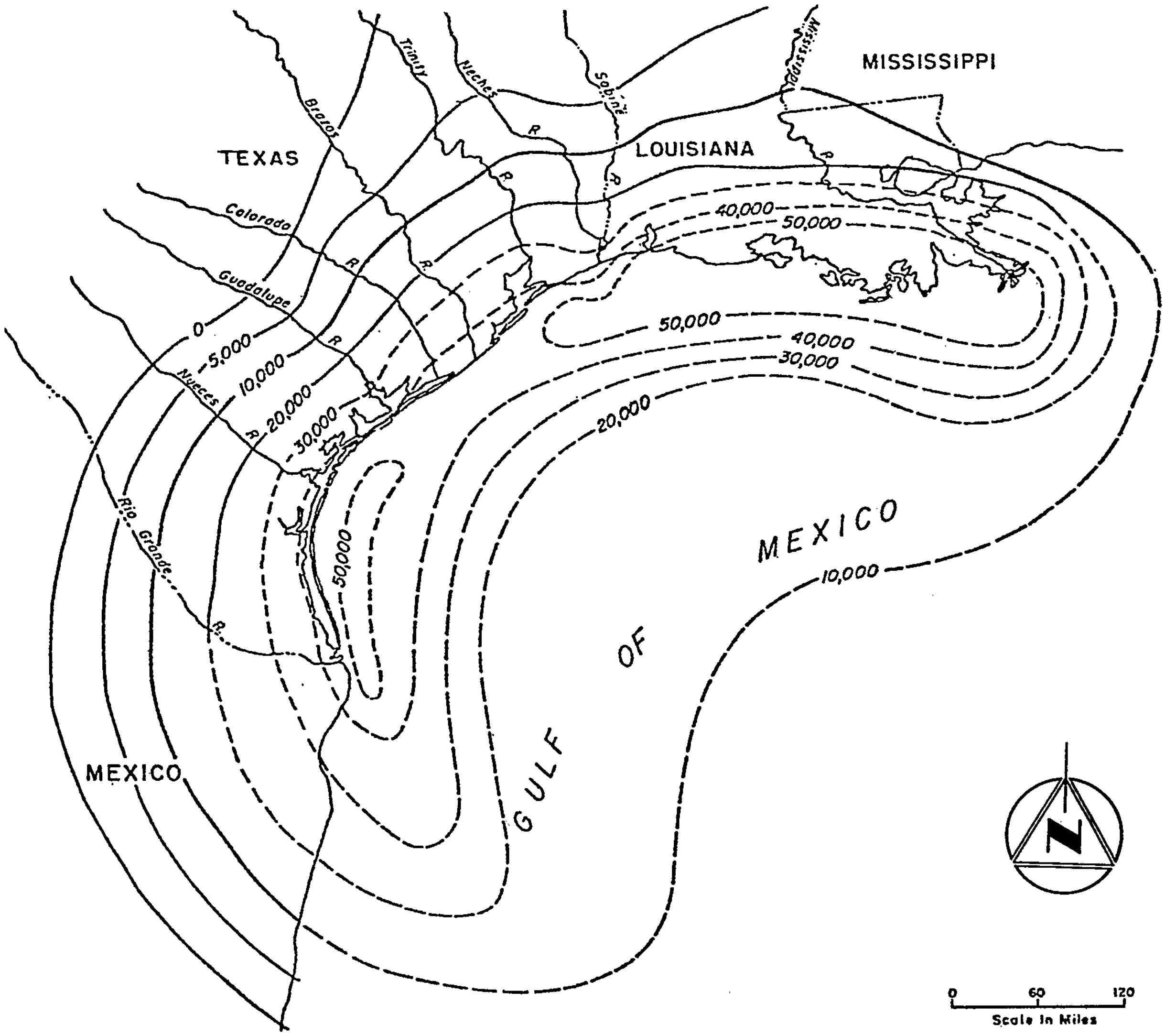
The marshlands include the deltaic plain of the Mississippi in the east and the chenier plain in the southwestern part of the state. The deltaic plain has been constructed by the shifting of Mississippi River courses; the chenier plain consists of a series of relict beach ridges. The floodplain consists of the Mississippi and a series of distributaries to the Mississippi and their associated natural levees and floodplains. Inland from the marshes and flanking the floodplain are the terraces of Pleistocene age. These deposits have been dissected by the modern streams. In the northern part of the state the older deposits form the hills area.

The nearshore features of the Capline sector are dominated by the Atchafalaya Bay and Marsh and Point Au Fer Islands. The mouth of the bay is bounded by oyster shell reefs. Beyond these reefs, water depths



Source: Caisey, 1950

FIGURE B.2-1 Section across the delta of the Mississippi River, showing the nature of the formations associated with some of the salt domes of the area.



SOURCE: Rainwater and Zingula, 1962

FIGURE B.2-2 Cenozoic sediment thickness (feet) in the Gulf Coast storage region.

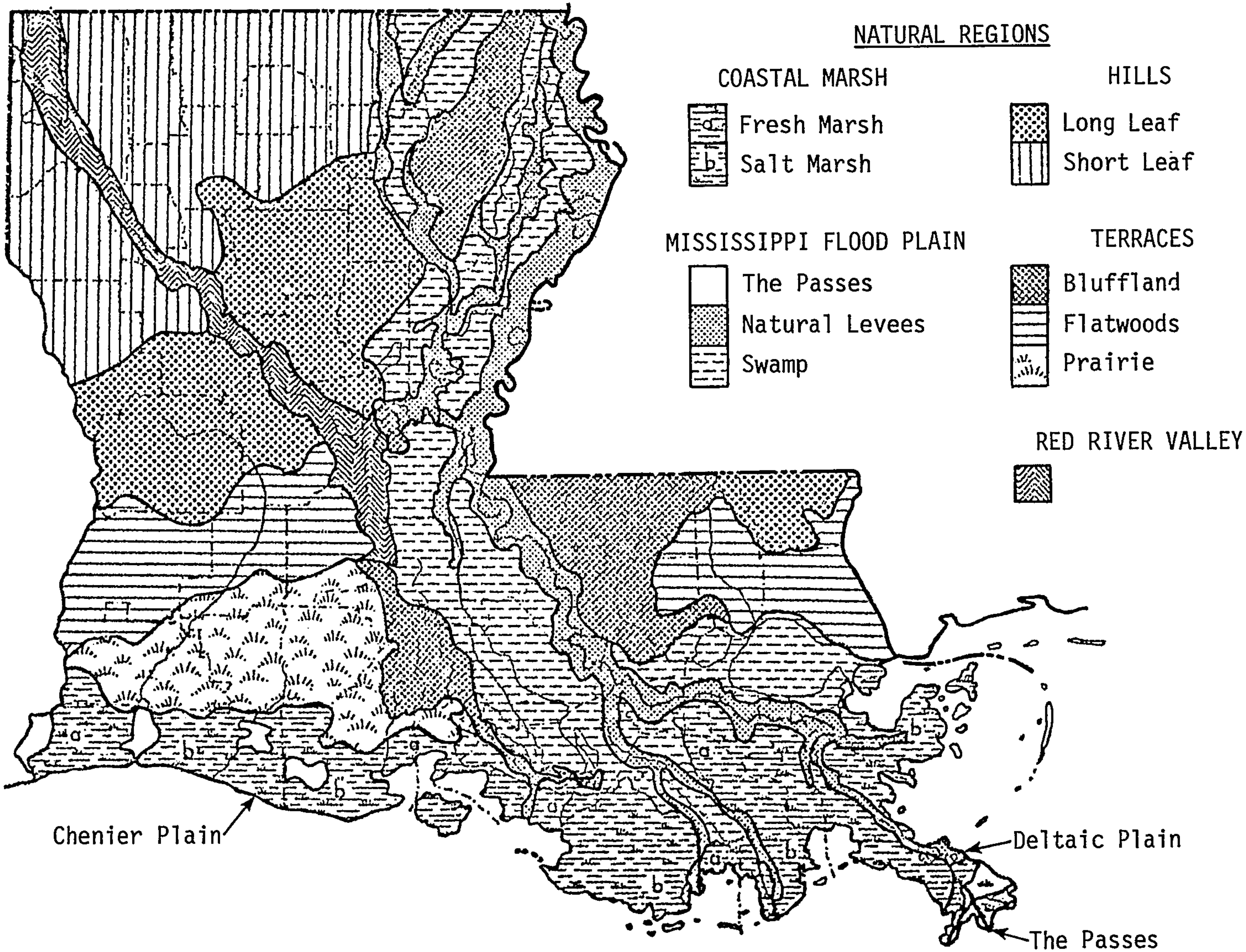


FIGURE B.2-3 Natural regional of the state of Louisiana.

in the gulf increase gradually from 18 feet 10 miles offshore to 600 feet 115 miles offshore. The Atchafalaya River is actively building a delta such that in 20-30 years, this delta could become a major topographic feature of the Gulf coast. Three shoals are found within the nearshore gulf waters of central Louisiana: Tiger Shoal, Trinity Shoal and Ship Shoal.

Structure

The major regional structure is the Gulf Coast Geosyncline described previously. Superimposed on the geosyncline are several minor structures (Figure B.2-4), the most noticeable of which is a system of faults that approximately parallels the geosynclinal axis. Faults composing the system are typically normal and downthrown to the south. The faulting is believed to have occurred gradually but concurrently with the geosynclinal development. Though there are active faults in the Gulf Coast region, the faulting is not tectonic in origin and is not genetically or causally related to earthquakes. The only fault of the system that is believed to be active is the Baton Rouge Fault (Figure B.2-4), whose major period of movement was in the mid-Eocene to the mid-Oligocene. Many other smaller faults have resulted from salt plug emplacement and are locally associated with individual salt domes (Johnson and Bredeson, 1971). (The evolution of salt domes is discussed in Section B.2.1.2).

Another minor structural feature is the Five Islands Syncline. The axis of the syncline is a mile or so northwest of, and parallel to, a line connecting the Five Islands salt domes of which Weeks Island is one. Seglund (1974) related the formation of this syncline to subsidence caused by deep lateral withdrawal of salt. The northern part of Louisiana is influenced by the Sabine Uplift. Also, the northern Louisiana salt dome basin is in the north-central part of the state.

Stratigraphy

The stratigraphy of the region is complex due to interfingering of various facies (see Figures B.2-5 and B.2-6). Differences in sources of sediment, transport mechanisms, and dispersal determined the gross aspects of the stratigraphy. However, local variations in the thickness

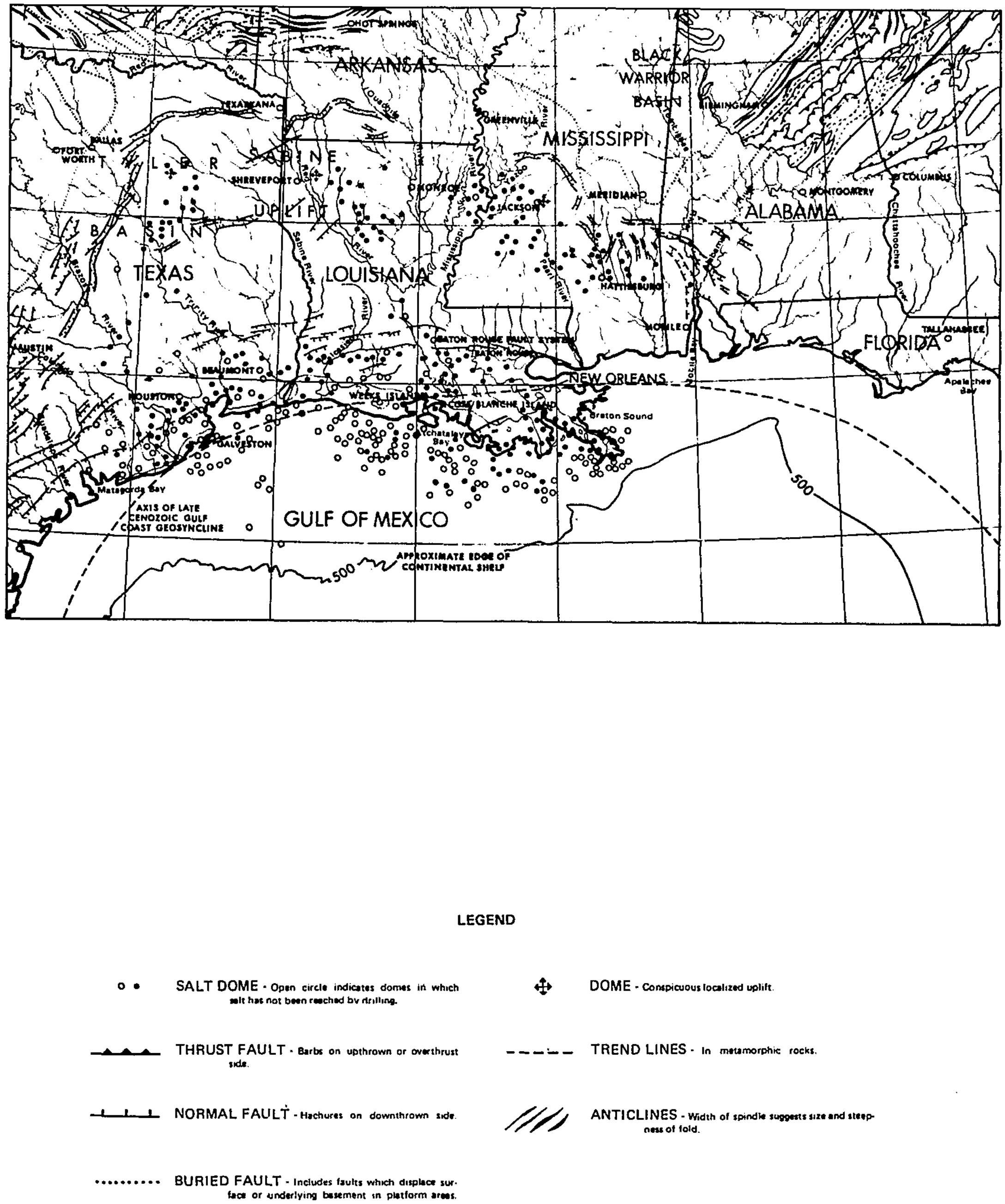


FIGURE B.2-4 Regional geologic structure.

SYSTEM	SERIES	GENERALIZED STANDARD SECTION: Group or Section	LOUISIANA: FORMATION	LOUISIANA: MEMBER
QUATERNARY	PLEISTOCENE	HOUSTON	PRAIRIE	
QUATERNARY	PLEISTOCENE	HOUSTON	MONTGOMERY	
QUATERNARY	PLEISTOCENE	HOUSTON	BENTLEY	
QUATERNARY	PLEISTOCENE	HOUSTON	WILLIANA	
TERTIARY	PLIOCENE	CITRONELLE		
TERTIARY	MIOCENE	FLEMING	MIOCENE	Upper Middle Lower
TERTIARY	OLIGOCENE	CATAHOULA	ANAHUAC	
TERTIARY	OLIGOCENE	CATAHOULA	FRIO	
TERTIARY	OLIGOCENE	VICKSBURG	RED BLUFF (Only in downdip subsurface)	
TERTIARY	EOCENE	JACKSON	YAZOO	Danville Landing Beds Verda Union Church Tullas
TERTIARY	EOCENE	JACKSON	WOODY'S BRANCH	
TERTIARY	EOCENE	CLAIBORNE	COCKFIELD	
TERTIARY	EOCENE	CLAIBORNE	COOK MOUNTAIN	
TERTIARY	EOCENE	CLAIBORNE	SPARTA	
TERTIARY	EOCENE	CLAIBORNE	CANE RIVER	
TERTIARY	EOCENE	WILCOX	CARRIZO	
TERTIARY	EOCENE	WILCOX	SABINETOWN	
TERTIARY	EOCENE	WILCOX	PENDLETON	
TERTIARY	EOCENE	WILCOX	MARTHAVILLE	
TERTIARY	PALEOCENE	MIDWAY	HALLS SUMMIT	
TERTIARY	PALEOCENE	MIDWAY	LOGANSPORT	
TERTIARY	PALEOCENE	MIDWAY	HARBORTON	
TERTIARY	PALEOCENE	MIDWAY	PORTERS CREEK	
TERTIARY	PALEOCENE	MIDWAY	KINCAID	

Source: Rainwater and Zingula, 1962

FIGURE B.2-5 Cenozoic correlation chart.

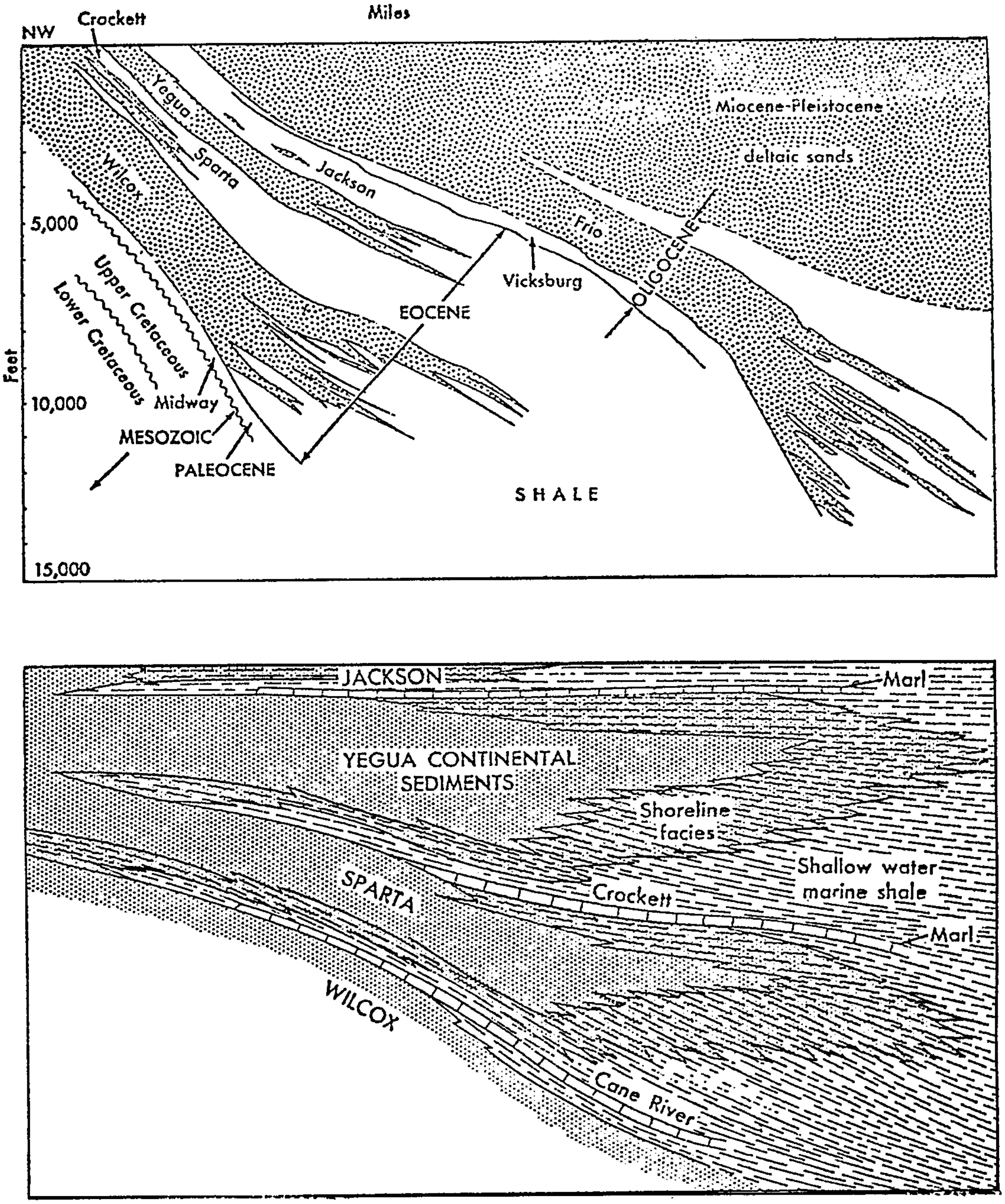


FIGURE B.2-6 Diagrammatic representations of typical stratigraphic variations in the gulf coast region (top). Dip section showing regional relations of sandy (stippled) and clayey (white) units (bottom). Detail of the facies in one part of the top illustration and lithology of individual formations were caused by the influence of numerous local structures during deposition. Generally, the earlier Tertiary formations are comprised of variable, unequal amounts of sand and clay, and the more recent Quaternary formations, representing only the uppermost few thousand feet of sediments, are more sandy, yet also have substantial amounts of clay. The generalized cross-sections of Figure B.2-6 illustrate typical subsurface relations commonly encountered between marine and non-marine sediments. Generally speaking, the near surface strata at locations of interest to this program are alternating sands and clays in beds of variable thickness and lithology.

In central and northern Louisiana, most of the strata that compose the inner portion of the geosyncline are fairly well known and documented from either surface exposures or petroleum exploration. However, near the coast, data are sparse and are limited principally to petroleum well logs. The deepest of these logs extends only to mid-Tertiary strata; therefore, the nature of deeper sediments is virtually unknown. Also, due in large part to the marked lateral variations that characterize the units, the explored portions of the stratigraphic column are known only in a general manner.

In the coastal vicinity of the Five Islands, petroleum exploration presently extends to about 15,000 feet below sea level (Johnson and Bredeson, 1971), just barely into the top of the Oligocene (Figure B.2-6). Johnson and Bredeson show the top portion of the Oligocene to be composed of deepwater shales, and suggest that these and other shales may comprise a thickness of several thousand feet. The entire 15,000-foot section above the Oligocene is composed of variable thicknesses of alternating sands, silts, and clays. The lower two-thirds is Miocene-Pliocene, comprised principally of interbedded transitional and shallow marine facies. Partly because of the lateral lithologic variability, these facies are not differentiated into separate formations.

The Pleistocene strata appear to be more laterally continuous and have been divided into four regionally recognizable formations (Figure B.2-7). From oldest to youngest, they are the Williana, Bentley,

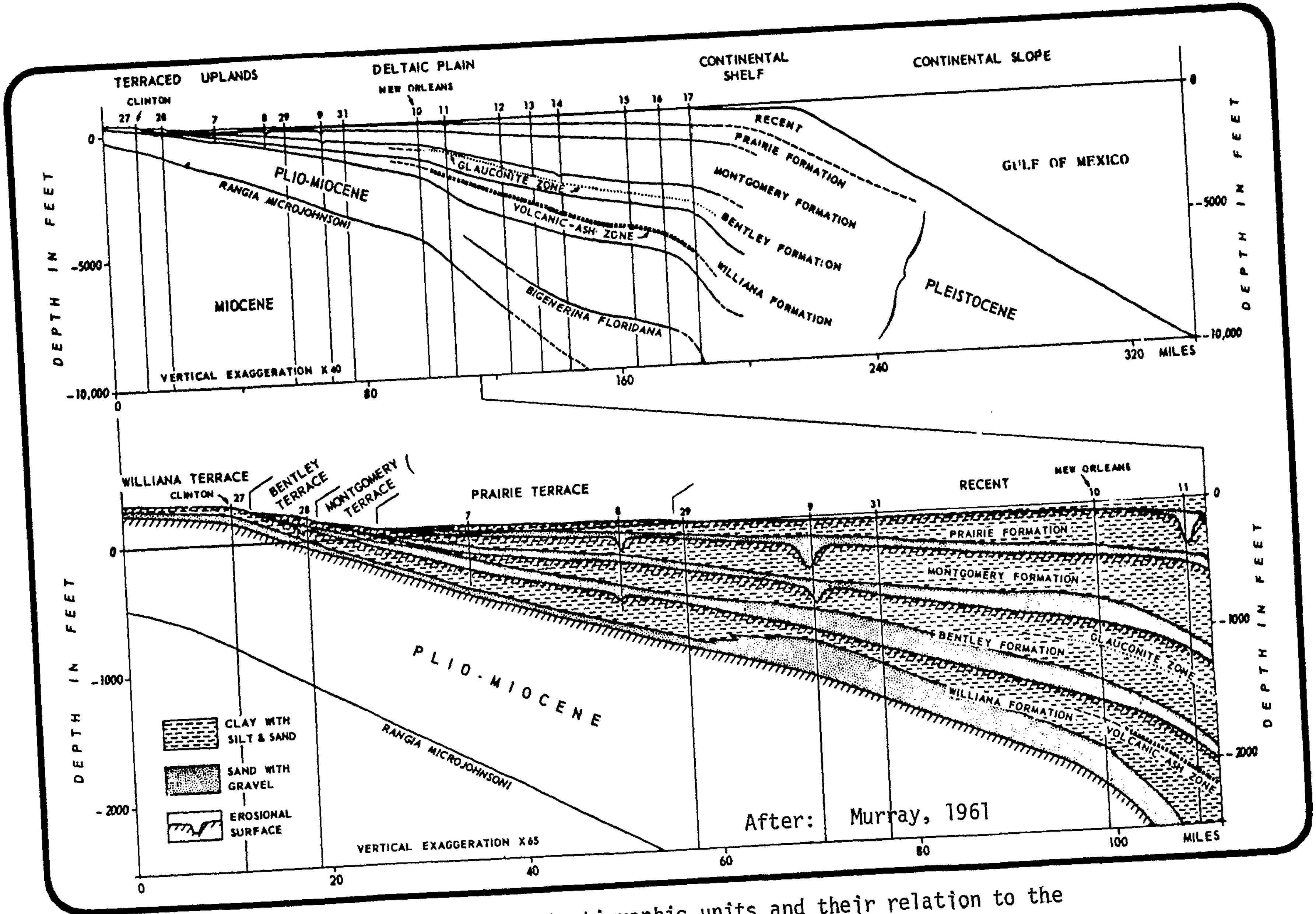


FIGURE B.2-7 Subsurface Quaternary stratigraphic units and their relation to the surface deposits of the terraced uplands.

Montgomery, and Prairie Formations. Each corresponds with a landward time-equivalent terrace of the same name. Murray, (1961) reported that all four formations are lithologically similar, each one composed of a thick basal unit of sands with gravels, grading upwards to clays with silts and minor sands.

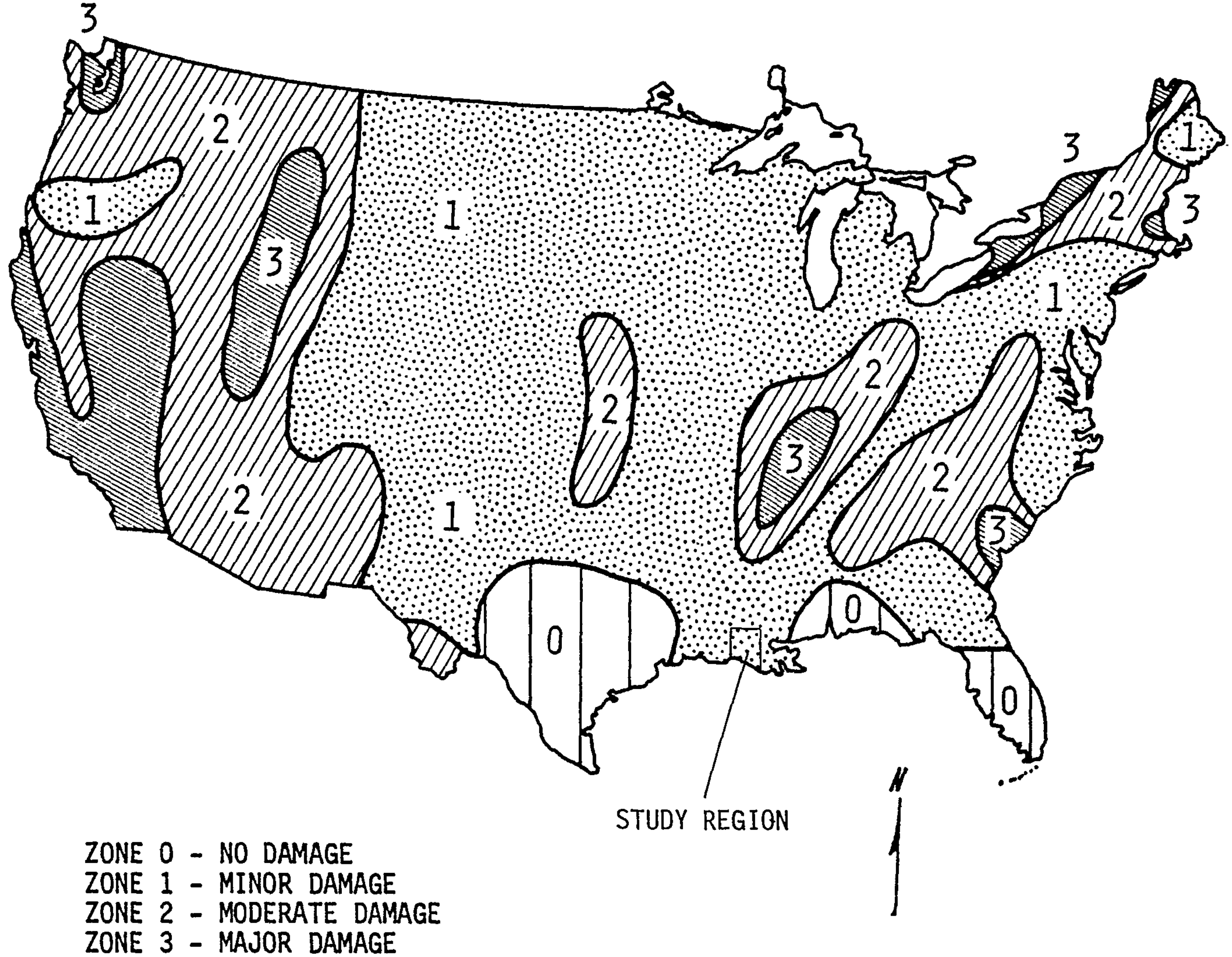
B.2.1.1.2 Economic Geology

The most important mineral resources in the Gulf Coast region are oil and gas, which are extensively produced throughout the region. Oil and gas production is often associated with salt domes, and most known domes in the province have been extensively explored for petroleum on their margins. Other oil and gas fields are associated with faults and variations in lithology (stratigraphic traps). Salt domes are also the source of commercial salt and brine, which are used both as chemical feedstocks and as a source of salt for commercial purposes. The caprock of many salt domes is an important source of sulfur. Sulfur is produced by the Frasch process in which superheated steam is pumped into wells open to sulfur-bearing caprock. The steam melts the sulfur which is then forced up the intermediate annulus of the well by compressed air in injection tubing.

Sand and gravel, used as aggregate in making concrete, are mined by surface mining techniques throughout the coastal plain. Most of the material is mined from the extensive and moderately thick modern flood-plain deposits in the upper reaches of most major streams, although some sand and gravel production, especially in Louisiana and Mississippi, comes from broad alluvial terraces of relict or ancient streams (Jones and others, 1954). Other mineral resources exploited at several locations in the coastal plain include lignite, uranium, bentonite, and limestone.

B.2.1.1.3 Regional Seismicity

The softness of the rock underlying the Gulf Coast permits deformation to take place without brittle fracture; consequently, seismic activity in the region is very low. The National Oceanic and Atmospheric Administration (NOAA) has classified the United States into four zones with differing degrees of expected seismic risk (Figure B.2-8). These



After: Coffman and VonHake, 1973

FIGURE B.2-8 Seismic risk map.

subdivisions are based on the recorded history of past seismic activity. Zone 0 covers areas having no reasonable expectancy of surface earthquake damage; Zone 1, expected minor damage; Zone 2, expected moderate damage; and Zone 3, possible major destructive earthquakes.

The project region lies within the boundary of seismic risk Zone 1. However, in order to acquire more specific information, an earthquake data search was requested from the NOAA seismic information service. This NOAA office has cataloged the records of all known tremors occurring since the mid 1900's. The data search was requested to cover the rectangular area from 28°55' North to 30°19' North and from 90°45' West.

Events having an intensity of magnitude V or greater are indicated below.

Nearest City to Epicenter	Intensity	Coordinates N Lat	Coordinates W Long
Napoleonville	VII	29.92	91.05
Donaldsonville	VI	30.08	91.00
Allemamos	V	29.83	90.47
Berwick	V	29.68	91.22
Franklin	V	29.77	91.50
Morgan City	V	29.67	91.17
White Castle	V	30.18	91.17

No damage to well-built surface structures would be expected from events of this magnitude. As underground workings are less affected by earthquakes than surface structures it appears unlikely that damage would occur to the underground storage facilities.

B.2.1.2 Evolution of Salt Domes

Salt deposits are widely distributed throughout the United States. The salt basin along the Gulf Coast is characterized by the presence of some 500 salt domes (Figure B.2-4). These features have been intruded into the thick sequence of Cenozoic and Mesozoic strata deposited in the Gulf Coast geosyncline.

The "mother" salt, the Louann salt of Triassic-Jurassic age, underlies virtually the entire Gulf Coast basin. The average thickness of the salt is poorly known but probably ranges from 1000 to 5000 feet.

The Louann salt probably was deposited contemporaneously throughout a restricted basin on the continental margin that permitted at least partial evaporation of marine water and accumulation of evaporite deposits. It has been suggested that the deposits were formed by intermittent spills of Pacific Ocean waters into a sub-sea level graben during the breakup of the supercontinent Pangaea (Burk, 1975). The salt has been covered by a seaward-thickening wedge of sediment, reaching as much as 50,000 feet of thickness in deeper parts of the basin (Figure B.2-1).

The salt dome structures result from the difference in specific gravity between the bedded salt and overlying sediments. Upward movement of the salt is initiated when a sufficient thickness of sediments has been deposited over the salt bed. Viscoplastic flow is caused by the weight (pressure) of the sediment overburden and the increased temperatures of the geothermal gradient (Kupfer, 1970). While no drill has yet penetrated the bottom of a salt dome, the flanks of domes usually are thinly sheathed in a fine-grained material called "gouge," which is crushed rock resulting from the movement of the salt. Upturned, and radially and obliquely faulted strata generally encircle the domes, and thus provide excellent structural and stratigraphic traps for hydrocarbons (Halbouty, 1967). Essentially, the domes resemble gigantic plugs, tens of thousands of feet deep and commonly several square miles in area, that have risen forcibly upward into overlying strata (Figure B.2-9). At least some salt domes, particularly offshore or coastal domes, are generally considered dynamic features, which are still rising continuously at a small but finite rate on the order of 1 millimeter per year. The domes are simultaneously consumed at the upper surface through dissolution by ground water (Bodenlas, 1970).

As the salt rises, normal block faulting occurs in the overlying sediments. The increased permeability along the fault planes allows the relatively easy descent of meteoric water. This water combined with existing ground water leaches the upper leading edge of the salt dome, leaving various insoluble residues: primarily anhydrite, with minor amounts of dolomite, calcite, barite, pyrite, quartz, and sulfur (Halbouty,

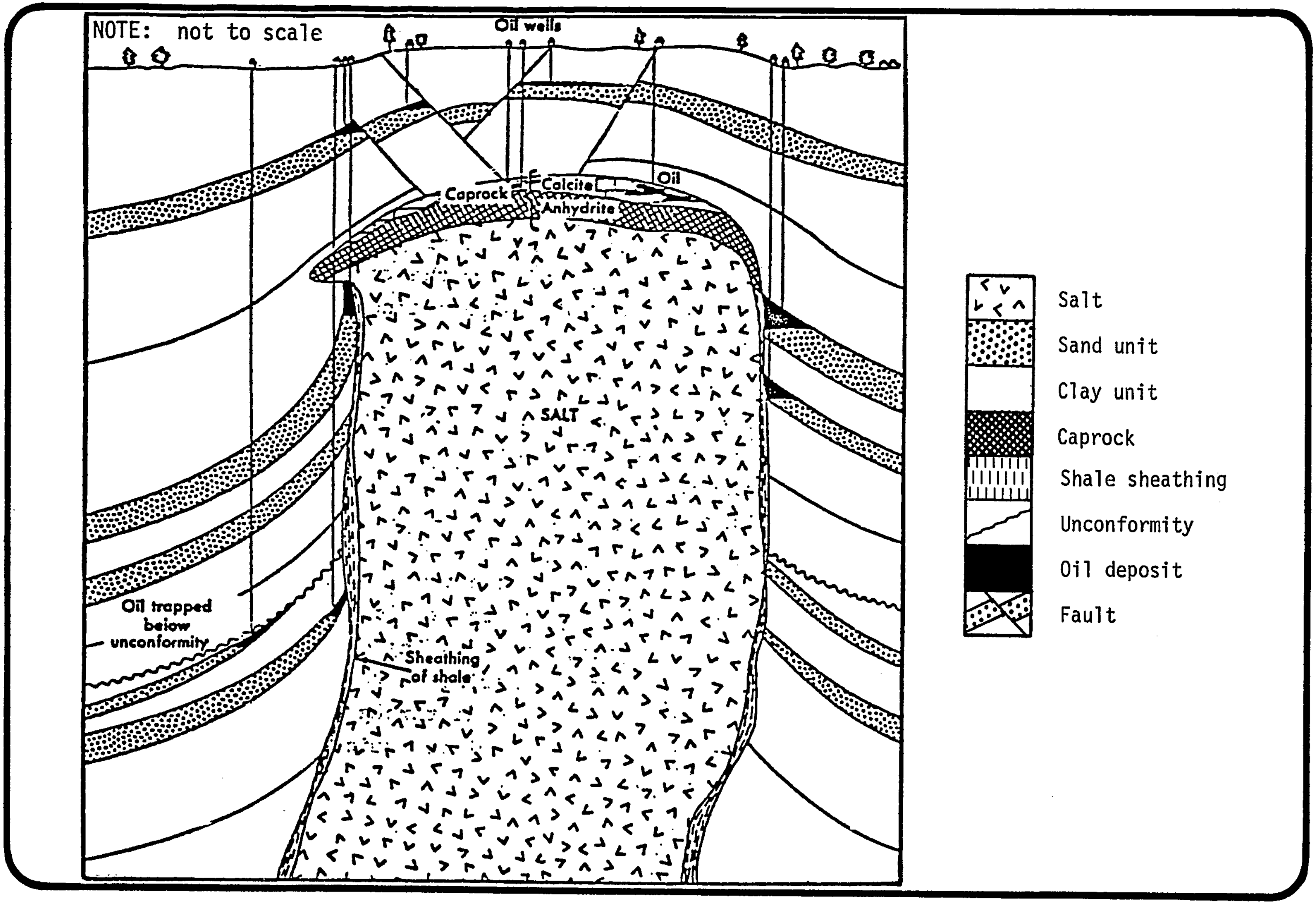


FIGURE B.2-9 Typical salt dome structure and related strata.

1967). The continuing rise of the salt further fractures the caprock, allowing deeper water percolation and additional salt leaching, and hydration of the upper anhydrite layers. The result is a thickening of the caprock and the formation of gypsum. These residues are the prime constituents of the salt dome caprock.

B.2.1.3 Soils and Surficial Sediments

In southern Louisiana the soils are developed primarily from alluvial materials laid down during the Oligocene and Pleistocene Epochs by coalescing deltas of the Mississippi River and its major distributaries. These deposits consist of sands, silts, and clays which comprise the natural levees, swamps, and prairies of the region. The soil associations that occur in the region have been classified and described by the U.S. Department of Agriculture Soil Conservation Service (1969, 1970a, 1970b, 1971, and 1972), Cockerham and others (1973), Lytle and others (1959), and Lytle and others (1960). The soil associations that occur in the vicinity of each proposed development are described in the sections of this report dealing with site land features.

The offshore areas consist primarily of silts and clayey silts near shore (Barrett and others, 1971). Farther offshore from the East Cote Blanche - Atchafalaya Bay area the bottom sediments are sands. At depths proposed for brine discharge, the bottom sediments are clayey silts (U.S. Department of Interior, 1977).

B.2.2 Water Environment

The Capline Group of SPR sites is located hydrologically between the Mississippi and Vermillion Rivers (Figure B.2-10). Most of this area is wetland. Dry land is found to the north, on the natural levees of the major watercourses, and occasionally on the dome sites. Surface water grades from fresh in the Gulf of Mexico. Annual precipitation is on the order of 54 to 64 inches. The Gulf Coast aquifer is the regional name for the fresh and slightly saline water bearing sands. Both water-table (unconfined) and artesian (confined) conditions exist in the area. Watertable aquifers are recharged directly by percolation of surface waters, while artesian aquifers are usually recharged by percolation at distant outcrops.

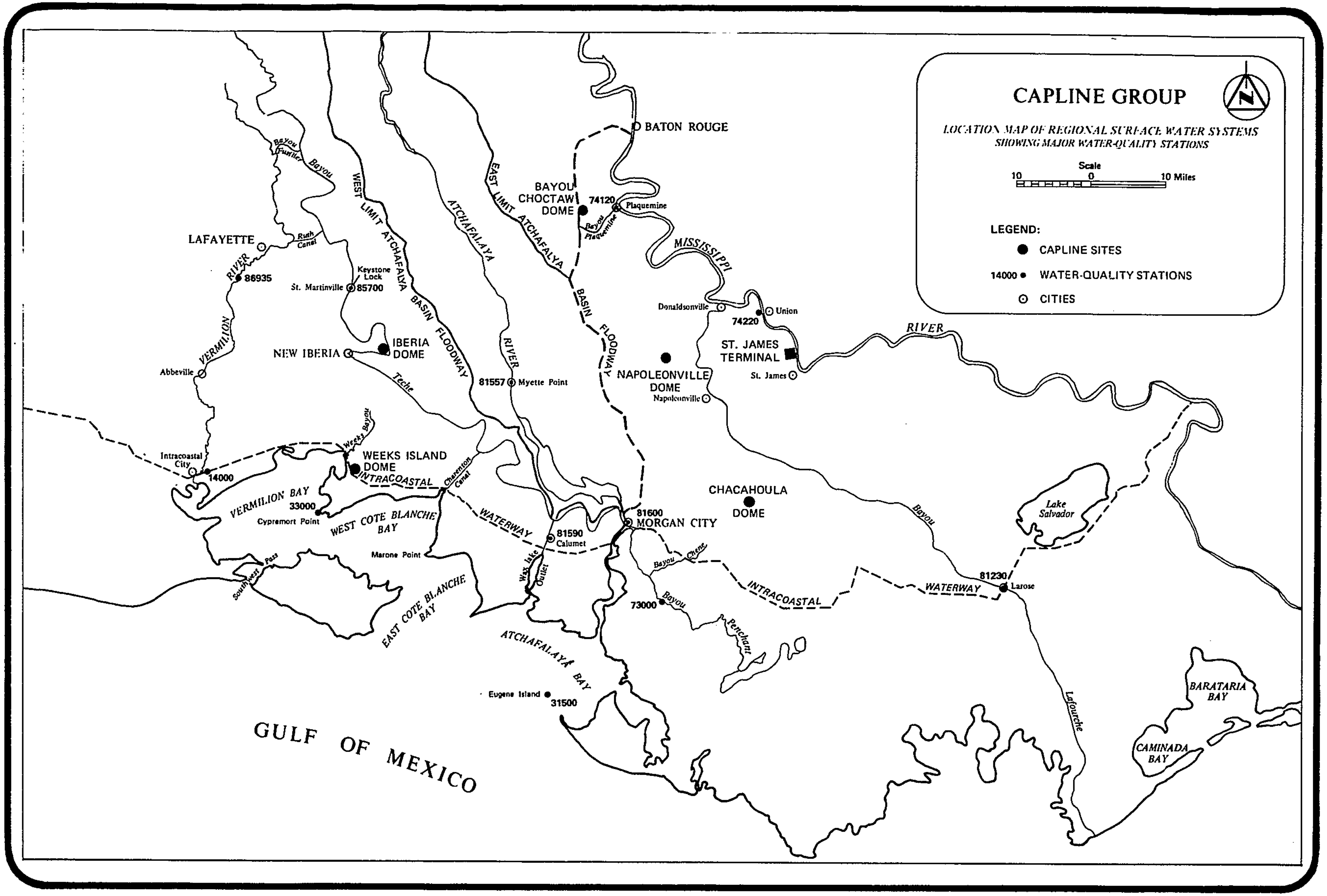


FIGURE B.2-10 Capline Group location map of regional surface water systems showing major water quality stations.

B.2.2.1 Surface Water Systems

The surface water system is comprised of a network of rivers, bayous, canals, and waterways with several small lakes. The surface water systems addressed here are shown in Figure B.2-10. These systems include the Mississippi River, Vermilion River, the Atchafalaya River and Floodway, Bayou Lafourche, Bayou Teche, Bayou Penchant, the Intracoastal Waterway, coastal estuaries and the nearshore Gulf of Mexico.

The descriptions of streamflow characteristics of the various surface water bodies which follow are based on the closest gaging station data (collected by the U.S. Geological Survey or U.S. Army Corps of Engineers). For the coastal bays, flow data collected by the Corps of Engineers and tidal stage and current predictions by the National Oceanographic and Atmospheric Administration were used.

Discussion of existing water-quality conditions is based on the most recent water-quality data measured at major sampling stations in the study region, as compared with applicable standards for the respective surface water segments on which the stations are located. Major sampling stations are listed in Table B.2-1 and their locations and stream segment numbers are shown in Figure B.2-10.

B.2.2.1.1 Regulations

The Louisiana Stream Control Commission issued revised Water Quality Criteria in April 1973 in order to comply with the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). Pertinent sections of the publication setting forth the criteria are presented below.

The general criteria are applicable to the surface waters of the State of Louisiana and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena.

Natural waters may, on occasion, have characteristics outside the limits established by these criteria; in which case these criteria do not apply. The criteria adopted herein relate to the condition of water as affected by waste discharges of man's activities.

TABLE B.2-1 Major water quality stations in the study region.

Station Number *	Stream Segment Agency I.D. No.	Latitude Longitude Deg-Min-Sec	Description (Stream, Location)	Number of Samples Reported Water Year, 1976
81557	010010	29-53-40 91-26-46	Atchafalaya R. at Myette Point	20
81600	010010	29-43 91-12	Lwr. Atchafalaya R. at Morgan City	21
81590	010060	29-42-09 91-22-07	Wax Lake Outlet at Calumet	21
31500	010070	29-22-15 91-23-15	Atchafalaya Bay at Eugene Island	21
86935	040120	30-09-45 92-03-20	Vermilion R. at State Hwy. 3073	12
85700	040190	30-04-15 91-49-45	Bayou Teche at Keystone Lock	12
33000	040230	20-41-10 91-53-30	Vermilion Bay at Cypremort Point	20
14000	040270	29-47-00 92-11-40	Intercoastal Waterway at Vermilion Lock (East)	20
74120	050020	30-17-00 91-13-21	Mississippi R. at Plaquemine	12
74220	050020	30-05-52 90-54-45	Mississippi R. at Union	12
93000	110210	29-35-40 91-09-30	Bayou Penchant at Bayou Chene	21
81230	110280	29-34-20 90-23-02	Bayou Lafourche at Larose	21

*Last 5 digits of the U. S. Geological Survey Station Number

These general criteria do not supersede specific exceptions to any one or more of the following if the exception is specifically stated in a specific water quality standard. All waters of the state shall be capable of supporting desirable diversified aquatic life.

(1) Aesthetics - The present and future use of all streams and water bodies considered in these criteria. The waters of the state shall be maintained in an aesthetically attractive condition and shall meet the generally accepted aesthetic qualifications.

(2) Color - True color shall not be increased to the extent that it will interfere with present usage and projected future use of the streams and water bodies.

(3) Floating, Suspended and Settleable Solids - Free from substances that will produce distinctly visible turbidity, solids or scum, nor shall there be any formation of slimes, bottom deposits or sludge banks attributable to waste discharges from municipal, industrial, or other sources including agricultural practices.

(4) Taste and Odor - Taste and odor producing substances shall be limited to concentrations in the water of the state that will not interfere with the production of potable water by reasonable water treatment methods, or impart unpalatable flavor to food fish, including shellfish, or result in offensive odors arising from the waters, or otherwise interfere with the reasonable use of the waters.

(5) Toxic Substances - None present in quantities that alone or in combination will be toxic to animal or plant life. In all cases, the level shall not exceed $^{1/10}$TLM. Bioassay techniques will be used in evaluating toxicity utilizing methods and species of the organisms suitable to the purpose at hand. In cases where the stream is used as a public water supply, the level of toxic substances shall not exceed the levels established by the United States Public Health Service drinking water standards latest edition.

(6) Oils and Greases - There shall be no free or floating oil or grease present in sufficient quantities to interfere with the designated uses, nor shall emulsified oils be present in sufficient quantities to interfere with the designated uses.

(7) Foaming or Frothing Materials - None of a persistent nature.

(8) Nutrients - The naturally occurring nitrogen-phosphorus ratio shall be maintained. On completion of detailed studies on the naturally occurring levels of the various macro and micro nutrients the state will establish numerical limits on nutrients where possible.

(9) Turbidity - There shall be no substantial increase in turbidity from ambient conditions due to waste discharges.

(10) Other Materials - Limits on other substances not specified in these revised water quality standards shall be in accordance with recommendations set by the Louisiana Stream Control Commission and/or the Louisiana Health and Social and Rehabilitation Services Administration for municipal raw water sources.

In addition to the general criteria, water quality standards have been established by the State of Louisiana specific to the various surface-water segments in the study area. Those standards are detailed in Table B.2-2.

The U.S.Environmental Protection Agency has established guidelines for various water uses (i.e., domestic raw water supply, propagation of aquatic life). These recommended criteria differ from standards in that they do not have legal standing, may be more stringent that geographical (states) standards, or may recommend different levels of the same pollutants for different use designations. The proposed EPA criteria for public water supply, marine water that supports aquatic life, and fresh water that supports aquatic life as discussed in Section B.2.2.1.2 are presented in Table B.2-3. By using Tables B.2-2 and B.2-3, the EPA criteria can be applied to the various segments of surface water.

Table B.2-4 contains a summary of water-quality data (maximum and minimum values) for the 12 major water-quality sampling stations applicable to the study region. These stations are included because at least an average of one sample per month was collected and tested for a significant number of parameters.

A general description of these regional water bodies is presented below. More detailed descriptions are included in the specific site sections which follow.

TABLE B.2-2 Specific water quality criteria - State of Louisiana.

AGENCY I.D. NUMBER	SEGMENT DESCRIPTION	WATER USES: PRIMARY CONTACT RECREATION	SECONDARY CONTACT RECREATION	PROPAGATION OF FISH AND WILDLIFE	DOMESTIC RAW WATER SUPPLY	CRITERIA: CHLORIDE (mg/l) Not to exceed	SULPHATE (mg/l) Not to exceed	DISSOLVED OXYGEN (mg/l) Not less than	pH RANGE	COLIFORM	TEMPERATURE °C	TOTAL DISSOLVED SOLIDS (mg/l) Not to exceed
	1. ATCHAFALAYA BASIN											
010010	Atchafalaya River - Headwaters (Barbre Landing) to Mile 118 (1.2 miles below mouth of Bayou Boeuf) (Includes Grand Lake and Six Mile Lake)	X	X	X	X	65	70	5.0	6.5 to 8.5	200	33	440
010020	West Atchafalaya Borrow Pit Canal (St. Landry and St. Martin Parishes)	X	X	X		100	75	5.0	6.0 to 8.5	200	32	500
010030	Atchafalaya River - Mile 118 to Atchafalaya Bay (Tidal)	X	X	X		--	--	4.0	6.5 to 9.0	200	35	--
010040	Intracoastal Waterway (North-South) - Bayou Sorrel to Morgan City		X	X		150	75	5.0	6.0 to 8.5	1000	32	500
010050	Intracoastal Waterway (East-West) - Bayou Boeuf Locks to Wax Lake Outlet		X	X		150	75	5.0	6.0 to 8.5	1000	32	500
010060	Wax Lake Outlet (Tidal)		X	X		--	--	4.0	6.5 to 9.0	1000	35	--
010070	Atchafalaya Bay (Tidal)		X	X		--	--	5.0	6.5 to 9.0	70	35	--
	2. BARATARIA BASIN											
020010	Bayou Verret (Includes Bayou Chevereuil, Bayou Citamon and Grand Bayou, etc.)	X	X	X		1000	500	5.0	6.0 to 8.5	200	32	2000
	4. MERMENTAU - VERMILION-TECHE BASIN											
040120	Vermilion River - Origin to Intracoastal Waterway	X	X	X		230	36	5.0	6.0 to 8.5	200	32	350
040130	Vermilion River - Intracoastal Waterway to Vermilion Bay (Tidal)		X	X		--	--	4.0	6.5 to 9.0	1000	35	--
040140	Bayou Tigre - Origin to Vermilion Bay (Tidal)		X	X		--	--	4.0	6.5 to 9.0	1000	35	--
040150	Lake Peigneur (Tidal)		X	X		--	--	4.0	6.0 to 8.5	--	35	--
040190	Bayou Teche - Headwaters to Keystone Locks and Dam	X	X	X	X	43	32	5.0	6.0 to 8.5	200	32	220
040200	Spanish Lake	X	X	X		250	75	5.0	6.0 to 8.5	200	32	500
040210	Bayou Teche - Keystone Locks and Dam to Charenton Canal	X	X	X	X	80	50	5.0	6.0 to 8.5	200	32	350
040213	Tete Bayou	X	X	X	X	80	50	5.0	6.0 to 8.5	200	32	350
040214	Loreauville Canal	X	X	X	X	80	50	5.0	6.0 to 8.5	200	32	350
040215	Lake Fausse Point (Including Dauterive Lake)	X	X	X	X	80	50	5.0	6.0 to 8.5	200	32	350
040216	Charenton Canal - Lake Fausse Point to Bayou Teche	X	X	X	X	80	50	5.0	6.0 to 8.5	200	32	350
040220	Bayou Teche - Charenton Canal to Wax Lake	X	X	X	X	125	68	5.0	6.0 to 8.5	200	32	500
040225	Charenton Canal - Bayou Teche to Intracoastal Waterway	X	X	X		250	75	5.0	6.0 to 8.5	200	32	500

TABLE B.2-2 continued.

AGENCY I.D. NUMBER	SEGMENT DESCRIPTION	WATER USES: PRIMARY CONTACT RECREATION	SECONDARY CONTACT RECREATION	PROPAGATION OF FISH AND WILDLIFE	DOMESTIC RAW WATER SUPPLY	CRITERIA: CHLORIDE (mg/l) Not to exceed	SULPHATE (mg/l) Not to exceed	DISSOLVED OXYGEN (mg/l) Not less than	pH RANGE	COLIFORM	TEMPERATURE °C	TOTAL DISSOLVED SOLIDS (mg/l) Not to exceed
040226	Charenton Canal - Intracoastal Waterway to West Cote Blanche Bay (Tidal)	X	X	X		--	--	4.0	6.5 to 9.0	200	35	--
040230	Vermilion Bay (Tidal)		X	X		--	--	4.0	6.5 to 9.0	70	35	--
040240	West Cote Blanche Bay (Tidal)		X	X		--	--	4.0	6.5 to 9.0	70	35	--
040250	East Cote Blanche Bay Waterway (Tidal)		X	X		--	--	4.0	6.5 to 9.0	70	35	--
040270	Intracoastal Waterway (East-West) - Vermilion Lock		X	X		--	--	4.0	6.5 to 9.0	1000	35	--
	5. <u>MISSISSIPPI BASIN</u>											
050020	Mississippi River: From Old River Control Structure to Huey P. Long Bridge above New Orleans		X	X	X	75	120	5.0	6.5 to 9.0	2000	32	400
	11. <u>TERREBONNE BASIN</u>											
110010	Lake Verret	X	X	X		100	75	5.0	6.0 to 8.5	200	32	350
110020	Lake Palourde	X	X	X	X	100	75	5.0	6.0 to 8.5	200	32	300
110030	Bayou Boeuf - Lake Palourde to Morgan City	X	X	X	X	100	75	5.0	6.0 to 8.5	200	32	300
110040	Intracoastal Waterway (East-West) - Morgan City to Larose	X	X	X	X	250	75	5.0	6.0 to 8.5	200	32	500
110050	Bayou Black - Intracoastal Waterway to Houma	X	X	X	X	250	75	5.0	6.0 to 8.5	200	32	500
110060	Bayou Terrebonne - Thibodaux to Bourg	X	X	X		230	55	5.0	6.0 to 8.5	200	32	875
110100	Bayou Choctaw - Headwaters to Intracoastal Waterway		X	X		250	75	5.0	6.0 to 8.5	1000	32	500
110110	Bayou Grosse Tete - Headwaters to Intracoastal Waterway		X	X		25	25	5.0	6.0 to 8.5	1000	32	200
110120	Bayou Plaquemine - Headwaters to Intracoastal Waterway		X	X		250	75	5.0	6.0 to 8.5	1000	32	500
110130	Upper Grand River and Lower Flat River - Headwaters to Intracoastal Waterway		X	X		250	75	5.0	6.0 to 8.5	1000	32	500
110140	Intracoastal Waterway (North-South) - Port Allen to Bayou Sorrel		X	X		250	75	5.0	6.0 to 8.5	1000	32	500
110150	Lower Grand River and Bell River - Bayou Sorrel to Lake Palourde (Includes Bayou Goula and Grand Bayou)		X	X		250	75	5.0	6.0 to 8.5	1000	32	500
110190	Bayou du Large - Houma to Bay Junop (Tidal)	X	X	X		--	--	4.0	6.5 to 9.0	70	35	--
110200	Lake Hache, Lake DeCade, Lost Lake and Four-League Bay (Tidal)		X	X		--	--	4.0	6.5 to 9.0	70	35	--
110210	Bayou Penchant and Lake Penchant - Morgan City to Lake DeCade (Scenic River) (Tidal)	X	X	X		--	--	4.0	6.5 to 9.0	70	35	--
110220	Caillou Bay		X	X		--	--	5.0	6.5 to 9.0	70	35	--
110280	Bayou Lafourche - Donaldsonville to Larose	X	X	X		70	55	5.0	6.0 to 8.5	200	32	50
110290	Bayou Lafourche - Larose to Gulf of Mexico (Tidal)	X	X	X		--	--	4.0	6.5 to 9.0	200	35	--
	12. <u>GULF OF MEXICO</u>											
	Gulf of Mexico and other open coastal waters not specifically identified in the tables	X	X	X		--	--	5.0	6.5 to 9.0	70	32	--

TABLE B.2-3 Proposed EPA numerical criteria for water quality.

Parameter	Public Water Supply Intake (μg/l)	Marine Water Constitutents (Aquatic Life) (μg/l)	Freshwater Aquatic Life (μg/l)
Arsenic	50	50	---
Cadmium	10	10	30 (hardness >100 μg/l) 4 (hardness <100 μg/l)
Chromium	50	100	50
Copper	1000	50	1/10 LC 50
Lead	50	50	30
Mercury	2.0	1.0	0.2
Nickel	---	100	1/50 LC 50
Zinc	5000	100	5/1000 LC 50
Cyanides	200	10	1/20 LC 50 (.005 μg/l)
Aldrin	1	5.5	0.01
DDT	50	0.6	0.002
Dieldrin	1	5.5	0.005
Chlorodane	3	---	0.04
Endrin	0.2	0.6	0.002
Heptachlor	0.1	8	0.01
Heptachlor epoxide	0.1	---	---
Lindane	4	5	0.02
Phenols	1.0	---	1/20 LC 50 (0.1 μg/l)
Oil and Grease	---	1. Not detectable as a visible film, sheen discoloration of the surface, or by odor. 2. Does not cause tainting of fish or invertebrates or damage to biota. 3. Does not form an oil deposit on the shores or bottom of the receiving body of water.	1. None visible on surface. 2. 1000 μg/kg hexane extractable substances in sediments. 3. 1/20 LC 50.
pH	---	6.5 - 8.5	6 - 9
Ammonia	---	400	1/20 LC 50 (20 μg/l)
Hydrogen Sulfide	---	10	---
Sulfides	---	---	2
Dissolved Oxygen	---	6.0 μg/l	4.0 μg/l (>31°C)
Phosphorus	---	0.1	---
Diazinon	---	---	0.009
Malathion	---	---	0.008
Parathion	---	---	0.001
Suspended and settleable solids	---	---	80 μg/l
Turbidity and light penetration	---	---	10% change in compensation pT
Color	---	---	10% change in compensation pT
Toxaphene	5	0.10	0.01

Source: "Proposed Criteria for Water Quality", Vol. 1, U.S. Environmental Protection Agency, 1973.

TABLE B.2-4 Water quality data for the twelve major sampling stations.

	ATCHAFALAYA RIVER (MAIN CHANNEL) AT MYETTE POINT		LOWER ATCHAFALAYA RIVER AT MORGAN CITY		WAX LAKE OUTLET AT CALUMET		ATCHAFALAYA BAY AT EUGENE ISLAND		VERMILION RIVER AT STATE HWY 3073 NEAR LAFAYETTE		BAYOU TECHE AT KEYSTONE LOCK NEAR ST. MARTINVILLE	
Station No.	81557		81600		81590		31590		31500		86935	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Dielorin (ug/l)	.01	0	.01	0	.01	0	2.01	0	.01	0	0	-
Endrin (ug/l)	.01	0	.01	0	.01	0	<.01	0	0	0	0	-
Ethion (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Heptachlor (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Heptach. Epoxide (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Lindane (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Malathion (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Methylparathion (ug/l)	.02	0	.01	0	.01	0	0	0	0	0	0	-
Methyltrithion (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Parathion (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
P.C.S. (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
P.C. Naphthalenes (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Toxaphene (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Trithion (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
2, 4-D (ug/l)	.05	.04	.03	0	.04	0	.03	.03	1.3	0	0	-
2, 4, 5-T (ug/l)	.03	.03	.02	0	.03	0	.02	.02	.25	0	0	-
Silvex (ug/l)	0	0	0	0	0	0	0	0	.29	0	0	-
Arsenic (As) (ug/l)	3	1	4	1	5	2	11	1	-	-	3	-
Dis. Arsenic (As) (ug/l)	2	0	2	0	2	0	2	0	5	4	2	-
Tot. Cadmium (Cd) (ug/l)	2	0	2	0	3	0	3	<0	-	-	0	-
Dis. Cadmium (Cd) (ug/l)	2	0	2	0	2	0	0	0	3	0	0	-
Tot. Chromium (Cr) (ug/l)	20	6	20	0	30	<10	60	<10	-	-	<10	-
Hex. Chromium (Cr_6) (ug/l)	0	0	0	0	0	0	0	0	0	0	0	-
Tot. Copper (Cu) (ug/l)	6	4	11	3	12	4	13	3	-	-	8	-
Dis. Copper (Cu) (ug/l)	6	1	7	2	6	1	10	0	12	5	8	-
Tot. Lead (Pb) (ug/l)	8	0	12	0	14	0	14	0	-	-	3	-
Dis. Lead (Pb) (ug/l)	8	0	2	0	2	0	2	0	3	0	0	-
Tot. Mercury (Hg) (ug/l)	.6	0	.3	0	1.5	0	.9	0	.9	.3	0	-
Sus. Mercury (Hg) (ug/l)	.2	0	.3	0	1.2	0	.6	0	-	-	-	-
Dis. Mercury (Hg) (ug/l)	.2	0	.1	0	.3	0	.3	0	-	-	0	-
Tot. Nickel (Ni) (ug/l)	13	2	16	3	22	3	20	3	-	-	-	-
Dis. Nickel (Ni) (ug/l)	3	0	5	0	5	0	4	0	-	-	-	-
Tot. Zinc (Zn) (ug/l)	140	0	80	10	80	20	90	10	-	-	30	-
Dis. Zinc (Zn) (ug/l)	20	0	20	0	20	0	20	0	30	7	10	-
Dis. Silica (SiO_2) (mg/l)	-	-	-	-	-	-	-	-	19	8	14	7
Dis. Sodium (Na) (mg/l)	-	-	-	-	-	-	-	-	46	10	26	8
Dis. Potassium (K) (mg/l)	-	-	-	-	-	-	-	-	4.5	2.6	3.8	2.0

	VERMILION BAY AT CYPREMORT POINT		INTERCOASTAL WATERWAY AT VERMILION LOCK (EAST)		MISSISSIPPI RIVER AT PLAQUEMINE		MISSISSIPPI RIVER AT UNION		BAYOU PENCHANT AT BAYOU CHENE		BAYOU LAFOURCHE AT INTERCOASTAL WATER AT LAROSE	
Station No.	85700		33000		14000		74220		93000		21230	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Dielorin (ug/l)	0	0	<.01	0	-	-						
Endrin (ug/l)	0	0	0	0	-	-	-	-	0	0	<.01	0
Ethion (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Heptachlor (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Heptach. Epoxide (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Lindane (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Malathion (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Methylparathion (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Methyltrithion (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Parathion (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
P.C.S. (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
P.C. Naphthalenes (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Toxaphene (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
Trithion (ug/l)	0	0	0	0	-	-	-	-	0	0	0	0
2, 4-D (ug/l)	0	0	.25	0	-	-	-	-	.04	.02	0	0
2, 4, 5-T (ug/l)	0	0	.08	0	-	-	-	-	.02	.01	0	0
Silvex (ug/l)	.01	0	0	0	-	-	-	-	.02	.01	.07	.04
Arsenic (As) (ug/l)	3	1	12	1	4	2	8	2	6	1	6	1
Dis. Arsenic (As) (ug/l)	2	0	2	0	2	1	2	1	3	0	2	1
Tot. Cadmium (Cd) (ug/l)	6	0	3	0	1	0	2	0	3	0	12	0
Dis. Cadmium (Cd) (ug/l)	1	0	0	0	1	0	0	0	1	0	0	0
Tot. Chromium (Cr) (ug/l)	30	<10	40	<10	30	0	30	0	30	<10	30	<10
Hex. Chromium (Cr_6) (ug/l)	0	0	0	0	0	0	0	0	0	0	0	0
Tot. Copper (Cu) (ug/l)	9	2	14	1	65	4	27	4	9	3	18	4
Dis. Copper (Cu) (ug/l)	5	1	7	1	5	2	6	0	6	1	10	1
Tot. Lead (Pb) (ug/l)	12	0	18	3	12	0	16	0	20	0	18	3
Dis. Lead (Pb) (ug/l)	0	0	7	0	0	0	3	0	3	0	4	0
Tot. Mercury (Hg) (ug/l)	.3	0	.6	0	.6	0	.4	0	.9	0	1.1	0
Sus. Mercury (Hg) (ug/l)	.1	0	.3	0	.5	0	.8	0	.8	0	.9	0
Dis. Mercury (Hg) (ug/l)	.2	0	.5	0	.3	0	.3	0	.2	0	.5	0
Tot. Nickel (Ni) (ug/l)	21	0	16	2	24	3	13	4	15	0	10	5
Dis. Nickel (Ni) (ug/l)	4	0	4	0	2	0	2	0	7	0	6	0
Tot. Zinc (Zn) (ug/l)	100	10	90	10	130	20	90	10	80	10	110	10
Dis. Zinc (Zn) (ug/l)	20	0	20	0	40	0	20	0	20	0	50	0
Dis. Silica (SiO_2) (mg/l)	-	-	-	-	6.8	1.0	6.8	1.1	-	-	-	-
Dis. Sodium (Na) (mg/l)	-	-	-	-	35	14	29	12	-	-	-	-
Dis. Potassium (K) (mg/l)	-	-	-	-	3.4	2.3	3.3	2.3	-	-	-	-

TABLE B.2-4 continued.

Station No.	ATCHAFALAYA RIVER (MAIN CHANNEL) AT MYETTE POINT 81557		LOWER ATCHAFALAYA RIVER AT MORGAN CITY 81600		WAX LAKE OUTLET AT CALUMET 81590		ATCHAFALAYA BAY AT EUGENE ISLAND 31500		VERMILION RIVER AT STATE HWY 3073 NEAR LAFAYETTE 86935		BAYOU TECHE AT KEYSTONE LOCK NEAR ST. MARTINVILLE 85700		VERMILION BAY AT CYPREMORT POINT 33000		INTERCOASTAL WATERWAY AT VERMILION LOCK (EAST) 14000		MISSISSIPPI RIVER AT PLAQUEMINE 74120		MISSISSIPPI RIVER AT UNION 74220		BAYOU PENCHANT AT BAYOU CHENE 93000		BAYOU LAFOURCHE AT INTERCOASTAL WATER AT LAROSE 81230	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Dis. Iron (Fe) (ug/l)	80	0	110	0	90	0	70	0	-	-	70	-	220	0	100	10	50	0	230	0	70	0	210	0
Dis. Calcium (Ca) (mg/l)	47	28	47	27	45	27	130	28	28	10	24	8	120	35	81	8	44	33	43	34	40	15	62	23
Dis. Magnesium (Mg) (mg/l)	21	8.6	76	7.9	19	8.5	300	8.5	11	3	10	2.3	310	18	180	4	14	9	14	9.7	13	5.3	100	8.3
Bicarbonate (HCO_3) (mg/l)	152	93	146	85	158	87	141	90	40	47	123	36	95	63	110	34	145	101	142	98	128	63	130	86
Carbonate (CO_3) (mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0
Dis. Sulfate (SO_4) (mg/l)	73	27	160	31	70	34	830	30	15	5	16	5	620	83	360	9	68	42	79	42	54	15	220	14
Dis. Chloride (Cl) (mg/l)	78	16	1200	20	72	9.1	4400	21	66	13	33	9	4900	470	2800	35	42	17	33	14	60	19	4200	23
Tot. Nitrate (N) (mg/l)	1.1	.48	1.3	.34	2.2	.35	1.5	0	.65	.13	.35	.12	.81	0	.48	0	2.2	.47	2.1	.49	1.2	0	.90	.20
Tot. Nitrite (N) (mg/l)	.05	.01	.06	0	.08	0	.06	0	.09	.04	.04	.01	.01	0	.09	0	.03	0	.04	0	.08	0	.06	.01
Tot. Nitrate/ite (N) (mg/l)	1.1	.49	1.5	.38	2.2	.38	1.5	.01	1.0	.18	.49	.14	.82	0	.56	0	-	-	-	-	1.2	0	.92	.21
Dis. Kjet. Nit. (N) (mg/l)	.95	.26	.78	.27	1.8	.28	..95	.53	-	-	.97	.26	1.1	.23	1.4	.41	.86	.36	.30	.34	.99	.30	1.2	.42
Tot. Phosphorus (P) (mg/l)	.76	.09	2.7	.09	5.9	.08	1.7	.09	1.2	.3	.51	.12	1.7	.05	6.1	.05	.32	.06	.38	.09	2.3	.11	5.6	.09
Sus. Solids (mg/l)	184	8	862	11	412	17	310	26	-	-	-	-	292	10	540	1	216	16	332	10	288	9	124	9
Set. Matter (ml/l/hr)	<1	<1	<1	<1	<1	<1	<1	<1					<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Hardness (Ca, Mg) (mg/l)	200	110	430	100	190	100	1600	110	120	35	100	30	1600	230	950	36	170	120	170	130	150	62	570	89
Non-Car. Hardness (mg/l)	87	25	340	25	90	10	1500	32	7	0	13	0	1500	160	900	5	52	36	62	35	52	10	480	3
Sp. Conductance (M.MHOS)	607	273	4150	274	744	274	13K	281	1000	20	414	72	14K	1770	8870	396	493	317	454	304	504	195	4840	323
Ph (Units)	8.2	7.6	8.2	7.4	8.2	7.5	8.3	7.7	7.6	6.7	7.7	6.9	8.2	7.4	8.1	7.3	8.2	7.0	8.2	7.1	8.5	7.5	8.2	7.4
Temperature (Deg C)	25	7	25	6	25.5	7	27	7	32	6	32	18	28	9	27	11	29	5	30	4	28	6	30	11
Color (Pt-Co Units)	50	3	45	5	50	5	35	3	100	30	100	30	30	3	80	15	40	5	50	5	55	5	120	15
Turbidity (JTU)	65	15	125	15	130	15	100	8	200	10	55	9	55	3	210	6	130	4	110	6	120	15	110	30
Dis. Oxygen (mg/l)	10.4	5.4	11.0	7.1	10.4	7.0	10.8	7.1	12.2	0	-	-	10.3	7.7	9.7	6.2	11.7	5.9	11.4	7.5	11.3	7.4	6.8	5.7
Chem. Ox. Dem. (mg/l)	45	10	350	5	30	5	310	5	-	-	-	-	130	35	180	4	20	3	28	8	39	9	39	11
B.O.D. (5-day) (mg/l)	7.3	.5	4.3	.4	6.8	.3	7.4	.2	6.9	.8	3.2	.9	4.2	.7	3.7	.8	5.2	.5	5.2	.6	7.6	1.5	12	.3
Coliform (Col./100 mg)	2500	25	12K	140	3000	40	2300	60	-	-	-	-	3900	<5	4100	80	5500	1300	8800	300	3200	20	7500	430
Fecal Col. (Col./100 ml)	340	<5	3200	<5	330	<5	230	<5	34K	550	2100	<5	100	<5	500	<5	1400	<5	1000	<5	250	<5	4000	27
T.O.C. (mg/l)	21	3.2	9.6	2.2	12	1.0	14	3.2	17	6	-	-	13	1	20	4.5	15	3.8	13	3.3	29	3.6	25	3.4
Cyanide (Cn) (mg/l)	0	.0	0	0	0	0	0	0	-	-	-	-	0	0	.01	0	0	0	.01	0	0	0	0	0
Phenols (ug/l)	13	0	7	0	9	9	8	0	-	-	-	-	7	0	14	0	9	0	3	0	150	0	10	0
Oil/Grease (mg/l)	3	0	2	0	2	0	53	0	-	-	-	-	2	0	1	0	2	0	2	0	1	0	13	0
Aldrin (μg/l)	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	-	-	-	-	0	0	0	0
Chlordane (μg/l)	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	-	-	-	-	0	0	0	0
DDD (μg/l)	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	-	-	-	-	0	0	0	0
DDE (μg/l)	0	0	0	0	0	0	0	0	0	0	<.01	-	0	0	0	0	-	-	-	-	<.01	0	0	0
DDT (ug/l)	<.01	0	.01	0	.02	0	0	0	.01	0	0	-	0	0	0	0	-	-	-	-	.09	0	.11	0
Diazinon (ug/l)	.29	0	.03	0	.01	0	.32	0	.05	.01	.02	-	.01	0	.02	0	-	-	-	-	<.01	0	<.01	0

TABLE B.2-4 continued.

Station No.	ATCHAFALAYA RIVER (MAIN CHANNEL) AT MYETTE POINT 81557		LOWER ATCHAFALAYA RIVER AT MORGAN CITY 81600		WAX LAKE OUTLET AT CALUMET 81590		ATCHAFALAYA BAY AT EUGENE ISLAND 31500		VERMILION RIVER AT STATE HWY 3073 NEAR LAFAYETTE 86935		BAYOU TECHE AT KEYSTONE LOCK NEAR ST. MARTINVILLE 85700	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Alkalinity (Ca Co_3) (mg/l)	-	-	-	-	-	-	-	-	115	39	-	-
Dis. Fluoride (F) (mg/l)	-	-	-	-	-	-	-	-	.3	.2	.3	.1
Dis. Solids (mg/l)	-	-	-	-	-	-	-	-	241	84	182	70
CO_2 (mg/l)	-	-	-	-	-	-	-	-	16	3	-	-

Station No.	VERMILION BAY AT CYPREMORT POINT 33000		INTERCOASTAL WATERWAY AT VERMILION LOCK (EAST) 14000		MISSISSIPPI RIVER AT PLAQUEMINE 74120		MISSISSIPPI RIVER AT UNION 74220		BAYOU PENCHANT AT BAYOU CHENE 93000		BAYOU LAFOURCHE AT INTERCOASTAL WATER AT LAROSE 81230	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Alkalinity (Ca Co_3) (mg/l)	-	-	-	-	119	83	116	80	-	-	-	-
Dis. Fluoride (F) (mg/l)	-	-	-	-	.6	.2	.9	.2	-	-	-	-
Dis. Solids (mg/l)	-	-	-	-	264	184	264	166	-	-	-	-
CO_2 (mg/l)	-	-	-	-	17	1.1	13	1.1	-	-	-	-

NOTES: (1) Zero means lab tests resulted in zero concentration.
(2) Dash means no determination was made.
(3) Where a value is listed under "Max", and a dash is listed under "Min", only one sample was tested for that parameter.
* Source: "Water Resources Data for Louisiana - Water Year 1976", U.S. Geological Survey Water-Data Report LA-76-2.

B.2.2.1.2 Water Bodies

Mississippi River

The Mississippi River below Baton Rouge is the major fresh surface water body in the region.

The U.S. Army Corps of Engineers maintains gaging stations at Baton Rouge (Gage 01160 at Mile Point 228.4) and Donaldsonville (Gage 01120 at Mile Point 175.4). Streamflow is relatively constant over this 53 mile reach. The highest flow rate observed over the 98 years of record was 1,473,000 cubic feet per second, (cfs); the minimum flow rate over the same period was 73,700 cfs (U.S. Army Corps of Engineers, 1975c). The average flow rate for the period October 1973 through September 1974 was 925,000 cfs. The maximum flow rate during that period was 1,160,000 cfs and the minimum was 398,000 cfs. Highest flow conditions typically occur during January, while September and October usually experience the lowest flow conditions. Maxim flows experienced in this reach of the river, and below, are somewhat less than those experienced at the USGS gaging station at Vicksburg, Mississippi (maximum flow rate recorded 2,080,000 cfs) due to numerous distributory streams and overflow points between Vicksburg and Baton Rouge.

Applicable water-use designations for this 53-mile reach of the Mississippi River are secondary contact recreation, propagation of fish and wildlife and domestic raw water supply. Water-quality stations at Plaquemine and Union (Table B.2-1) are shown on Figure B.2-10. Data collected during water year 1976 (October 1975 to September 1976) indicate that standards are met at these two stations with the following exceptions: maximum suspended solids exceeded the EPA freshwater aquatic-life standard by more than a factor of four (332 as compared to 80 mg/l); cyanide exceeded the standard by a factor of two; and mercury by a factor of three. Maximum phenol concentration met the aquatic-life standard, but was nine times greater than that allowed under proposed EPA Public Water-Supply Intake standards. Also, the Louisiana standard for total coliform bacteria was exceeded by more than a factor of four at Union and a factor of nearly three at Plaquemine. It should be noted that no test results were reported for many of the chemical standards at these Mississippi River stations.

The EPA has proposed the sediment quality standards which are compared with chemical analyses of bottom sediments at sampling stations in each area of the study. Sediment along the Mississippi River is generally comprised of fine sand (100 to 250 micrometers). Analyses of sediment samples for total Kjeldahl nitrogen, chemical oxygen demand, and oil and grease, approach the upper limits of established EPA guidelines. These high concentrations result from heavy use of the navigable waterways, and the agricultural and industrial development of the drainage area.

Vermilion River

A smaller but also important navigable waterway is the Vermilion River (Figure B.2-10).

This river, a major source of freshwater discharge into the western portion of the Vermilion Bay Complex discharges a calculated average of 160 cfs into the northwestern part of the Vermilion Bay. Large commercial vessels dock at the port facilities located at Intracoastal City, Louisiana. Other important ports on the Vermilion River are Abbeville and Lafayette, Louisiana. Navigable depths along the Vermilion River range from its outlet to Vermilion Bay to 10 feet in the vicinity of the Intracoastal Waterway, decreasing to five feet upstream at mile 50 near Pinhook Bridge (U.S. Army Corps of Engineers, 1977). The river is also utilized by commercial and sport fishermen.

The major water-quality station on the Vermilion River (Figure B.2-10) nearest to the study region is at State Highway 3073 near Lafayette, Louisiana (Table B.2-1). The Vermilion River, from its origin to the Intracoastal Waterway (ICW) is designated for primary and secondary contact recreation and propagation of fish and wildlife. Comparing applicable standards to measured water quality during water year 1976 reveals that the State of Louisiana standards for dissolved oxygen was violated; a minimum dissolved oxygen content of zero was measured. Also, while total coliform was not reported, fecal coliform exceeded the total-coliform standard by factors ranging from 2.8 to 170. Proposed EPA freshwater aquatic-life standards were exceeded for DDT, diazinon and mercury. Other species were either not reported, or they met standards. Industrial and domestic discharges into the Vermilion River have been cited as possible causes for the 1973 closing of the oyster reefs in Vermilion Bay to commercial fishermen.

Atchafalaya River

The Atchafalaya is a distributary stream of the Mississippi River and is maintained by the U.S. Army Corps of Engineers for navigation and flood control purposes (Figure B.2-10). The Atchafalaya is used to divert water from the Mississippi during periods of high flooding, and to divert additional flow from the Red River to the north. The Atchafalaya has an average discharge of 149,824 cfs. There is a deep water port on the river at Morgan City, below which the Atchafalaya has a navigable depth of from 14 to 18 feet (U.S. Army Corps of Engineers, 1977).

Three major water-quality sampling stations exist in the Atchafalaya Basin (Figure B.2-10): Atchafalaya River at Myette Point, Lower Atchafalaya River at Morgan City, and at Calumet on a distributary known as Wax Lake Outlet (Table B.2-1). The first two are located on segments designated for all four of the state's use classifications (Table B.2-1). Wax Lake Outlet, considered to be in a tidal area, is designated for secondary contact recreation and aquatic-life uses.

Comparison of reported water quality for water year 1976 at the Atchafalaya River stations, with applicable standards, shows the following violations. The state standards for sulfate, chloride, and coliform bacteria were exceeded at both stations for at least some, but not all of the time. In addition, proposed EPA freshwater aquatic-life standards for suspended solids, diazonin, endrin, and mercury were exceeded at both stations at least part of the time, and for DDT at the Lower Atchafalaya station part of the time. Also, the porposed EPA water-supply standard for phenol was exceeded at both stations part of the time. All other measured constituents met applicable standards. One parameter that appears in the standards, total dissolved solids, was not reported. Table B.2-5 presents proposed EPA sediment quality standards.

TABLE B.2-5 Sediment quality in the Capline region.

Parameter	Proposed Upper Limit for Sediment (mg/kg)	Vermilion River at S.H. 3073 86935[a]	Mississippi River at Indicated Mile Point[b] 212	224	228.5	Bayou Plaquemine[c]	Intercoastal Waterway (10 mi. south of Bayou Plaquemine)
Lead (Pb)	50	<10	<10	<10	30	122	4.6
Mercury (Hg)	1	0.1	0	0	0.1	80	4.6
Zinc (Zn)	50	70	14	11	44	153	34
C.O.D.	50K	--	3100	1000	22K	2000	1300
TKN	1000	--	370	84	730	1000	1300
Oil and Grease	1500	--	1000	1000	<1000	9100	1000
Sulfide	1700	--	--	--	--	--	--

[a]Maximum April 1976.

[b]Maximum March/April 1975.

[c]Maximum March 1975.

Water quality for Wax Lake Outlet showed only minor departures from standards. The State standard for coliform was exceeded part of the time. Also, the proposed EPA marine aquatic-life standards for phosphorus and mercury were exceeded part of the time. All other reported measurements met these standards.

The Atchafalaya River is a major source of sediment in the Vermilion West and East Cote Blanche-Atchafalaya Bay system. The sedimentary characteristics of these and other coastal bays are presented in Table B.2-6.

Bayou Lafourche

A large number of communities rely on Bayou Lafourche for domestic and industrial water supply.

This bayou came into existence circa 1300 A.D. when the Mississippi River changed course at what is now Donaldsonville, Louisiana (Figure B.2-10). This section of the Mississippi is presently blocked off from the river by a levee, and is called Bayou Lafourche. The bayou is supplied with water by a pumping station located at Donaldsonville which extracts water from the Mississippi River. This pumpage provides the total flow at Bayou Lafourche except for small amounts of local storm water. The average daily discharge recorded at Donaldsonville over the 19-year period of record beginning in August 1957 is 252 cfs (U.S. Geological Survey, 1977). Extremes in flow over the same period of record range from a maximum of 600 cfs to a minimum of no flow. Bayou Lafourche discharges into the Gulf of Mexico as shown in Figure B.2-10.

The only major water-quality sampling station on this waterway is at Larose at the intersection of the ICW. This station provides an opportunity to observe compliance with standards for both Bayou Lafourche and a segment of the ICW. Both water courses have identical use classifications; primary and secondary contact recreation, aquatic life, and water supply. However, state numerical criteria differ for sulfate and chloride, the criteria applicable to the bayou being more stringent. Both standards for the two segments were violated part of the time, as was the standard for coliform. The maximum value recorded for coliform

TABLE B.2-6 Summary of sedimentary characteristics of bays in the Capline region

Water Body	Mean Grain Size phi	Standard Deviation phi	Skewness	Kurtosis	Percent Sand	Percent Silt	Percent Clay
Atchafalaya Bay	7.1	2.56	0.24	0.78	7.4	56.4	36.2
East Cote Blance Bay	7.7	2.71	-0.07	0.77	6.6	43.0	50.4
West Cote Blance Bay	8.4	2.67	-0.28	0.77	6.1	38.3	55.6
Vermilion Bay	7.9	2.38	-0.15	0.95	4.9	42.3	52.8

Source: Louisiana Wildlife and Fisheries Commission, Technical Bulletin No. 13, April, 1975.

was 7500 as compared to a 200 counts per 100 ml criteria. Departures from proposed EPA standards included suspended solids, diazinon and mercury, part of the time, for aquatic-life criteria; and phenols and cadmium, part of the time, for municipal water-supply standards. All other measured parameters showed compliance with these standards. The only standard-applicable parameter not reported was total dissolved solids.

Bayou Teche

This waterway is one of the important fresh water bodies in the western side of the study area. Streamflow records at Keystone Lock near St. Martinville (station number 8570) indicate the average discharge of Bayou Teche during the 17-year period beginning in 1959 was 492 cfs, the maximum discharge was 3970 cfs, and the minimum discharge of zero flow has been experienced on several occasions (U.S.G.S., 1977). During flood conditions, considerable flow is diverted to or from the Red River, the West Atchafalaya floodway, and other areas. Water for irrigation is diverted from Bayou Teche through Ruth Canal into the Vermilion River. This irrigation diversion has averaged 135 cfs during the same 17-year period of record.

The major water-quality sampling station on Bayou Teche (Table B.2-1) is located at Keystone Lock, near St. Martinville and upstream from New Iberia (Figure B.2-10). Designated use classifications for this bayou include primary and secondary contact recreation, fish and wildlife, and domestic raw water supply. Numerical criteria are identical upstream and downstream of Keystone Lock, except for chloride, sulfate and total dissolved solids that are 43, 32, and 220 mg/l, respectively, for the upstream segment and 80, 50, and 350 mg/l, respectively, downstream. For samples collected during water year 1976, these criteria were met in every case. Also, the State standards for pH, temperature, dissolved oxygen, and total dissolved solids were also met. However, the coliform bacteria standard was exceeded part of the time. With respect to proposed EPA freshwater aquatic-life standards, only diazinon exceeded the criteria;

and none of the proposed EPA water-supply standards were exceeded. However, it should be noted that four of these standard-related parameters were not reported, and for 19 of these parameters, only one sample was analyzed during water year 1976.

Bayou Penchant

One additional major water-quality sampling station completes the inventory. It is located on Bayou Penchant at Bayou Chene (Figure B.2-10), as referenced in Table B.2-1. The indicated stream segment is classified for primary and secondary contact recreation, and for the propagation of fish and wildlife. As discussed in previous paragraphs, a definite pattern emerges when comparing measured water quality to applicable state and proposed EPA marine aquatic-life standards were met except for coliform bacteria (State standard) and phosphorus (EPA standard), which were exceeded part of the time. The same is true for this station on Bayou Penchant.

Intracoastal Waterway

One of the most important navigable waterways in the area is the Intracoastal Waterway (ICW), which is used as a vital artery for east-west commercial water shipment in the southern United States (Figure B.2-10). Several easily navigable north-south channels connect cities in the study area to the ICW. Between the Mississippi River in the east and the Vermilion River in the west, the ICW has a length of nearly 160 miles, a width of 125 feet, and a depth of 12 feet (U.S. Army Corps of Engineers, 1977).

Two major water-quality sampling stations are located on the ICW in the study region (Figure B.2-10). One station, at Larose on the eastern extremity of the region, was treated under the Bayou Lafourche discussion. The other station is lcoated on the western extremity of the region at Vermilion Lock (East) as referenced in Table B.2-1. This segment of the ICW is designated by the State for secondary-contact recreation and propagation of fish and wildlife. Water quality measured during water year 1976 showed that the State numerical criteria were met except for coliform that exceeded the limit part of the time. Since this segment of the ICW is considered to be in a tidal area, measured water quality is compared to proposed EPA standards for marine aquatic life. All parameters met the EPA criteria except for phosphorus that exceeded the standard part of the time.

Coastal Estuaries

Major estuaries included in the study area are Atchafalaya Bay, East Cote Blanche Bay, West Cote Blanche Bay, and Vermilion Bay (Figure B.2-10). The Vermilion Bay - Atchafalay Bay Complex is a shallow estuarine system with an average depth of about five to seven feet. A maximum depth of 175 feet is reached at Southwest Pass in Vermilion Bay. The Bay Complex is bounded on four sides by navigable waterways. Several other navigational canals cut through the area in a north to south direction.

The tide is chiefly diurnal along the central Louisiana coast. The average diurnal range of the tide in Vermilion and West Cote Blanche Bay is about 1.6 feet. Local winds significantly alter tidal heights, which generally have a maximum range of from 3.6 feet below to 4.0 feet above mean sea level (MSL).

Tidal currents have been measured at three stations in the Vermilion Bay/West Cote Blanche Bay system (U.S. Army Corps of Engineers, 1959) at 1) the northern end of Southwest Pass; 2) off Cypremort Point, the boundary between Vermilion Bay and West Cote Blanche Bay; and 3) off Marone Point, the boundary between West Cote Blanche Bay and East Cote Blanche Bay. Current speeds at the Southwest Pass station in Vermilion Bay ranged from slightly over 4.0 feet/second (2 knots) at the surface to about 2.0 feet/ second (1 knot) near the bottom. Current speed at the Cypremort Point and Marone Point stations was approximatley 1.0 foot/second (0.6 knots). The data show a preponderance of ebb tide at the Southwest Pass station indicating a net outflow through the channel, while there appears to be a net flood tide at the other stations.

Significant freshwater inflow into the Vermilion Bay/West Cote Blanche Bay system is contributed not only from the Atchafalaya and East Cote Blanche Bays, but also through the Vermilion River, Weeks and

Petite Anse Bayous, and the Charenton Canal. The total freshwater inflow from those sources causes a net seaward flow of water from the Vermilion Bay/West Cote Blanche Bay system. Thus, a counterclockwise net flow appears to exist in the Vermilion Bay/West Cote Blanche Bay/Gulf of Mexico system.

Two major water-quality sampling stations are located in the coastal area of the study region (Figure B.2-10). One is in Vermilion Bay at Cypremort Point, the other is in Atchafalaya Bay at Eugene Island (Table B.2-1). Both water bodies are designated for secondary-contact recreation and propagation of fish and wildlife and applicable state standards for both are identical except for dissolved oxygen (DO). Minimum DO in Vermilion Bay is four mg/l, while the Atchafalaya Bay minimum is five mg/l. Water quality data collected at these two stations show that, with two exceptions, applicable criteria were met. One is the state coliform bacteria standard with which boths stations failed to comply part of the time. The other is the proposed EPA marine aquatic-life standard for phosphorus that was exceeded part of the time at both stations.

Sediments in Vermilion Bay and West Cote Blanche Bay are finer grained than those in any of the other major water bodies in coastal Louisiana. The average size of the sediments in the bays ranges from fine to very fine silt. The major source of sediments in this region is the Atchafalaya River, although the Vermilion River contributes sediments to western Vermilion Bay.

There is a predominantly westward drift of sediments in the coastal waters in the Vermilion Bay/West Cote Blanche Bay area due to the net influx of the Atchafalaya River on the east and the net efflux through deep Southwest Pass of Vermilion Bay on the west. As a result of this drift effect, sediments grade westward from coarse to fine. There is also a coarse to fine grading of sediments from north to south. The coarse particles are found near the discharge points of the major rivers; the finer particles are located to the south away from the outlets of the rivers. Grain sizes generally decrease westward toward Vermilion

Bay. Vermilion Bay has slightly coarser grained sediments compared to West Cote Blanche Bay due to the large size particles contributed by the Vermilion River. The Vermilion Bay sediments grade from coarse to fine from west to east. The clay area in Vermilion Bay is the largest clay area in coastal Louisiana. The size classification and the composition limits of sediment types are presented in Table B.2-7.

The waters in the Vermilion Bay/Cote Blanche Bay are extremely turbid as a result of the large amount of sediments emptied into them by the Atchafalaya River. The shallow water depths also allow wave action to reach the bottom and resuspend the fine sediments.

Mean sediment grain sizes are coarsest in Atchafalaya Bay near the discharge points of the Atchafalaya River. A relatively high percentage of sand and low percentage of clay is found in this bay, compared to the other bays in the area. The most abundant sediment type is clayey silt.

Nearshore Gulf of Mexico

Gulf surface currents in the central Louisiana region have a westerly net annual flow, parallel to the shore, with speeds ranging from 0.2 to 0.4 knots. Shallow water, wind driven currents and barotropic slope currents, both which parallel isobaths, contribute to the generally westward current (NOAA, 1977). Currents vary seasonally, controlled by regional wind conditions. An easterly surface flow (0.4 knots) has been found in the summer and a westerly surface flow (0.82) has been found to persist during the winter and spring. Bottom currents were onshore and easterly during the summer; and westerly, onshore, and offshore, respectively during the winter and early spring (Oetking, 1974).

Superimposed on the above currents is a rotary tidal current which seldom exceeds 0.3 knots. Generally the tide heights in nearshore central Louisiana Gulf ranges from 1.5 to 2.0 feet and the tide wave moves from west to east. When the moon is at its maximum declination, the tide is diurnal and of greatest range. When the moon is over the equator, the tidal range is lowest and several days of semidiurnal tides may occur (NOAA, 1977).

TABLE B.2-7 Composition limits and size classification of sediment types.

Wentworth Sediment Class		Phi	mm
Granules		-1	2.0
Sand	Very Coarse	0	1.0
	Coarse	1	0.5
	Medium	2	0.25
	Fine	3	0.125
	Very Fine	4	0.0625
Silt	Coarse	5	0.0313
	Medium	6	0.0156
	Fine	7	0.0078
	Very Fine	8	0.0039
Clay		9	0.00195
		10	0.00098
		11	0.00049
		12	0.00024

Classification of sediment types

Sediment Type	Composition limits (percent by weight) Sand	Silt	Clay
Sand	75.0-100.0	0.0- 25.0	0.0- 25.0
Silty sand	33.5- 75.0	12.5- 50.0	0.0- 33.5
Clayey sand	33.5- 75.0	0.0- 33.5	12.5- 50.0
Silt	0.0- 25.0	75.0-100.0	0.0- 25.0
Sandy silt	12.5- 50.0	33.5- 75.0	0.0- 33.5
Clayey silt	0.0- 33.5	33.5- 75.0	12.5- 50.0
Clay	0.0- 25.0	0.0- 25.0	75.0-100.0
Sandy clay	12.5- 50.0	0.0- 33.5	33.5- 75.0
Silty clay	0.0- 33.5	12.5- 50.0	33.5- 75.0

Source: Louisiana Wildlife and Fisheries Commission, Technical Bulletin No. 13, April, 1975.

Wave direction generally corresponds to wind direction and changes according to the season of the year. Between March and August, waves travel in a northwesterly direction while in the fall and winter, they will travel more to the west. When strong northers are present, the waves can travel offshore. Wave heights range from 0 to 0.2 feet; 95% of the time, waves 15 miles offshore of Atchafalaya Bay do not exceed 4 feet (Horrer, 1961).

Salinities and their distribution are determined mainly by the inflow of freshwater from the Mississippi and Atchafalaya Rivers. Within five to six miles of the Louisiana coast, seasonal salinity variations can range from 15 to 35 ppt at a depth of 10 feet (Geyer, 1950). Typical salinity values in the summer increase from a surface value of about 23 ppt to over 36 ppt in the upper 50 feet with a strong halocline at 23 to 26 feet. Temperatures are nearly isothermal, ranging from 77 to 79^{0}F. The well developed density gradient weakens in the winter; average salinity becomes vertically uniform at approximately 32 ppt and average temperature decreases to approximately 60^{0}F (NOAA, 1977).

Generally, surface dissolved oxygen values in the northern Gulf average approximately 8.0 ppm. Lower DO values are found in bottom waters, especially during the warm months. The biochemical oxygen demand in the eastern Louisiana Gulf waters are generally low, 2 mg/l. There is a tremendous input of nutrients and suspended matter into the Gulf by the Mississippi River system. As a result, turbidity, nitrate, nitrite, orthophosphate and dissolved silicon show an inverse relationship to salinity. Trace metal and hydrocarbon levels are within the ranges expected for coastal values.

B.2.2.2 Subsurface Water Systems

B.2.2.2.1 Occurrence of Ground Water

More than 9000 feet of Miocene and younger unconsolidated to poorly consolidated sediments consisting primarily of deltaic sands and clays underlie the region. The sand units comprise about 40 percent or more of the total thickness and generally qualify as aquifers in that they contain sufficient saturated permeable material to yield significant quantities of water to wells. Fresh to slightly saline water is found only in the uppermost units in the parishes south of Baton Rouge. Traditionally, only those formations containing fresh water are studied in detail by ground-water hydrologists. Therefore, information regarding the characteristics of deeper formations or those containing saline water is normally lacking except in areas where extensive petroleum exploration has taken place.

Formations containing fresh (less than 1000 milligrams per liter dissolved solids) or slightly saline water (1000 to 3000 milligrams per liter dissolved solids) are regionally grouped into the Gulf Coast Aquifer. Water in the Gulf Coast Aquifer occurs under both watertable (unconfined) and artesian (confined) conditions. Where watertable conditions occur, there is no confining bed, and the water is exposed to atmospheric pressure only. Water in a well tapping a watertable aquifer will stand at the top of the zone of saturation. Watertable conditions occur principally in shallow sands less than 100 feet deep.

Artesian conditions exist in the deeper sands of the Gulf Coast where a confining bed of clay or shale causes the water to be under pressure greater than atmospheric pressure. A well tapping an aquifer under artesian conditions will become filled with water above the depth where the sand was first encountered. If pressure is sufficient the well may flow at the surface. However, artesian wells do not necessarily flow.

The shallow watertable sands may be recharged from rainfall on the land surface directly overlying them, but artesian sands are usually recharged from rainfall on distant outcrops.

The topography of the coastal plain in the project area generally consists of very flat, relatively featureless coastal marshes broken by broad, relatively shallow, meandering streams. In the subsurface, the formations dip toward the coast at a greater angle than the slope of the land surface and, consequently, are encountered at progressively greater depth toward the coast. The coastline generally corresponds with the axis of the Gulf Coastal Geosyncline, the dominant geologic feature of southern Louisiana. The project area is on the northern flank of the geosyncline. Because the formations thicken downdip, each formation dips at a greater angle than the overlying formation at a given location. The stratigraphic record indicates that the geosyncline has been subsiding continuously since the Cretaceous. Continued subsidence is indicated by the fact that natural levees in the region are tilted toward the Gulf and also by the pattern of prehistoric Indian settlements (Howe and others, 1938).

The region was deeply dissected by streams during the last glacial periods when sea level was about 350 to 400 feet lower than its present level. The streams readjusted their gradients to the lower sea level, and became well entrenched by eroding deep valleys in the coastal areas. With the retreat and melting of the ice sheets, immense amounts of water were released to the ocean, sea level rose, and the entrenched deep valleys of the streams were drowned and became estuaries. Present-day examples of these estuaries in Louisiana are Cote Blanche Bay and Barataria Bay. The valley fill sediments in the drowned valleys of present-day estuaries (see Section B.2.1.1.2) are generally coarser at their base, becoming finer in the upward direction due to the decreased gradient of the river as deposition progressed. These valley fill deposits may act as conduits for discharge from or recharge to aquifers or for movement of contaminants.

In areas not affected by pumping, natural ground-water movement in the region is to the south toward the Gulf of Mexico. In areas of large ground-water withdrawals, the direction of movement may be modified or reversed.

The movement of ground water in the deeper formations (approximately 2800 feet, msl) may be impeded by large normal faults generally trending parallel to the axis of the Gulf Coast Geosyncline.

The ground water of southwestern Louisiana and eastern Texas has been developed to a greater extent than that of southeastern Louisiana and has generally been covered separately in the literature. This has resulted in some confusion in aquifer names. The approximate dividing line between eastern Texas ground water and southwestern Louisiana ground water is a saltwater "ridge" to the west of, and parallel to, the Atchafalaya River. The ridge is situated along a former axis of the Mississippi River. It is a structural trough and is the remnant of a large saltwater body that was trapped during deposition and has not yet been flushed (Whiteman, 1972). To the west of this line, the aquifers that contain fresh water are: the Jasper of Miocene age, the Evangeline of Miocene and Pliocene age, and the Chicot of Pleistocene age. To the east of the line, the Plaquemine aquifer is generally equivalent to the Chicot and, in turn, to the Gonzales aquifer to the east of the Mississippi River. The sands underlying the Plaquemine aquifer do not contain fresh water in the area south of Baton Rouge and therefore have not been named as aquifers. The occurrence of ground water in the respective areas has been described by Long (1965), Whiteman (1972) and Whitfield (1975) with a more general discussion provided by Rollo (1960).

B.2.2.2.2 Aquifer Characteristics

The Miocene and Pliocene formations in the project area have not been investigated in detail from the standpoint of water supply because they appear to have little potential as a source of fresh water. However, the sands in these deposits are potentially a prolific source of brackish or salty water (Whiteman, 1972). Examination of well logs and of data from side wall core samples from oil exploration wells in the project region indicates a net sand thickness of 1000 feet to 1500 feet in the depth interval from -3000 feet to -8000 feet. Porosity decreases linearly with depth, ranging downward from about 40 percent at -3000 feet ot about 30 percent at -8000 feet. This range and systematic variation of porosities with depth concurs with values derived from other electrical and geophysical surveys of Texas-Louisiana Gulf Coast wells. The permeability of these deep formations is less than that of the overlying Chicot and Plaquemine aquifers, and is generally in the Darcy range. This water is under artesian pressure and wells flow naturally at the surface upon completion.

The principal fresh water-bearing sands of Pleistocene age are interconnected in the project area and are considered as a single artesian aquifer system known as the Plaquemine (or Chicot) aquifer. The aquifer is confined by a top stratum of clay and silt about 100 feet thick, and in much of the project area consists of a massive body of sand and gravel with only a few thin, lenticular interbeds of clay and silt The depth to the base of the aquifer in the project area ranges from about 800 feet near Bayou Choctaw to about 1500 feet near Chacahoula dome. The depth to the base of fresh water ranges from about 200 feet at Chacahoula dome to about 400 feet at Bayou Choctaw to over 600 feet at Weeks Island.

The Plaquemine aquifer is very permeable, with a coefficient of permeability on the order of 2000 fpd per square foot over most of the area. Well yields of over 500 gpm have been reported in the project area. The aquifer is in direct hydraulic contact with the Mississippi River in places where the river has cut through the silt and clay of the top stratum and into the upper sand of the aquifer. The deepest portions of the Mississippi River channel range from about 50 feet in the straight sections of the river to more than 130 feet below sea level in the major bends. No tributaries enter the Mississippi River below Baton Rouge, and all surface drainage, except for the area between the artificial levees, is away from the river.

The potentiometric level in the Plaquemine aquifer closely reflects the stage of the Mississippi River. As the Mississippi River has built its delta seaward, it has also built up its natural levees within the alluvial valley, and the average river stage has increased. Peak flood stages have also been increased by the construction of the artificial levee system. During flood stage, the water level between the artificial levee is often higher than the surrounding land areas. Within the project area, the range of head fluctuations is such that most wells are capable of flowing at least briefly in most years, although none in the inhabited portions of the area flow continuously.

B.2.2.2.3 Water Use

As might be expected, water use in the region has increased steadily with increased population and industrialization. Early development in southern Louisiana below Baton Rouge was confined to the higher parts of the natural levees. Towns, plantation buildings, and light industries such as sugarmills were built near the crests of the natural levees to reduce the potential for flood damage. Agricultural development also followed the topography, with cultivated cropland restricted to the higher parts of the natural levees, grazing lands at the intermediate elevations, and the swampy lowlands left forested. With this pattern of development, water demands were generally light and widely scattered.

New plants and processes, growing population, and rising living standards require constantly increasing supplies of fresh water. Although all foreseeable water needs in the project area could be met by surface water, the costs of diversion, treatment, and distribution of available surface water supplies often make ground water preferable where it is available in adequate quantity and quality. Ground water also offers the advantages of relatively uniform temperature and chemical quality. All domestic and municipal water supplies in the project area are provided by ground water with the exception of a few residences and fishing or hunting camps that use rainwater stored in cisterns.

Water use data for the entire project area is not well documented. However, C.E. Whiteman (1972) reported a 250 percent increase in industrial use in the Plaquemine-White Castle area during the years 1955 to 1969. Ground water use for that area averaged 15.3 mgd in 1969 and surface water use averaged 1100 mgd. Surface water use consisted primarily of Mississippi River water diverted for industrial cooling and returned to the river unchanged except for temperature.

Water from the Plaquemine aquifer is generally hard, with sufficient iron content to clog well screens and leave rust stains on porcelain and laundry. In addition, over much of the area the water has an undesirably high color. These undesirable properties can be alleviated by treatment but the processes are not well adapted to small-scale domestic use. One of the techniques used by municipalities near the Mississippi River is to place their well fields near the outside of river bends and pump at very high rates. This induces continuous recharge from the river. The river water has a lower dissolved solids content, a lower iron content, and is softer than the ground water. This induces movement through the aquifer and provides filtration and clarification of the river water prior to treatment.

B.2.3 Climatology and Air Quality

B.2.3.1 Climatology

B.2.3.1.1 General

The general classification of the climate of southern Louisiana is humid subtropical with a strong maritime influence. Prevailing wind flow is from the south much of the year. This movement of maritime air from the Gulf of Mexico helps to temper extremes of summer heat, to shorten the duration of winter cold spells, and provides a source of abundant moisture and rainfall. Extended periods of subfreezing temperatures are rare and, except for unusual occurrences, significant amounts of snowfall are quite rare. During the winter and spring, the cold Mississippi River water enhances the formation of river fogs, particularly when light southerly winds transport warm, moist air into the area from the Gulf of Mexico. Severe weather is generally associated with heavy thunderstorms and tropical cyclones.

The terrain of the southern portion of Louisiana is very flat. With the exception of scattered hills and bluffs, the elevation ranges from 0 to 100 feet above sea level. Therefore, the effects of surface features upon synoptic scale (100 to 1000 km) or mesoscale (10 to 100 km) meteorological processes are negligible.

Climatological records from the nearest National Weather Service (NWS) stations served as the basis for approximating climatic conditions that may be expected in the Capline area. Most of the data are from the NWS stations located at the New Orleans International Airport, the Lake Charles Municipal Airport, and Ryan Airport at Baton Rouge.

B.2.3.1.2 Wind Characteristics

Annual percentage frequencies of surface wind at New Orleans, Baton Rouge, and Lake Charles, for the years 1966-1970 are shown in Figures B.2-11, B.2-12, and B.2-13 (USDC, 1971). These data indicate a predominance of northerly through southerly (clockwise) winds with a maximum frequency of southerly winds at Lake Charles and northerly winds at Baton Rouge and New Orleans. The annual average wind speed based on these data is 6.9 knots (7.9 mph) at New Orleans, 6.3 knots (7.3 mph), at Baton Rouge, and 7.1 knots (8.2 mph) at Lake Charles. Calms occurred 7, 11, and 6 percent of the time, respectively.

There is a land or sea breeze effect that is most noticeable along the coast during the spring, summer and fall seasons. During the daytime, a land breeze (southerly flow) is usually observed, and during the late evening and early morning hours, a sea breeze (northerly flow) often occurs. As one moves inland, the land-sea breeze phenomena becomes less noticeable.

Estimated extreme winds at 30 feet above ground for a 50-year recurrence interval vary from about 90 to 95 mph over the region (Thom, 1968). Extreme winds with a 100-year return period are approximately 10 mph higher.

B.2.3.1.3 Temperature

Summer weather in southern Louisiana is consistently warm, but maximum temperatures rarely exceed 100^{o}F, due to the moderating effects of cloudiness and scattered convective showers and thundershowers. During the normally mild winters, the temperature drops to freezing or below on an average of 11, 13, and 24 days per year, respectively, at Lake Charles, New Orleans, and Baton Rouge (USDC, 1974).

Monthly and annual values of daily mean temperatures, and average daily maximum and minimum temperatures are shown in Table B.2-8 for New Orleans, Baton Rouge, and Lake Charles (USDC, 1974). Based on these data, the annual mean temperature over the region is approximately 68^{o}F. The highest average daily maximum temperature, near 91^{o}F, occurs during the months of July and August, while the lowest average daily minimum temperature, ranging from about 41^{o} to 43^{o}F, occurs during January.

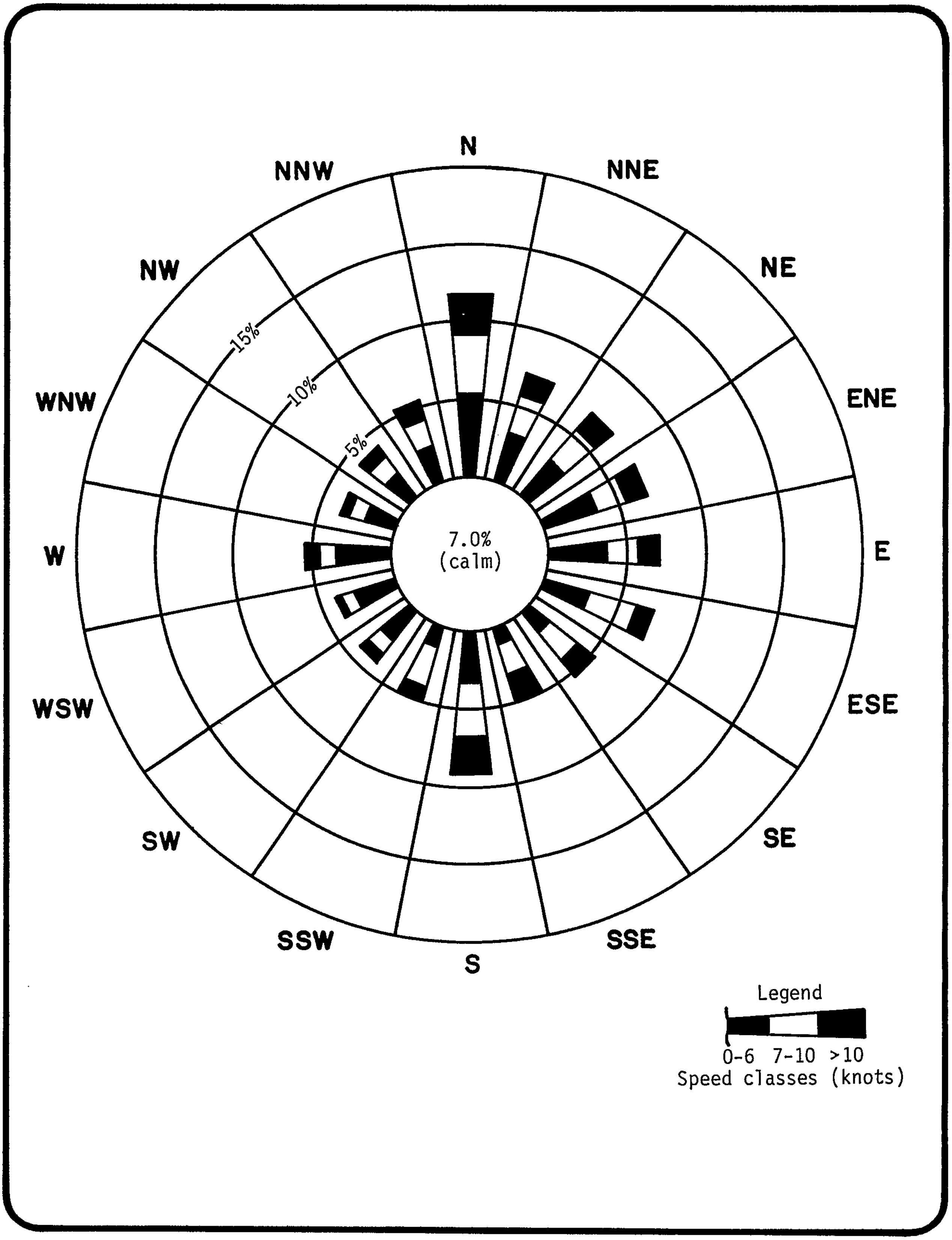


FIGURE B.2-11 Annual wind frequency distribution for New Orleans (1966-1970).

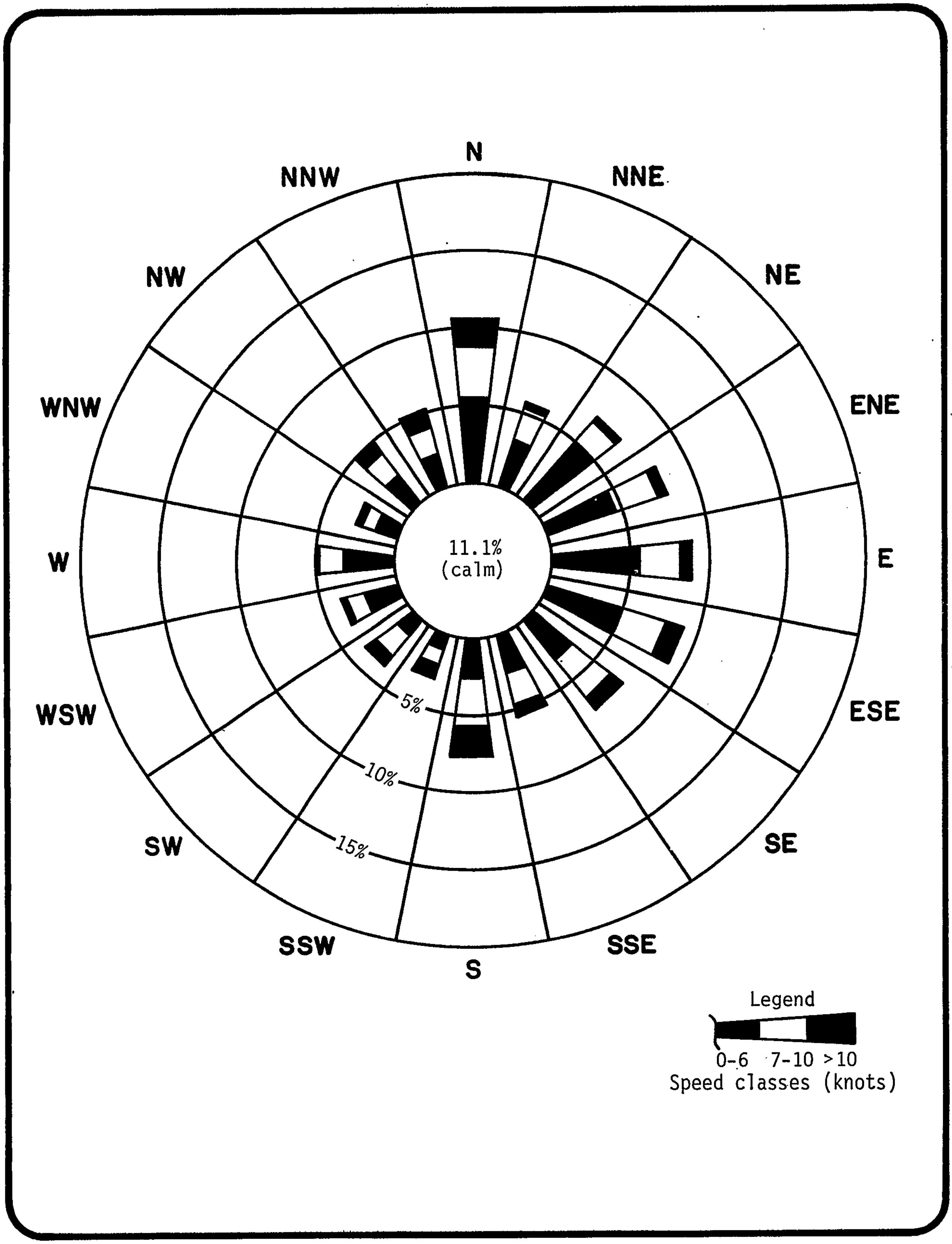


FIGURE B.2-12 Annual wind percent frequency distribution for Baton Rouge (1966-1970).

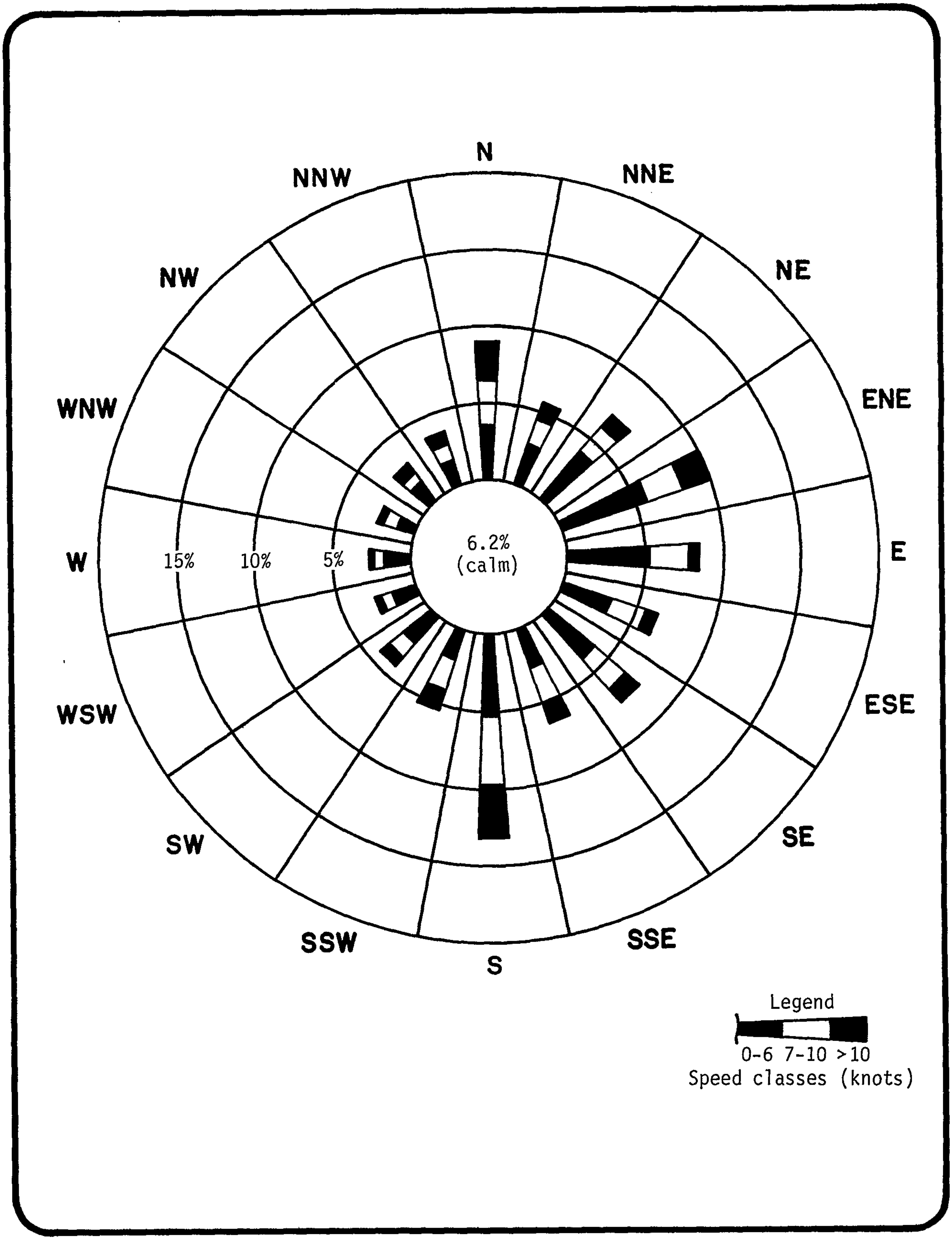


FIGURE B.2-13 Annual wind percent frequency distribution for Lake Charles (1966-1970).

TABLE B.2-8 Values of mean and average daily maximum and minimum temperatures (°F.).

Month	New Orleans (1941-1970)			Baton Rouge (1941-1970)			Lake Charles (1941-1970)		
	Mean	Average Daily Maximum	Average Daily Minimum	Mean	Average Daily Maximum	Average Daily Minimum	Mean	Average Daily Maximum	Average Daily Minimum
January	52.9	62.3	43.5	51.0	61.5	40.5	52.3	61.6	42.9
February	55.6	65.1	46.0	53.9	64.5	43.2	55.1	64.6	45.5
March	60.7	70.4	50.9	59.7	70.6	48.7	60.3	70.0	50.5
April	68.6	78.4	58.8	68.4	79.0	57.7	68.9	78.2	59.5
May	75.1	84.9	65.3	74.8	85.3	64.3	75.2	84.3	66.0
June	80.4	89.6	71.2	80.3	90.3	70.3	80.7	89.6	71.8
July	81.9	90.4	73.3	82.0	91.2	72.7	82.4	91.2	73.6
August	81.9	90.6	73.1	81.6	91.1	72.1	82.2	91.2	73.2
September	78.2	86.6	69.7	77.5	87.2	67.7	78.4	87.9	68.8
October	69.8	79.9	59.6	68.5	80.4	56.6	70.0	81.6	58.4
November	60.1	70.3	49.8	58.6	70.3	46.9	60.2	71.1	49.2
December	54.8	64.2	45.3	52.9	63.7	42.0	54.3	64.2	44.3
Annual	68.3	77.7	58.9	67.4	77.9	56.9	68.3	78.0	58.6

B.2.3.1.4 Atmospheric Humidity

Relative humidity is generally quite high in the region. The annual average is approximately 78 percent at Lake Charles, 77 percent at New Orleans, and 74 percent at Baton Rouge (USDC, 1974). Seasonally, monthly averages are lowest in February and March and highest during the summer except they are highest in December and January at Lake Charles. Diurnally, the highest relative humidities are observed near sunrise (usually near 90 percent) and the lowest relative humidities are normally reached by mid-day or early afternoon. The mid-day average is slightly more than 60 percent.

The average number of days each year with heavy fog (visibility reduced to one-quarter mile or less) observed at Baton Rouge, Lake Charles, and New Orleans are 48, 37, and 31, respectively (USDC, 1974). The number of days with heavy fog reaches a peak during winter, with few occurrences during summer.

B.2.3.1.5 Precipitation

Monthly and annual precipitation normals at selected stations in the region are presented in Table B.2-9 (USDC, 1964). Rainfall is heavy and quite variable in this portion of Louisiana; this justifies the use of cooperative weather station data near the individual sites. For the given stations, the annual average precipitation varies from 54 to 64 inches. Monthly average rainfall reaches a maximum in July with a minimum in October. Daily rainfall amounts of one-half inch or more can be expected approximately 35 to 40 days each year including a monthly maximum of 5 to 6 days in July and August (USDC, 1964). Maximum monthly rainfall amounts in excess of ten inches can occur during any month of the year.

The annual average snowfall in the region is only about 0.4 inches based on data from several stations in the region (USDC, 1964), and many years pass with no measureable snow.

B.2.3.1.6 Storms

Thunderstorms occur approximately 70 days each year over the region (USDC, 1974). Thunderstorm activity reaches a peak in July and August (12 to 16 occurrences each month over the region) with only 2 or 3

TABLE B.2-9 Monthly and annual average precipitation (inches) at selected station in the region

Month	Jeanerette (1931-1960)	Baton Rouge (1931-1960)	Donaldsonville (1931-1960)	Houma (1931-1960)
January	4.51	4.78	4.76	4.11
February	4.34	4.42	5.09	4.09
March	4.58	4.91	5.05	5.27
April	4.15	4.77	5.14	4.48
May	4.82	4.80	5.66	4.81
June	5.57	4.09	4.62	6.39
July	8.13	6.27	6.22	8.43
August	6.24	5.26	5.74	7.62
September	4.53	3.52	5.40	6.63
October	2.85	2.45	2.73	3.76
November	3.90	4.09	4.33	3.99
December	5.10	5.10	5.13	4.81
Annual	58.72	54.46	59.87	64.39

thunderstorm days per month from October through February. However, severe thunderstorms accompanied by high winds, hail or possibly a tornado are infrequent.

During the period 1955 through 1967, only 22 tornadoes (1.7 mean annual frequency) were recorded within the one-degree latitude-longitude square that contains Baton Rouge (USDC, 1969). According to Thom (1963), the probability and return period of a tornado occurrence at a specific point in this region would be .00117 and 857 years, respectively.

Tropical cyclone statistics for four 50 nautical mile strips (57.6 statute mile strips) of the Louisiana coastline are summarized below (Simpson and Lawrence, 1971):

Number of Tropical Cyclones Reaching the Mainland 1886-1970

	West	West-Central	East-Central	East
All Tropical Cyclones	10	11	15	18
All Hurricanes	5	5	8	11
Great Hurricanes	1	0	0	2

Number of Years Between Tropical Cyclone Occurrences
(Average for Period 1886-1970)

	West	West-Central	East-Central	East
All Tropical Cyclones	8	7	5	4
All Hurricanes	17	17	10	7
Great Hurricanes	85	-	-	42

Risk of Tropical Cyclones

	West	West-Central	East-Central	East
All Tropical Cyclones	12%	13%	18%	21%
All Hurricanes	6%	6%	9%	13%
Great Hurricanes	1%	-	-	2%

The West strip of coastline extends from near Cameron, Louisiana to a point southwest of New Iberia; the West-Central strip extends from southwest of New Iberia to Atchafalaya Bay (South of Morgan City); the East-Central strip extends from Atchafalaya Bay to a point south of Houma; and the East strip extends from Houma to a point south of New

Orleans. Risk is defined as the probability (%) that a tropical storm, hurricane or great hurricane will occur in any one year in a 50 natutical mile segment of coastline. Definitions of the three storm classes are:

Tropical Cyclone	39-73 mph
Hurricane	74-124 mph
Great Hurricane	125 mph or greater

Three recent hurricanes with winds of 100 mph or greater passed through the area. These were Hilda (1964), which passed west of Morgan City and north of Baton Rouge with winds between 100-120 mph; Betsy (1968), which passed just each of Morgan City, including peak gusts of 92 mph recorded in Baton Rouge; and Fern (1971), which passed through New Orleans.

B.2.3.2 Climatology - Factors Affecting Dispersion

Atmospheric stability in conjunction with the general ventilation (winds) indicates the ability of the atmosphere to disperse airborne effluents. The degree of atmospheric stability determines the amount of vertical and lateral mixing or dispersion of air pollutants as they are carried away from their source.

Meteorological conditions which lead to high air pollution potential are light winds accompanied by surface inversions and above-surface stable layers (limited mixing). Surface inversions are short-term, early morning phenomena; usually, heating eliminates them and creates a uniform mixing layer by mid-afternoon. Mixing depth is defined as the surface layer in which relatively vigorous vertical mixing takes place.

Holzworth (1972) has compiled isopleths of seasonal and annual mean mixing depths for both morning and afternoon. Estimated mean morning mixing depths for the Capline region range from a minimum of about 450 meters in winter to a maximum of about 700 meters in summer. Values in the spring and fall average between 500 and 600 meters over the area. Afternoon mixing depths are much higher, averaging about 1100 meters annually. Holzworth has also compiled data on the number of forecast days of high meteorological potential for air pollution in the contiguous United States; this value is near 10 for the Capline region.

The mean annual frequency distributions of stability classes at New Orleans, Baton Rouge, and Lake Charles for the period 1966-1970 are presented below (USDC, 1971). The stability classes are based on Pasquill's classification (Turner, 1964). According to these data, there is little variation in stability over the region, with both neutral and stable stability conditions occurring about 40 percent of the time on an annual basis.

Annual Stability Class Percent Frequency Distribution
(1966-1970)

Pasquill Stability Class	Definition	New Orleans	Baton Rouge	Lake Charles
A	Extremely unstable	0.8	1.4	1.1
B	Unstable	8.5	8.0	7.3
C	Slightly unstable	12.9	11.1	10.9
D	Neutral	38.2	38.7	40.9
E,F,G	Slightly, moderately or extremely stable	39.6	40.7	39.8

Generally, dispersion conditions in the area are good since winds off the Gulf of Mexico provide good ventilation and tend to prevent extended periods of air stagnation. However, frequent periods of limited dispersion do occur (mostly of short duration), as evidenced by the fact that surface inversions are present about 40 percent of the time.

B.2.3.3 Air Quality

B.2.3.3.1 Air Quality Legislation

The Federal Clean Air Act provides for the prevention and control of air pollution. Several categories of air quality standards, i.e., the National Ambient Air Quality Standards (NAAQS), the air quality regulations of the state of Louisiana, and federal significant deterioration regulations, were reviewed to extract all of the regulations and standards applicable to the Capline region. The NAAQS were issued by the U.S. Environmental Protection Agency (EPA) in April 1971, and are listed in Table B.2-10. They include primary standards, which are

TABLE B.2-10. National ambient air quality standards.[a]

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Particulate matter	Annual (Geometric mean)	75 $\mu g/m^3$	60 $\mu g/m^3$ [b]
	24-hour	260 $\mu g/m^3$	150 $\mu g/m^3$
Sulfur Dioxide	Annual (Arithmetic mean)	80 $\mu g/m^3$ (0.03 ppm)	- -
	24-hour	365 $\mu g/m^3$ (0.14 ppm)	
	3-hour	-	1300 $\mu g/m^3$ (0.5 ppm)
Carbon Monoxide	8-hour	10 mg/m^3 (9 ppm)	Same as primary
	1-hour	40 mg/m^3 (35 ppm)	
Photochemical oxidants[c]	1-hour	160 $\mu g/m^3$ (0.08 ppm)	Same as primary
Hydrocarbons[d] (nonmethane)	3-hour (6 to 9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	Same as primary
Nitrogen Dioxide	Annual (arithmetic mean)	100 $\mu g/m^3$ (0.05 ppm)	Same as primary

(a) All standards (other than annual standards) are specified as not to be exceeded more than once per year.

(b) A guide to be used in assessing implementation plans to achieve the 24-hour standard.

(c) Expressed as ozone by the Federal Reference Method.

(d) For use as a guide in devising implementation plans to achieve oxidant standards.

Source: U.S. Environmental Protection Agency, 1971, 1976e intended to protect public health, and secondary standards, which are intended to protect public welfare. Additional air quality standards that are applicable in Louisiana are summarized in Table B.2-11.

In November 1974, the U.S. EPA issued a regulation to prevent significant deterioration (PSD) of air quality in areas with air cleaner than the standards at the time of issuance of the regulation (EPA, 1974b). The Clean Air Act Amendments of 1977 contian significant changes in PSD requirements. Major changes affecting this project include the expansion of PSD designated source categories from 19 to 28, one of which is petroleum storage and transfer facilities with a capacity exceeding 300,000 barrels, and the extension of the regulations to all criteria pollutants and not just sulfur dioxide (SO_2) and particulate matter (PM). However, except for SO_2 and PM where allowable incremental increases in baseline concentrations are specified, other criteria pollutants are to be controlled using Best Available Control Technology (BACT) at present. Therefore, hydrocarbon emissions from crude oil storage tanks would probably have to be controlled using floating roofs equipped with double seals.

In response to the Clean Air Act, Louisiana created an air quality control program and issued a State Implementation Plan (SIP) defining measures to be taken by the state to achieve the NAAQS. Subsequently, the U.S. EPA (1976a) has required the State of Louisiana to revise its SIP for photochemical oxidants for the Louisiana portion of Air Quality Control Region (AQCR) 106 which includes all of southern Louisiana.

The State has been ordered to prepare and submit by July 1, 1977,* a revision containing:

1. All achievable emission limitations that are needed to provide for the attainment of the national standard for photochemical oxidants, and

2. A demonstration of the effect on air quality concentra tions of such measures.

If additional control measures such as land use and transportation measures are needed for attainment of the national standard, the State will submit by July 1, 1978:

*The state was granted a six-month extension to December 15, 1977. Major changes submitted to the EPA include the lifting of certain exemptions in Section 22 and A22 of the Louisiana Air Control Regulations including crude oil and condensate.

TABLE B.2-11 Louisiana ambient air quality standards in addition to NAAQS.

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Dustfall	1 Month	20 tons/sq. mile	----
Coeffient of Haze (coh)	Annual (Geometric mean)	0.6 coh/1,000 linear feet	----
	Annual (Arithmetic mean)	0.75 coh/1,000 linear feet	----
	24-hour	1.50 coh/1,000 linear feet	----
Sulfur Dioxide (SO_2)	Annual (Arithmetic mean)	---	60 $\mu g/m^3$ (0.03 ppm)
	24-hour[(a)]	---	260 $\mu g/m^3$ (0.10 ppm)
Sulfur Acid Mist, Sulfur Trioxide or any combination thereof	Annual (Arithmetic mean)	4 $\mu g/m^3$	----
	24-hour [(b)]	12 $\mu g/m^3$	----
	1-hour[(b)]	30 $\mu g/m^3$	----
Total Oxidants	Annual (Arithmetic mean)	58.8 $\mu g/m^3$ (0.03 ppm)	58.8 $\mu g/m^3$
	4-hour [(a)]	98.0 $\mu g/m^3$ (0.05 ppm)	98.0 $\mu g/m$ (0.05 ppm)

(a) Not to be exceeded more than once per year.

(b) Not to be exceeded over 1% of the time.

1. Such measures for attainment of the standard for photo chemical oxidants, and

2. A demonstration that the control strategy will attain the standard for photochemical oxidants.

As a result of the current status of the Louisiana SIP, neither vapor emissions from crude oil storage nor those from crude oil transfer operations are regulated at this time. Although it is impossible to predict with certainty if any control measures will be required when the final EPA-approved SIP is promulgated, it is possible to gain an insight into the probable approach which may be taken toward crude oil storage and transfer operations by examining the recently proposed EPA (1976b) revision to the Texas SIP for the Houston-Galveston AQCR.

Like Louisiana, the Texas SIP is currently in a state of disapproval because of the inability to meet the primary standard for photochemical oxidants. The proposed EPA strategy for achieving the NAAQS for photochemical oxidants is to control reactive hydrocarbon emissions. Additional controls considered necessary for the Houston/Galveston area include crude oil storage controls (floating roof tanks or vapor recovery system) and ship and barge vapor recovery (gasoline loading only).

Floating roof storage/surge tanks are specified for the Capline Group, and are considered by EPA to be the best available control technology. The technology for vapor control and recovery systems for marine terminal crude oil transfer operations has been developed, but there has been relatively little application of it. Since the SIP does not presently require such systems to be employed, the feasibility design upon which this EIS is based does not include them. This was done so that the document would reflect a worst case analysis of the impacts. However, the working designs for the facilities are still being formulated, and inclusion of a vapor recovery system for marine terminal operations is being considered.

Another requirement of the SIPs, to meet the NAAQS, is new source review. The most recent ruling from EPA regarding new source review has established the emissions offset (EPA, 1976c). Under this provision, new sources are required to show that emissions from the new source plus

SIP-required reductions from existing sources equal a net decrease in emissions. That is, the new source should not delay progress toward achieving the NAAQS in non-attainment air quality control regions. However, this regulation applies only to permanent onshore facilities and is expected to exclude new sources with "potential" emissions less than 100 tons/year. Since double-seal floating roof tanks are planned for the Capline SPR Program, "potential" emissions from new sources would be less than 100 tons/year. DOE has been advised by EPA that the offset policy is under review, and that a clarification will be forthcoming in the near future. DOE will take any necessary actions consistent with this clarification.

B.2.3.3.2 Existing Air Quality

The Louisiana Air Control Commission (LACC) routinely monitors air quality in the state and several sampling sites are located in the general vicinity of the proposed Capline distribution system. The locations of these stations are shown in Figure B.2-14. Selected air quality data from these stations for the period 1972 through 1974 are summarized in Table B.2-12.

Although the period of record is short, these data indicate that air quality has improved in this region between 1972 and 1974. This trend is particularly notable in the particulate and SO_2 levels. During 1972, almost all stations listed were in violation of the annual particulate standard, but in 1974 only Metaire and Donaldsonville recorded annual mean particulate values in excess of the national and state primary standard of 75 $\mu g/m^3$. Although none of the stations were in violation of the annual SO_2 standard in 1972, there was nevertheless a sizeable decline in the annual mean SO_2 levels in 1973 and 1974 at most stations. The maximum 24-hour SO_2 averages were all considerably below the standard during 1973 and 1974. The annual mean NO_2 and oxidant levels were also below appropriate standards in this region. Hydrocarbon monitoring was not conducted.

Preliminary summaries of 1975 and 1976 LACC air quality data indicate a continuing decrease in levels of SO_2, NO_2, and particulates at most sampling locations. Particulate data during 1975 at several LACC sampling stations in the region are presented in FES 76-5. These data indicate

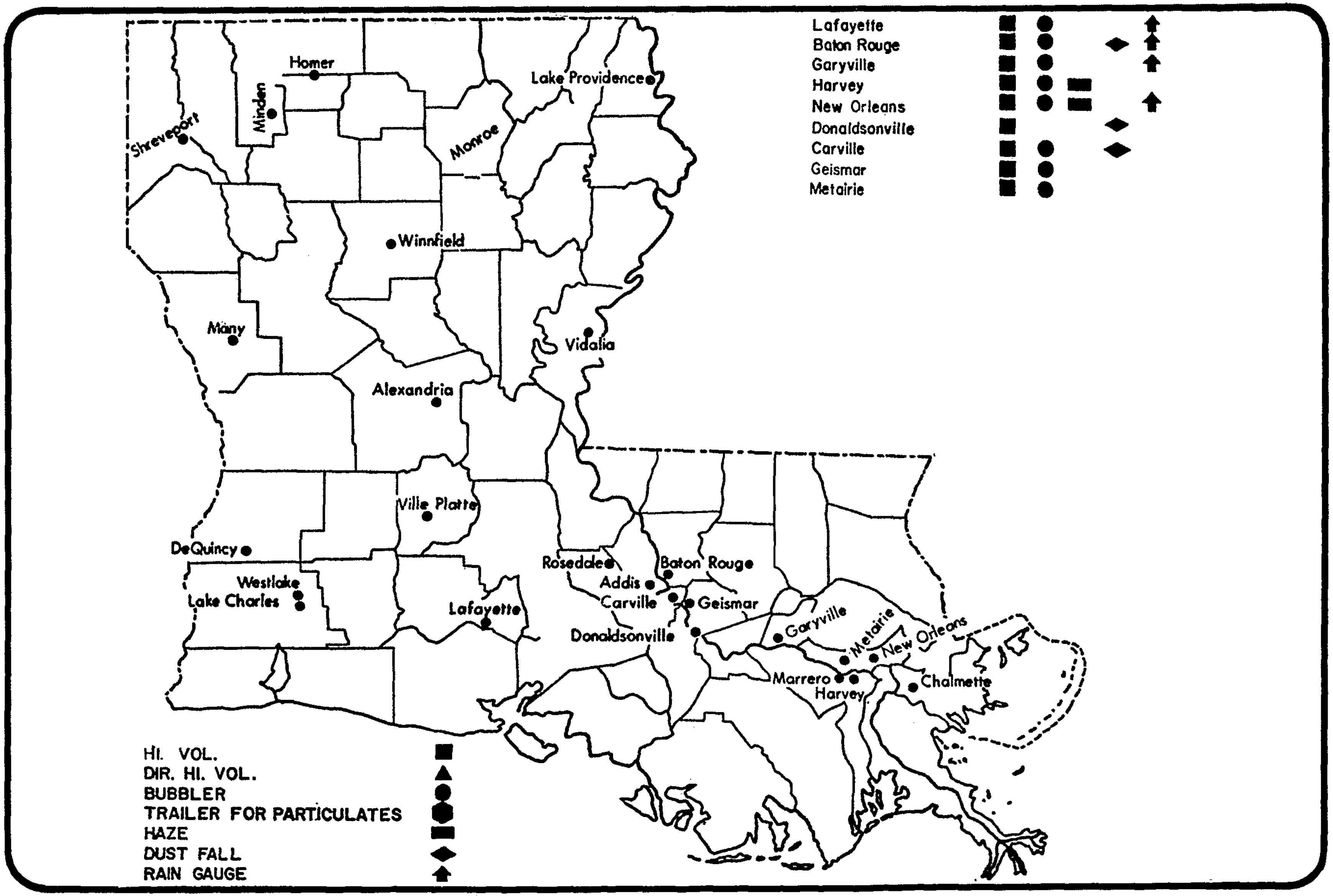


FIGURE B.2-14 Louisiana air sampling network.

TABLE B.2-12 Summary of LACC air quality sampling in the region ($\mu g/m^3$).

LOCATION	TOTAL SUSPENDED PARTICULATES						SULFUR DIOXIDE						NITROGEN DIOXIDE			PHOTOCHEMICAL OXIDANTS(a)		
	Annual Geometric Mean			Maximum 24-Hour Average			Annual Arithmetic Mean			Maximum 24-Hour Average			Annual Arithmetic Mean			Annual Arithmetic Mean		
	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972	1973	1974	1972	1973	1974
New Orleans	82	77	74	-(b)	197	143	19	5	8	-	26	56	66	70	72	10	12	8
Harvey	81	65	58	-	134	157	13	8	5	-	41	51	44	58	68	10	8	8
Metairie	76	74	76	-	167	158	24	5	3	-	18	21	72	70	54	10	10	6
Garyville	85	68	45	-	147	91	13	3	3	-	6	11	[38](c)	42	34	[6]	8	6
Donaldsonville	104	92	78	-	561	288	24	3	3	-	23	32	44	46	40	10	8	6
Geismar	-	[90]	61	-	[150]	241	-	3	3	-	24	16	-	38	42	-	6	6
Carville	58	[43]	44	-	[115]	125	[13]	[5]	5	-	[24]	19	[36]	[32]	46	[8]	[12]	6
Baton Rouge	106	95	64	-	168	230	29	37	[29]	-	-	[181]	-	-	[68]	-	-	[8]
LSU (Baton Rouge)	[54]	61	59	-	126	149	[8]	8	8	-	51	61	[50]	56	58	[10]	10	8
Lafayette	78	79	66	-	164	176	16	5	3	-	12	45	60	64	70	12	8	10
Primary Standards	75			260			80			365			100			58.8		

(a) Measured as Ozone

(b) Dash indicates data is missing or not available

(c) Brackets indicate more than three months of missing data during the year.

that particulate levels are highest in the late fall and winter; however, all values were below the primary standards. Oxidant data presented in these documents for Baton Rouge show that the 1-hour standard was occasionally exceeded during 1975.

Neither the U.S. EPA nor the State of Louisiana monitor for hydrocarbon concentrations in southern Louisiana. However, these data have been reported as a result of a short-term ambient air quality study performed in Lafourche Parish (Kem-Tech, 1975). In this study, air quality was monitored continuously for several days in September and December in two non-urban areas of coastal Louisiana. One of the monitoring sites was located in a fresh marsh area of Lafourche Parish, 45 miles southeast of St. James; the other site was located within 5 miles of the Gulf of Mexico, 75 miles southeast of St. James. Analysis of the data taken at these stations indicates that the NAAQS for non-methane hydrocarbons (NMHC) (160 $\mu g/m^3$ during a 3-hour period) was exceeded 39 percent of the time in September and 16 percent of the time in December. Maximum and average one-hour values ($\mu g/m^3$) were as follows:

	Marsh Site		Coastal Site	
Sampling Period	Maximum	Average	Maximum	Average
September 1974	812	275	472	174
December 1974	360	125	83	71

The report concluded that, although based on limited data, the NAAQS for non-methane hydrocarbons (NMHC) is probably exceeded quite frequently in southern Louisiana. However, these hydrocarbons were generally felt to be of the non-reactive type, and thus not precursors of ozone formation. The NAAQS for NMHC is intended only as an indirect control in the ultimate formation of ozone; no relationship to public health has been established.

Other measurements have shown that NMHC levels in excess of the 3-hour standard may occur in the Gulf of Mexico, over 100 miles from shore (Richardson and others, 1973).

Photochemical oxidant levels for 1975 at New Orleans, Baton Rouge, and Lake Charles are listed in Table B.2-13. These are the three closest stations for which the most recent photochemical oxidant data are available.

TABLE B.2-13 Photochemical Oxidants - 1975 data[a] (in parts per million).

	2nd Highest Hourly Concentration	Annual Arithmetic Mean
New Orleans	.094	.011
Lake Charles	.174	.013
Baton Rouge	.170	.016
Federal and State Standards	.08[b]	.03

[a] Lafayette, Louisiana and Donaldsonville, Louisiana data are not available.

[b] 1 hour concentration not to be exceeded more than once per year.

Source: Medal, Leonard, 1976. Louisiana Air Quality Control Commission, personal communication, November 1976.

These data indicate that all three stations exceeded the state and national 1-hour standard of 0.08 ppm (160 $\mu g/m^3$) more than once during 1975, whereas all sites were below the Louisiana annual standard of 0.03 ppm (80 $\mu g/m^3$).

Air quality stations near industrialized areas such as New Orleans and Baton Rouge should not be considered representative of air quality conditions in rural areas, but rather as extreme levels that might be reached under unfavorable dispersion conditions. Under these conditions, high levels of pollutant concentrations may occur 50 or more miles downwind. Furthermore, the St. James Terminal is a focal point for extensive crude oil distribution and movement and thus is an important source for hydrocarbon emissions in the region. This aspect is also true, but to a lesser degree, for the oil and gas production and storage at other locations in the region. Thus, it is likely that the area traversed by the proposed oil distribution system is exposed, at least on occasion, to atmospheric pollutant concentrations nearly equal to the highest measured in southern Louisiana.

B.2.3.3.3 Emissions Inventory

The sites of the Capline Group and marine terminals are located in five parishes in southern Louisiana, which, together with 34 other parishes constitute the Louisiana portion of AQCR 106.

Estimates of the annual rate of particulate, SO_x, NO_x, hydrocarbon, and CO emissions in the parishes most likely to be affected by the proposed oil distribution system are shown in Table B.2-14 (EPA, 1976). These data indicate that East Baton Rouge, St. James, and St. Mary parishes have the highest total emissions. The five proposed storage sites are located in Iberia, Iberville, Assumption, and Lafourche parishes, while the terminal location is in St. James Parish. The largest regional sources of pollutants are petroleum refineries and petrochemical industries. Transportation sources and the combustion of industrial fuels are also important sources.

TABLE B.2-14 Emissions inventory (tons/year) for selected parishes in AQCR 106.

Parish	Particulates	SO_x	NO_x	Hydrocarbons	CO
Ascension	8,026	14,200	23,551	23,225	20,426
Assumption	657	211	2,611	2,856	11,103
East Baton Rouge	55,841	75,533	68,473	162,619	263,552
Iberia	3,584	5,661	6,540	5,120	25,219
Iberville	17,200	79,752	48,233	11,167	27,648
Jefferson	4,162	2,561	45,472	39,792	109,511
Lafayette	1,201	408	5,036	7,411	38,191
Lafourche	850	338	5,169	5,837	27,243
Livingston	1,975	101	2,281	5,130	26,402
Plaquemines	2,678	19,437	13,486	9,995	14,194
St. Charles	6,328	25,935	56,851	66,718	46,551
St. James	166,007	31,120	14,519	22,870	10,637
St. John the Baptist	332	263	2,705	2,800	8,993
St. Martin	648	177	2,899	5,166	13,670
St. Mary	2,672	1,927	12,597	9,676	261,548
Terrebonne	903	409	5,879	6,603	29,315
Vermilion	943	235	3,291	4,357	22,346

Source: U.S. Environmental Protection Agency, 1976d

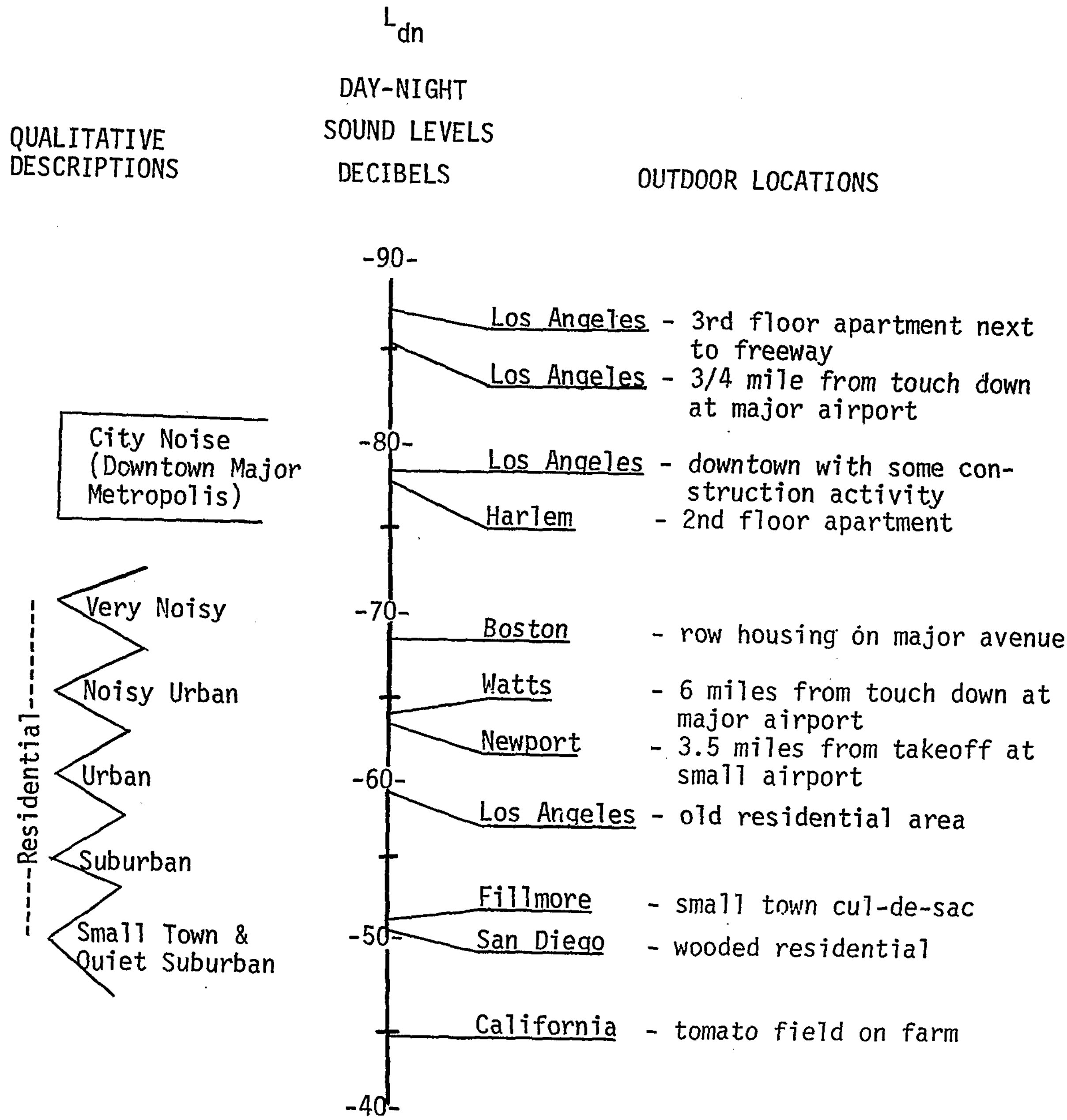
B.2.4 Background Ambient Sound Levels

Background ambient sound levels in the Capline Group region are reflective of an area having a wide diversity of sound sources. These background levels and sound sources are directly related to the land uses found within an area. Ambient sound surveys made under earlier studies at similar sites and principal land uses identified from topographic maps and site visit reports have formed the basis for the ambient sound estimations in this report. Salt mine and chemical plants, barge traffic on the Intracoastal Waterway, and human activity in population centers produce sound levels typical of a suburban or urban-industrial zone in some areas. In the majority of areas, however, noise levels are typical of marshland areas with low population densities. Principal noise sources in these areas are insect and animal noise, wind noise, and traffic on local roads.

Figure B.2-15 (EPA, 1974a) presents sound levels for various locations from rural to busy urban areas.

The U.S. Environmental Protection Agency has identified levels for limits of L_{dn} requisite for the protection of public health and welfare. The State of Louisiana has no noise regulation pertaining to the construction or operation of the proposed project.

According to EPA information, outdoor ambient sound levels, L_{dn}, below 55 dB will not degrade public health and welfare.



Source:

Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," U.S. EPA, 550/9-74-004, March, 1974.

FIGURE B.2-15 Examples of outdoor day-night sound level in dB measured at various locations.

SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY[a]

Effect	Level	Area
Hearing loss	$L_{eq(24)} \leq 70$ dB	All areas
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoors in residential areas and farms and other outdoor areas where peopl spend widely varying amounts of time, and othe places in which quiet is basis for use.
	$L_{eq(24)} \leq 55$ dB	Outdoor areas where peopl spend limited amounts of time, such as school yard playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas
	$L_{eq(24)} \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

$L_{eq(24)}$ represents the sound energy averaged over a 24-hour period.

L_{dn} represents the L_{eq} with a 10 dB nighttime weighting.

[a] Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, "U.S. EPA, 550/9-74-004, March 1974.

Terminology used in this and subsequent sections on noise is defined in the following glossary of acoustical terminology.

GLOSSARY OF ACOUSTICAL TERMINOLOGY

The range of sound pressures that can be heard by humans is very large. This range varies from two ten-thousand-millionths (2×10^{-10}) of an atmosphere for sounds barely audible to humans to two thousandths (2×10^{-3}) of an atmosphere for sounds which are so loud as to be painful. The decibel notation is used to present sound levels over this wide physical range. Essentially, the decibel unit compresses this range to a workable range using logarithms. It is defined as:

$$\text{Sound pressure level (dB)} - 20 \log_{10} \left(\frac{P}{P_0}\right)$$

where P_0 is a reference sound pressure required for a minimum sensation of hearing.

Zero decibels is assigned to this minimum level and 140 decibels to sound which is painful. Thus, a range of more than one million is expressed on a scale of zero to 140.

The human ear does not perceive sounds at low frequencies in the same manner as those at higher frequencies. Sounds of equal intensity at low frequency do not seem as loud as those at higher frequencies. The A-weighted network is provided in sound analysis systems to simulate the human ear. A-weighted sound levels are expressed in units of dBA. These levels in dBA are used by the engineer to evaluate hearing damage risk (OSHA) or community annoyance impact and are also used in federal, state, and local guidelines and ordinances.

Sound is not constant in time. Statistical analysis is used to describe the temporal distribution of sound and to compute single number descriptors for the time-varying sound. The following are commonly used statistical descriptors:

L_{90} - This is the sound level exceeded 90 percent of the time during the measurement period and is often used to represent the "residual" sound level.

L_{50} - This is the sound level exceeded 50 percent of the time during the measurement period and is used to represent the "median" sound level.

L_{10} - This is the sound level exceeded 10 percent of the time during the measurement period and is often used to represent the "intrusive" sound level.

L_{eq} - This is the equivalent steady sound level which provides an equal amount of acoustic energy as the time-varying sound.

L_d - Equivalent sound level, L_{eq}, for the daytime period (0700-2200) only.

L_n - Equivalent sound level, L_{eq}, for the nighttime period (2200-0700) only.

L_{dn} - Equivalent day/night sound level, defined as:

$$L_{dn} = 10 \log_{10} ([15 \times 10^{L_d/10} + 9 \times 10^{(L_n + 10)/10)}]/24)$$

Note: A 10 dB correction factor is added to the nighttime equivalent sound level when computing L_{dn}.

B.2.5 <u>Ecosystems and Species</u>

The Southern Louisiana Delta Zone, formed primarily of alluvial deposits, covers an area of 8 million acres. The lowland physiography of this area has had a significant role in determining the wildlife that inhabits the region. Characterized by numerous swamps, marshes, lakes, and bays, this area of Louisiana provides a rich environment for an abundant wildlife resource (see Figure A.1-1). Freshwater and marine environments are common and assist in increasing the diversity of wildlife found in the area.

The deciduous swamps, bottomland forests, and marshes of the study area are considered ecologically sensitive in view of the resources they provide to highly diverse faunal groups. The ecosystems supported by these habitats are particularly sensitive to changes in salinity and surface and ground water levels.

The deciduous swamp provides suitable habitat for the southern bald eagle and the alligator, both of which are rare and endangered species. Marshes also provide habitat for the alligator as well as the peregrine falcon, another endangered species encountered in the study area during the migratory season.

Populations of recreationally and commercially important fish and wildlife species, in addition to hundreds of other species, are supported by the bottomland forest, swamp, and marsh ecosystems.

The following section describes the general ecosystems of southern Louisiana. These ecosystems occur in successive zones of varying widths throughout the delta zone.

B.2.5.1 Ecosystems

There are six ecosystems which have been identified for the southern Louisiana delta zone (Figure B.2-16) which correspond to the general units described in the Inventory of Basic Environmental Data - South Louisiana (U.S. Army Corps of Engineers, 1973a). These ecosystems include:

- Cleared land
- Bottomland forest
- Deciduous swamp
- Saline, brackish, intermediate, and freshwater marsh
- Estuarine and nearshore Gulf of Mexico waters.
- Rivers, inland waters, and freshwater wetlands.

Some of the major organisms characterizing these ecosystems are presented in Table B.2-15.

B.2.5.1.1 Cleared Land

Cleared land refers principally to crop, pasture, urban, suburban, and industrial land areas. Cropland acreages are located primarily along the Mississippi River and major drainageways. The reason for this distribution is due to the natural levees which were formed from the alluvial deposits of the Mississippi River and its tributaries. Generally, the vegetation production and carrying capacity of cleared land is less than that found in adjacent habitat types. Animal species common to the

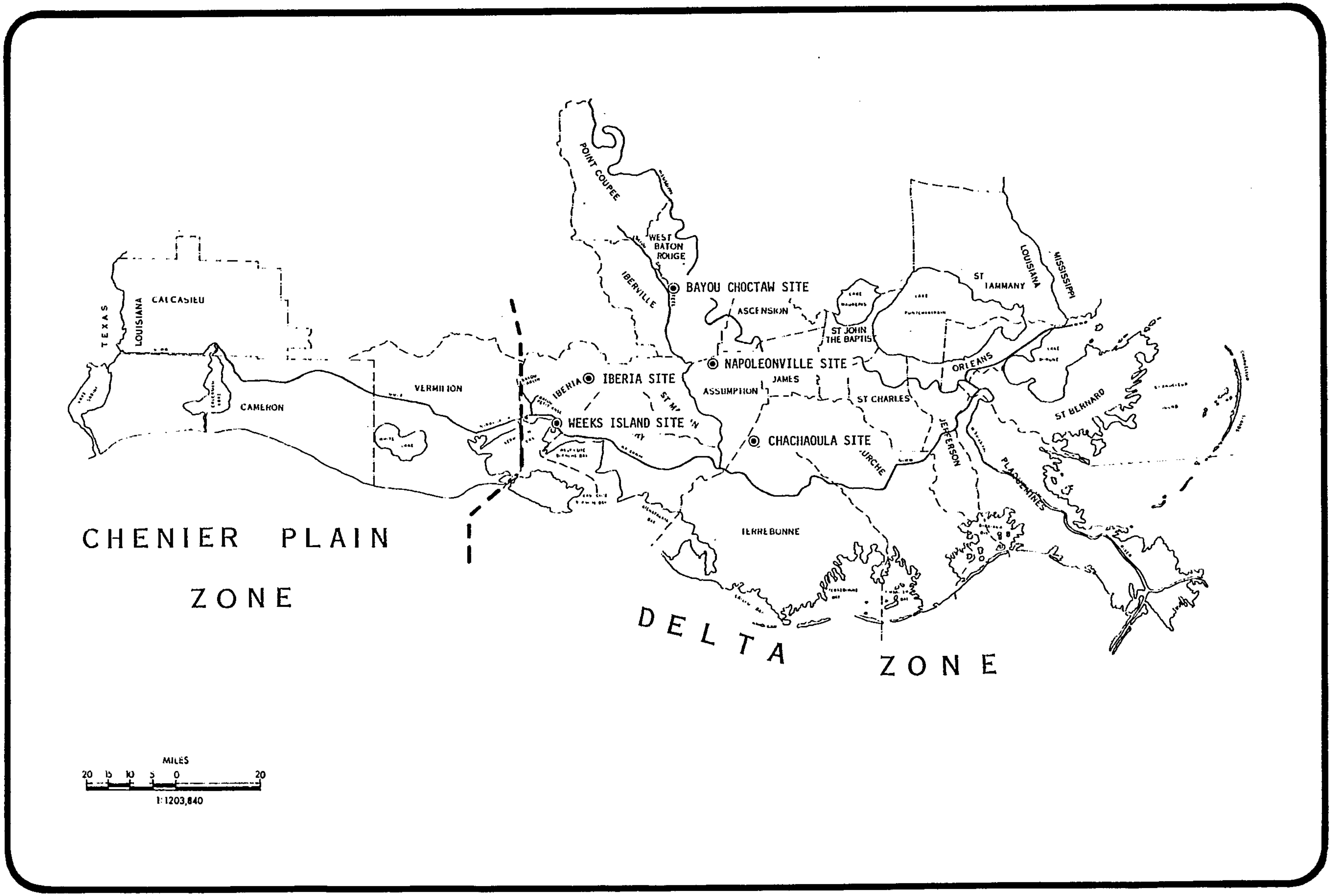


FIGURE B.2-16 Physiographic divisions of Coastal Louisiana showing Capline sites.

TABLE B.2-15 Typical fauna and flora of the region.

Ecosystem	Cleared Lands		Woodlands	Marshlands		Coastal and Inland Waters	
Vegetation Type	Croplands and Pasture Lands	Urban and sub-urban areas	Deciduous swamp and bottomland Forest	Saline Marsh	Intermediate and Brackish marsh	Fresh water and freshwater wetlands	Saline
Typical herbs and grasses	signal grass, goat-weed	St. Augustine carpet grass	sedges, spiderwort, panic grass	wire grass, three corner grass, coco, widgeon grass	wire grass, saw grass, wild millet	N/A	N/A
Typical shrubs	N/A	ornamentals	palmetto, elderberry, youpon, pawpaw	N/A	N/A	N/A	N/A
Typical trees	N/A	ornamentals	cypress, water tupelo, water oak	N/A	N/A	N/A	N/A
Typical mollusks and crustaceans	N/A	N/A	snails	Fiddler crabs, mud crabs, clams, snails, shrimp	snails, oysters, crabs clams, shrimp	clams, snails, crayfish	clams, oysters, shrimp, snails,crabs
Typical amphibians and reptiles	eastern garter snake ornate box turtle Gulf coast toad	woodhouses toad Gulfcoast toad squirrel treefrog e. garter snake	Mississippi ringneck snake, w. cottonmouth, yellow-bellied water snake, southern copperhead, Miss. mud turtle, Missouri slider, broad-headed skink, ground skink, dusky salamander, N. cricket frog, green tree-frog, upland chorus frog	banded water snake, green water snake, mud snake, marsh brown snake	mobile cooter, southern legged frog, broad-banded water snake, speckled king snake, western cottonmouth	southern leopard frog, bull frog, northern spring peaper, stinkpot, common snapping turtle, red-eared turtle, marbled salamander diamond back water snake, broad-banded water snake	diamond backed terapin river cooter, hawks-bill turtle, logerhead turtle, Atlantic ridley, leatherback
Typical fish	N/A	N/A	N/A	killfish, cyprinids, immature mullet spot	killifish, catfish, gar	bass, crappie, catfish, gar, buffalo,	mullet, anchovy, men-haden, seatrout, drum sea catfish
Typical birds	ducks, bobwhite, mourning dove, eastern meadowlarks, red-winged blackbirds, sparrow, horned lark, kill-deer, marsh hawk	starling, house sparrow, grackles, blackbirds, song-birds, sparrows	herons, egrets, ibises, wood-peckers, wood duck, warblers, woodcock, vultures, red-tailed and red-shouldered hawks, barred owl, thrushes, vieros, thrufted titmouse, Carolina chicadae, cardinal	waterfowl, herons, egrets, plovers, ibises, least-bitten, roseatespoonbill, rails, terns, gulls	herons, egrets, waterfowl, American coot, seaside sparrow, greater & lesser yellowlegs, terns, gulls	waterfowl, shorebirds, herons, egrets, marsh hawk	gulls, terns, water-fowl
Typical mammals	opossum, striped skunk, cotton rat, rice rat, fox squirrel	bats, opossum, squirrels, cotton-tail rabbit	gray and fox squirrels, swamp rabbit, raccoon, bobcat, gray fox, arradillo, nutria, mink, cotton mouse, white-footed mouse, white-tailed deer, opposum	raccoon, mink, otter, muskrat	mink, muskrat, otter, nutria, racoon, swamp rabbit	nutria, otter, mink, raccoon, bat, swamp rabbit	Atlantic bottle-nosed dolphin

cleared land habitat include, but are not limited to, meadow larks, killdeer, blackbirds, sparrows, other songbirds, hawks (*Buteo* spp.), rabbits, squirrels, skunks, and small rodents.

Lands devoted to agriculture within this cleared land category are primarily used for production of sugar cane, rice, cotton, soybeans, and truck crops. Pasturelands in the area generally consist of a mixture of introduced cool and warm season grasses and legumes. Commonly occurring species in pasture locations include signal grass and goatweed.

Urban and suburban developments in the area generally are located at higher elevations along natural levees. These areas are located near the major waterways or in areas that were previously major waterways during an earlier geologic time.

Industrial development is another use of cleared land. Primary industrialization centers around extractive petrochemical developments. Gas, oil, sulfur, and salt are the major products which have caused the development of the many well fields and refining operations scattered throughout the area.

B.2.5.1.2 Bottomland Forest

The bottomland forests of the area include both glade and hardwood bottoms which are seasonally flooded for several months and relatively dry for the remainder of the year. The forests of the hardwood bottoms are generally very dense with an abundance of understory trees, shrubs, and lianas. The bottomland forests of the study area appear to be predominantly of the oak-gum-cypress type and cover more than half of the land in the area. The forested portion of the study area is made up of hydrophytic species including bald cypress, sweet gum, eastern cottonwood, oaks, black willow, ash, red maple, boxelder, hackberry, pecan, and swamp tupelo. Palmetto is commonly found in the understory vegetation.

The bottomland forest of the study area provides a diverse wildlife population with excellent habitat. Mammal species which are likely inhabitants of the area include opossum, swamp rabbits, gray and fox squirrels, small rodents, nutria, raccoon, bobcat, armadillo, and white-tailed deer. Commercially and recreationally important inhabitants include rabbits, squirrels, furbearers, and deer. Avifauna which frequent the study area include red-tailed and red-shouldered hawks, owls, woodcock, woodpeckers, thrushes, vireos, finches, and warblers. The bottomland forest also provides suitable habitat for the endangered southern bald eagle. Likely occurring herpetofauna species within the bottomland forest ecosystem include the southern copperhead, ring-neck snake, ground skink, dusky salamander, upland chorus frog, green treefrog, and spring peeper.

B.2.5.1.3 Deciduous Swamp

The deciduous swamp of the study area is an alluvial swamp, and contains bald cypress and water tupelo as principal species. Commonly, near the swamp margins many other species of trees occur, forming a band of intergrading cover types which often make demarcation of the borders of the swamp highly subjective. The development and extent of the deciduous swamp is dependent on water level fluctuation.

In addition to the dominant overstory species previously mentioned, a rich understory flora is present. Major species include silver maple, red maple, water ash, pumpkin ash, and swamp tupelo. Other species consist of grasses, sedges, cattails, arrowheads, smartweeds, wild rice, pickerelweed, cutgrass, and spatterdock. Along the margins of the swamp, maidencane, water pennywort, water hyacinth, pickerelweed, alligatorweed, and bull tongue commonly occur.

Approximately 40 percent of the study area is deciduous swamp. Deciduous swampland is an important ecosystem due to its high productivity and the valuable habitat which it provides to many wildlife species. This habitat provides forage and cover for several commercially important fur-bearing mammals including the nutria, raccoon, and mink. Other mammal residents of the deciduous swamp ecosystem include swamp rabbits, gray and fox squirrels, small rodents, bobcats and white-tailed deer. Bird life is highly diverse in the bottomland deciduous swamps of Louisiana. Major bird groups representative of the ecosystem include waterfowl, herons, egrets, ibises, hawks, owls, woodpeckers, thrushes, vireos, finches, and warblers. Some herpetofauna species expected to occur in the swamps are the American alligator, western cottonmouth, yellow-bellied water snake, broad-headed skink, Mississippi mud turtle, dwarf salamander, green treefrog, and northern cricket frog. Commercially important species of the swamp include snapping turtles and the bullfrog.

B.2.5.1.4 Saline, Brackish, and Intermediate Marsh (Coastal Marshes)

As one proceeds inland from the Gulf of Mexico, the coastal marshes may be divided into three distinct belts consisting of salt marsh, brackish marsh, and intermediate marsh. These belts lie along the Louisiana coastline in varying widths. The spatial distribution of the marshes is determined by factors such as surface elevation, soil characteristics, drainage, and tidal action. Each belt may be considered as a separate and unique ecosystem that produces tremendous amounts of plant and animal biomass (St. Amant, 1959).

The saline marsh occupies the land immediately adjacent to the bays and open waters of the gulf and is subject to daily ebb and flow. Freshwater drainage has a relatively small effect on salinity. A fairly low diversity of vegetation grows abundantly in the salt marsh year-round. Vegetative productivity is high; much of the partially decomposed plant material (detritus) is flushed into the bays and open waters, rather than left to accumulate in the marsh as peat. A diverse and abundant community of animals inhabits the salt marsh during the year. Many species of marine animals use the salt marsh periodically as a feeding and nursery ground. Fishing and wading birds are abundant, especially adjacent to open water bodies.

The brackish marshes of the study area have salinities ranging from 10 to 20 parts per thousand (ppt) - lower than the saline marshes, but higher than the intermediate marshes. The brackish marsh is characterized by a lowland vegetation cover of wiregrass, three-cornered grass, coco, and widgeongrass. Waterfowl and furbearing species utilize this type of marsh heavily, but not as extensively as the intermediate marsh.

The intermediate marshes of the study area have low salinities and are seasonally inundated. They occur in the topographic depressions, and their characteristic vegetation consists of wiregrass, sawgrass, wild millet, bullwhip, and bull tongue. This diversity of plant life is greater than that found in brackish marshes, and for this reason the intermediate marsh is generally a more valuable resource for wildlife than the brackish marsh.

The coastal marshes provide high concentrations of nutrients that are cycled through the ecosystem and are made available to the organisms in the system according to their positions in the food chain. As a result of this rich nutrient supply, the coastal marsh system supports high productivity of organic matter, and a large diversity of both plants and animals.

The coastal marshes provide the base for the fur industry in Louisiana, the number one state in fur production in the United States. Major furbearing species of the coastal marshes include muskrat, nutria, mink, otter, and raccoon. Muskrat and mink are most common within the intermediate and brackish marshes. Nutria and raccoon prefer the bottomland swamps and marshes. The estimated fur catch by species per 1000 acres of coastal marsh is presented in Table B.2-16. Other mammal species expected to occur in the coastal marshes are presented in Table B.2-17.

The coastal marsh bird population is probably one of the most diverse in the entire United States. The marshes provide resources for a large number of wading birds and shorebirds, particularly during the winter months and migration periods. Some of the common bird groups include gulls, terns, herons, egrets, ibises, plovers, sandpipers, and rails. In the spring and summer, mottled ducks utilize the brackish marshes. Saline marshes are least utilized by waterfowl (Palmisano, 1972). A list of birds occurring in the study region is presented in Table B.2-18.

Amphibians and reptiles expected to occur in the coastal marshes are presented in Table B.2-19. Some expected common residents include western cottonmouth, banded water snake, green water snake, mud snake, mobile cooter, and southern leopard frog. Turtles are the most common herpetofauna species of the open water habitats.

TABLE B.2-16 Estimated fur catch per 1000 acres of coastal marsh.

Species	Saline		Brackish		Intermediate		Fresh	
	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
Muskrat	b	b	84.4	6,477.7	97.5	513.9	78.5	646.8
Nutria	b	b	86.4	191.1	284.9	499.6	512.7	884.4
Mink	b	b	1.1	12.8	.9	11.9	2.1	14.2
Raccoon	b	b	b	15.6	b	6.3	b	31.0
Otter	b	b	.2	.7	.4	1.3	.5	1.3

[a] Mean values determined from recent records. Maximum values are an average of long term maximum catch figures.

[b] Inadequate records

Source: Palmisano (1972).

TABLE B.2-17 Amphibians and reptiles likely to occur in the region.

Common Name (*Scientific Name*)	Occurrence in[b] Project Area	General Habitat[a] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Lesser Siren (*Siren intermedia*)	b	X	X	X		X	X		X			Throughout
Three-Toed Amphiuma (*Amphiuma tridactyuum*)	b	X	X	X		X	X		X			Throughout except Florida parishes
Small-Mouthed Salamander (*Ambystoma texanum*)	c	X	X				X		X			Throughout
Mole Salamander (*Ambystoma talpoideum*)	d		X									Throughout except SW corner and extreme N
Marbled Salamander (*Ambystoma opacum*)	b	X	X				X					Throughout
Spotted Salamander (*Ambystoma maculatum*)	c	X	X	X		X	X		X			Throughout except SW corner
Newt (*Diemictylus viridenscens*)	c	X	X			X	X		X			Throughout
Dusky Salamander (*Desmograthus fuscus*)	b	X				X	X					Throughout
Dwarf Salamander (*Manculus quadridigitatus*)	b					X	X					Throughout except extreme NW corner
Northern Cricket Frog (*Acris crepitans*)	b	X	X	X		X	X		X			Throughout
Spring Peeper (*Hyla crucifer*)	b		X			X	X	X		X		Throughout
Green Treefrog (*Hyla cinerea*)	b	X	X			X	X		X	X	X	Throughout
Squirrel Treefrog (*Hyla Squirella*)	b					X	X	X		X	X	Throughout except extreme NW corner
Gray Treefrog (*Hyla versicolor*)	c	X	X			X	X		X	X		Throughout
Bird-Voiced Treefrog (*Hyla avevoca*)	d	X				X		X				Southern half
American Alligator (*Alligator mississipiensis*)	b	X	X	X	X	X						Throughout
Common Snapping Turtle (*Chelydra serpentira*)	a	X	X	X		X			X			Throughout
Alligator Snapping Turtle (*Macroclemys temmincki*)	b	X	X	X								Throughout
Stinkpot (*Sternothaerus odoratus*)	b	X	X	X		X	X		X			Throughout
Keel-Backed Musk Turtle (*Sternothaerus carinatus*)	b	X	X	X		X						Throughout
Pond Slider--Red-eared turtle (*Chrysemys scripta*)	a	X	X	X		X	X		X			Throughout
River Cooter (*Chrysemys concinns*)	b	X			X							Throughout

TABLE B.2-17 continued.

Common Name (*Scientific Name*)	Occurrence in[b] Project Area	General Habitat[a] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Cooter (*Chrysemys floridana*)	b	X	X	X		X			X			Throughout
Chicken Turtle (*Deirochelys reticularia*)	b	X	X	X								Throughout
Atlantic Green Turtle (*Chelonia mydas*)	d											Coastal waters
Hawkbill Turtle (	d				X							Coastal waters
Loggerhead Turtle (*Caretta caretta*)	d				X							Coastal waters
Woodhouse's Toad (*Bufo woodhousei*)	b	X	X			X	X		X			Throughout
Gulf Coast Taod (*Bufo valliceps*)	b	X	X	X		X	X		X			Southern half
Chorus Frog (*Pseudacris triseriata*)	b	X	X	X		X	X		X	X		Throughout
Eastern Narrow-Mouthed Toad (*Gastrophryne carolinensis*)	b	X	X	X		X	X		X		X	Throughout
Bullfrog (*Rana catesbeiana*)	b	X	X	X		X	X		X			Throughout
Big Frog (*Rana grylio*)	b	X	X	X		X	X		X			Southern third
Green or Bronze Frog (*Rana clamitans*)	b	X	X	X		X	X		X			Throughout
Leopard Frog (*Rana pipiens*)	b	X	X	X		X	X		X			Throughout
Common Mud Turtle (*Kindsternon subrubrum*)	a	X	X	X		X			X			Throughout
Box Turtle (*Terrapene caroline*)	c	X	X				X	X	X			Throughout
Diamondback Terrapin (*Malaclemys terrapin*)	c			X	X							Coastal areas
Mississippi Map Turtle (*Graptemys kohni*)	a	X	X			X	X		X			Throughout except Florida parishes
Painted Turtle (*Chrysemys picta*)	b	X	X	X		X	X		X			East of Mississippi River and Atchafalaya River
Atlantic Ridley (*Lepicodhelys kempi*)	d				X							Coastal waters
Leatherback (*Dermochelys coriacea*)	d				X							Coastal waters
Spiny Softshell (*Trionyx spinifer*)	b	X	X	X		X			X			Throughout
Smooth Softshell (*Trionyx muticus*)	b	X	X	X								Throughout
Green Anole (*Anolis carolinensis*)	a	X	X	X		X	X	X	X	X	X	Throughout
Fence Lizard (*Sceloporus undulatus*)	d						X	X	X	X		Throughout

TABLE B.2-17 continued.

Common Name (Scientific Name)	Occurrence in[b] Project Area	General Habitat[a] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Six-Lined Racerunner (*Cnemidophorus sexlineatus*)	d						X	X	X			Throughout
Ground Skink (*Lygosoma laterale*)	b	X		X		X	X		X			Throughout
Five-Lined Skink (*Eumeces fasciatus*)	b	X		X		X	X	X	X	X		Throughout
Broad-Headed Skink (*Eumeces laticeps*)	b					X	X	X		X	X	Throughout
Eastern Glass Lizard (*Ophisaurus ventralis*)	d						X		X			Florida parishes and SE area
Slender Glass Lizard (*Ophisaurus attenuatus*)	d						X	X	X			Throughout
Banded Water Snake (*Natrix fasciata*)	b	X	X	X	X	X	X		X			Throughout
Green Water Snake (*Natrix cyclopion*)	b	X	X	X	X	X	X		X			Throughout
Diamond-Backed Water Snake (*Natrix rhombifera*)	b	X	X	X		X	X		X			Throughout
Plain-Bellied Water Snake (*Natrix erythrogaster*)	d	X	X	X		X	X		X			Throughout
Graham's Water Snake (*Regina grahami*)	b	X	X	X		X						Throughout
Glossy Water Snake (*Regina rigida*)	a	X	X	X		X	X		X			Throughout
Brown Snake (*Storeria dekayi*)	b			X		X	X	X	X			Throughout
Red-Bellied Snake (*Storeria occipitomaculata*)	d					X	X					Throughout except Sabine drainage
Common Garter Snake (*Thamnopttis sirtalis*)	d	X	X	X			X	X	X			Throughout
Western Ribbon Snake (*Thamnopttis proximus*)	b	X	X	X		X	X		X			Throughout
Rough Earth Snake (*Virginia striatula*)	d						X		X			Throughout
Smooth Earth Snake (*Virginia valeriae*)	d						X		X		X	Throughout
Eastern Hognose Snake (*Heterodon platyrhinos*)	c			X		X	X		X		X	Throughout
Ringneck Snake (*Diadophis punctatus*)	c	X				X	X		X			Throughout
Mud Snake (*Farancia abacura*)	b	X	X	X	X	X	X		X			Throughout
Racer (*Coluber constrictor*)	b		X	X		X	X	X	X	X	X	Throughout
Coachwhip (*Masticophis flagellum*)	d					X	X	X	X			Throughout
Rough Green Snake (*Opheodrys aestivus*)	b	X	X	X		X	X	X	X	X		Throughout

TABLE B.2-17 continued.

Common Name (*Scientific Name*)	Occurrence in[b] Project Area	General Habitat[a] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Corn Snake (*Flaphe cuttaya*)	c						X	X	X		X	Southeastern two-thirds
Rat Snake (*Flaphe obsoleta*)	b	X	X	X		X	X	X	X	X		Throughout
Common King Snake (*Lampropeltis getulus*)	b	X	X	X		X	X	X	X			Throughout
Milk Snake (*Lampropeltis triargulum*)	d						X	X	X			Throughout
Scarlet Snake (*Cemophora coccinea*)	d					X	X	X	X			Eastern half
Eastern Coral Snake (*Micrurus fulvius*)	d		X			X	X	X	X			Throughout except Florida parishes
Copperhead (*Agkistrodon contortrix*)	b	X	X	X		X	X		X			Throughout
Cottonmouth (*Agkistrodon piscivorus*)	a	X	X	X		X	X	X	X			Throughout
Pigmy Rattlesnake (*Sistrurus miliarius*)	b	X	X	X		X	X					Throughout
Timber or Canebrake Rattlesnake (*Crotalus horridus*)	b						X		X			Throughout

a = 1. Streams and Rivers
2. Lakes and Ponds
3. Fresh Marsh
4. Salt Marsh or Sea
5. Swamp
6. Woods
7. Brush
8. Fields
9. Arboreal
10. Buildings

b = a abundant
b common
c uncommon
d rare

Source: U.S. Army Corps of Engineers, 1975

TABLE B.2-18 Birds likely to occur in the region.

Common Name (Scientific Name)	Occurrence in[a] Project Area	General Habitat 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Common Loon (Gavia immer)	e						X					Throughout
Horned Grebe (Podiceps auritus)	e						X					Southern Half
Eared Grebe (P. nigricollis)	c					X	X					Southwest Parts
Pied-Billed Grebe (Podilymbus podiceps)	b		X			X	X					Throughout
White Pelican (Pelecanus erythrorhynchos)	b					X	X		X			Coastal Areas
Brown Pelican (P. occidentalis)	d						X		X	X		Coastal Areas
Double Crested Cormorant (Phalacrocorax auritus)	b						X					Throughout
Anhinga (Anhinga anhinga)	b		X									Throughout
Magnificent Frigate-Bird (Fregata magnificens)	b						X		X	X		Coastal Areas
Great Blue Heron (Ardea herodias)	b		X		X	X					X	Throughout
Green Heron (Butorides virescens)	b		X			X	X					Throughout
Little Blue Heron (Florida caerulea)	b		X		X	X					X	Throughout
Cattle Egret (Bubulcus ibis)	a		X	X	X	X						Southern Half
Reddish Egret (Dichronanassa rufescens)	c					X	X		X	X		Coastal Areas
Great Egret (Casmerodius albus)	b		X		X	X	X				X	Throughout
Snowy Egret (Egretta thula)	b		X		X	X					X	Throughout
Louisiana Heron (Hydranassa tricolor)	b		X		X	X					X	Coastal Areas
Black-Crowned Night Heron (Nycticorax nycticorax)	b		X			X						Throughout
Yellow-Crowned Night Heron (Nyctanassa violacea)	b		X			X						Throughout
Least Bittern (Ixobrychus exilis)	b					X						Throughout
American Bittern (Botaurus lentiginosus)	c		X			X						Throughout
Wood Stork (Hycteria americana)	b		X			X	X					Throughout
White-Faced Ibis (Plegadis chini)	b		X		X	X						Coastal Areas

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in Project Area[a]	General Habitat 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
White Ibis (*Eudocimus albus*)	b		X		X	X						Southern Half
Canada Goose (*Branta canadensis*)	c				X	X	X				X	Coastal Areas
White-Fronted Goose (*Anser albifrons*)	c				X	X	X					Coastal Areas
Snow Goose (*Chen caerulescens*)	b				X	X	X					Throughout
Fulvous Tree Duck (*Dendrocygna bicolor*)	b				X	X						Coastal areas of SW Louisiana
Mallard (*Anas platyrhynchos*)	b		X			X	X					Throughout
Mottled Duck (*A. fulvigula*)	b				X	X	X					Coastal Areas
Gadwall (*A. strepera*)	e				X	X	X					Throughout
Pintail (*A. acuta*)	e				X	X	X					Throughout
Green-Winged Teal (*A. crecca*)	e					X	X					Throughout
Blue-Winged Teal (*A. discors*)	b					X	X					Throughout
Northern Shoveler (*A. clypeata*)	b				X	X	X					Throughout
American Wigeon (*A. americana*)	b				X	X	X					Throughout
Wood Duck (*Aix sponsa*)	b		X			X						Throughout
Redhead (*Aythya americana*)	b						X					Throughout
Ring-Necked Duck (*A. collaris*)	b						X					Throughout
Canvasback (*A. valisineria*)	c						X					Coastal Areas
Greater Scaup (*A. marila*)	c						X					Coastal Areas
Lesser Scaup (*A. affinis*)	b						X					Throughout
Common Goldeneye (*Bucephala clangula*)	c						X					Coastal Areas
Bufflehead (*B. albeola*)	c						X					Throughout
Oldsquaw (*Clangula hyemalis*)	d						X					Throughout

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in[a] Project Area	1	2	3	4	5	6	7	8	9	0	Range in Louisiana
		General Habitat										
White-Winged Sooter (Melanitta deglandi)	d						X					Southern Half
Ruddy Duck (Oxyura jamaicensis)	c					X	X					Throughout
Hooded Merganser (Lophodytes culcullatus)	c		X				X					Throughout
Common Merganser (Mergus merganser)	d						X					Throughout
Red-Breasted Merganser (M. serrator)	b						X					Throughout
Turkey Vulture (Cathartes aura)	a	X	X	X	X	X						Throughout
Black Vulture (Coragyps atratus)	b	X	X	X	X							Throughout Except Coastal Marshes
Mississippi Kite (Ictinia mississippiensis)	b		X									Throughout
Sharp-Shinned Hawk (Accipiter striatus)	c	X	X									Throughout
Cooper's Hawk (A. cooperii)	c	X	X	X								Throughout
Red-Tailed Hawk (Buteo jamaicensis)	b	X	X	X	X	X						Throughout
Red-Shouldered Hawk (Buteo lineatus)	b	X	X	X								Throughout
Broad-Winged Hawk (B. platypterus)	b	X	X									Throughout
Golden Eagle (Aquila chrysaetos)	d	X	X		X							Throughout
Bald Eagle (Haliaeetus leucocephalus)	d		X				X					Throughout
Marsh Hawk (Circus cyaneus)	b				X	X						Throughout
Osprey (Pandion haliaetus)	d					X	X					Throughout
Peregrine Falcon (Falco peregrinus)	d				X	X			X			Throughout
Merlin (F. columbarius)	d			X	X	X						Coastal Areas
American Kestrel (Falco sparverius)	b	X			X							Throughout
Bobwhite (Colinus virginianus)	b	X		X	X				X			Throughout
King Rail (Rallus elegans)	b					X						Throughout

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in Project Area[a]	General Habitat 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Clapper Rail (Rallus longirostris)	b					X						Coastal Areas
Virginia Rail (Rallus limicola	b				X	X						Coastal Areas
Sora (Porzana carolina)	b				X	X						Throughout
Yellow Rail (Coturnicops noveboracensis)	d				X	X						Southern Half
Purple Gallinule (Porphyrula martinica)	b		X		X	X	X					Throughout
Common Gallinule (Gallinula chloropus)	b		X			X	X					Throughout
American Coot (Fulica americana)	a		X			X	X					Throughout
American Oystercatcher (Haematopus palliatus)	d								X	X		Coastal Areas and Islands
Black-Necked Stilt(Wimantopus mexicanus)	b				X	X					X	Coastal Areas
American Avocet (Recurvirostra americana)	b				X	X					X	Coastal Areas Migrant Inland
Semipalmated Plover (Charadrius semipalmatus)	b								X	X	X	Coastal Areas Migrant Inland
Wilson's Plover (Charadrius wilsonia)	c								X		X	Coastal Areas
Killdeer (Charadrius vociferus)	a				X	X			X			Throughout
Piping Plover (Charadrius melodus)	c								X		X	Coastal Areas and Mississippi River
Snowy Plover (Charadrius alexandrinus)	c								X			Throughout
American Golden Plover (Pluvialis dominica)	b				X	X						Throughout
Black-Bellied Plover (Pluvialius squatarola)	b				X	X			X	X	X	Coastal Areas
Marbled Godwit (Limosa fedoa)	b				X	X			X	X		Coastal Areas
Whimbrel (Numenius phaeopus)	b				X	X			X		X	Coastal Areas

TABLE B.2-18 continued.

Common Name (*Scientific Name*)	Occurrence in Project Area[a]	General Habitat 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Long-Billed Curlew (*Numenius americanus*)	b				X	X				X	X	Coastal Areas
Upland Sandpiper (*Bartramia americana*)	b				X							Throughout
Greater Yellowlegs (*Tringa melanoleuca*)	b					X			X	X	X	Coastal Areas
Lesser Yellowlegs (*Tringa flavipes*)	b					X			X	X	X	Throughout
Solitary Sandpiper (*Tringa solitaria*)	b		X			X						Throughout
Willet (*Catoptrophorus semipalmatus*)	b					X			X		X	Coastal Areas
Spotted Sandpiper (*Actitis macularia*)	b					X			X			Throughout
Ruddy Turnstone (*Arenaria interpres*)	b								X	X		Coastal Areas
Wilson's Phalarope (*Steganopus tricolor*)	c				X				X	X	X	Throughout
American Woodcock (*Philohela minor*)	b	X	X		X							Throughout except Coastal Marshes
Common Snipe (*Capella gallinago*)	b				X	X						Throughout
Short-Billed Dowitcher (*Limnodromus griseus*)	b				X	X			X		X	Coastal Areas
Long-Billed Dowitcher (*Limnodromus scolopaceus*)	b				X	X			X		X	Throughout
Red Knot (*Calidris canutus*)	d								X	X		Coastal Areas
Sanderling (*Calidris alba*)	b								X	X		Coastal Areas
Semipalmated Sandpiper (*Calidris pusilla*)	b					X			X	X	X	Throughout
Western Sandpiper (*Calidris mauri*)	b					X			X	X	X	Throughout
Least Sandpiper (*Calidris minutilla*)	b				X	X			X	X	X	Throughout
White-Rumped Sandpiper (*Calidris fuscicollis*)	b				X				X	X	X	Throughout
Pectoral Sandpiper (*Calidris melanotos*)	b				X	X			X	X	X	Throughout
Dunlin (*Calidris alpina*)	b								X	X	X	Throughout

TABLE B.2-18 continued.

Common Name (*Scientific Name*)	Occurrence in Project Area[a]	General Habitat 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Stilt Sandpiper (*Micropalama himantopus*)	c										X	Throughout
Buff-Breasted Sandpiper (*Tryngites subruficollis*)	c				X	X						Throughout
Herring Gull (*Larus argentatus*)	b						X		X	X		Coastal Areas and Mississippi River
Ring-Billed Gull (*Larus delawarensis*)	a				X		X		X	X		Coastal Areas and Mississippi River
Laughing Gull (*Larus atricilla*)	a					X	X		X	X		Coastal Areas
Franklin's Gull (*Larus pipixcan*)	c				X		X					Coastal Areas Migrant Inland
Bonaparte's Gull (*Larus philadelphia*)	c						X		X	X		Throughout
Gull-Billed Tern (*Gelochelidon nilotica*)	c				X	X	X		X	X		Coastal Areas and Inlands
Forster's Tern (*Sterna forsteri*)	b					X	X		X	X		Throughout
Common Tern (*Sterna hirundo*)	b						X		X	X		Throughout
Least Tern (*Sterna albifrons*)	b						X		X	X		Throughout
Royal Tern (*Thalasseus maximus*)	b						X		X	X		Coastal Areas and Islands
Sandwich Tern (*Thalasseus sandvicensis*)	b						X		X	X		Coastal Areas and Islands
Caspian Tern (*Hydroprogne caspia*)	b					X	X		X	X		Throughout
Black Tern (*Chlidonias niger*)	b					X	X		X	X		Throughout
Black Skimmer (*Rynchops niger*)	b						X		X	X		Throughout
Rock Dove (*Columba livia*)	b							X				Throughout
White-Winged Dove (*Zenaida asiatica*)	d	X	X	X								Coastal Areas

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in Project Area[a]	General Habitat 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Mourning Dove (*Zenaida macroura*)	b	X	X	X	X			X				Throughout
Common Ground Dove (*Columbina passerina*)	c	X	X	X	X							Throughout
Yellow-Billed Cuckoo (*Coccyzus americanus*)	b	X	X	X	X							Throughout
Black-Billed Cuckoo (*Coccyzus erythropthalmus*)	c	X	X	X								Throughout
Groove-Billed Ani (*Crotophaga sulcirostris*)	d			X	X							Southern Half
Barn Owl (*Tyto alba*)	b	X	X		X			X				Throughout
Screech Owl (*Otus asio*)	b	X	X	X								Throughout
Great Horned Owl (*Bubo virginianus*)	b	X	X					X				Throughout
Burrowing Owl (*Speotyto cunigularia*)	d				X				X			Throughout
Barred Owl (*Strix varia*)	b	X	X									Throughout
Short-Eared Owl (*Asio flammeus*)	d				X	X						Throughout
Chuck-Will's-Widow (*Caprimulgus carolinensis*)	b	X	X									Throughout
Whip-Poor-Will (*Caprimulgus vociferus*)	d	X	X	X								Throughout
Common Nighthawk (*Chordeiles minor*)	b	X	X		X			X				Throughout
Apodidae (Swifts) (*Apodidae*)	b							X				Throughout
Chimney Swift (*Chaetura pelagica*)	b	X	X					X				Throughout

TABLE B.2-18 continued.

Common Name (*Scientific Name*)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Vaux's Swift (*Chaetura valusi*)	d											Southeastern one-third
Ruby-Throated Hummingbird (*Archilochus colubria*)	b	X	X	X								Throughout
Rufous Hummingbird (*Solasphorus rufus*)	d	X	X	X								Southern half
Belted Kingfisher (*Megaceryle alcyon*)	b		X			X	X					Throughout
Common Flicker (*Colaptes auratus*)	b	X	X		X							Throughout
Pileated Woodpecker (*Dryocopus pileatus*)	c	X	X									Throughout
Red-Bellied Woodpecker (*Centurus carolinus*)	b	X	X									Throughout
Red-Headed Woodpecker (*Melanerpes erythrocephalus*)	c	X	X									Throughout
Yellow-Bellied (*Sphyrapicus varius*)	b	X	X									Throughout
Hairy Woodpecker (*Dendrocopos villosus*)	b	X	X									Throughout
Downy Woodpecker (*Dendrocopos pubescens*)	b	X	X									Throughout
Red-Cockaded Woodpecker (*Dendrocopos borealis*)	d	X										Throughout
Eastern Kingbird (*Tyrannus tyrannus*)	b			X	X							Throughout
Western Kingbird (*Tyrannus verticalis*)	f				X	X						Throughout
Scissor-Tailed Flycatcher (*Muscivora forficata*)	d			X	X							Throughout
Great Crested Flycatcher (*Myiarchus crinitus*)	b	X	X									Throughout
Ash-Throated Flycatcher (*Myiachus cinerascens*)	d			X	X							Southern one-third
Eastern Phoebe (*Sayornis phoebe*)	b	X	X	X	X							Throughout
Yellow-Bellied Flycatcher (*Empidonax flaviventris*)	d	X	X	X								Throughout
Acadian Flycatcher (*Empidonax virescens*)	b	X	X									Throughout
Willow Flycatcher (*Empidonax traillii*)	f			X	X							Throughout
Least Flycatcher (*Empidonax minimus*)	b	X	X	X								Throughout
Eastern Wood Pewee (*Contopus virens*)	b	X										Throughout
Olive-Sided Flycatcher (*Nuttallornis borealis*)	d	X	X	X								Throughout
Vermilion Flycatcher (*Pyrocephalus rubinus*)	d				X		X					Throughout

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Hormed Lark (Eremophila alpestris)	d				X							Throughout
Tree Swallow (Iridoprocne bicolor)	b					X	X					Throughout
Bank Swallow (Riparia riparia)	c			X	X	X						Throughout
Rough-Winged Swallow (Stelgidopteryx ruficollis)	h			X			X					Throughout
Barn Swallow (Hirundo rustica)	b			X	X			X		X		Throughout
Cliff Swallow (Petrochelidon pyrrhonota)	c			X	X		X					Throughout
Purple Martin (Progne subis)	a			X	X			X				Throughout
Blue Jay (Cyanocitta cristata)	b	X	X	X	X							Throughout
Common Crow (Corvus brachyrhynchos)	b	X	X	X	X							Throughout except Coastal Marshes
Fish Crow (Corvus ossifragus)	a		X	X	X	X						Southern half
Carolina Chickadee (Parus carolinensis)	b	X	X									Throughout except Coastal Marshes
Tufted Titmouse (Parus bicolor)	b	X	X									Throughout except Coastal Marshes
Red-Breasted Nuthatch (Sitta canadensis)	d	X	X	X								Throughout except Coastal Marshes
Brown Creeper (Certhia familiaris)	c	X	X									Throughout
Mouse Wren (Troglodytes troglodytes)	b	X	X	X	X			X				Throughout
Winter Wren (Troglodytes troglodytes)	d	X	X	X								Throughout
Bewick's Wren (Thryomanes bewickii)	b			X								Throughout
Carolina Wren (Thryothorus ludovicianus)	b	X	X	X								Throughout
Long-Billed Marsh Wren (Cistothorus platensis)	a					X						Throughout
Short-Billed Marsh Wren (Cistothorus platensis)	b				X	X						Throughout
Mockingbird (Mimus polyglottos)	a	X	X	X	X			X				Throughout
Gray Catbird (Dumetella carolinensis)	b		X	X								Throughout
Brown Thrasher (Toxostoma rufum)	a	X	X	X	X							Throughout

TABLE B.2-18 continued.

Common Name (*Scientific Name*)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
American Robin (*Turdus migratorius*)	b	X	X	X	X							Throughout
Wood Thrush (*Hylocichla mustelina*)	b	X	X	X								Throughout except Coastal Marshes
Hermit Thrush (*Catharus guttatus*)	b	X	X	X								Throughout
Swainson's Thrush (*Catharus ustulatus*)	b	X	X	X								Throughout
Gray-Cheeked Thrush (*Catharus minimus*)	c	X	X	X								Throughout
Veery (*Catharus fuscescens*)	b	X	X	X								Throughout
Eastern Bluebird (*Sialis sialis*)	b			X	X							Throughout
Blue-Gray Gnatcatcher (*Polioptila caerulea*)	b	X	X	X								Throughout
Golden-Crowned Kinglet (*Regulus satrapa*)	d	X	X	X								Throughout
Rudy-Crowned Kinglet (*Regulus calendula*)	a	X	X	X								Throughout
Water Pipit (*Anthus spinoletta*)	b				X	X						Throughout
Cedar Waxwing (*Bombycilla cedrorum*)	b	X	X	X								Throughout
Loggerhead Shrike (*Lanius lodovicianus*)	b				X							Throughout
Starling (*Stwinus vulgaris*)	b	X	X	X	X							Throughout
White-Eyed Vireo (*Vireo griseus*)	a			X								Throughout
Yellow-Throated Vireo (*Vireo flavifrons*)	b	X	X	X								Throughout
Solitary Vireo (*Vireo solitarius*)	d	X	X									Throughout
Red-Eyed Vireo (*Vireo olivaceus*)	b	X	X									Throughout
Philadelphia Vireo (Vireo philadelphicus)	f	X	X	X								Throughout
Black-and-White Warbler (*Mniotilta varla*)	b	X	X	X								Throughout
Golden-Winged Warbler (*Vermivora chrysoptera*)	c	X	X	X								Throughout
Blue-Winged Warbler (*Vermivora pinus*)	c	X	X	X								Throughout
Tennessee Warbler (*Vermivora peregrina*)	b	X	X	X								Throughout
Orange-Crowned Warbler (*Vermivora celata*)	b	X	X	X								Throughout

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in Project Area[a]	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Nashville Warbler (Vermivora ruficapilla)	d	X	X	X	X							Throughout
Northern Parula (Parula americana)	a	X	X	X								Throughout
Yellow Warbler (Dendroica petechia)	g	X	X	X							X	Throughout
Chestnut-Sided Warbler (Dendroica pensylvanica)	c			X								Throughout
Cerulean Warbler (Dendroica cerulea)	b		X	X								Throughout
Pine Warbler (Dendroica pinus)	c	X	X	X						X		Throughout
Yellow-Throated Warbler (Dendroica dominica)	b	X	X	X								Throughout
Black-Throated Gray Warbler (Dendroica nigrescens)	d	X		X								Southern half
Black-Throated Green Warbler (Dendroica virens)	b	X	X	X								Throughout
Cape May Warbler (Dendroica tigrina)	d	X	X	X								Throughout
Blackburnian Warbler (Dendroica fusca)	c	X	X									Throughout
Magnolia Warbler (Dendroica magnolia)	b	X	X									Throughout
Yellow-Rumped Warbler (Dendroica coronata)	b	X	X	X								Throughout
Palm Warbler (Dendroica palmarum)	b	X	X	X								Throughout
Blackpoll Warbler (Dendroica striata)	c	X	X									Throughout
Bay-Breasted Warbler (Dendroica castanea)	c	X	X									Throughout
American Redstart (Setophaga ruticilla)	b	X	X									Throughout
Ovenbird (Seiurus aurocapillus)	b			X								Throughout
Northern Waterthrush (Seiurus noveboracensis)	c	X	X	X								Throughout
Louisiana Waterthrush (Seiurus motacilla)	b	X	X	X								Throughout
Swainson's Warbler (Limnothlypis swainsonii)	c		X	X	X							Throughout
Worm-Eating Warbler (Helmitheros vermivorus)	c	X										Throughout
Brothonotary Warbler (Protonotaria citrea)	b		X									Throughout
Common Yellowthroat (Geothylpis trichas)	b		X	X		X						Throughout

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Kentucky Warbler (*Oporornis formosus*)	b	X	X	X								Throughout
Hooded Warbler (*Wilsonia citrina*)	b		X	X								Throughout
Wilson's Warbler (*Wilsonia pusilla*)	f			X								Throughout
Canada Warbler (*Wilsonia canadensis*)	b			X								Throughout
Yellow-Breasted Chat (*Icteria virens*)	b			X								Throughout
House Sparrow (*Passer domesticus*)	a				X			X				Throughout
Bobolink (*Dolicnonyx oryzivorus*)	c			X	X	X						Throughout
Eastern Meadowlark (*Sturnella magna*)	b				X							Throughout
Western Meadowlark (*Sturnella neglecta*)	c				X							Throughout
Yellow-Headed Blackbird (*Xanthocepalus xanthocepalus*)	a				X	X						Throughout
Orchard Oriole (*Icterus spurius*)	b	X	X	X	X							Throughout
Northern Oriole (*Icterus galbula*)	b	X	X	X	X							Throughout
Rusty Blackbird (*Euphagus carolinus*)	b	X	X	X	X							Throughout
Brewer's Blackbird (*Euphaqus cyanocephalus*)	b	X	X	X	X							Throughout
Great-Tailed Grackle (*Cassidix mexicanus*)	b			X	X	X						Southern half
Boat-Tailed Grackle (*Cassidix major*)	b			X	X	X						Coastal areas
Common Grackle (*Quiscalus quiscula*)	b		X	X	X							Throughout
Brown-Headed Cowbird (*Molothrus ater*)	b			X	X							Throughout
Scarlet Tanager (*Piranga olivacea*)	b	X	X									Throughout
Summer Tanager (*Piranga rubra*)	b	X	X									Throughout
Northern Cardinal (*Cardinalis cardinalis*)	b	X	X	X	X							Throughout
Rose-Breasted Grosbeak (*Pheucticus ludovicianus*)	c	X	X	X								Throughout
Blue Grosbeak (*Guiraca caerulea*)	b	X		X	X							Throughout
Indigo Bunting (*Passerina cyanea*)	b			X								Throughout except Coastal Marshes

TABLE B.2-18 continued.

Common Name (*Scientific Name*)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Painted Bunting (*Passerina ciris*)	b	X	X	X								Throughout
Dickcissel (*Spiza americana*)	b				X							Throughout
Purple Finch (*Carpodacus purpureus*)	c	X	X	X								Throughout
American Goldfinch (*Spinus tristis*)	b			X	X							Throughout
Rufous-Sided Towhee (*Pipilo erythrophthalmus*)	b			X								Throughout
Savannar Sparrow (*Passerculus sandwichensis*)	b			X	X	X						Throughout
Grasshopper Sparrow (*Ammodramus savannarum*)	c			X	X							Throughout
Le Conte's Sparrow (*Ammospiza leconteii*)	b			X	X							Throughout
Sharp-Tailed Sparrow (*Ammospiza caudacuta*)	b					X						Throughout
Seaside Sparrow (*Ammospiza maritima*)	b					X			X			Coastal areas
Vesper Sparrow (*Pooecetes gramineus*)	b			X	X							Throughout
Lark Sparrow (*Chondestes grammacus*)	c			X	X							Throughout
Bachmanis Sparrow (*Aimophila aestivalis*)	c	X		X								Throughout except Coastal Marshes
Barkleyed Junco (*Junco hyemalis*)	b	X	X	X								Throughout
Chipping Sparrow (*Spizella passerina*)	b	X		X	X							Throughout except Coastal Marshes
Field Sparrow (*Spizella pusilla*)	b			X	X							Throughout
White-Crowned Sparrow (*Zonotrichia leucophrys*)	c			X	X							Throughout
White Throated Sparrow (*Zonotrichia albicollis*)	b			X								Throughout
Fox Sparrow (*Passerella iliaca*)	c			X	X							Throughout
Lincoln's Sparrow (*Melospiza lincolnii*)	c			X	X							Throughout
Swamp Sparrow (*Melospiza georgiana*)	b		X		X	X						Throughout
Song Sparrow (*Melospiza melodia*)	b			X								Throughout
Chestnut-Collared Longspur (*Calcarius ornatus*)	d				X							Western half

TABLE B.2-18 continued.

Common Name (Scientific Name)	Occurrence in[a] Project Area	General Habitat[b] 1 2 3 4 5 6 7 8 9 0	Range in Louisiana

[a]OCC in Proj. Area

a = abundant
b = common
c = uncommon
d = rare
e = common in winter, rare in summer
f = rare in spring, common in fall
g = common in spring, common in fall
h = rare in winter, common in summer

[b]General Habitat

1 = Upland Forest
2 = Bottomland Forest
3 = Brush
4 = Fields
5 = Marsh
6 = Buildings
7 = Fresh Water
8 = Marine

Sources: American Birds (1959, 1960, 1968, and 1971) American Ornithologists Union (1961 and 1973); Lowery (1974); Palmisana (1969)

TABLE B.2-19 Mammals likely to occur in the region.

Common Name (Scientific Name)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Virginia Oppossum (Didelphis virginiana)	b	X	X	X	X	X	X					Throughout
Least Shrew (Cryptotis parva)	b			X	X	X						Throughout except East Coastal Marshes
Short-Tailed Shrew (Blarina brevicauda)	b	X	X	X	X	X						Throughout except Coastal Marshes
Eastern Mole	c	X	X	X	X							Throughout except Coastal Marshes
Southeastern Myotix (Myotis austroriparius)	b	X	X	X	X	X	X					Throughout except S.W. corner
Eastern Pipistrelle (Pipistrellus subflarus)	b	X	X	X	X	X	X					Throughout except Coastal Marshes
Big Brown Bat (Estesicus fuscus)	c	X	X	X	X	X	X					Throughout except Coastal Marshes
Red Bat (Lasiurus borealis)	b	X	X	X	X	X	X					Throughout except East Coastal Marshes
Seminole Bat (Lasiurus seminolus)	b	X	X	X	X	X						Throughout
Hoary Bat (Lasiurus cinereus)	d	X	X									Throughout except Coasta Marshes
Northern Yellow Bat (Lasiurus intermedius)	d	X	X	X	X	X						Southern half
Evening Bat (Nycticeius humeralis)	b	X	X	X	X	X	X					Throughout except Coastal Marshes
Rafinesque's Big-Eared Bat (Plecotus rafinesquii)	d	X	X	X	X	X	X					Throughout except Coastal Marshes
Brazilian Free-Tailed Bat (Tadarida brasiliersis)	b	X	X	X	X	X	X					Throughout except Coastal Marshes
Northern Raccoon (Procyon lotor)	b	X	X	X	X	X						Throughout
Long-Tailed Weasel (Mustela frenata)	b	X	X	X	X	X						South-Central and North areas
North American Mink (Mustela vison)	b		X	X	X	X						Throughout

TABLE B.2-19 continued.

Common Name (*Scientific Name*)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
Nearctic River Otter (*Lutra canadensis*)	b		X	X	X	X						Throughout
Striped Skunk (*Mephitis mephitis*)	b	X	X	X	X	X	X					Throughout except East Coastal Marshes
Red Fox (*Vulpes fulva*)	c	X	X	X	X	X						Throughout except Coastal Marshes
Gray Fox (*Urocyon cinereoargenteus*)	b	X	X	X	X							Throughout except Coastal Marshes
Bobcat (*Lynx rufus*)	b	X	X	X	X							Throughout except Coastal Marshes
Fox Squirrel (*Sciurus niger*)	b	X	X									Throughout except Coastal Marshes
Gray Squirrel (*Sciurus carolinensis*)	b	X	X									Throughout except Coastal Marshes
Southern Flying Squirrel (*Glancomys volans*)	b	X	X	X	X	X	X					Throughout except Coastal Marshes
Fulvous Harvest Mouse (*Reithrodontomys fulvescens*)	b			X	X							Throughout except Coastal Marshes
Cotton Mouse (*Peromyscus gossypinus*)	b	X	X	X								Throughout except Coastal Marshes
Eastern Wood Rat (*Neotoma floridana*)	b		X	X			X					Throughout except Coastal Marshes
Marsh Rice Rat (*Oryzomys palustris*)	b		X		X	X						Throughout
Hispid Cotton Rat (*Sigmodon hispidus*)	b			X	X	X						Throughtou
Common Muskrat (*Ondatra zibethica*)	b		X			X						Coastal Marsh ESR Brackish,also N.E.
Norway Rat (*Rattus norvegicus*)	b						X					Throughout except Coastal Marshes
Roof Rat (*Rattus rattus*)	b						X					Throughout

TABLE B.2-19 continued.

Common Name (Scientific Name)	Occurrence in[a] Project Area	General Habitat[b] 1	2	3	4	5	6	7	8	9	0	Range in Louisiana
House Mouse (Mus musculus)	b			X	X		X					Throughout except Coastal Marshes
Nutria Nutria (Myocastor coypus)	b		X			X						Throughout
Eastern Cottontail (Sylvilagus floridanus)	b	X	X	X	X							Throughout except Coastal Marshes
Swamp Rabbit (Sylvilagus aquaticus)	b	X	X			X						Throughout
White-Tailed Deer (Odocoileus viginianus)	b	X	X	X	X	X						Throughout
Nine-Banded Armadillo (Dasypus novemcinctus)	b	X	X	X	X							Throughout except East Coastal Marshes
Atlantic Bottle Nosed Dolphin (Tursiops truncatus)	b								X			Coastal Waters

[a]OCC in Proj. Area

a = abundant

b = common

c = uncommon

d = rar.

[b]General Habitat

1 = Upland Forest

2 = Bottomland Forest

3 = Brush

4 = Fields

5 = Marsh

6 = Buildings

7 = Fresh Water

8 = Marine

9 =

0 =

-Range from Lowery and Burt & Grossenheider
-Habitat from Burt & Grossenheider, Lowery, Palmisano, and GSRI
-Names from Lowery and Burt & Grossenheider

Source: Burt (1964); Gulf South Research Institute 1973; Lowery (1974); Palmisana (1971)

B.2.5.1.5 Estuarine and Nearshore Gulf of Mexico Waters

The coastal region of Louisiana is interlaced with numerous lakes and ponds, large bays, rivers, streams, and man made canals. Several major bays (estuaries) located in the region include Vermilion Bay, West Cote Blanche Bay, East Cote Blanche Bay, Atchafalaya Bay, and Caillou Bay (Figure B.2-10). These water bodies are important components of the aquatic ecosystems that act as large nursery grounds and habitats for an array of recreationally and commercially important shellfish and finfish. Louisiana waters are very productive for shrimp, crabs, oysters, and several species of fish. The high productivity of these bays is primarily due to their ability to act as nutrient traps, the nutrient and waste transportation benefits provided by tidal cycles, and the presence of a variety of producers which are capable of almost year-round photosynthesis (Odum, 1971). Odum (1971) has estimated gross primary productivity in a generalized estuary to be about 20,000 kcal/ m^2/year.

The open bays, estuaries, and tidal passes provide habitat and migration routes for many species of fish and benthos; intertidal and subtidal oyster beds are prominent structures forming macrohabitat for many small organisms. Mud flats are rich in benthos. Receding tides flush detritus out of the salt marshes into the bays, and out into the gulf to enrich offshore waters. Most spawning of estuarine-dependent species occurs offshore during fall and winter. Larvae often become part of the temporary zooplankton community offshore and in the bays until spring migration into the marshes to feed on concentrated sources of detritus and other food supplies.

Phytoplankton are probably the most important primary producers in the offshore coastal waters. The offshore area provides little habitat for larger plants (macrophytes) since solid substrate is generally lacking, and in the littoral (shallow) zone, the sandy or mud bottom is subject to scouring due to wave action. Thus, the floating phytoplankton, which do not need the solid substrate required by the macrophytes, are the important primary producers in deep water. Approximately 100 species of phytoplankton are common to the coastal waters of Louisiana (Table B.2-20).

TABLE B.2-20 Phytoplankton identified from regional Louisiana coastal waters[a].

Coccoid Blue-Green

- *Microcystis* sp.
- Unidentified

Filamentous Blue-Green

- *Anabaena* sp.
- *Merismopedia* sp.
- *Merismopedia major*
- *Merismopedia elegans*
- *Merismopedia punctata*
- *Merismopedia convoluta*
- *Merismopedia glauca*
- *Oscillatoria* sp.
- *Gleocapsa* sp.
- *Gomphosphaeria* sp.
- *Gomphosphaeria aponina*
- *Gomphosphaeria wichurae*
- *Aphanocapsa* sp.
- *Meriso* sp.
- *Diplococcus* sp.
- *Polycystis* sp.
- *Chrococcus limnetics*

Coccoid Green

- Chlorella-like
- *Tetraedron triyonum*
- *Protococcus*-like

Flagellated Green

- *Chlaymydomonas*-like
- *Gonium* sp.
- Unidentified

Filamentous Green

- Unidentified

Centric Diatoms

- *Cyclotella* sp.
- *Cyclotella striata*
- *Cyclotella meneghiniana*
- *Cyclotella stelligera*
- *Coscinodiscus* sp.
- *Coscinodiscus radiatus*
- *Melosira* sp.

Pennate Diatoms

- *Amphora* sp.
- *Amphora ovalis*
- *Amphora angusta*
- *Navicula* sp.
- *Navicula hungarica*
- *Navicula longa*
- *Navicula cuspidata*
- *Nitzschia* sp.
- *Nitzschia closterium*
- *Nitzschia constricta*
- *Nitzschia paradoxa*
- *Nitzschia sigmaformis*
- *Nitzschia vermicularis*
- *Nitzschia obtusa*
- *Nitzschia sigma*
- *Cymbella* sp.
- *Cymbella ventricosa*
- *Gyrosigma* sp.
- *Gyrosigma peisonis*
- *Gyrosigma macrum*
- *Gyrosigma fasciola*
- *Epithemia* sp.
- *Epithemia argus*
- *Fragilaria* sp.
- *Synedra* sp.
- *Mastogolois* sp.
- *Cocconeus* sp.
- *Cocconeus placentula*
- *Pinnularia biceps*
- *Pinnularia viridis*
- *Gomphonema* sp.
- *Hantzchia* sp.
- *Diploneus* sp.
- *Diploneus smithii*
- *Mastogolois* sp.
- *Pleurosigma delicatulum*
- *Rhapalodia gibberula*
- *Asterionella* sp.

Dinoflagellate

- *Procentrium maximum*
- *Procentrium minimum*
- *Procentrium compressa*
- *Peridinium* sp.
- *Peridinium limbatum*
- *Amphidinium* sp.
- *Ceratium* sp.

TABLE B.2-20 continued.

Dinoflagellate (Cont.)

Glendinium sp.
Gymnodinium sp.
Unidentified

Euglenoids

Euglena sp.
Phacus sp.
Trachelmonas sp.
Trachelmonas schauinslandii
Trachelmonas rotunda
Trachelmonas volvocina

Others

Scenedesmus sp.
Scenedesmus acuminatus
Scenedesmus armatus
Scenedesmus quandricauda
Scenedesmus abundans
Ankistrodesmus sp.
Crucigenia sp.
Crucigenia spiculata
Crucidenia tetrapedia
Closterium kitzingii
Closterium setaceum
Calycomonas ovalis

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[a]Louisiana State University, 1975.

Simmons and Thomas (1962) described phytoplankton assemblages from the eastern Mississippi delta associated with two different salinity regimes. A low salinity regime of river water had an assemblage dominated by two species each of the genera Cyclotella, Melosira, and Navicula. A high salinity regime in gulf waters had an assemblage composed of Asterionella japonica, Nitzschia seriata, Skeletonema costatum, Thalassionema nitzochioides, Thalassiothrix frauenfeldii, and three species of Chaetoceros. The nearshore Gulf regime had higher diversity due to mixing of freshwater genera and marine genera. As a result of the wide salinity range within this region, phytoplankton are capable of tolerating wide salinity ranges. During the spring and summer, diatoms and dinoflagellates are the dominant genera. With the onset of cold weather, diatoms become the dominant genera. Phytoplankton biomass undergoes large seasonal spatial and temporal fluctuations. Maximum densities occur from June through August and minimum densities occur from October to March.

Copepods are the dominant zooplankton in the coastal marshes, bays, and nearshore Gulf. Acartia is the most common genus and is responsible for a large percentage of zooplankton biomass. At least 45 taxa of zooplankton were collected by Juneau (1975) during a study of coastal waters in the region (Table B.2-21). Commercially important organisms occurring in the zooplankton during this study included eggs and larvae of brown and white shrimp, and blue crabs. Other common zooplankton are ostracods, cladocerans, fish and invertebrate eggs and larvae, ctenophores, polychaete larvae, arrow worms, tunicates, and amphipods. In general zooplankton maxima occur during the months of May, June, September and November. Minima have been noted in December through March and June through December (LOOP, 1975; Gillespie, 1971).

Benthic organisms are an important link in the food chain as they are a major source of food for many species of fish. Polychaete worms, snails, clams, oysters, shrimps, and crabs are typical benthic organisms inhabiting the region. During a regional survey (Dames & Moore, 1975) polychaetes (worms) were numerically dominant (69 percent), phoronids (worms) were second most abundant (18 percent), and pelecypods (clams)

TABLE B.2-21 Zooplankton identified from regional Louisiana coastal waters[a].

Phylum Coelenterata
Class Hydrozoa

Phylum Aschelminthes
Class Nematoda

Phylum Annelida
Class Polychaeta

Phylum Ectoprocta
Bryozoa

Phylum Mollusca
Class Gastropoda
snails

Class Pelecypoda
clams
oyster larvae

Class Cephalopoda
squids

Phylum Arthropoda
Class Crustacea
Penilia avirostrus
Daphnia longispinna

Order Calanoida
Acartia tonsa
Acartia spp.
Temora turbinata
Labidocera aestiva
Centropages furcatus
Centropages sp.
Paracalanus sp.
Eucalanus spp.
Eurytemora hirundoides

Order Cyclopoida
Halicyclops fosteri

Order Caligoida
Caligus sp.

Order Arguloida
Argulus sp.

Order Stomatopoda
Squilla sp.

Order Cumacea
Leptocuma minor

Order Isopoda
Sphaeroma quadridentatum
Aegathoa oculata
Ancinus depressus
Synidotea sp.
Edotea montosa

Order Amphipoda
Cerapus tubularis
Cerapus sp.
Carinogammarus mucronatus
Atylus sp.

Order Decapoda
Penaeus aztecus
Penaeus sp.
Penaeus setiferus
Acetes carolinae
Lucifer faxoni
Palaemonetes pugio
Palaemonetes vulgaris
Leander tenuicornis
Callinectes sapidus

Phylum Chaetognatha
Sagitta sp.
Sagitta hispida

[a]Juneau, 1975

made up the third most abundant group (7 percent). During this survey, at least 23 different taxa of invertebrates were collected (Table B.2-22) and are representative of typical benthic assemblages of the region.

The estuarine and offshore areas of the southern Louisiana region are very productive environments for fish. This is partially related to the proximity of the vast marsh complex which serves as a breeding ground, nursery, and/or feeding ground for many fish of the region and the high primary and secondary productivity of the nearshore Gulf. As a result, Louisiana led all states in the volume of commercial fish catch and ranked third in the value of catch. The major commercial fisheries include menhaden, white and brown shrimp, oysters and blue crab. Other abundant invertebrates, though not of economic importance include the brief squid and seabob. Some of the more abundant fish include the bay anchovy, Gulf menhaden, Atlantic croaker, sea catfish, rock seabass, Atlantic cutlassfish, fringed flounder, spot, sand seatrout, Gulf butterfish, Atlantic bumper, blue spotted searobin and Atlantic threadfin. Day et al. (1973) and Juneau (1975) identified nearly 100 species of fish in the region (Table B.2-23). During periods of low salinity in the estuaries and bays, several species of freshwater fish may be found, including catfish, sunfish, crappie, and gar as the most abundant.

Gunter (1961) reported a gradual decrease in numbers of species occurring in open waters as compared with nearshore or estuarine waters. The study of Day et al. (1973) confirms that greater amounts of fish and biomass are found nearshore in spring and summer compared to open waters. In fall or winter, more fish are found in deep bay waters. The largest number of species in the bay occur in late summer or early fall.

Few mammals are expected to occur in the open water habitats of the bays and gulf.

B.2.5.1.6 Rivers, Inland Waters, and Freshwater Wetlands

Major bodies of open freshwater within the study region are the Mississippi River, Atchafalaya River, Intracoastal Waterway, Lake Verret, Lake Palourde, and Lake Fausse Point. In addition, there are numerous canals and bayous (such as Bayou Teche, Grand Bayou, Bayou Lafourche,

TABLE B.2-22 Benthic macroinvertebrates collected from regional Louisiana coastal waters[a].

Phylum Coelenterata
- Class Scyphozoa: Medusae
- Class Anthozoa: Sea anemones

Phylum Nemertinea: Ribbon worms

Phylum Aschelminthes
- Class Nematoda: Roundworms

Phylum Annelida
- Class Polychaeta: Sandworms

Phylum Mollusca
- Class Gastropoda:
  - *Cancellaria reticulata*
  - *Oliva sayana*
  - *Polinices duplicate*
  - Other gastropods
- Class Pelecypoda:
  - *Mulina* sp.
  - Other pelecypods

Phylum Arthropoda
- Class Crustacea
  - Subclass Malacostraca
    - Order Isopoda: Isopods
    - Order Amphipoda; Amphipods
    - Order Decapoda: Decapods
      - *Clibanarius vittatus* (hermit crab)
      - Other hermit crabs
      - Spider crabs
      - Unidentified crabs
      - Snapping shrimp - *Crangon* sp.
      - Sea bobs - *Xiphopenaeus* sp.
      - Unidentified shrimp

Phylum Phoronida

Phylum Chaetognatha
- Arrow worm - *Sagitta* sp.

Phylum Echinodermata
- Class Ophiuroidea: Brittle star

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[a]Dames & Moore, 1975.

TABLE B.2-23 Fish of the regional Louisiana coastal waters[a].

Atlantic stingray	Skilletfish
Shark	Halfbeak
Alligator gar	Atlantic needlefish
Ladyfish	Gulf killifish
Speckled worm eel	Longnose killifish
Shrimp eel	Bayou killifish
Skipjack herring	Rainwater killifish
Gulf menhaden	Diamond killifish
Gizzard shad	Sheepshead minnow
Threadfin shad	Sailfin molly
Atlantic threadfin herring	Mosquitofish
Striped anchovy	Rough silverside
Dusky anchovy	Tidewater silverside
Bay anchovy	Disky pipefish
Inshore lizard fish	Chain pipefish
Channel catfish	Gulf pipefish
Blue catfish	White crappie
Gafftopsail catfish	Sand perch
Southern hake	Branded pygmy sunfish
Gulf toad fish	Crevalle jack
Crested cusk-eel	Atlantic bumper
Atlantic midshipman	Leatherjacket
Sea catfish	Rock seabass

TABLE B.2-23 continued.

Lookdown	Great barracuda
Atlantic moonfish	Atlantic threadfin
Florida pompano	Freckled blenny
Sheepshead	Fat sleeper
Pinfish	Lyre goby
Spotfin mojarra	Green goby
Tripletail	Sharptail goby
Freshwater drum	Darter goby
Black drum	Freshwater goby
Red drum	Violet goby
Banded drum	Naked goby
Star drum	Harvestfish
Silver perch	Gulf butterfish
Spotted seatrout	Spotted scopionfish
Sand seatrout	Bighead searobin
Atlantic croaker	Bay whiff
Spot	Lined sole
Southern kingfish	Hogchoker
Atlantic spadefish	Fringed flounder
Atlantic cutlassfish	Southern flounder
King mackerel	Blackcheek tonguefish
Striped mullet	Southern puffer
White mullet	Least puffer
	Bluespotted searobin

[a]Day et al., 1973; Juneau, 1975.

and Bayou Choctaw), and many small ponds, swamps, marshes, and backwater areas (Figure B.2-10). The heavy vegetation and low topography of the region contribute to excellent habitat for a wide variety of aquatic organisms.

Macrophytes (aquatic plants with complex structures; i.e., leaves, roots, and stems) are the dominant aquatic vegetation in the region and serve as a primary food source for many insects, mammals, and birds. In places, the water surface is completely covered with a blanket of duckweed.

Benthic (bottom dwelling) and suspended algae are abundant in the wetlands of the region. Many of the macrophytes contain growth of periphyton on their submerged portions. Besides being utilized as food by herbivorous fish, grazing zooplankton, snails, and insect larvae, benthic algae provide a considerable amount of detritus to the system upon their death and decay.

Zooplankton groups which are likely to occur in the wetlands are copepods, cladocerans, rotifers, ostracods, and amphipods. As primary and secondary consumers, zooplankters are an important intermediate link between primary producers and detritus, and other consumers.

Benthic invertebrates in wetlands of the region are dominated by dipterans, oligochaetes, and amphipods (U.S. Army Corps of Engineers, 1973a). Other benthic invertebrates perform an important function in the ecosystem by feeding on detritus, phytoplankton, and bacteria and by providing food for larger invertebrates and fish. The benthic invertebrate organisms are relatively immobile as a group, rendering them especially vulnerable to environmental stress.

The most common freshwater fish in the region are catfish, freshwater drum, largemouth bass, sunfish, crappie, buffalo, gar, mosquitofish, and several species of minnows. Chabreck (1976) estimated that a total of about 68 kinds of fish inhabit the region (Table B.2-24).

Several authors have reported that stocked and fertilized fish ponds and highly productive marsh waters can produce 200 to 500 pounds of fish per acre per year (Odum, 1971; Lantz, 1974). Lantz (1974)

TABLE B.2-24 Freshwater fish of the Atchafalaya Basin region[a].

Chestnut lamprey	Blackbullhead
Southern brook lamprey	Yellow bullhead
Paddlefish	Channel catfish
Spotted gar	Tadpole madtom
Longnose gar	Flathead catfish
Shortnose gar	Pirate perch
Alligator gar	Golden topminnow
Bowfin	Blackstripe topminnow
American eel	Blackspotted topminnow
Skipjack herring	Mosquitofish
Gizzard shad	Sailfin molly
Threadfin shad	Brook silverside
Grass pickerel	Mississippi silverside
Chain pickerel	Striped bass
Carp	Yellow bass
Cypress minnow	Flier
Speckled chub	Green sunfish
Golden shiner	Warmouth sunfish
Pallid shiner	Orangespotted sunfish
Emerald shiner	Bluegill
Red shiner	Dollar sunfish
Weed shiner	Longear sunfish
Blacktail shiner	Redear sunfish
Mimic shiner	Spotted sunfish
Pugnose minnow	Largemouth bass
Bullhead minnow	White crappie
River carpsucker	Black crappie
Creek chubsucker	Banded pygmy sunfish
Lake chubsucker	Bluntnose darter
Buffalo (smallmouth and largemouth)	Cypress darter
Black buffalo	Dusky darter

[a]source: Chabreck, 1976

TABLE B.2-24 continued.

Spotted sucker	River darter
Blacktail redhorse	Freshwater drum
Blue catfish	Striped mullet

reported fish biomass varying from 56 to slightly over 504 pounds per acre for four shallow lakes in south-central Louisiana. The average biomass during 1969 and 1970 was approximately 250 pounds per acre. Sunfish, catfish, suckers, and gizzard shad often constituted over 80 percent of the total biomass reported, which is probably representative of the annual fish productivity of the bayou-swamp-canal complex of southern Louisiana.

Freshwater wetlands provide resources for a number of permanent wildlife residents plus many part-time inhabitants. Mammal species found in and around the freshwater wetlands include otter, mink, raccoon, muskrat, and nutria. Major avian groups associated with the wetlands include waterfowl, herons, egrets, ibises, and shorebirds. Amphibian and reptile species expected to occur in the freshwater habitats include the American alligator, snapping turtles, red-eared turtle, water snakes, southern leopard frog, and bullfrog.

Millions of waterfowl in Louisiana make use of the coastal marshes as a winter habitat. Over 80 percent of the 2 million puddle ducks which winter in southeastern Louisiana are found in the freshwater marshes (Palmisano, 1972). Wintering puddle duck population estimates by species in mid-December 1976 for coastal Louisiana were: mallards, 816,000; gadwall, 1,241,000; galdpate, 402,000; green-winged teal, 1,495,000; blue-winged teal, 208,000; shovelers, 206,000; pintail, 882,000; and mottled ducks, 68,000 (Louisiana Wildlife and Fisheries Commission, 1976a).

B.2.5.2 Commercially Important Species

B.2.5.2.1 Vegetation

Softwood timber species including oak-gum-cypress sawtimber that grows over major portions of the parishes in the study area are the primary components of the commercially important timber industry. Cypress is the most abundant as well as the most important commercial species.

A large portion of arable land within the study area is cropland and pasture (U.S. Department of Commerce, 1969). Principal commercial cash crops of the study area include sugar cane, rice, cotton, soybeans, tobacco, and truck crops. In 1969, the leading crops were soybeans, followed by field corn (U.S. Department of Commerce, 1969).

B.2.5.2.2 Wildlife

Furbearers are the most important commercial wildlife species in the study area. Louisiana leads the United States in wild fur production. Most of the fur comes from the coastal swamps and marshes. The most common species in the brackish and intermediate marshes of the region include the muskrat and mink. The maximum yield of muskrat (average of long-term maximum catch figures) in the brackish marsh habitat in coastal Louisiana is 6447 muskrats per 1000 acres (Palmisano, 1972). Other important species include raccoon, otter, and nutria. Major species of the freshwater marshes and bottomland swamps and forest include nutria, raccoon, mink, and otter. The maximum yield of nutria (average of long term maximum catch figures) in the freshwater marsh habitat in coastal Louisiana is 884 per 1000 acres (Palmisano, 1972). The projected fur harvest, based on 1972 field survey data per square mile of bottomland swamp in the Atchafalaya Basin, adjacent to the study area includes: 27 muskrat, 218 nutria, 46 mink, 63 raccoon, and 1 otter (Nichols and Chabreck, 1973). Similar harvest estimates can be expected in the bottomland swamps and forests of the study area.

Other furbearing species having commercial value include the opossum, fox, skunk, and bobcat.

Waterfowl are also termed commercially important, especially in the coastal portion of the study area because of the revenue paid in hunting licenses and other expenses associated with waterfowl hunting. The following waterfowl population estimates and harvest results depict the availability and importance of waterfowl resources. The total waterfowl population estimate in southeastern coastal Louisiana (eastern portion of study area) during mid-December 1976 was 2,411,000 birds (Louisiana Wildlife and Fisheries Commission, 1976a). The 1975-76 harvest results for both segments of the hunting season in eastern coastal Louisiana (Figure B.2-17) were 215,076 birds, plus or minus 12 percent (estimated

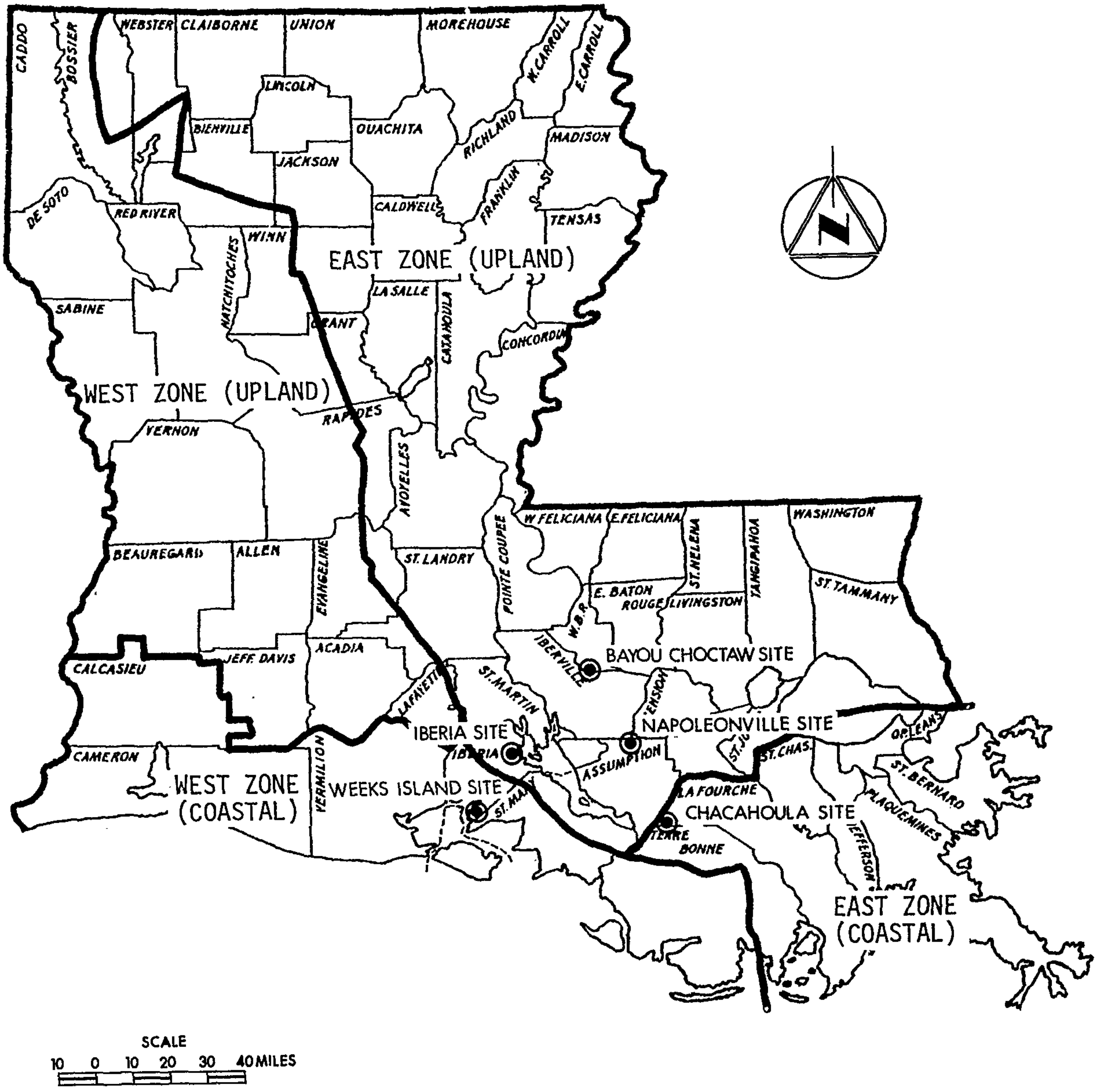

FIGURE B.2-17 Louisiana duck and coot hunting zones - upland and coastal - 1975-1976 season.

at 80 percent confidence limits) and 190,525 birds, plus or minus 17 percent (Louisiana Wildlife and Fisheries Commission, 1976b). The total waterfowl population during mid-December 1976 was 3,101,000 birds (Louisiana Wildlife and Fisheries Commission, 1976a). The 1975-76 results for both segments of the hunting season in western coastal Louisiana (Figure B.2-17) were 443,848 birds plus or minus 15 percent (estimated at 80 percent confidence limits) and 384,110 birds plus or minus 17 percent (Louisiana Wildlife and Fisheries Commission, 1976b).

Other major game species of commercial importance, in terms of the revenue sportsmen generate through hunting activities and associated expenses, include rabbits, squirrels, dove, quail, and deer.

Herpetofauna species of commercial importance include both turtles and frogs in coastal Louisiana (U.S. National Marine Fisheries Service, 1974). Turtles of greatest importance are the diamondback terrapin, common snapping turtle, alligator snapping turtle, and soft-shell turtles. With the exception of the diamondback terrapin, which may be found in brackish and salt marshes, these turtles occur primarily in freshwater habitats. Snapping turtles inhabit rivers, streams, lakes, ponds, freshwater marshes, and swamps, whereas soft-shell turtles prefer open water and infrequently occur in marsh and swamp habitats. The bullfrog is commercially the most important frog in coastal Louisiana, occupying swamps, marshes, and the brushy borders of lakes, ponds, and rivers (Fontenot, 1975).

B.2.5.2.3 Aquatic

Estuarine and Nearshore Gulf of Mexico Water

Louisiana ranks among the top five states in the nation with regard to the total value of its fishery. The shrimp fishery in Louisiana accounts for about 60 percent of the total value. The Barataria and Terrebonne basins are the most productive areas in the state (U.S. Army Corps of Engineers, 1973b).

Principal finfish species harvested from inshore Louisiana waters are menhaden, croaker, spot, catfish and bullheads, seatrout, and red drum (Table B.2-25). Other commercial fish include the red snapper,

TABLE B.2-25 Average annual harvest of major commercial fish and shellfish for Louisiana (1963-1967)[a]

Species	Weight[b]	Value[c]
Menhaden	713.06	10.12
Shrimp	73.51	26.68
Croaker	23.71	0.42
Oyster	9.97	4.39
Blue Crab	8.27	0.73
Spot	4.62	0.08
Catfish and bullheads	4.59	0.78
Seatrout	4.11	0.19
Red drum	0.53	0.09
TOTAL	842.37	43.48

[a]U.S. Army Corps of Engineers, 1973b

[b]Millions of pounds

[c]Millions of dollars

king fish, black drum, mullet, flounder, and a number of lesser species. Flounder production has shown a steady increase in recent years and may become more important in the future. For the last several years, Louisiana has been the number one state in weight of fishery products landed. The total has increased regularly, mostly due to the development of the menhaden fishery. The fish value has increased because of increased landings and inflation. Menhaden was the leading Louisiana fishery in weight (1.1 billion pounds) and second in value ($37 million) (U.S. Department of Commerce, 1977).

The shrimp fishery is the most valuable fishery in Louisiana (Table B.2-25) as well as in the United States. Management practices are necessary to maintain a suitable supply of commercial shrimp for the fisherman. Brown shrimp and white shrimp account for most of the commercial shrimp catch in the Gulf of Mexico. Shrimp landings in the gulf states account for 59 percent of the total landings in the United States. In 1976, Louisiana ranked second in shrimp landings with 82 million pounds caught, valued at $80 million (U.S. Department of Commerce, 1977).

Both the brown and white shrimp spawn in the coastal offshore waters. The white shrimp, however, generally do not spawn as far offshore as the brown. The major spawning season for the brown shrimp is late summer and fall, while the peak for the white shrimp is usually late spring and summer. The larval stage is probably the most sensitive part of the shrimp life cycle with respect to environmental stress.

The blue crab is the only species of crab fished commercially in Louisiana. The crab fishery in Louisiana presently ranks third in weight (15.2 million pounds in 1976) and fourth in value ($3.1 million in 1976) (U.S. Department of Commerce, 1977). However, pollution in many of the upper estuaries seems to be reducing the juvenile crab population (Jaworski, 1972).

The oyster harvest in Louisiana has deteriorated in the past quarter century because of overfishing, high salinity encroachment, and pollution. For these reasons, there is currently very little harvesting of "natural" oysters in estuarine waters of Louisiana. The increased salinity has allowed the oyster drill, a major predator of oysters, to devastate many of the old established oyster reefs. Therefore, most of the oysters are now artificially seeded and planted.

The oyster fishery in Louisiana ranked fourth in weight and third in dollar value in 1976 ($9 million) (U.S. Department of Commerce, 1977).

Rivers and Inland Waters

The overflow lakes, bayous, and backwater swamp areas support large populations of crayfish, frogs, and a number of commercially valuable fish. At least 22 species of crayfish are found in Louisiana. However, the swamp crayfish and river crayfish are the only species of commercial significance, with the Atchafalaya Basin as the hub of production. Commercially managed ponds have an annual production in excess of 5 million pounds at a value of more than $1 million, and unmanaged production was slightly higher (Gary, 1974; Penn, 1959).

The annual freshwater commercial fish landings in the Atchafalaya Basin region has been estimated at about 6.1 million pounds and valued at slightly more than $1 million. About 70 percent of the catch is made up of catfish, buffalo, and drum. Other fish of commercial value include the bowfin, carp, gar, and paddlefish (U.S. Army Corps of Engineers, 1975a).

B.2.5.3 Recreationally Important Species

B.2.5.3.1 Wildlife

Major wildlife species of recreational importance in the Capline study region include waterfowl, quail, dove, squirrels, rabbits, and white-tailed deer. Species having minor recreational value include woodcock and some furbearers.

Waterfowl hunting is an important activity in the coastal zone throughout the project area. The 1975-76 waterfowl harvest for the various zones in which the study area lies (Figure B.2-17) listed: eastern coastal zone, 405,601 birds; eastern uplands zone, 660,000 birds; and western coastal zone, 827,959 birds (Louisiana Wildlife and Fisheries Commission, 1976b).

Quail populations have undergone a decline in coastal Louisiana due to land use changes eliminating fence row, weed patches, and other early successional plant communities. The major vegetative types in the study area include bottomland forest and swamp, crop and pastureland, and residential and industrial land. Although open land habitats exist in the region, many of these areas are cleanly farmed or developed for residential or industrial purposes and provide limited resources for quail. Population densities of one quail per 2 acres of suitable habitat are present in the Atchafalaya Basin immediately adjacent to the study area.

Dove populations have also undergone decline as a result of habitat alteration. A huntable dove population of one per 5 acres is present in farmlands. The 1975-76 dove harvest estimates during both segments of the hunting season for Districts 5 and 6 (Figure B.2-18) were 176,053 plus or minus 23 percent birds; and 123,375 plus or minus 39 percent birds at 80 percent confidence limits, and 69,276 plus or minus 27 percent birds and 49,417 plus or minus 27 percent birds, respectively (Louisiana Wildlife and Fisheries Commission, 1976c).

Both gray and fox squirrels are found in the Capline study area. Population estimates for Louisiana during 1966-67 were 12 to 15 million squirrels of which 60 percent were grays (Lowery, 1974). St. Amant estimated 0.7 squirrels per acre in the upper and lower Mississippi alluvial plain (in the study area) where large blocks of mixed deciduous hardwoods provide excellent food and range conditions for squirrels (Lowery, 1974). The 1974-75 squirrel harvest (expanded estimate) in Districts 6 and 8 was 423,043 plus or minus 10 percent animals (at 80 percent confidence limits) and 313,943 plus or minus 21 percent animals, respectively (Louisiana Wildlife and Fisheries Commission, 1975).

Both the cottontail and swamp rabbit are hunted in the study region. Rabbit populations vary from one to five rabbits per 10 acres, according to habitat. The average carrying capacity in the region for swamp rabbits in bottomland woods is one rabbit per 2 acres (U.S. Army Corps of Engineers, 1973a). The 1974-75 rabbit harvest estimates for Districts

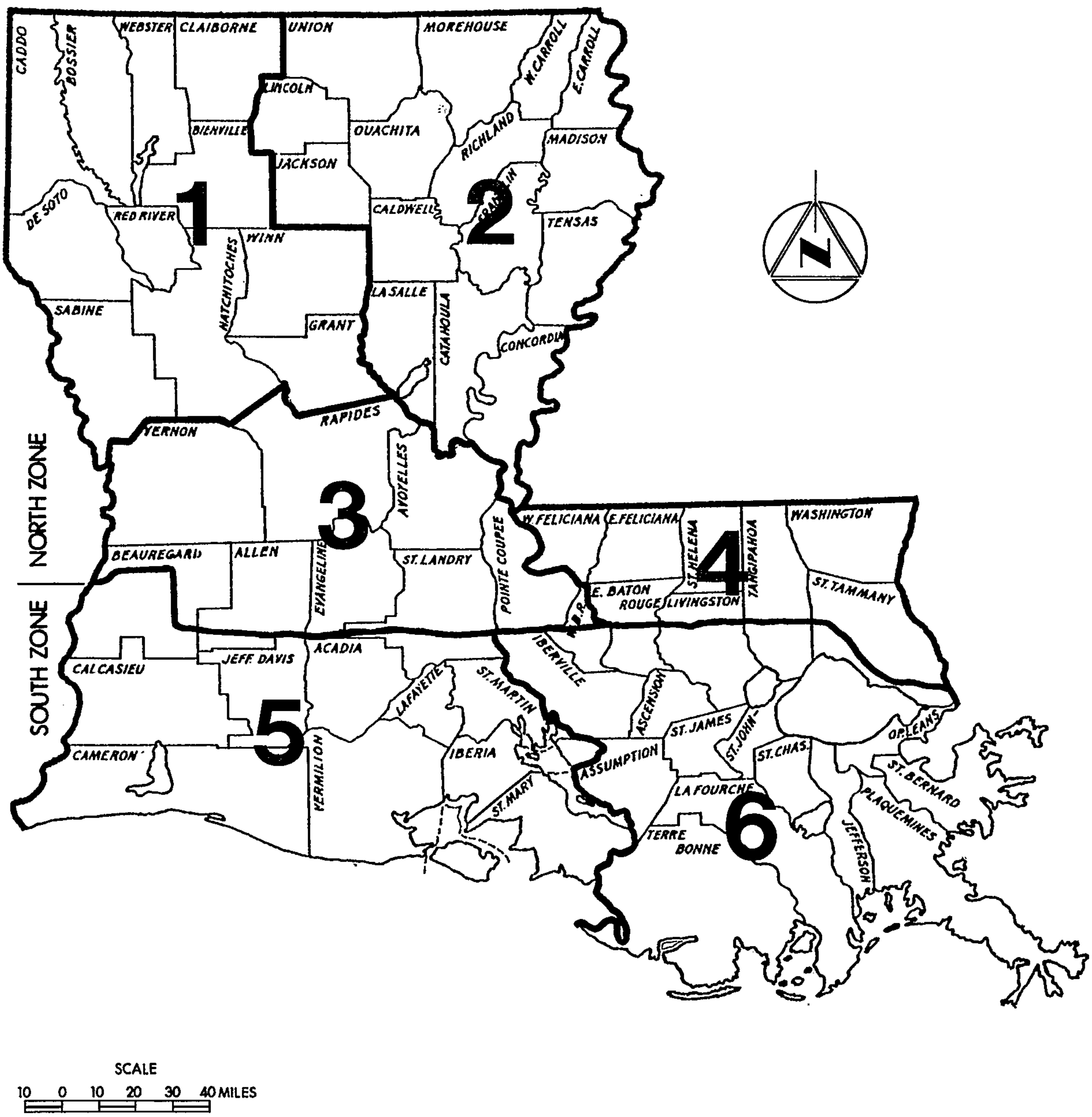

FIGURE B.2-18 Hunting districts in Louisiana.

6 and 8 were 245,000 plus or minus 29 percent rabbits at 80 percent confidence limits and 260,000 plus or minus 24 percent rabbits, respectively (Louisiana Wildlife and Fisheries Commission, 1975).

The white-tailed deer is the most hunted big game mammal in the study area. The bottomland forest is the major habitat type utilized by deer in the region. The carrying capacity of such areas in the Atchafalaya Basin (immediately adjacent to the study area) is approximately one deer per 13 acres (Lowery, 1974). The 1975-76 deer harvest for Districts 6 (Iberville parish and others) and 8 (Assumption, Lafourche, Iberia and others) was 8879 plus or minus 10 percent (80 percent confidence limits) and 6650 plus or minus 8 percent, respectively (Louisiana Wildlife and Fisheries Commission, 1976d).

B.2.5.3.2 Aquatic

Coastal and Estuarine Waters

Many fish and shellfish sought after for commercial value are also pursued for sport in coastal Louisiana. Saltwater-estuarine sport species include spotted seatrout, Atlantic croaker, spot, red drum, red snapper, pompano, and tarpon. A telephone survey by the Bureau of Sport Fisheries and Wildlife shows saltwater fishing equalled 6,660,900 man-days/year and $35,439,800. Of the saltwater sport fishing, finfishing accounted for 4,045,900 man-days/year and $28,321,300 (Louisiana State University, 1975).

The blue crab is also subjected to heavy fishing pressure from the sportsmen of the state. It was estimated (telephone survey conducted by the U.S. Bureau of Sport Fisheries and Wildlife) that the sport catch of crabs may be as much as four times as large as the commercial catch (Lindall and Hall, 1970).

Rivers and Inland Waters

The vast areas of swamp which make this region unique provide a level of productivity that supports one of the nation's best freshwater sport fisheries (Gresham, 1963). The major game fish of the region include several species of bass, crappie, sunfish and catfish. Bass of 5 pounds and crappie of 1-1/2 pounds are not uncommon. In 1963, during a 9-day period in May, over 200,000 pounds of sport fish were landed by about 18,000 fishermen in the Atchafalaya Basin region (Gresham, 1963).

B.2.5.4 Threatened or Endangered Species

In 1966 the Endangered Species Conservation Act was passed to prohibit the taking or possession of native endangered fish and wildlife. Other legislation has given special protection to migratory birds (Migratory Bird Treaty Act of 1965), to eagles (Bald Eagle Act of 1940) and to marine mammals (Marine Mammal Protection Act of 1972).

Various states have placed certain resident wildlife species under special jurisdiction providing protection to the species as well as important habitat. Endangered plant species have received recognition only recently. The U.S. Fish and Wildlife Service published a listing of endangered plants by state during 1975. Data are being gathered to determine which plant species are endangered and, when sufficient data are recorded, a formal proposal will be made to list these species under the Endangered Species Act.

B.2.5.4.1 Vegetation

Eleven species of plants from Louisiana are currently under consideration for inclusion in the list of endangered and threatened wildlife and plants. Of these, four species are under consideration as endangered species (Table B.2-26).

B.2.5.4.2 Wildlife

Species listed as "endangered" in the United States List of Endangered Fauna (U.S. Department of the Interior, 1974) are designated as being "in danger of extinction throughout all or a significant portion of their range." Seven such species which may occur in the Capline study area are: Atlantic ridley turtle, hawksbill turtle, leatherback turtle, American alligator, brown pelican, southern bald eagle, and Arctic peregrine falcon. The American alligator has recently been reclassified from endangered to threatened in Cameron, Calcasieu, and Vermilion Parishes; however, it remains classified as endangered in the remainder of the state. Threatened species are defined as "those species

TABLE B.2-26a Louisiana plants considered as endangered or threatened species[a].

Status	Family	Species
Endangered	Isoetaceae	Isoetes louisianesis
Threatened	Apocynaceae	Amsonia glaberrima
Threatened	Aquifoliceae	Ilex amelanchier
Threatened	Lamiaceae	Scutellaria thieretii
Threatened	Lauraceae	Lindera melissifolia
Threatened	Orchidaceae	Platanthera leucophaea
Threatened	Poaceae	Bothriochloa exaristata
Threatened	Sarraceniaceae	Sarracenia psittacina
Endangered	Scrophulariaceae	Agalinis caddoensis
Endangered-Extinct	Scrophulariaceae	Castilleja ludoviciana
Endangered	Asteraceae	Coreopsis intermedia

TABLE B.2-26b Delining "blue listed" bird species likely to occur in the coastal marshes of the Capline study area[b].

Common Name	Scientific Name
White-faced Ibis	Plegadis chichi
White Ibis	Eudocimus albus
Black-crowned Night Heron	Nycticorax nycticorax
Red-shouldered Hawk	Buteo lineatus
Marsh Hawk	Circus cyaneus
Osprey	Pandion haliaetus
White Pelican	Pelecanus erthororhynchos
American Oystercatcher	Haematopus palliatus
Piping Plover	Charadrius melodus
Snowy Plover	Charadrius alexandrinus
Least Tern	Sterna albifrons
Gull-billed Tern	Gelochelidon nilotica

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[a] U.S. Department of the Interior, 1975a 1976.

[b] National Audubon Society, 1973.

which are likely to become endangered in the foreseeable future throughout all or a significant portion of their range" (U.S. Deaprtment of the Interior, 1975b).

(a) Marine turtles. The Atlantic ridley, the hawksbill, and the leatherback may all occur irregularly in gulf waters along the Louisiana coast, and may occasionally be seen within 10 to 15 miles of the coast; no nesting is known to occur along the Louisiana coast (Killebrew, 1975). The occurrence of any of these species in the Capline study area may be considered accidental.

(b) American alligator. The alligator occupies marshes and lakes throughout coastal Louisiana, with populations concentrated in the southwestern portion of the state. The original population decline of the alligator was due to poaching and habitat destruction. However, populations have recovered well in recent years, and an estimated 200,000 now reside in the state's coastal marshes (U.S. Army Corps of Engineers, 1975c). Limited harvests have been permitted in some parts of the state. The alligator may be expected to occur in the rivers, bayous, swamps, and freshwater marshes of the study area.

(c) Eastern brown pelican. Formerly a common breeding bird of coastal Louisiana, the brown pelican is now rarely seen in the state. The last native Louisiana nesting colony was observed in 1961, and studies indicate that the pelican's poor reproductive success is related to persistent pesticides. A restocking program began in 1968 with yearly releases in the vicinity of Grand Terre and Rockefeller Wildlife Refuge (Batemen, 1975). However, successful nesting did occur on Grand Terre and around Barataria Bay (adjacent to the Capline study area), leading to the peak population of approximately 400 birds (Batemen, 1975). In the spring of 1975, scattered die-offs began to occur due to lethal concentrations of the pesticide endrin in brain tissues, and the population is currently estimated to be less than 200 birds (Batemen, 1975). It is therefore unlikely that any brown pelicans will be found in the Capline study area.

(d) Southern bald eagle. In the southeast, the southern bald eagle nests primarily in the estuarine areas of the Atlantic and gulf coasts and along the lower Mississippi Valley (Snow, 1973). Nest trees are generally the largest tree in the stand, have an open view of the surrounding area, and are within one-half mile of water (Snow, 1973). Bald eagle populations have declined for a variety of reasons, among which are high pesticide concentrations impairing reproductive processes, shooting, human disturbance, and the loss of suitable nest trees (U.S. Department of the Interior, 1973). The U.S. Fish and Wildlife Service estimates the current breeding eagle population in coastal Louisiana to be between 12 and 15 pairs (Aycock, 1975). Suitable habitat for the species is present throughout the study area and occurrence of these eagles is likely.

(e) Arctic peregrine falcon. The peregrine falcon, although uncommon, occurs through the coastal marshes and prairies of southern Louisiana and is likely to occur in the study area, particularly during migration. A regular winter migrant in coastal Louisiana, it generally preys upon ducks, shorebirds, pigeons, and various songbirds (Lowery, 1975; Sprunt, 1954). Declines in falcon populations have been related to poisoning and inhibition of reproduction by pesticides, with a highly significant negative correlation being demonstrated between shell thickness and DDE concentration in eggs (Cade et al., 1971). Habitat destruction and collection of young and adults for falconry have also influenced populations (U.S. Department of the Interior, 1973).

Twelve other species of birds that may occur in the coastal marshes of the study area are listed in the "blue list" (Table B.2-26), which is a list of birds experiencing difficulty in maintaining reasonable population numbers. This list is compiled and maintained by the American Ornithological Union. The birds listed are carefully watched and studied to determine their current status and future potential as a continuing species.

B.2.5.4.3 Aquatic

None of the fish known to inhabit the region near the site are considered endangered or threatened by the U.S. Department of Interior (1976b) or the state of Louisiana, which use the same federal list. However, the pallid sturgeon, which has been collected from the Mississippi River in northern Louisiana (a potential inhabitant of the area) is considered rare by several authors (U.S. Army Corps of Engineers, 1973a; Blair et al., 1968; Douglas, 1974; Miller, 1972). Miller (1972) lists 12 other fish considered to be rare or endangered in Louisiana; however, none of them are expected to inhabit waters in the vicinity of the Capline sites.

Six species of endangered marine whales have also been sighted in the northern Gulf: sperm whale, black right whale, humpback whale, sei whale, fin whale, and blue whale (U.S. Department of the Interior, 1977b).

B.2.6 Natural and Scenic Resources

B.2.6.1 Natural Resources

Within the region of influence for the five sites, several habitat types are encountered. To the south of this area, marsh is the dominant habitat type. Louisiana's coastal marsh covers about 4.2 million acres, with a width of from 15 to 20 miles in the western part of the state increasing to upwards of 50 miles south of New Orleans. It is estimated that in the past quarter-century the Louisiana coast has lost 16.5 square miles of land annually due to subsidence. In 1968, the freshwater marsh habitat was estimated to comprise about 30 percent of the entire Louisiana coastal marsh. The next most dominant ecosystem type within the project area is the swamp forest which occurs extensively in the area between Baton Rouge and the coastal marsh.

Croplands, concentrated along Bayou Lafourche, Bayou Teche and the Mississippi River, represent the next most common habitat type after marsh and swamp forest. Despite the rural nature of several of the parishes, agriculture is not the major economic function in the area. Land uses in the area are largely determined by the combination of low elevation, clay soil, and saltwater. A low percentage of land is devoted to agriculture (predominantly sugar cane) reflecting the high percentage of wetland.

In Louisiana, waterfowl (puddle ducks and diving ducks) are predominantly associated with fresh and brackish marshes. In southern Lafourche Parish the pattern is somewhat different, since much of the local waterfowl are at present attracted to a brackish water impoundment area, near Bay Champagne. The Louisiana coastline is used extensively by winter waterfowl with 68 percent of the U.S. population of ducks and 36 percent of its geese.

Hunting and fishing resources are used extensively in several parishes in the region. For example, about 8000 hunting licenses were sold in Lafourche Parish alone. East Baton Rouge had probably the largest number of fishing licenses sold in the region (22,000 during 1973-74). Much of the sport fishing, hunting, and other outdoor recreational activities owe their existence to the coastal marshlands and bays in the region (FEA, 1976a, c, 1977; DOT, 1976).

Recreational and wildlife areas in the region are both numerous and vast. The region contains a number of national and state wildlife refuges, bird sanctuaries, fishing lakes, and state parks. These areas provide important opportunities for scientific study, for outdoor recreation and for natural scenic appreciation. A listing of major recreation and wildlife areas is given in Table B.2-27, and their locations are shown in Figure B.2-19.

B.2.6.2 <u>Scenic Resources</u>

Much of the region's scenic beauty comes from the forests and marshes discussed above. Tall stands of trees and abundant lakes and bays provide numerous peaceful, natural vistas. Most of the region is quite flat with few areas of topographic interest except for scattered mounds such as Weeks Island which rise as much as 150 feet around the surrounding marshland.

TABLE B.2-27 Existing and potential recreation and wildlife areas.

	Site	Parish	Comments
1.	Beau Sejour Oaks	Lafayette	Area of 100 year-old oaks
2.	Lake Fausse Pointe	Iberia	Natural swamp and water area
3.	Cypremore Point	St. Mary	Vermillion Bay peninsula
4.	Burns Point	St. Mary	Accredited site on Cote Blanche Bay
5.	Spanish Lake	Iberia	Bass fishing mecca
6.	Grand-Lake-Six-Mile Lake Area (Atchafalaya Basin)		Future water recreation area with abundant wildlife
7.	Berwick Island	St. Mary	Seven acres of wooded island potentially acceptable for recreation
8.	Avery Island	Iberia	200-acre wooded island with bird sanctuary
9.	Burns Point	St. Mary	Shady camping and picnic areas with access to Gulf
10.	Lake Palourde	St. Mary	Recreational lake by Morgan City
11.	Shell Keys National Wildlife Refuge	Iberia	Eight-acre colonial bird nesting area
12.	Marsh Island Wildlife Refuge	Iberia	
13.	East Timbalier Island	Lafourche	337 acre wildlife refuge
14.	Wisner	Lafourche	3000 acre wildlife refuge
15.	Edward Douglas White State Park	Lafourche	Historical monument
16.	Bayou Penchant	Terrebonne	Scenic Waterway
17.	Point au Chein Area	Lafourche & Terrebonne	28,244 acre wildlife management area
18.	McElroy State Park Area	St. James	
19.	Lake Verret State Park	Assumption	
20.	Iberville State Park	Iberville	
21.	Untitled	Terrebonne	Proposed park or wildlife area

Source: FEA, 1976b, 1977

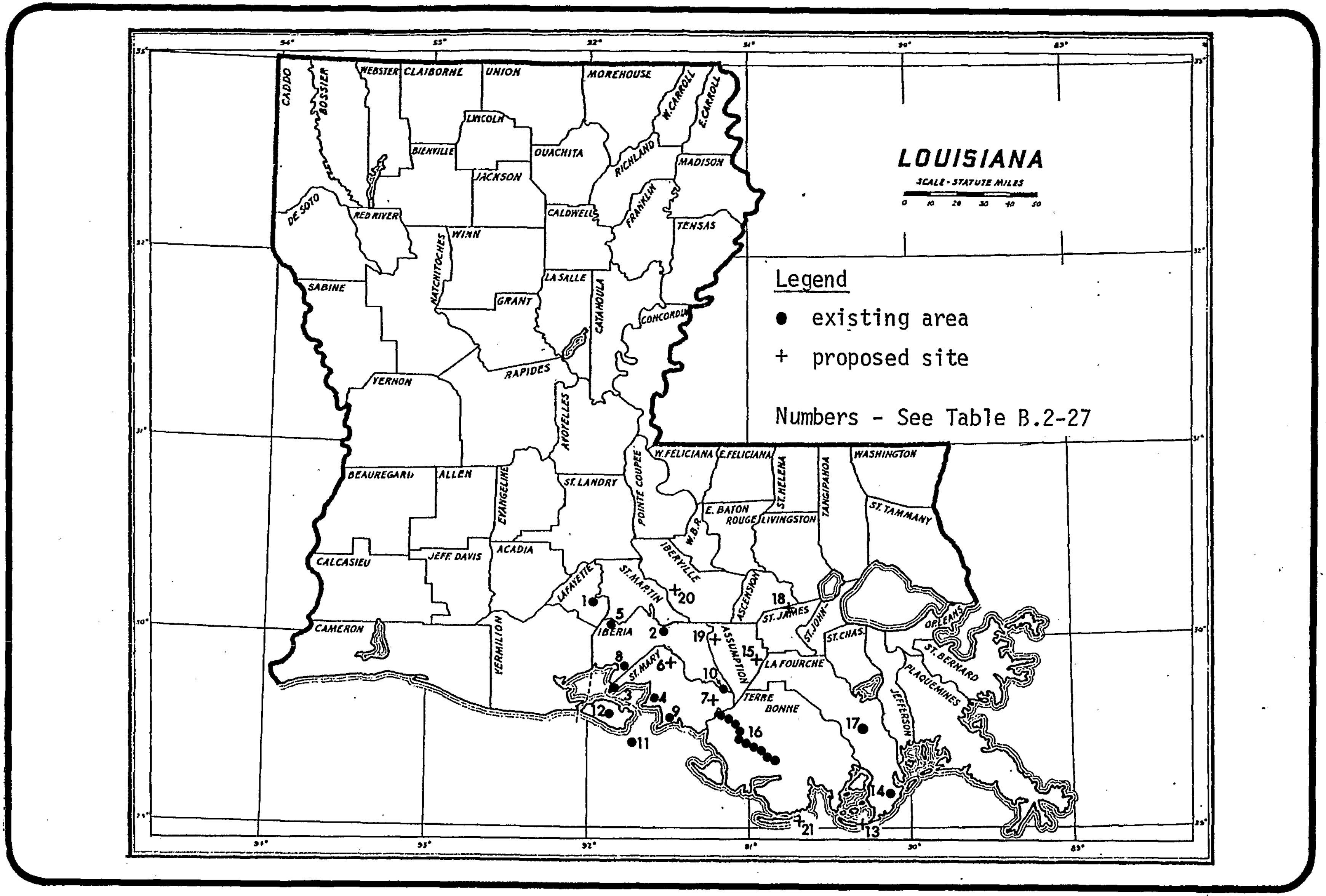


FIGURE B.2-19 Existing and potential recreation and wildlife areas.

B.2.7 Archaeological, Historical, and Cultural Resources

The coastal zone and Mississippi Delta region of southern Louisiana contain archaeological sites that indicate human habitation at least over the past 12,000 years. The discovery and study of archaeological sites provide essential understanding of prehistoric cultures and man's cultural evolution in this part of the world.

The Capline Group of potential Strategic Petroleum Reserve sites lies in the Lower Mississippi alluvial valley and delta region and the southern Louisiana coastal zone. In the six-parish region covered or influenced by the Capline sites, several hundred known archaeological or historic sites occur, according to the U.S. Army Corps of Engineers environmental inventory (1973a) and the U.S. Department of the Interior Places (1977b). The six parishes include Assumption, Iberia, Iberville, Lafourche, St. James, and Terrebonne. Thirteen historic sites are listed in the National Register (1977), five of which occur in Iberia Parish, two in Assumption Parish, four in Iberville Parish, one in Terrebonne Parish, and one in Lafourche Parish. None of these historic places occurs on a Capline site.

B.2.8 Socioeconomic Environment

While the physical development associated with the proposed SPR sites would be confined to a relatively small land area within south-central Louisiana, a fairly large region of the state would receive the socioeconomic impacts from the project. In order to study these impacts, an eleven-parish region surrounding the sites has been chosen in which most of the direct effects of development would occur. Included in this region are the parishes of Lafayette, Iberia, St. Mary, Terrebonne, Lafourche, Assumption, St. James, Ascension, Iberville, East Baton Rouge, and West Baton Rouge. The lower portion of St. Martin Parish is within the study region but is nearly unpopulated because it is largely within the Atchafalaya Basin Floodway. Meaningful statistical data are therefore not available for this parish; impacts are expected to be minimal. These parishes and the location of the proposed SPR sites are shown in Figure B.2-20.

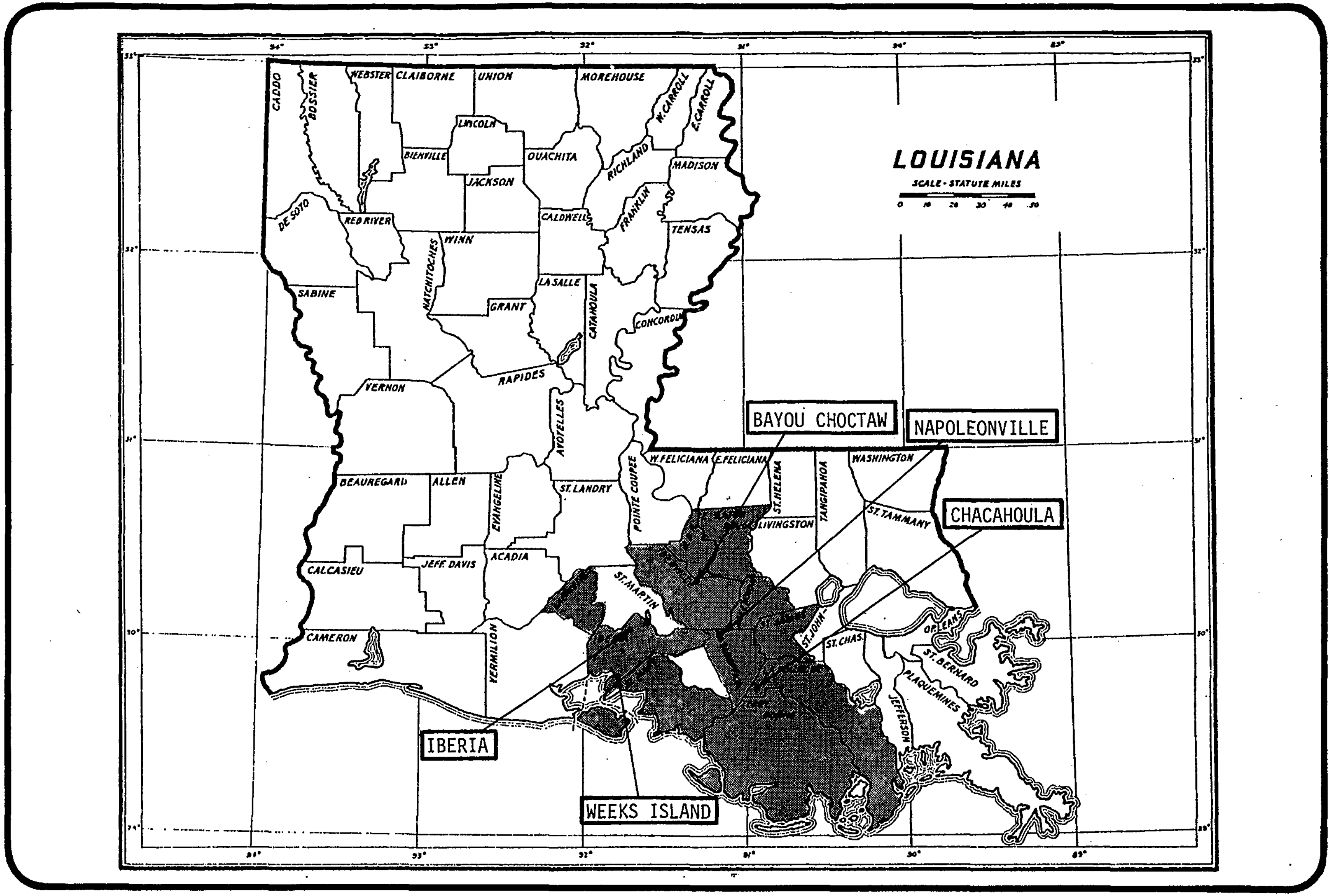


FIGURE B.2-20 SPR sites and socioeconomic region.

B.2.8.1 History

Before European settlement, much of this coastal region was inhabited by Chitimacha Indians of gulf linguistic stocks. From the early 1700's when French settlement began to the early 1800's when Louisiana was purchased by the U.S., the region was ruled alternately by Spain and France. A notable immigration into the coast area by Acadians from Canada began in 1756. After the Louisiana Purchase and the gradual influx of American settlers from southern states, the economy of the area began to change. Large plantations developed, based on sugar cane. After the Civil War, the large plantations were dissolved, shattering the previous economic system and the plantations were replaced by tenant sharecropping. Discovery of oil in the early 1900's signaled the beginning of a new era as the activities of oil and gas exploration and mining stimulated the sagging economy. Today, the area's economy is based upon natural resources, especially agriculture, fishing, and mineral extraction.

B.2.8.2 Land Use Patterns and Planning

Topography in the region has influenced settlement patterns significantly with early settlement in the area limited to natural levees along the waterways. These were the only areas suitable for development in the low-lying region, and they provided easy access to the waterways which were the main means of transportation. Most of the urban/residential land uses are still located on these same levees especially along the Mississippi River, Bayou Lafourche and Bayou Teche. Today, most major state highways and railroad links in the region still follow these levees. Agricultural land in the region is also generally confined to the natural levees. Most of the land is used for sugar cane production. Between the levees and along the immediate coast, most of the land is lower in elevation and subject to frequent or continuous flooding, either from tides, local rainfall, or upstream flooding of the Mississippi and Atchafalaya Rivers. These lands are seldom suitable for development due to poor soil conditions and high water table. An extensive system of canals has been built, however, to provide navigable waterways and to allow exploration and production of oil and gas resources. In some areas, oil and gas wells are extensive. Because of the extensive acreage of undeveloped forests and marshes, southern Louisiana is a virtual paradise for hunters and fishermen. These and more developed recreational uses occupy a notable portion of land within the region. Recreational use of this land and the nearshore Gulf of Mexico are discussed in Section B.2.6.1.

Louisiana is divided into eight districts by the state for regional planning purposes following parish boundaries. Three of these are represented, in part, in the region of concern. Lafayette, Iberia, and St. Mary Parishes are included in the state's District IV; East and West Baton Rouge, Iberville, and Ascension Parishes are in the Capital Region (District II); Assumption, St. James, Terrebonne, and Lafourche Parishes are in District III.

B.2.8.3 Transportation Systems

The region is served by a network of highways, railroads, and waterways which generally follow the system of natural levees in the area. U.S. 90 connects the major population centers in the cities of Lafayette, New Iberia, Jeanerette, Franklin, Morgan City, and Houma and continues on to New Orleans. It is a major multi-lane highway along most of its length and plans exist to upgrade the remaining two-lane segments. Many highways radiate from Baton Rouge to serve the region. Interstate 10 links Baton Rouge with Lafayette to the west and with New Orleans to the southeast. Louisiana State Highway 1 follows Bayou Lafourche and links the population centers of Baton Rouge, Plaquemine, Donaldsonville, and Thibodaux. The regional highway system can be seen in Figure B.2-21.

The Southern Pacific Railroad roughly parallels U.S. 90 along its entire length from Lafayette to New Orleans with a spur connecting Houma and Thibodaux. The Texas and Pacific Railroad parallels State Highway 1 from Baton Rouge to Thibodaux. AMTRAK, which operates between New Orleans and Los Angeles, provides the only passenger rail service to Lafayette, Iberia, and St. Mary Parishes. It provides tri-weekly passenger service to Lafayette and New Iberia.

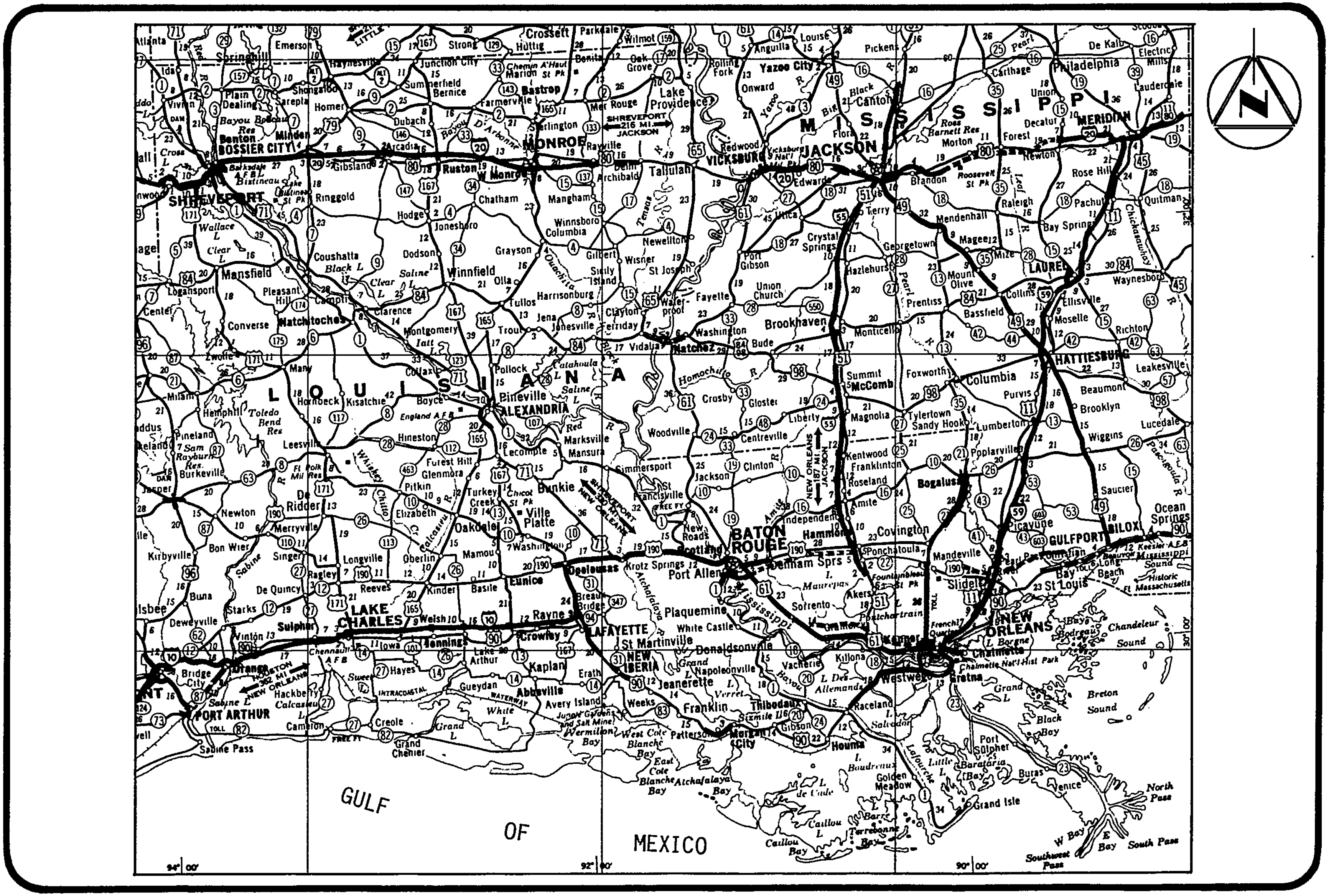


FIGURE B.2-21 Regional highway network.

The region's system of waterways includes the Intracoastal Waterway (ICW), Bayou Teche, Bayou Lafourche, and the Mississippi River, as well as the coastal bays and connecting canals. Baton Rouge and Morgan City are both major shipping ports.

The region's major commercial airport is in Baton Rouge. Smaller commercial airports are located in Lafayette and Morgan City.

B.2.8.4 Population Characteristics

Population Centers

Baton Rouge, the state capital, is the largest city in the region, with over 150,000 inhabitants. It is expected to be a major source of labor for several of the proposed sites, especially the Bayou Choctaw dome. There are five other major cities in the region with populations of over 10,000 inhabitants (Lafayette, New Iberia, Houma, Morgan City, and Thibodaux). New Orleans, while not in the eleven-parish area, is within feasible commuting distance from several proposed sites and may provide some labor for the projects: its 1970 population was 593,471 (University of New Orleans, 1974). Figure B.2-21 shows the location of the major urban areas in the region.

All of the 11 parishes, except St. Mary, Lafayette, and East Baton Rouge, had substantial rural non-farm populations in 1970, indicating that a major part of the region's population resided in non-urban areas. Many also lived in small towns of 2500 or fewer inhabitants.

Throughout the region, population has been growing rapidly, but not at the same rate in each parish. The average growth rate was over 25 percent during 1960-1970, with five parishes having a net increase of less than 15 percent (Assumption, Iberia, Iberville, St. James, and West Baton Rouge), and two having a net increase of greater than 30 percent (Ascension and West Lafayette). Much of this population growth was due to an increase in births over deaths, since only four out of eleven parishes experienced a positive net migration of greater than 1 percent during this time period (Ascension, East Baton Rouge, Lafayette, West Baton Rouge) (see Table B.2-28).

TABLE B.2-28 Impact area growth trends.

Parish	Population 1970	% Increase 1960-1970	Migration Rate 1960-1970
Assumption	19,654	9.2	- 8.7
Ascension	37,086	32.8	12.9
East Baton Rouge	285,167	24.0	5.8
Iberia	57,397	11.1	-10.5
Iberville	30,746	2.7	-13.0
Lafayette	111,745	32.0	10.2
Lafourche	68,941	24.5	0.8
St. James	19,733	7.4	-12.6
St. Mary	60,752	24.4	0.7
Terrebonne	76,049	25.1	- 1.7
West Baton Rouge	16,864	14.0	1.7

Source: University of New Orleans, 1974

Two corridors have been identified as locations of probable future rapid development. The first is the New Orleans-Lafayette Corridor (NOLAF) which roughly parallels Highway 90 between these two cities (Figure B.2-21). This portion of the project region includes the Bayou Teche levee from Morgan City to New Iberia, in St. Mary and Iberia Parishes. Growth factors include abundant mineral resources, access to highways and navigable waterways, and existence of developable land on the levee ridge. The second growth corridor is the New Orleans-Baton Rouge Corridor (NOBAR), within which lies the CAPLINE Terminal at St. James. Growth factors include excellent transportation, proximity to industrial and trade centers, and developable land. Population growth is projected to be more than 20 percent during the 1970-1980 and 1980-1990 decades for NOBAR and probably somewhat less for NOLAF.

B.2.8.5 Housing Characteristics

Vacancy rates throughout the 11 parishes vary somewhat, but in all areas, are lower than the state average of eight percent. Seven of the parishes have very low vacancy rates averaging around 2.5 percent, while East Baton Rouge, Iberia, Ascension, and St. Mary Parishes have vacancy rates averaging close to seven percent.

The median value of owner-occupied units in the region is generally lower than the state average of $14,600 by about $2000. However, in East Baton Rouge, St. Mary, Lafayette, and Terrebonne Parishes, median values are slightly higher than the rest of the state (see Table B.2-29).

B.2.8.6 Economy

Major components of the region's economy are mining, manufacturing, shipping, and agriculture. Mining is of substantial economic importance in St. Mary and Iberia Parishes, where this activity accounted for approximately 20 percent of each parish's real earnings and approximately 12 to 13 percent of the employment in 1970. A number of minerals are extracted throughout the region, the most important being petroleum, natural gas, and natural gas liquids. Other minerals extracted from the area include salt, sand and gravel, lime, cement, and natural clays. St. Mary and Iberia Parishes are important centers for salt mining.

TABLE B.2-29 Housing characteristics of the region, 1970.

Parish	Year-Round Housing Units	Owner Occupied	Renter Occupied	Vacancy Rate %	Median Value Owner Occupied $
Iberville[a]	9,096	5,202	2,942	3.6	10,30(
West Baton Rouge[a]	4,803	2,906	1,497	2.8	12,400
East Baton Rouge[a]	88,936	54,049	27,411	6.8	17,800
Ascension[a]	11,214	7,394	2,636	7.3	12,600
St. James[b]	4,796	3,369	1,255	1.2	11,900
Lafourche[b]	19,091	12,754	5,247	2.5	12,500
Terrebonne[b]	20,817	18,855	5,739	3.6	15,500
Assumption[b]	5,290	3,384	1,581	2.9	8,900
St. Mary[d]	17,279	9,974	6,116	7.0	14,900
Iberia[c]	16,595	10,388	5,230	6.0	12,000
Lafayette[e]	32,057	20,621	9,349	N.A.	16,700
State of Louisiana[d]	1,150,669	663,927	388,111	8.0	14,600

Source: a) FEA, 1976a
b) FEA, 1977
c) FEA, 1976b
d) FEA, 1976c
e) University of New Orleans, 1974

Manufacturing is a major activity in the area surrounding Baton Rouge. This industry provides the greatest number of jobs to East and West Baton Rouge, Iberville, and Ascension Parishes. Chemical plants dominate the manufacturing field, and the region surrounding Baton Rouge is a major source of minerals and raw materials for the production of chemical compounds.

The manufacture of fabricated metal products, oil field machinery, offshore oil rigging, and related industries are major portions of the economy in the Houma and Morgan City areas.

Baton Rouge is a major shipping center in the region. The volume of cargo handled at this port has been steadily increasing. Morgan City in St. Mary Parish is also an important Gulf Coast harbor, and is a leading center for shipbuilding.

Agriculture in the region is limited to grazing cattle and production of a few varieties of cash crops. Sugar cane is the predominant crop grown in the region. Other crops cultivated in this area include cotton, soybeans, and truck crops. The number of paid farm workers in relation to farm acreage and dollar value of the crops is generally high in the region (U.S. Department of Commerce, 1974).

Fishing also makes a significant contribution to the local economy. Morgan City reported a commercial harvest worth almost $8 million in 1974. The production of shrimp is a major source of income for the Houma area. The importance of the Louisiana fishery is further discussed in Section B.2.5.2.3.

Employment within the region relies heavily on the industries discussed above. Manufacturing, construction and mining are important industrial occupation categories within the region. Agriculture and retail trade and services are also significant employers. There are a substantial number of workers in the region who would be classified as: 1) craftsmen, foremen and kindred workers; 2) equipment and vehicle operators; and 3) laborers.

There is a widespread pattern of commuting in the region. In the parishes near the city of Baton Rouge, in particular, the number and proportion of workers who commute out of their home parishes to their jobs is high.

Unemployment in the 11 parishes in 1976 varied from a high of 9.2 percent in West Baton Rouge down to 4.1 percent in Lafourche Parish. The average unemployment in the entire region was substantial; slightly over 5 percent (see Table B.2-30). There is a large pool of available workers in East Baton Rouge Parish.

In general, mean family income in the region was above the state average in 1970. The percentage of families below poverty level varied considerably by parish and was above the state average in five of the eleven parishes. East Baton Rouge had the highest mean family income and lowest percentage of families under the poverty level. Assumption, Iberville, and St. Mary Parishes had the highest percentage of families below poverty level. The personal economic status, mean family income, and percentage of families below poverty level for each parish is shown in Table B.2-31.

B.2.8.7 Government

Most of the public services provided in the region come from local governmental units - the parishes, municipal governments and special districts. In terms of overall expenditures, schools generally account for one-half to two-thirds, highways for 5 to 10 percent, and "other" (which includes police and fire protection) for 15 to 25 percent of local spending. Expenditures for health vary widely depending on whether the parish maintains a hospital or other major facilities. Low capital spending generally indicates that few new public facilities are being provided. Capital expenditures vary widely within the region (U.S. Department of Transportation, 1976) (see Table B.2-32).

In extreme cases, such as Assumption Parish, where incomes are low and the economy rural, and where there has been little growth, per capita spending and outstanding debt is low. Rapid influx of people would place severe burdens on existing schools and other infrastructure, and financing expanding programs and new facilities would place severe financial burdens on the parish. On the other hand, rapidly growing

TABLE B.2-30 Employment status, by parish, 1976 estimates.

	Civilian Labor Force	Employed	Unemployed	Unemployment Rate
Ascension[a]	15,753	14,775	975	6.2
Assumption[a]	8,725	8,250	475	5.4
East Baton Rouge[a]	148,050	140,375	7,675	5.2
Iberville[a]	12,700	11,900	800	6.4
St. James[b]	6,750	6,275	475	7.0
St. Mary[a]	25,925	24,750	1,175	4.6
Lafourche[b]	28,600	27,425	1,175	4.1
Terrebonne[b]	29,575	28,225	1,350	4.6
West Baton Rouge[a]	6,900	6,275	625	9.2
Iberia[a]	24,425	23,350	1,075	4.4
Lafayette[a]	54,225	51,975	2,250	4.1

Source: a) Louisiana Department of Employment Security, 1977
b) FEA, 1977

TABLE B.2-31 Income distribution in the eleven parish area, 1969[a].

Parish	Number of Families	Mean Family Income, $	Percent of Families Below Poverty Level
Ascension	8,697	8,470	22.2
Assumption	4,402	6,920	30.2
East Baton Rouge	67,471	10,842	13.6
Iberia	13,556	7,985	22.7
Iberville	6,820	7,567	30.3
Lafayette	25,717	9,599	19.3
Lafourche	16,279	8,728	15.4
St. James	4,013	8,260	21.5
St. Mary	7,404	6,204	36.1
Terrebonne	17,298	9,081	15.3
West Baton Rouge	3,780	8,020	21.2
State of Louisiana[b]	872,772	7,527	21.6

Source: a) University of New Orleans, 1974
b) U.S. Department of Commerce, 1972b

TABLE B.2-32 Tax revenue sources and assessed valuation.

Parishes	Total Severance Tax (1971-1972)	Revenue from State Sales Tax (1972-1973)($1000's)	Total from Property Taxes (1971)($1000's)	Total Assessed Value of all Real Property (1971)($1000's)
Ascension	723,141	1,587	2,209	52,044
Assumption	2,966,012	301	997	25,109
East Baton Rouge	263,087	26,616	32,053	663,548
Iberia	13,256,147	3,251	3,840	71,578
Iberville	3,113,293	1,593	2,255	52,244
Lafayette	1,798,548	12,048	5,356	90,253
Lafourche	20,524,202	2,935	6,787	93,338
St. James	811,833	433	2,012	39,802
St. Mary	24,651,137	3,042	4,503	150,748
Terrebonne	39,106,064	5,097	7,545	125,749
West Baton Rouge	287,063	344	1,000	23,054
State of Louisiana	242,297,035	308,818	285,505	5,820,662

Source: University of New Orleans, 1974

parishes have comparatively high per capita operating expenditures and debts, duue to increased demand for services, schools, highways, and other facilities; these parishes would be better able to accommodate a continued rapid influx of people.

The three most important sources of revenue for local government in Louisiana are intergovernmental transfers, real property (or ad valorem) taxes, and sales taxes. The most important local source of taxation to parishes is the ad valorem tax. This tax is levied locally based on tax rates and valuations that are established individually by parish (U.S. Department of Transportation, 1976).

Parish tax situations vary considerably because of the variety and number of special taxing districts contained in each. Data on the sources of revenue for each parish in the region are shown in Table B.2-32. Discussions of the provision of public services to each site is provided later in this report.

Education

The Louisiana State guidelines for pupil-teacher ratios assign one teacher to each 27 pupils (or major fraction of that unit) at the elementary level, and one teacher per 25 pupils at the secondary level. Additionally, high schools (grades 9 through 12) are entitled to a minimum of two enrichment teachers, and an additional two more for every additional 300 pupils. These "enrichment" teachers specialize in music, art, vocational education, counselling, and library science.

On the aggregate, state guidelines for student/teacher ratios are being met in each of the parishes (Louisiana State Board of Education, 1977). There may, however, be shortages of teachers and facilities at specific schools.

There are numerous institutions of higher learning in the socio-economic region surrounding the sites including Louisiana State University in Baton Rouge and Nicholls State University in Thibodaux.

B.3 SITE SPECIFIC ENVIRONMENT - PROPOSED DEVELOPMENT - EARLY STORAGE PHASE SITES PLUS NAPOLEONVILLE DOME

The following sections present details of the existing environment specific to the proposed development of the Capline Group. The sections have been developed to include the various physical, chemical, biological and socioeconomic factors important to the development of Napoleonville dome as the proposed site. References are provided to the appropriate sections of the Bayou Choctaw and Weeks Island EIS's FES 76-5 and FES 76/77-8, respectively.

B.3.1 Early Storage Sites

B.3.1.1 Bayou Choctaw Dome Early Storage Phase Site

The existing environment of Bayou Choctaw dome prior to construction of early storage facilities at that site is detailed in FES 76-5 (Section 2.0) and FES 76-5 Supplement of May, 1977. Modifications to the environment resulting from that construction are also detailed therein.

B.3.1.2 Weeks Island Dome Early Storage Site

Development of Weeks Island dome as an early storage site that will modify the existing environment is presented in FES 76/77-8 (Section 3.0) and FES 76/77-8 Supplement of July, 1977. The construction modifications are also detailed therein.

B.3.2 Capline Group Oil Distribution Terminal Systems

Oil distribution terminal systems being considered for use by the Capline Group of SPR sites would be located near St. James and Sunshine, Louisiana. The various components comprising these systems are described in detail in Section A.4.2, as are the operational scenarios involved. Facilities being considered at the Koch terminal system near St. James include 3-500,000 bbl oil tanks on the west bank of the Mississippi River, one new dock on the east bank of the river, and a pipeline connecting the new dock and the tanks. Facilities being considered at the Nordix terminal system near Sunshine include one new dock, 10-150,000 bbl oil tanks, and a pipeline connecting the terminal system to the Bayou Choctaw - St. James early storage oil pipeline. Facilities being considered at the DOE terminal system near St. James are 4-200,000 bbl oil tanks. It is anticipated that a combination of either the DOE/Koch terminal systems or DOE/Nordix terminal system could be utilized for the Capline Group oil distribution.

The sections below describe the environmental settings of the Koch and Nordix terminal system locations. As the environmental setting of the DOE terminal system at St. James has been described in a previous EIS (FES 76/77-5) and its supplement, the description presented will center on the setting of the Koch terminal system and the Nordix terminal system.

B.3.2.1 Land Features

B.3.2.1.1 Koch Terminal System

The Koch terminal system would be located within the Mississippi River Alluvial Plain, an area characterized by low relief and crossed by abandoned courses and distributaries of the Mississippi River system. Most of the soils found at the site are a result of Holocene alluvial deposits which form the natural levee ridges. The soils are interfingering deposits of clays and silts, and are used extensively for agriculture. In the river, substratum soils are composed of massive sands, grading to gravelly sands and gravel with increasing depths. Accretionary soils consist of alternating layers of clay, silt, silty sands, and sands.

In the vicinity of the site, three general soil associations are found: the Convent-Silty alluvial land association; the Commerce-Sharkey association; and the Sharkey association (Soil Conservation Service, 1973). The Convent-Silty alluvial land association is characterized as frequently flooded, loamy soils that formed in sediments recently deposited by the Mississippi River. It occurs as a narrow band on both sides of the river, between the river and the levee. The Commerce-Sharkey association is characterized as nearly level, loamy and clayey soils found on the broad, natural levees of the Mississippi River and its distributaries. The Sharkey association is characterized as clayey soils found in a broad band between the natural levees and the low back swamps.

B.3.2.1.2 Nordix Terminal System

The Nordix terminal system also lies within the Mississippi River Alluvial Plain, and its soils are also the results of Holocene alluvial deposits. The nature of substratum soils found in the Mississippi River are the same as those described above.

Soil associations found in the vicinity of the site and the connecting pipeline are: the Commerce-Convent association; the Sharkey-Tunica association; and loamy alluvial land (U.S. Soil Conservation Service, 1971). The Commerce-Convent association is characterized as nearly level, loamy soils. Somewhat poorly drained, these soils are found on the natural levees of the Mississippi River and its distributaries. These soils are used mostly for cropland, urban, and industrial uses. The Sharkey-Tunica association is characterized as level to nearly level, clayey soils. Poorly drained, these soils are found in depressions on natural levees and also on broad flats at the base of natural levees of the Mississippi and its distributaries. These soils are used mostly for cropland and pasture. Loamy, alluvial land is characterized as nearly level, unprotected alluvial land between the Mississippi River and its protection levees. These lands are mostly woodlands and wildlife habitat.

B.3.2.2 Water Environment

B.3.2.2.1 Koch Terminal System

The principal water body in the vicinity of the Koch terminal system is the Mississippi River, which separates the proposed tanker dock and storage tanks and would be crossed by a pipeline connecting these two components. Also in the vicinity of the terminal facilities are a series of drainage canals that provide intermittent flow of surface water. These surface water systems are shown in Figure B.3-1.

The average flow in the Mississippi River in the vicinity of the project was 925,000 cubic feet per second (cfs) during 1973-1974. Over the 98-year period of record, the highest recorded flow was 1,473,000 cfs; the minimum flow was 73,700 cfs. The stream cross section at the pipeline crossing is approximately 120,000 square feet and has an average width of 2400 feet and average depth of 50 feet.

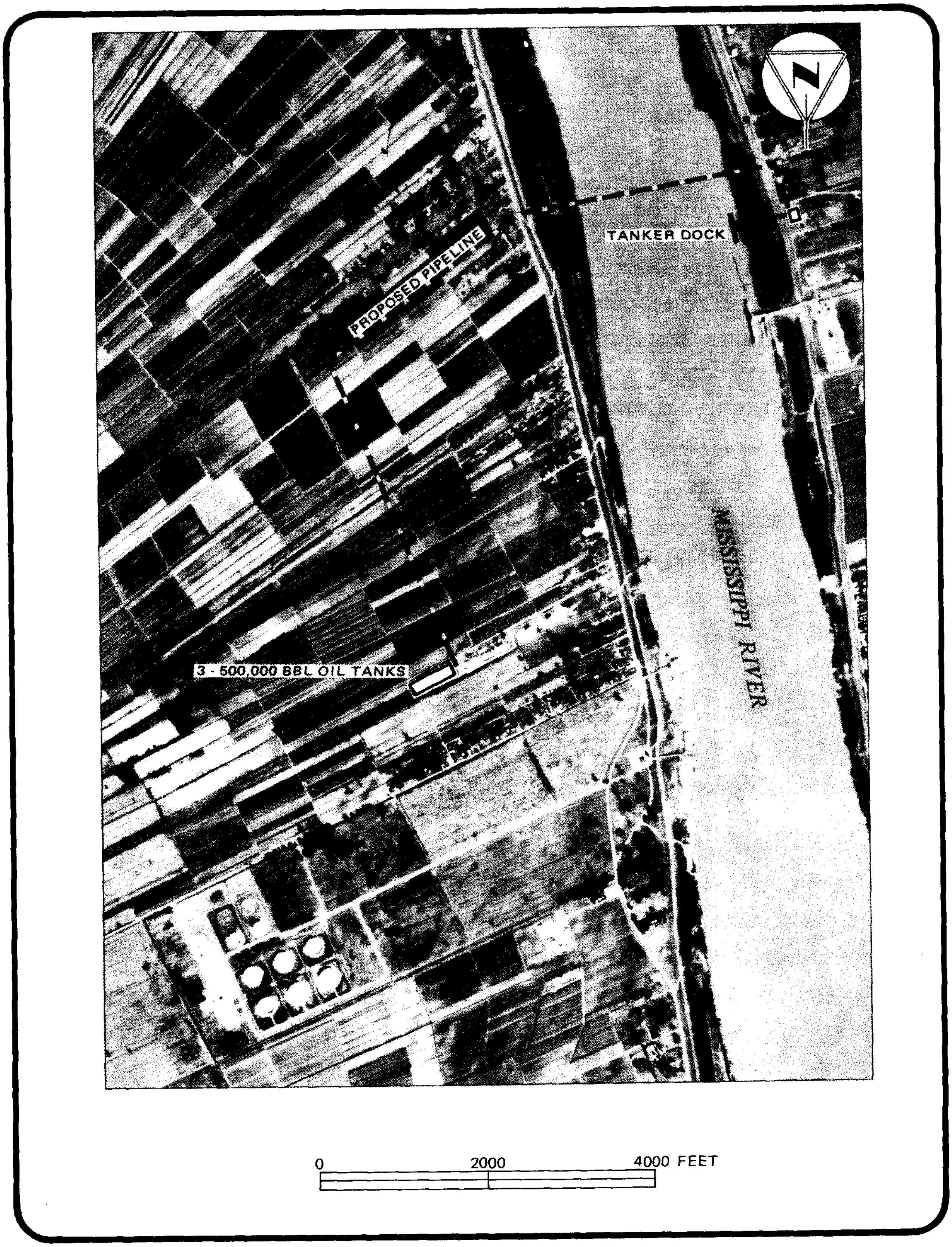


FIGURE B.3-1 Koch oil distribution terminal system.

No data is available on flow rates in the drainage canals crossed by the pipeline on the west bank of the Mississippi River. Because of low gradients found in these areas, water flow is typically sluggish and intermittent. One factor controlling water quantity in the canals is the seasonal variations in precipitation.

Drainage from the land area of the storage tanks or that are crossed by the pipeline is generally to the west, toward the St. James Canal; however the direction of flow varies. Under certain conditions, back-flow will occur up the canals from the west.

Water use designations and numerical limits for selected water quality parameters have been established by the State of Louisiana for the Mississippi River (U.S. Corps of Engineers, 1973). The Mississippi River has been designated for use as domestic water supply, and as suitable for secondary contact recreation (eg. fishing and boating) and for the propagation of fish and wildlife.

Water and sediment quality data for the Mississippi River is presented in Section B.2.2.1.2. Water quality data for the Mississippi River at Union, Louisiana, 10 miles above St. James, is presented in this section. Water quality at that location conforms to State of Louisiana numerical standards. Concentrations of phenols, diaginon, cyanide, and DDD exceed U.S. Environmental Protection Agency guideline criteria for water supply, but are within limits recommended for aquatic biota. Most of the industrial and municipal wastes in the area are discharged into the river.

Sediment in the Mississippi River generally consists of fine sand (100 to 250 micrometers). Standard elutriate tests have been performed on the sediments taken from the Mississippi River at river mile points 212, 224, and 228.5, the results of which are presented in Section B.2.2.1.2. The volume of dredged material expected to be discharged from construction of the tanker dock and laying of the pipeline will be less than 100,000 cubic yards. Results of the elutriate tests for similar types of dredged spoil show that no appreciable oxygen demanding materials, nutrients, or heavy metals are expected to be released from this material.

Potable ground water supplies in the vicinity of the Koch terminal system come from the Plaquemine aquifer, the major shallow subsurface aquifer in the region. It is comprised of deltaic and alluvial deposits of sand and gravel which are covered by a clay and silt surface layer approximately 100 feet thick. In the vicinity of St. James, fresh water (less than 250 mg chloride/liter) occurs to a maximum depth of less than 300 feet).

B.3.2.2.2 Nordix Terminal System

The principal waterway affected by the proposed facilities is the Mississippi River, which would be the site of a tanker dock and a 3400-foot pipeline crossing at about Mile Post 203.7. Two other very small waterways would be crossed by the pipeline and are shown on Figure B.3-2. Bayou Paul, which crosses the Nordix site just south of the proposed tank farm, provides local drainage to wetlands in the Mississippi River and tributaries drainage system, and to the Bayou-Pontchartrain-Maurepas system to the east. Bayou Butte is a channelized canal which drains the Point Pleasant sector of the west levee to the wetlands of the Barataria-Salvador-Des Allemands drainage system west of the river. Several very small, intermittent channels which drain local rainfall from the agricultural land are crossed on the west bank levee (Figure B.3-2).

The hydrology of the Mississippi River is described in Section B.2.2.1.2. Channel depth ranges up to 70 feet or more. The 500-foot navigation channel is maintained at a minimum depth of 40 feet. The river discharge may range from recorded extremes of 70,000 cfs to nearly 1.5 million cfs. River stage fluctuates as much as 30 to 45 feet with these extremes; annual fluctuations of 25 feet are common at Baton Rouge, approximately 25 miles upstream of the Nordix Terminal site. River current velocities may range from 0.6 to 9 feet/second (fps) at the surface, from 0.8 to 12 fps at 60 percent of river depth, and from 0.3 to 4.5 fps at the bottom (U.S. Army Corps of Engineers, unpublished data). The high-water season generally lasts from near the end of March through mid-May and the low water season occurs from August through mid-December.

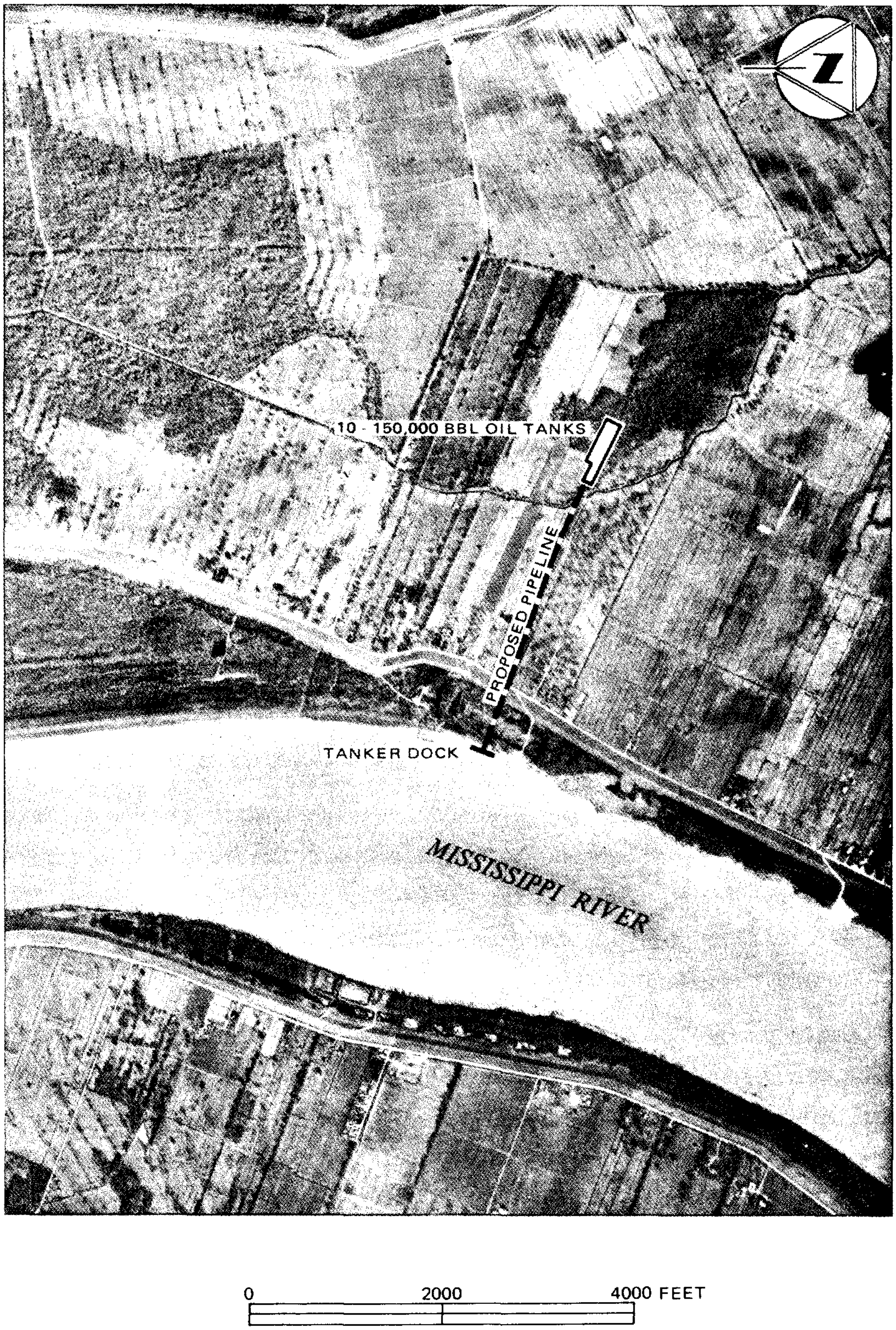


FIGURE B.3-2 Nordix oil distribution terminal system.

The water and sediment quality of the Mississippi River is described in Section B.2.2.1.2. The USGS (United States Geological Survey) water quality monitoring station nearest to the Nordix Terminal site is located at Plaquemine, approximately 4 miles upstream. The nearest location to the site at which published sediment composition data is available is at river mile 208.8, about 5 miles upstream. Section B.2.2.1.2 provides supporting water and sediment quality data, pertinent Louisiana water quality standards, and the EPA (Environmental Protection Agency) water quality guidelines. Generally, the water quality of samples taken at Plaquemine (Mile Post 208) and Union (Mile Post 166), meet most water quality standards and criteria for secondary contact recreation, propagation of fish and wildlife, and domestic water supply.

A sediment sampling program was conducted during March 11-23, 1975 along the Mississippi River from Baton Rouge to the Gulf of Mexico (Corps of Engineers, 1976). A reported sampling station was located at Granada Crossing, very close to the Nordix site between river Mile Post 203.3 and 205.3. The results of two sediment analyses for organics and metals are shown in Table B.2-5. Both sediment samples taken from Granada Crossing met the applicable EPA bottom sediment criteria.

Bottom sediments from the Granada Crossing sample site were tested for pesticides; they showed no detectable concentrations for the parameters tested. These included the following: aldrin, chlordane, DDD, DDE, DDT, dieldrin, endrin, heptachlor epoxide, heptachlor, lindane, PCB, PCN, and toxaphene.

Potable ground water supplies in the project vicinity come primarily from the Plaquemine aquifer, which is overlain by 100 feet of generally impermeable deposits of clay and silt. Though there may be an interconnection with the Mississippi River in places, the water supply is only locally affected by recharge from the river (Whiteman, 1972). Deep aquifers would not be affected by the Nordix Terminal facilities.

B.3.2.3 Climatology and Air Quality

B.3.2.3.1 Koch Terminal System

The climatic conditions from Section B.2.3.1 are generally applicable at St. James and vicinity. Specifically, climatological summaries from New Orleans are believed to be representative for this area since both are about the same distance from the coast. Typically, St. James is expected to experience a less pronounced coastal effect than at Weeks Island (Section B.4.2.3).

Tropical storm effects will be significantly less pronounced than along the coast where the additional hazard of hurricane tides (waves and swells) exists.

The air quality data presented in Section B.2.3.3 are applicable to the St. James vicinity. The nearest sampling station to the area is located at Donaldsonville, where particulate concentrations in excess of the national and state standard have been recorded. This station is located approximately 14 miles north of St. James and both sites are in the same heavily industrialized corridor as is the station. As such, air quality at St. James is expected to be very similar to that recorded at Donaldsonville. As indicated in Section B.2.3.3.1, the three-hour standard for non-methane hydrocarbons is probably exceeded quite frequently in southern Louisiana, including St. James.

B.3.2.3.2 Nordix Terminal System

The climatic conditions from Section B.2.3.1 are generally applicable to Sunshine. Specifically, climatological summaries from Baton Rouge are more representative due to the proximal location of this station to the site. Compared to sites nearer the coast, Sunshine is expected to experience: 1) lower wind speeds, including a higher frequency of calms; 2) slightly cooler weather, especially in winter, with about twice as many days below freezing; 3) slightly lower humidity; 4) somewhat less rainfall, especially in summer; and 5) a slightly higher frequency of stable periods.

Tropical cyclones, including hurricanes, lose strength rapidly as they move inland. The greatest concern at Sunshine is potential damage from wind or flooding due to excessive rainfall.

Generally, the air quality data presented in Section B.2.3.3 are applicable at Sunshine. However, since the site is 10 miles away from the nearest industrial center (Baton Rouge), the air quality at Sunshine normally will be less polluted than in industrial areas. Data presented for Carville are probably indicative of the low levels expected at this site. The one exception is non-methane hydrocarbons, with levels in excess of the three-hour standard recorded in remote areas of southern Louisiana.

B.3.2.4 Background Ambient Sound Levels

B.3.2.4.1 Koch Terminal System

Prefacility ambient sound levels were estimated in order to properly assess the potential noise impact due to construction and operation of the terminal system facilities. Although site-specific ambient sound data were not available, data from ambient sound surveys conducted at potential SPR sites at Cote Blanche (FES 76/77-7) and Weeks Island (FES 76/77-8) were used to estimate baseline sound levels at the Koch terminal site. Ambient sound levels at the site are dominated by sounds from highways, river traffic, and other industrial sources. Ambient day-night weighted sound levels at the Koch terminal site are estimated to be 65 dB.

B.3.2.4.2 Nordix Terminal System

Ambient sound levels along the proposed pipeline route between the Nordix terminal site and the Bayou Choctaw tie-in are typical of levels expected for a secluded, essentially flat, moderately forested area. The sounds in the area are dominated by the wind in the trees, insects, crickets, birds, and other wildlife. Noise levels measured at undeveloped areas on Weeks Island in the coastal area of Louisiana indicate that day-night weighted sound levels are slightly above 50 decibels (dB) (FEA, 1977b). It is expected that a similar sound level (53 dB) should apply to the undeveloped areas located along the proposed Nordix pipeline route.

Noise levels near small communities and at highway crossings (based on measurements made at similar land uses near Weeks Island, FES 76/77-8) indicate that daytime and nighttime sound levels would be 58 dB and 39 dB, respectively. Day-night sound levels are estimated at 56 dB.

At the Nordix terminal site, the ambient sound levels may occasionally be significantly higher than along other area of the pipeline route due to ongoing industrial activity. Ambient day-night weighted sound levels at the Nordix terminal site are mainly contributed by truck and barge traffic and are estimated to be 65 dB.

B.3.2.5 Ecosystems and Species

The description of the environmental setting of the proposed Koch and Nordix terminal facilities site areas are based on regional inventories, known species ranges, literature sources, topographic maps, aerial photographs, and a field inspection of the site.

B.3.2.5.1 Koch Terminal System

The 32-acre site (Table B.3-1) is dominated by cleared lands, supporting both industrial and agricultural activities, that intergrades with bottomland forest and the Mississippi River (Figure B.3-1). Industrial activities in the vicinity of the site on the west bank are primarily concerned with oil terminalling (including docks, pipelines, and oil storage tanks), while on the east bank, these activities include a chemical plant. No bottomland forest, swamp forest or marshland would be affected by the proposed oil distribution terminal facilities.

Land near the Koch terminal facilities is presently used for agricultural purposes, principally cultivation of sugar cane; and for industrial purposes. Crop and pastureland support a less diverse fauna and flora than do bottomland forests. Vegetation is generally sugar cane, soy beans, signal grass, or goatweed. Common wildlife include blackbirds, sparrows, field birds (such as dove and quail), cottontail rabbits, skunks, rats, and mice. Migrant wildfowl often feed in croplands in high densities.

Bottomland forests in the vicinity of the Koch terminal system occur on the east bank of the Mississippi River. These alluvial lands, or batture, which front the river, are periodically flooded. Common species of trees include the willow, cottonwood, huckberry, sycamore,

TABLE B.3-1 Estimated acreage analysis - DOE/Koch oil distribution terminal system combination.

Total for DOE/Koch Terminal System Combination	103 acres
Total for Cleared Land	93 acres
Total for Bottomland Forest	0 acres
Total for Open Water	10 acres

	Acreage for Construction	Acreage for Operation
DOE Terminal System		
Oil Surge Tanks	36	36
Cleared Land	36	36
Bottomland Forest	0	0
Koch Terminal System		
Oil Surge Tanks	27	27
Cleared Land	27	27
Bottomland Forest	0	0
Tanker Dock	5	5
Cleared Land	5	5
Bottomland Forest	0	0
Pipeline from Tanker Dock to Oil Surge Tanks	35	15
Cleared Land	25	15
Bottomland Forest	0	0
Open Water (total water crossings - 1)	10	0

honey locust, sweetgum, Drummond red maple, and water locust. Many species of herbs, grasses, and sedges, as well as submerged plants and floating vegetation, occur in the zone between normal low and high water and in the numerous borrow pits created by excavation during levee construction (Corps of Engineers, 1974). Bottomland forest provides excellent habitat for a variety of terrestrial and avian wildlife. Common species include small rodents, fur-bearing mammals (nutria, muskrat, mink, fox, raccoon, and opossum), rabbits, white-tail deer, skunk, armadillo, and a variety of wading birds, hawks, owls, and song birds.

Fish which can be found in the Mississippi River in the vicinity of the Koch terminal system include largemouth bass, bluegill, redear, warmouth, black crappie, white crappie, several other sunfishes, catfishes (blue, channel, flathead, and bullhead), and several species of gar and carp.

B.3.2.5.2 Nordix Terminal System

Approximately 4.2 miles of agricultural land on the west side of the river would be crossed by the proposed 36-inch pipeline. In addition, approximately 38 acres of land at the Nordix terminal system site is presently cleared and suitable for agriculture (see Table B.3-2). Crop and pasture lands support a less diverse fauna and flora than nearby bottomland forests and wetlands. Vegetation is generally sugar cane, soy beans, signal grass, or goatweed. Common wildlife include blackbirds, sparrows, field birds (such as dove and quail), cottontail rabbits, skunks, rats, and mice. Migrant waterfowl often feed in croplands in high densities.

Common species of trees occurring on well-drained levee lands which have not been cleared include honey and water locust, various oaks (Nuttall, shumard, water, overcup, cherry bark, and live), elms (American, cedar, water), persimmon, pecan, swamp privet, hawthorne and green ash. Several species of shrubs, vines, and grasses occur in the understory. The alluvial land, or batture, which fronts the Mississippi River, is flooded periodically. Common trees include the willow, cottonwood,

TABLE B.3-2 Estimated acreage analysis - DOE/Nordix oil distribution terminal system combination.

Total for DOE/Nordix Terminal System Combination	175 acres
Total for Cleared Land	104 acres
Total for Bottomland Forest	55 acres
Total for Open Water	16 acres

	Acreage for Construction	Acreage for Operation
DOE Terminal System		
Oil Surge Tanks	36	36
Cleared Land	36	36
Bottomland Forest	0	0
Nordix Terminal System		
Oil Surge Tanks	37	37
Cleared Lands	28	28
Bottomland Forest	9	9
Tanker Dock	10	10
Cleared Land	10	10
Bottomland Forest	0	0
Pipeline from Nordix Terminal to Bayou Choctaw - St. James early storage Pipeline	92	31
Cleared Land	30	15
Bottomland Forest	46	16
Open Water (Total water crossings - 15)	16	0

hackberry, sycamore, honey locust, sweetgum, Drummond red maple, and water locust. Many species of herbs, grasses and sedges, as well as submerged plants and floating vegetation, occur in the zone between normal low and high water and in the numerous borrow pits created by excavation during levee construction (Corps of Engineers, 1974).

The bottomland forest provides excellent habitat for a variety of terrestrial and avian wildlife. Common species include small rodents, fur-bearing mammals (nutrial, muskrat, mink, fox, raccoon, opossum), rabbits, white-tail deer, skunk, armadillo, and a variety of wading birds, hawks, owls, and song birds.

Fish which can be found in the Mississippi River and its tributaries in the study area include largemouth bass, bluegill, redear, warmouth, black crappie, white crappie, several other sunfishes, catfishes (blue, channel, flathead, bullhead), and several species of gar and carp. Zooplankton and benthos are present in small populations.

Several species of waterfowl occasionally rest on the river during migration.

B.3.2.5.3 <u>Threatened or Endangered Species</u>

Although the eastern cougar, southern bald eagle, and arctic peregrine falcon are endangered species which occur in southern Louisiana, neither the Koch terminal system facilities nor the Nordix terminal system facilities pass through habitat expected to be used by these species. The American alligator is presently considered threatened and could occur occasionally in small water bodies or along the batture in the area.

A list of endangered or threatened plant species which occur in Louisiana is provided in Section B.2.5. It is unlikely that any of these occur on lands used for the Koch or Nordix terminal system facilities.

B.3.2.6 <u>Natural and Scenic Resources</u>

B.3.2.6.1 <u>Koch Terminal System</u>

Scenic resources in the vicinity of St. James, Louisiana consist primarily of a landscape dominated by agricultural and industrial land uses. There is little variation in topography with the Mississippi River levee providing the highest topography for some miles on either side of the river. Away from those agricultural and industrial areas, however, the vegetative cover is lush and provides a natural beauty to the area.

Although there are several National, state, and private wildlife refuges in the coastal wetlands of south Louisiana, there are none located in the vicinity of the Koch oil distribution terminal system. Nor are any state forests, commemorative areas, or preservation areas located in that vicinity.

B.3.2.6.2 Nordix Terminal System

Scenic resources in the vicinity of the Nordix terminal system are similar to those discussed above, although agricultural and industrial activities are somewhat less predominant. The visual intrusions that these activities present to the more natural areas are less extensive and residential areas are also found.

B.3.2.7 Archaeological, Historical, and Cultural Resources

B.3.2.7.1 Koch Terminal System

Although there are numerous sites in southern Louisiana that have been identified as having historical, archaeological, architectural, or cultural importance, there are very few known sites in St. James Parish. The U.S. Army Corps of Engineers (1973) lists three known archaeological sites in the Parish. Federal historical sites listed in the National Register of Historic Places include two sites in the Parish.

B.3.2.7.2 Nordix Terminal System

The Corps of Engineers (1973) lists 23 archaeological sites recorded in Iberville Parish. None are thought to be located within the proposed project corridor. Other sites may exist which have not been recorded but it is unlikely any would be within proposed project lands because most areas have been developed for many years.

There are presently three sites in Iberville Parish listed in the National Register of Historic Places. There are at least 46 sites listed in the Louisiana State Plan, including the communities of Soulouque and Tallyho which are near the proposed pipeline right-of-way.

B.3.2.8 Socioeconomic Environment

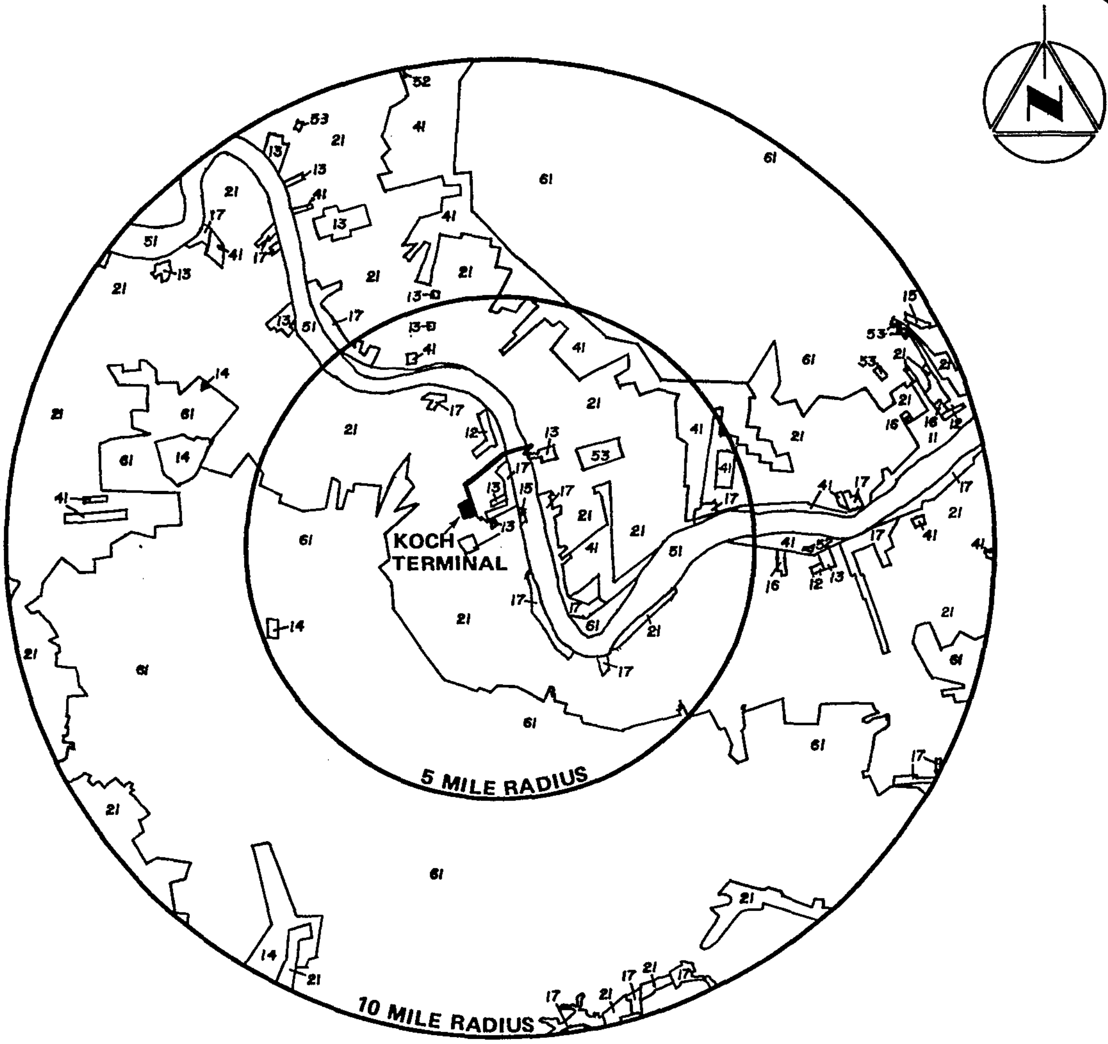
B.3.2.8.1 Koch Terminal System

St. James Parish is a predominantly rural area located on either bank of the Mississippi River. Of 157,000 total acres within the Parish, over half (79,781 acres) is forested wetlands, 6700 acres are waterways and streams, 7400 acres are deciduous forestlands, 55,575 acres are crop and pastureland, and 6400 are urban and built-up lands. In this latter category is included 1200 acres of residential uses, 1500 acres of industrial use, and 2700 acres of cluster and strip development areas. These urban land uses are generally found in close proximity to the Mississippi River.

Land within the vicinity of the Koch terminal system is generally used for agricultural, industrial, or residential uses. Figure B.3-3 shows the land uses within five and ten miles of the site area. Agricultural land is predominated by the cultivation of sugar cane, with small areas (such as the levee) being used as pastureland. Industrial uses are predominated by oil handling facilities and petroleum and petrochemical refineries. Near the dock area on the east bank of the river, a chemical plant is located. Throughout the vicinity, residential, industrial, and agricultural land uses are intermingled.

The population of St. James Parish in 1970 was 19,733, an increase of 7.4 percent from the 1960 population level (University of New Orleans, 1974). Most of this population is rural, non-farm, and reside in numerous small towns having populations less than 2500. Near the Koch terminal are the towns of St. James (located approximately 4 miles south), Burton Lane, Chatman Town, and Convent. Population density in the Parish, in 1970, was 78 persons per square mile.

Principal sources of income in St. James Parish are found in manufacturing, shipping, resource production, and agriculture. Manufacturing activities are centered around the Mississippi River and are predominated by chemical plants, the manufacture of goods related to construction activities, and the refining of petroleum. The value of mineral production, in 1971, in St. James Parish was $11.1 million.



LEGEND

- ◆ SITE
- 14 EXTRACTIVE
- 13 INDUSTRIAL
- 11 RESIDENTIAL
- 17 STRIP AND CLUSTER SETTLEMENTS
- 16 INSTITUTIONAL
- 61 WETLAND, FORESTED
- 62 WETLAND, NON-FORESTED
- 21 CROPLAND AND PASTURE
- 41 FOREST, DECIDUOUS
- 42 FOREST, EVERGREEN
- 43 FOREST, MIXED
- 51-53 WATER

FIGURE B.3-3 Land use map-Koch Terminal.

The median family income for St. James Parish for 1970 was $8048, which is considerably higher than the state median income of $7527. Low income families in the Parish accounted for 21.5 percent of the number of families, only slightly lower than the percentage of low income families in the state (21.5 percent).

Transportation in the vicinity of the Koch terminal system include two state highways (route 18 on the west bank and route 44 on the east bank), two railroads (Texas and Pacific on the west bank and Illinois Central Gulf on the east bank), the Mississippi River, and numerous pipelines for the transport of petroleum products. Shipping traffic on the Mississippi River transports grains, coal and coke, petroleum products, non-metallic minerals, metal products, building materials, sand and gravel, salt, sulfur, chemicals, and miscellaneous other commodities. Traffic in the 40-foot channel between Baton Rouge and New Orleans more than doubled between 1960 and 1970 (from 22 to 44 million tons of ocean-going commerce and from 31 to 87 million tons of barge commerce, Corps of Engineers, 1974). During 1975, there were a total of 46,852 vessel trips in the segment of the river between St. James and Baton Rouge reported by the Corps of Engineers in Waterborne Commerce of the United States, 1975. Approximately 95 percent of these trips were made by vessels with a draft of less than 18 feet. There are many barge and tanker terminals along both banks of the river, which is the focus of most industrial and manufacturing development in the area.

Data on housing availability and community services are presented in FES 76-5 and its supplement (FEA, 1977). Generally, housing is severely limited on the east bank of the river, though more available in the larger population centers in the region.

B.3.2.8.2 Nordix Terminal System

Iberville Parish contains predominantly rural land south and west of the Baton Rouge area. The eastern edge of the parish includes both sides of the Mississippi River near Sunshine; the western edge includes a part of the Atchafalaya Basin. Predominant land use is agricultural (more than 100,000 acres under cultivation, Fielder, 1973) and forest land (over 410,000 acres including 279,000 acres in commercial production, Earles, 1975). Figure B.3-4 shows the land uses within 5 and 10 miles of the site area.

The 1975 population of Iberville Parish was approximately 30,700 (Segal, et al., 1976), which was slightly lower than in 1970. Segal predicts a 7 percent net loss in population by the year 2000, in part due to the continuing trend toward fewer, larger farms with increased mechanization. The 1975 population density was 47 per square mile, or 168 per square mile of habitable land. Plaquemine (pop. 7739) and White Castle (pop. 2206) are the largest communities in the parish.

Prinicpal sources of basin income in Iberville Parish are agriculture, forestry, mineral resource production, and manufacturing. Crops were valued at $7.2 million in 1972, nearly 90 percent being sugar cane (Fielder and Guy, 1973). Three million cubic feet of timber were harvested in 1973 (Earles, 1973). Mineral production in 1970 was valued at about $6.2 million, mostly oil and gas with some salt, sand and gravel (Corps of Engineers, 1973). Total manufacturing income for 1972 was $26 million (Bobo and Charlton, 1974). Commercial fishing is not an important economic activity.

The median family income in Iberville Parish for 1970 was $6251, which was lowest of all nearby parishes and $108 below the Louisiana average (Bobo and Charlton, 1974). In part, this is a reflection of the fact that many people who work in Iberville Parish, particularly near Plaquemine, commute from homes in neighboring, more urbanized, parishes.

Transportation in the vicinity of the Nordix terminal system includes a state road that passes near the site (route 75), ferry connection to the town of Plaquemine, the Illinois Central Gulf railroad, numerous pipelines) principally transporting petroleum products), and the Mississippi River. The Nordix site lies between St. James and Baton Rouge segment of the river which is discussed above.

Data on housing availability and community services are presented in FES 76-5 and its supplement (FEA, 1977c). Generally, housing is severely limited on the west bank of the river, though more available in the Baton Rouge area to the northwest.

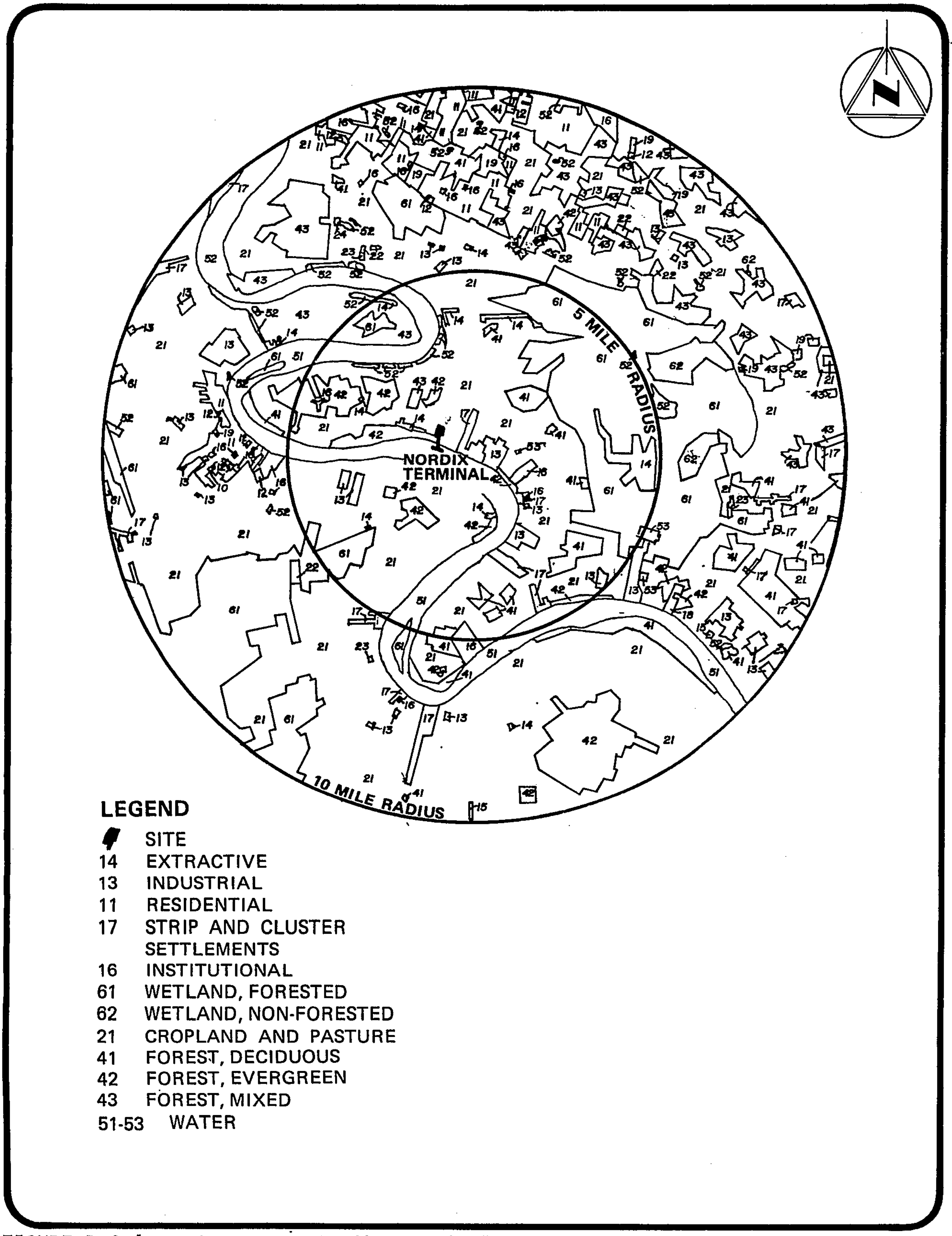


FIGURE B.3-4 Land use map-Nordix Terminal.

B.3.3 Napoleonville Dome - Proposed Site

B.3.3.1 Land Features

B.3.3.1.1 Local Geology

The Napoleonville salt dome is an elliptically shaped piercement dome with a flat top and three steep sides. A geologic structure map contoured on top of the salt (Figure B.3-5) and the accompanying geologic cross sections (Figures B.3-6 and B.3-7), show the shape of the top of the salt mass. These illustrations are compiled from data from some 40 drill holes reported to have intersected the salt or terminated in salt.

Near the top of the salt, at an elevation of -1000 feet, the east-west axis is about three miles long. Much deeper, at -15,000 feet, the long east-west axis is about 7.2 miles in length.

Unconsolidated and partially consolidated muds, sands, and shales of Pleistocene to Recent age overlie the central portion of the dome, developing thicknesses of 600 to 1000 feet. Unconsolidated and partially consolidated sands and shales of Pliocene and Miocene age extend downward to between -15,000 and -16,000 feet adjacent to the dome.

Thickness of Miocene sediments is estimated at 10,000 feet, with the base estimated at approximately -15,500 feet. These sediments have been forced upward in the immediate vicinity of the dome by the salt piercement, as shown in the cross sections in Figures B.3-6 and B.3-7.

Faulting within the Miocene and overlying Pliocene formations adjacent to the dome is extensive and complex. A structure map constructed on a Miocene marker bed (Figure B.3-8) shows three major northeasterly trending faults which apparently control the northeasterly trend of the long axis of the salt stock. Salt emplacement has been affected by these structural weaknesses. In addition, a series of radial faults are interpreted along the southern perimeter of the dome.

Information on the quality of the salt mass is not available. Where extensive drilling programs have been conducted, a characteristic fault pattern has been found to exist in the caprock and around the flanks of the dome. This pattern reflects normal, radial faulting with connecting subsidiary, arcuate, concentric, normal faults between the

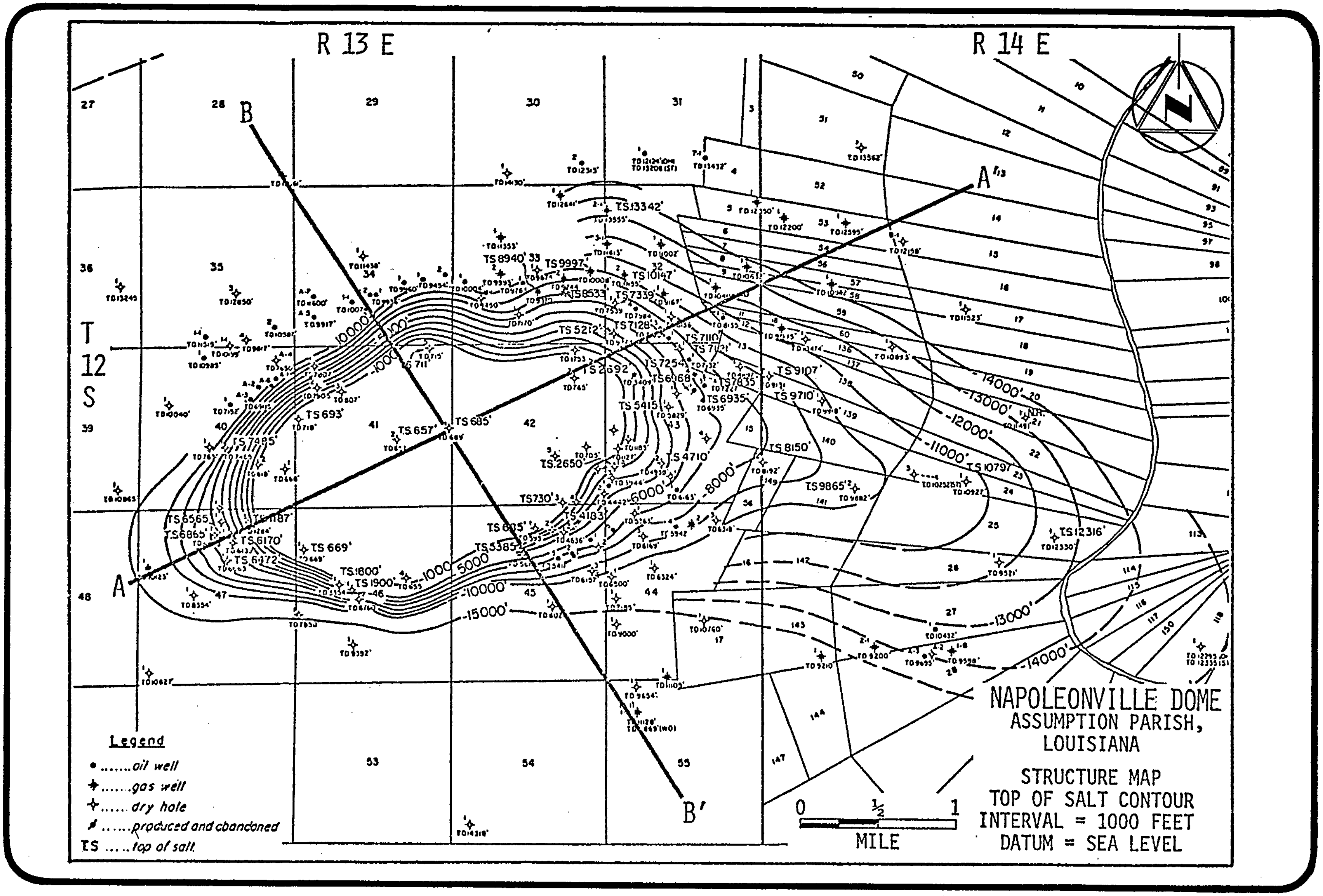


FIGURE B.3-5 Structure map - top of salt - Napoleonville dome.

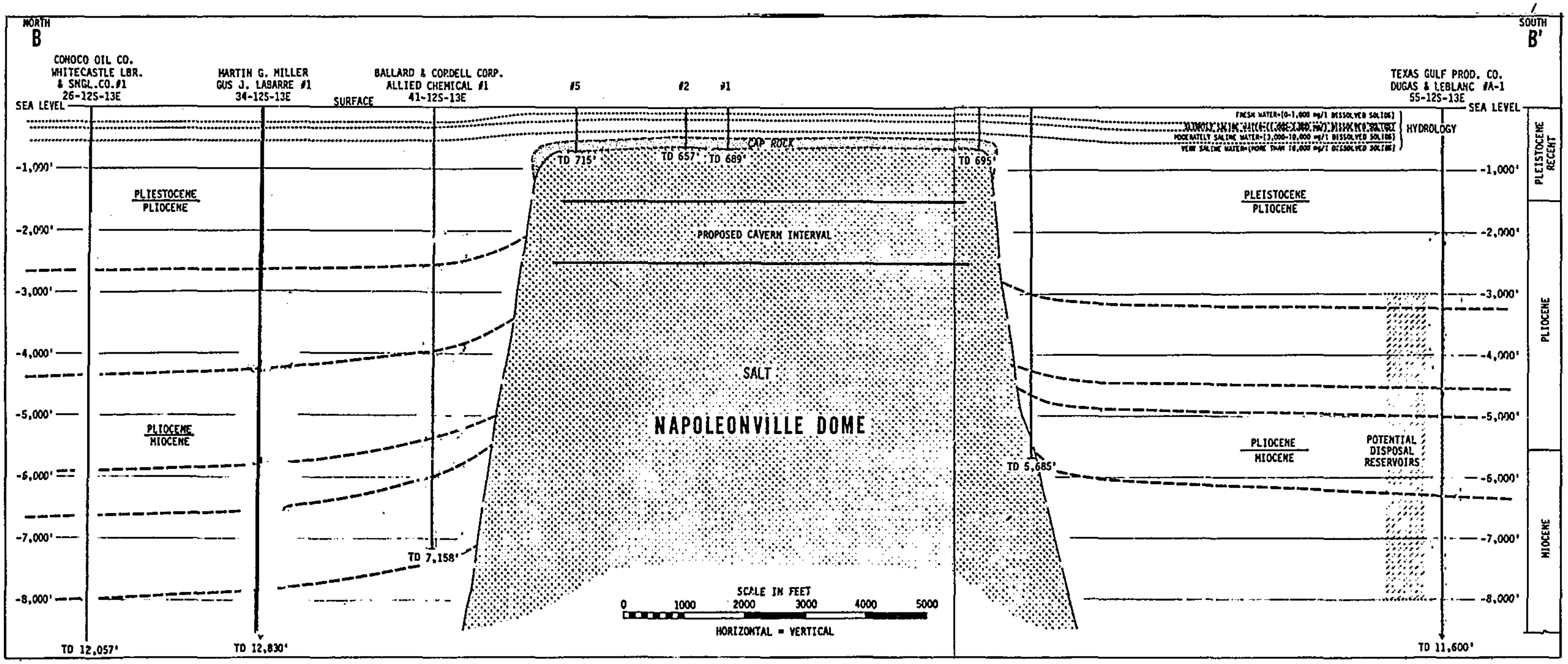
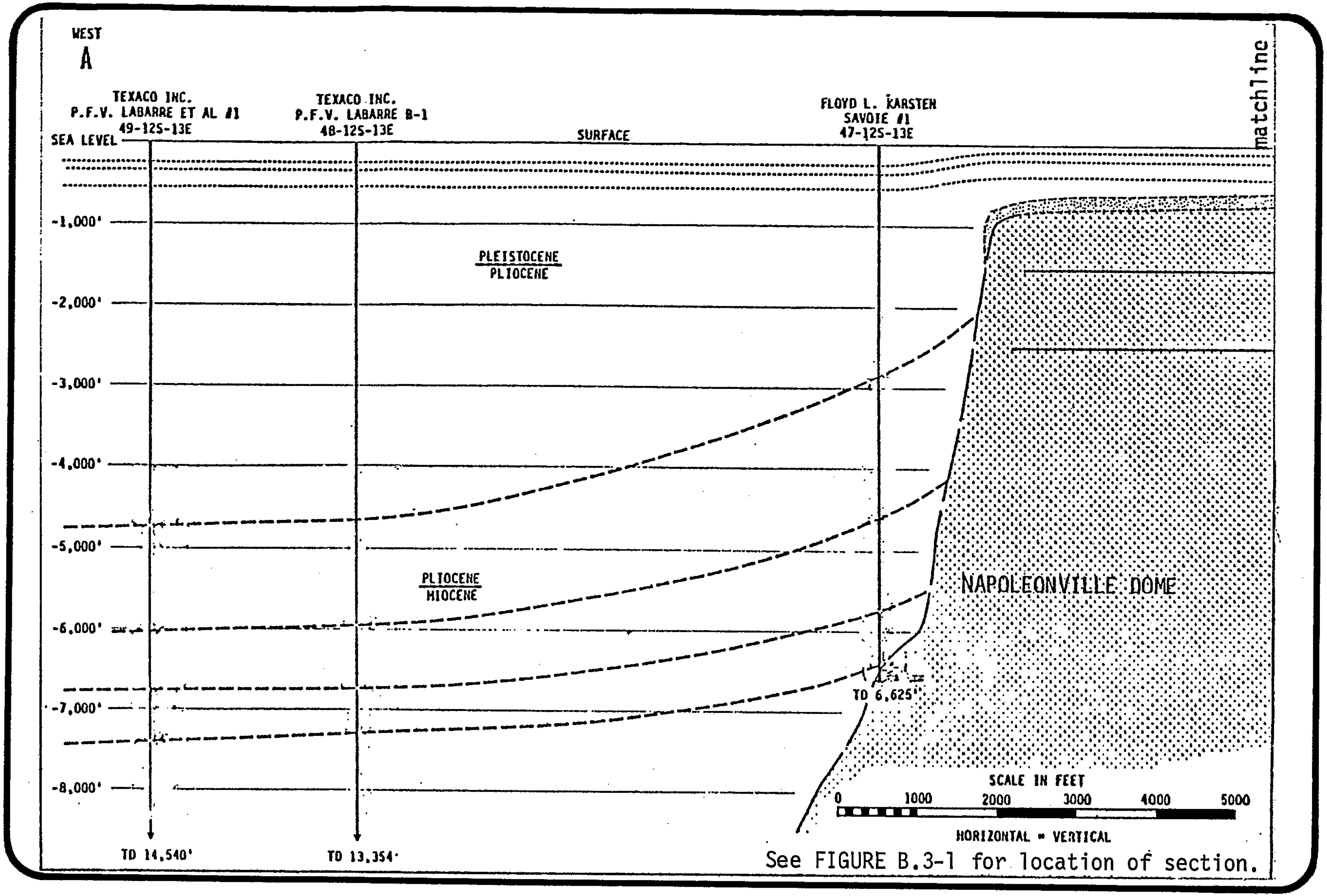


FIGURE B.3-6 Geologic cross section (north/south) Napoleonville dome.



See FIGURE B.3-1 for location of section.

FIGURE B.3-7 Geologic cross section (east/west) Napoleonville dome.

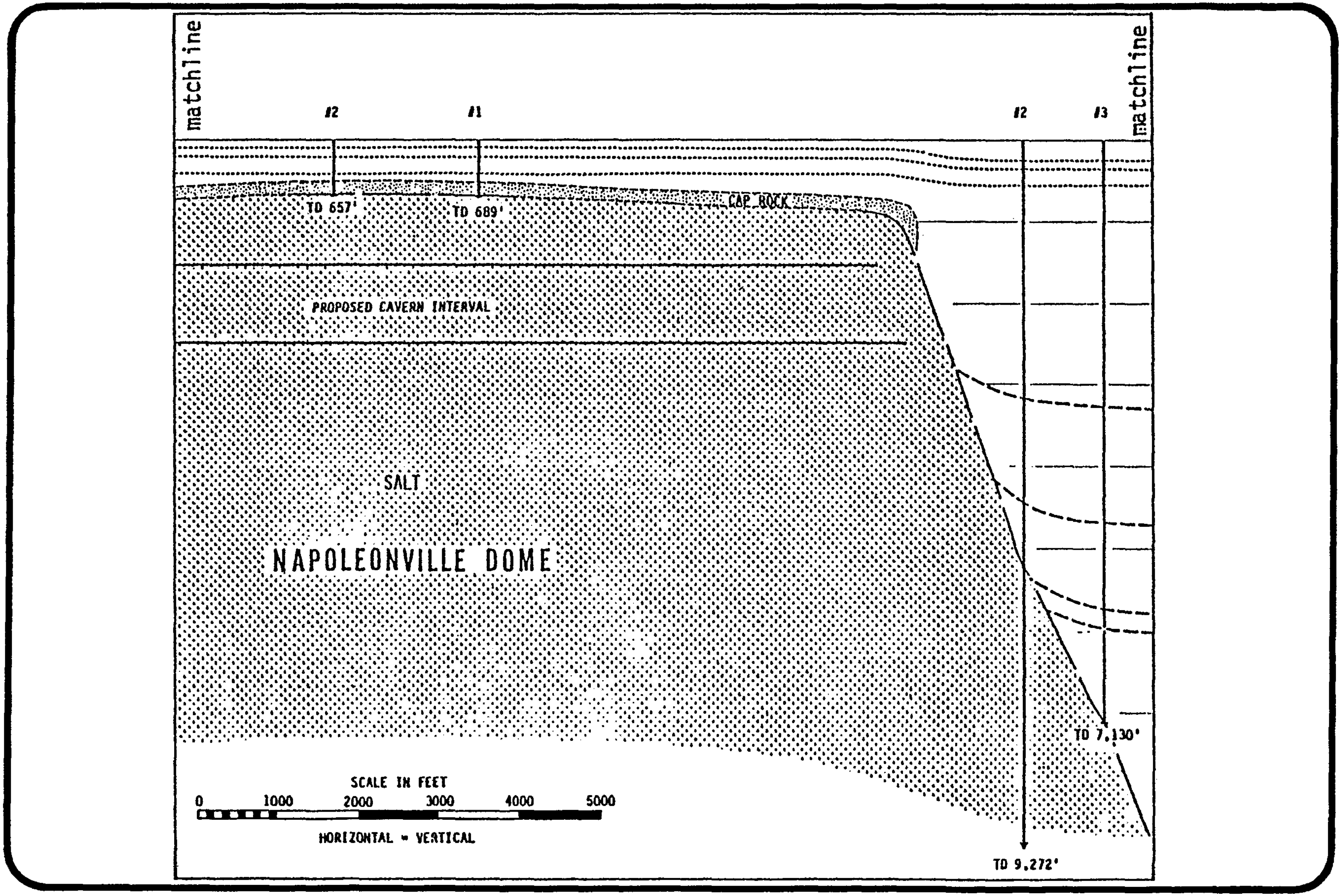


FIGURE B.3-7 continued.

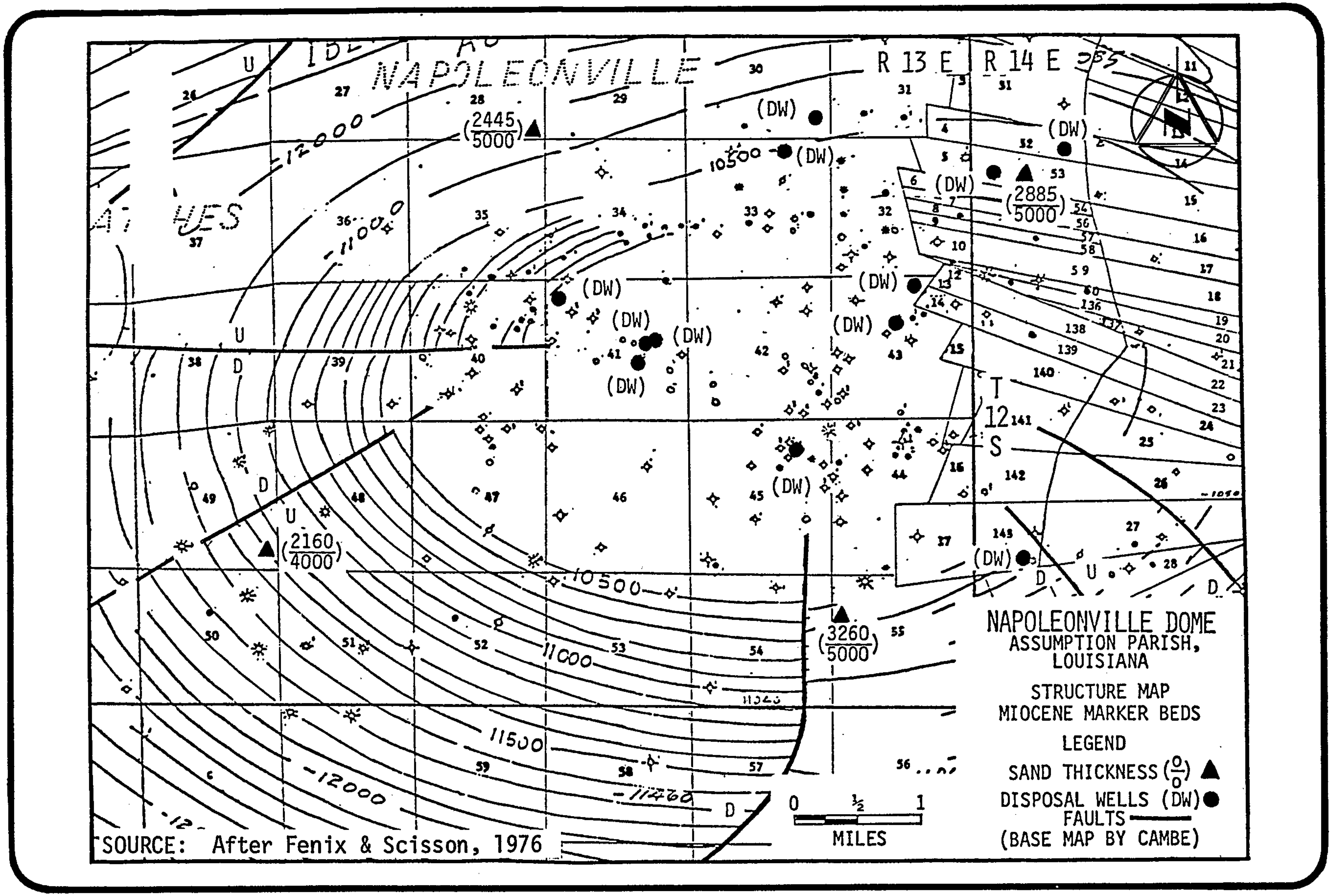


FIGURE B.3-8 Structure map - Miocene marker beds - Napoleonville dome.

radial faults. The greatest throw along the faults is generally away from the dome at depth, becoming progressively smaller upward. Such faults are believed to die out before reaching shallow, somewhat saline aquifers. Therefore, the faults should not affect these aquifers.

During the course of a sulfur exploratory program, Freeport Sulphur drilled at least 10 holes into the caprock, some of which also may have reached the underlying salt stock. Presence of sulfur in the caprock has not been verified, but valuable data were accumulated about the composition of caprock.

Napoleonville caprock is composed of an average (from top to bottom) of 105 feet of calcite ($CaCO_3$), 114 feet of gypsum ($CaSO_4.2H_2O$) - within which is commonly found a 25 foot bed of shale, and as much as 29 feet of anhydrite ($CaSO_4$). Other constituents include an average of eight percent sands and shales.

Average depth to the top of the caprock is 580 feet. Information concerning the extent of caprock is poor; and it has not been determined whether it covers only the dome, or whether it extends out over the flanks.

Caprock is usually intensely fractured and faulted due to the upward pressures exerted by the rising salt stock. During periods when the salt is not rising as fast as it is dissolving, caprock may be partially unsupported and fall along new or preexisting fault planes, thus creating the brecciation commonly encountered by drilling.

Caprock faulting and fracturing, aided by the leaching effect of percolating ground waters, results in the formation of vuggy to cavernous porosity and associated high permeabilities. As a result, severe drilling fluid loss is often encountered while drilling the caprock.

B.3.3.1.2 <u>Economic Geology</u>

The first Napoleonville dome oil production was from G.H. Echols No. 1 Kessler and Sternfels. Production has largely been confined to the north rim of the dome. The greatest density of drilling, however, has been on the northeast flank.

Interpretation of the salt structure map and geologic cross sections suggests that oil and gas occur on the flanks of the done in Miocene or later sediments that are faulted or pinched out against the sides of the dome.

Louisiana Department of Conservation records indicate that producible oil or gas has been found in numerous fairly deep zones, ranging from -8989 feet in Kessler and Sternfels B-1 in Section 36, T-12-S, R-14-E, to -12,016 feet in Callery No. 1 Dugas in Section 53, T-12-S, R-12-E.

No known oil or gas production is located over the top of the dome in the area proposed for the storage facility.

B.3.3.1.3 Local Soils

Three soil associations occur in the vicinity of the Napoleonville dome (U.S. Department of Agriculture, 1970a). Most prevalent is the Swamp-Sharkey association, comprising unprotected clayey soils, which occur at low elevations that are frequently flooded. The Sharkey-Tunica association, characterized by level, poorly drained, clayey alkaline soils in depressions and at the base of natural levees, occurs in a strip across the central area of the dome and along the margins of the Bayou Lafourche levees. The Commerce-Convent association characterizes the levees of Bayou Lafourche. These soils are somewhat poorly drained, alkaline, and occur at the higher elevations.

B.3.3.2 Water Environment

B.3.3.2.1 Surface Water Systems - Napoleonville

Figures A.3-1 and A.3-4 illustrate several surface water bodies in the vicinity of the Napoleonville site. Grand Bayou is located approximately 0.5 miles to the west of the site, and flows generally southerly to Lake Verret about six miles downstream. Other water bodies include Bayou Corne, about 2 miles to the west, and Bayou Lafourche, about 5 miles to the east. Numerous other smaller canals are located in close proximity to the site. Natural drainage is generally to the south and west.

B.3.3.2.2 Subsurface Water Systems

The Napoleonville salt dome penetrates the Plaquemine aquifer, the base of which is at a depth of about 1400 feet in the site vicinity, with highly saline water (greater than 10,000 mg/l dissolved solids) occurring below a depth of about 550 feet. The depth to salt is about 690 feet and the top of the caprock is at a depth of about 580 feet. The base of the fresh water (less than 1000 mg/l dissolved solids) is about 250 feet below sea level in the vicinity of the dome (Rollo, 1960).

Aquifers in the vicinity of Napoleonville dome are capable of delivering large quantities of slightly to moderately saline water to properly completed wells. Aquifer porosities are on the order of 40 percent with permeabilities in the range of 1000 to 2000 gpd per foot. Well yields of 5000 gpm or more may be anticipated.

Ground water use in the vicinity of Napleonville dome is minor, being primarily for domestic consumption.

B.3.3.3 Climatology and Air Quality

B.3.3.3.1 Climatology

The climatic conditions from Section B.2.3.1 are generally applicable at Napoleonville. Specifically, climatological summaries from New Orleans are believed to be representative for Napoleonville since both cities are about the same distance from the coast. Typically, Napoleonville is expected to experience a less pronounced coastal effect than at Weeks Island (Section B.4.2.3).

Tropical storm effects, while more pronounced at Napoleonville than farther inland, will be significantly less than along the coast where the additional hazard of hurricane tides (waves and swells) exists.

B.3.3.3.2 Air Quality

Generally, the air quality data presented in Section B.2.3.3 are applicable at Napleonville. The nearest sampling station to the site is located at Donaldsonville, where particulate concentration in excess of the national and state standards has been measured. However, Donaldsonville is near a more heavily industrialized area of the state, and air quality at Napoleonville will normally be less polluted than at Donaldsonville. As indicated in Section B.2.3.3.1 the three-hour standard for non-methane hydrocarbons is probably exceeded quite frequently in southern Louisiana, including Napoleonville.

B.3.3.4 Background Ambient Sound Levels

Prefacility ambient sound levels were estimated in order to properly assess the potential noise impact due to construction and operation of the SPR project. Site-specific ambient sound data were not available. Data from ambient sound surveys conducted at potential SPR sites at Cote Blanche (FES 76/77) and Weeks Island (FES 76/77-8) were used to estimate baseline sound levels at the Napoleonville site. Areas around Cote Blanche and Weeks Island have low denity population and marshland uses similar to Napoleonville. Ambient sound levels at the site are dominated by sounds from highways, pumping stations, storage facilities, and other industrial activities. Ambient sound levels in neighboring areas are dominated by insect and animal noise, wind noise, and traffic on local roads.

A summary of the estimated background ambient sound levels in terms of L_d (daytime), L_n (nighttime), and L_{dn} and (day/night average) are presented in Table B.3-3. Definitions of L_d, L_n, and L_{dn} are presented in Section B.2.4.

These ambient noise levels may be compared with levels identified by the EPA as being requisite to protect public health and welfare (Section B.2.4).

B.3.3.5 Ecosystems and Species

The description of the environmental setting of the Napoleonville site area is based on regional inventories, known species ranges, literature sources, topographic maps, aerial photographs, and a field inspection of the site.

The 437-acre storage site (Table B.3-4) is dominated by deciduous swamp that intergrades with bottomland forest, though there are some developed areas to the north and northwest (Figures B.3-9 and A.3-4).

TABLE B.3-3 Summary of background ambient sound levels (dB) estimated for Napoleonville site.

Location	L_d	L_n	L_{dn}
Center of Site	70	67	74
Noise-Sensitive Land Uses	58	39	56
Undeveloped Areas	55	39	53
St. James Terminal	65	55	65

TABLE B.3-4 Estimated site acreage analysis - Napoleonville[a].

Total for Fenced Site Area	437 acres
Total for Storage Site and Pipelines (Area to be developed)	589 acres
Total for Cleared Land[b]	66 acres
Total for Bottomland Forest	24 acres
Total for Deciduous Swamp	123 acres
Total for Open Water	2 acres

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Proposed Brine Disposal System (wells)	6.7	76	48
Cleared Land		16	10
Bottomland Forest		0	0
Deciduous Swamp		60	38
Open Water (total water crossings - 0)		0	0
Alternate Brine Disposal System (Gulf and wells)	78.1	947	61
Cleared Land		23	15
Bottomland Forest		5	3
Deciduous Swamp		45	28
Marsh		25	15
Open Water (total water crossings - 25)		849	0
Proposed Raw Water System (Bayou Laforche)	4.6	14	8
Cleared Land		11	7
Bottomland Forest		0	0
Deciduous Swamp		2	1
Open Water (total water crossings - 2)		1	0
Alternate Raw Water System (Grand Bayou)	0.4	4	3
Cleared Land		0	0
Bottomland Forest		0	0
Deciduous Swamp		4	3
Open Water (total water crossings - 0)		0	0
Alternate Raw Water System (wells)	4.9	27	17
Cleared Land		26	17
Bottomland Forest		0	0
Deciduous Swamp		0	0
Open Water (total water crossings - 2)		1	0
Alternate Raw Water System (Mississippi River)	19.1	62	38
Cleared Land		39	24
Bottomland Forest		0	0
Deciduous Swamp		22	14
Marsh		1	0
Open Water (total water crossings - 4)		1	0
Alternate Raw Water System (Gulf)	44.3	212	57
Cleared Land		17	11
Bottomland Forest		5	3
Deciduous Swamp		45	28
Marsh		25	15
Open Water (total water crossings - 25)		120	0
Proposed Oil Delivery System (to St. James)	19.1	62	38
Cleared Land		39	24
Bottomland Forest		0	0
Deciduous Swamp		22	14
Marsh		0	0
Open Water (total water crossings - 4)		1	0

[a]Based on features of USGS topographic maps (15 minute series)
[b]Cleared Land includes agricultural, industrial and rural

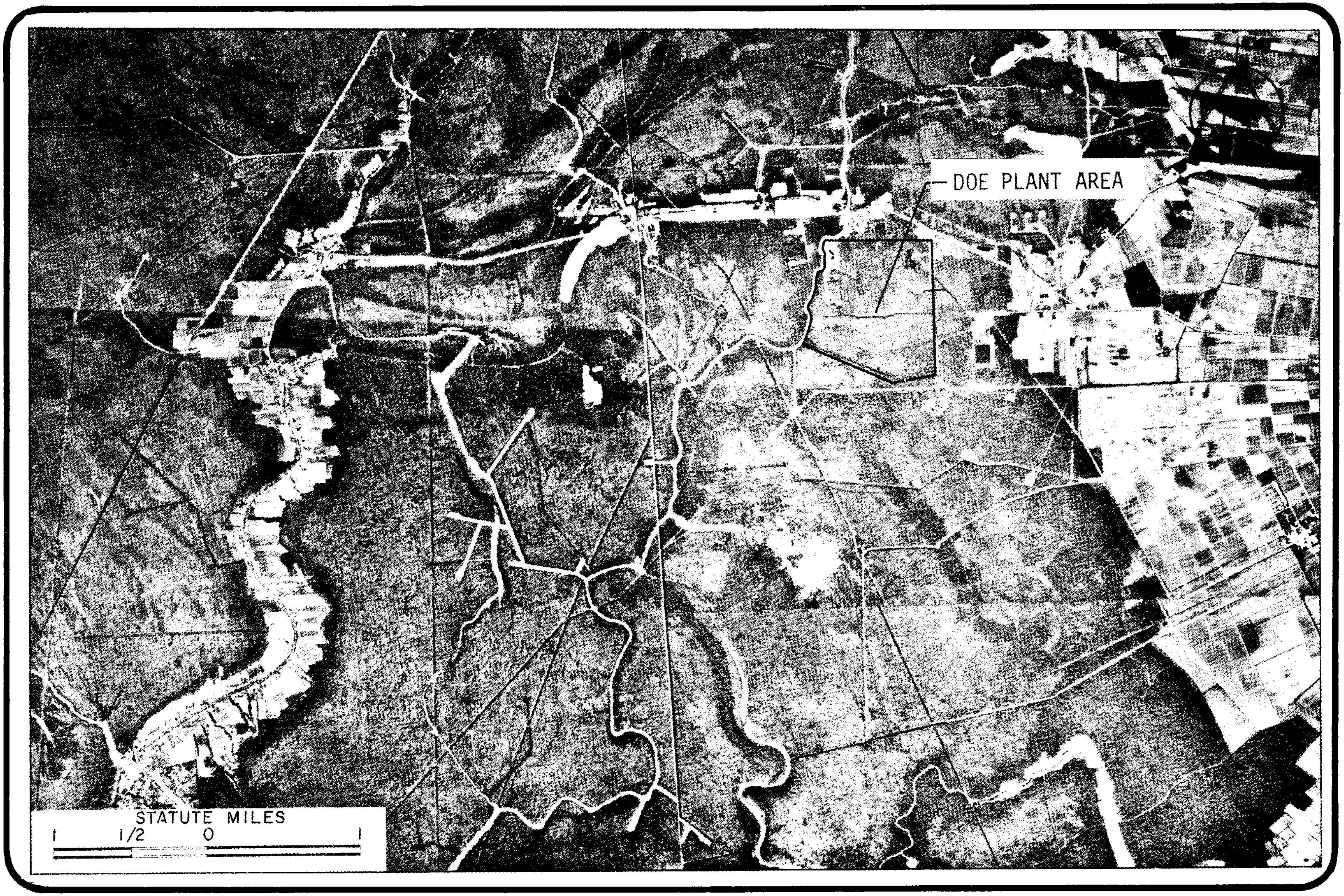


FIGURE B.3-9 Air photo - Napoleonville plant area.

The vegetation of the site area is largely determined by precipitation, relief, soil type, salinity, and temperature. Generally, arable land within the site area has been used for agricultural production of livestock, sugar cane, corn, sorghum, wheat, soybeans, and peanuts. The primary types of ecosystems within the immediate vicinity of the site are cropland, bottomland forest, and deciduous swamp. In addition, the village of Grand Bayou extends onto a portion of the dome. The vegetation found on and around the site is dominated by bald cypress, followed in importance by tupelo, gum, red maple, water ash, and pumpkin ash. Generally areas to the west of and close to Grand Bayou are vegetated by cottonwood, sycamore, red gum, black willow, and hackberry. Water oak and natall oak are also represented in the overstory.

Understory vegetation of the bottomland forest generally includes significant representation by regenerants of the dominant overstory stratum. Species of importance in the site vicinity include greenbriar, poison ivy, palmetto, blackberry, trumpet vine, Virginia creeper, peppervine, holly, and grape.

In addition to the native vegetation surrounding the site, areas such as roadway edges, levees, and built-up sites on the dome have been modified and revegated with Bermuda grass, wild rype, panic grass, Bahai grass, and Johnson grass.

Wildlife habitat types found at the Napoleonville site include deciduous swamp and bottomland forest, cleared lands (existing oil field development, urban areas, and agriculture lands), and freshwater wetlands (creeks, bayous, and marshes). Wildlife population and harvest estimates for various wildlife species by region and parish, made available by the Louisiana Wildlife and Fisheries Commission, are presented under Sections B.2.5.2.2 and B.2.5.3.1.

The deciduous swamp and bottomland forest is by far the most significant and characteristic habitat type (in terms of surface acres) found at the site. This habitat type provides resources for a large number of wildlife species (Section B.2.5, Tables B.2-15, B.2-17, B.2-18 and B.2-19). Some common bird species of the bottomland forest and swamp include herons, egrets, woodpeckers, wood duck, woodcock, thrushes, vireos, and warblers. Two important recreational species likely to occur on site are the wood duck and woodcock. Bottomland areas such as those present on the site, provide essential nesting and wintering habitat for both species. The bottomland swamps also provide suitable habitat for the endangered southern bald eagle.

Some common mammals expected to occur in the bottomland forest and swamp include opossum, squirrels, nutria, mink, raccoon, swamp rabbit, bobcat, and white-tailed deer. Important commercial or recreational inhabitants include squirrels, rabbits, furbearers, and deer.

Amphibians and reptiles expected to occur at the Napoleonville site are presented in Section B.2.5, Table B.2-15 and B.2-17. The bottomland swamp provides important habitat for the alligator which is considered an endangered species in the Napoleonville site area (see discussion in Section B.2.5).

Cleared lands provide limited habitat for wildlife. Most wildlife species found in these areas are those that have adapted to man and can survive in significantly altered habitats. Some of these species are presented in Table B.2-15 under the cleared lands category.

The freshwater wetlands found at the Napleonville site consist of a vast swamp area connected by a canal-bayou-lake complex to Grand Bayou at the western margin of the site (Figure A.3-4). Wildlife species expected to occur in these wetlands are presented in Section B.2.5, Tables B.2-15, B.2-17, B.2-18 and B.2-19. Commercially and recreationally important species present include waterfowl and furbearers.

The most apparent constituent of the swamp complex at the Napoleonville dome is the aquatic macrophyte community. Plants which often dominate the freshwater swamps in southern Louisiana include bulltongue, maidencane, and spike rushes (accounting for 66 percent of swamp vegetation). Giant cutgrass, elephant's ear, various pond weeks, and black willow also dominate the swamp/creek interface along Grand Bayou in many places. A blanket of duckweed covers much of the water surface on the site during warm parts of the year.

The freshwater swamps are most diverse habitats (Chabreck, 1970), and are among the most productive natural ecosystems in the world, with mean net productivity of organic materials as high as 2,000 grams dry weight per square meter per year (Whittaker, 1972). Since the Napoleonville dome is in a temperate, nutrient enriched area, this level of production should be indicative of specific production in the vicinity of the proposed facility.

Emergent swamp vegetation serves as the most important producer in the organic detritus cycle. More plant biomass is produced than is consumed by the herbivores, and as this material dies and decomposes, it furnishes food for a wide variety of detritus-feeding organisms. In freshwater swamps, this organic matter is incorporated into the soil, and is developed into peat consisting of approximately 80 percent organic matter.

Several groups of organisms feed directly on the aquatic macrophytes or on the detritus which macrophytes produce upon decay. The diet of nutria, common animals in the swamp-bayou complex around the Napoleonville dome, consists almost entirely of macrophytes. Crayfish and some other aquatic invertebrates also feed heavily on detritus.

The majority of phytoplankton likely to be encountered in the standing waters around the site include green algae, blue-green algae, and diatoms, (Chabreck, 1970), which are usually most abundant in the spring. Copepods are likely to the most abundant zooplankter; however, cladocerans, rotifers, and ostracods may also be abundant (U.S. Army Corps of Engineers, 1975b).

Benthic macroinvertebrate data specific to the site are not available and fisheries data are limited. However, the characterisitcs of these communities are probably not much different from those discussed for the regional environmental setting. A fishery survey of Grand Bayou (1973-1975) about 3 miles north of the site identified 19 fish (Table B.3-5), the most abundant being the gizzard shad. The most abundant game fish was the white crappie and the most abundant commercial fish were blue and channel catfish. Total standing crop for the 1973 sample was 307.0 pounds/acre and 126.0 pounds/acre in 1975 (Mangum, 1977).

TABLE B.3-5 Fish collected from Grand Bayou, 1973-1975[a]

Spotted gar	Flier
Bowfin	Warmouth sunfish
Gizzard shad	Bluegill
Grass pickerel	Largemouth bass
Carp	White crappie
Blue catfish	Black crappie
Black bullhead	Freshwater drum
Yellow bullhead	Striped mullet
Channel catfish	MIscellaneous minnows

[a]Mangum, 1977

In addition to the development of the site, a brine disposal, raw water, and oil delivery system will be designed, each having one or more alternatives (see Sections A.3.5 and Figure A.3-4). Estimates of acreages of various habitat types to be used for these systems and their alternatives are provided in Table B.3-4. The environmental setting of these systems and alternatives is composed of the same general habitat types discussed with respect to the Napoleonville dome site area. There are, however, some differences between the environmental setting of the site area and other areas covered by particular systems or alternates, which merit discussion.

The productivity of the habitats in the vicinity of the proposed brine disposal system may be higher than that of the dome since most of the habitats near the brine disposal system are undisturbed. The alternative brine disposal system to the Gulf of Mexico would require a pipeline across the Atchafalaya Basin. However, the alternative system would be in an area along pipeline routes already established for another system (pipeline from Weeks Island to St. James). The environmental setting of the alternative brine disposal system encompasses an area about 74.4 miles long, including a 32.1-mile section in the Gulf of Mexico. This area is characterized by the same ecosystems as discussed in the regional setting of the Capline Group (Section B.2.5) and for Weeks Island alternative since the same brine disposal pipeline would be used (Section B.4.2.5 and Appendix G). A major portion of the alternative brine disposal route would be through relatively undisturbed swamps and marshlands, and would require crossing many streams.

The primary oil delivery system and the alternatives for raw water from Grand Bayou or from the well field would involve habitats similar to those on the dome. The alternative system for raw water from the Gulf of Mexico would use the same habitat as the Gulf of Mexico brine disposal system but would be 30.1 miles shorter since the raw water system would extend offshore only 2 miles.

B.3.3.6 Natural and Scenic Resources

B.3.3.6.1 Natural Resources

The land overlying the Napoleonville dome is primarily swamp forest bordered on the south and east by cleared land predominantly in agricultural use. Grand Bayou bisects the western edge of the dome, flowing in a southwesterly direction. Directly south and west of the Napoleonville dome freshwater swamps are most prevalent, while to the southeast and east cleared land dominates. The swamps, marshes, and Grand Bayou are areas of abundant natural resources.

The area south of the storage site is primarily wooded wetland and open water to an area a few miles south of Route 90. South of this point coastal marshes and open water areas are the natural resources.

The proposed Lake Verret State Park is situated close to the Napoleonville site, about 3 miles to the south. Other wildlife and recreational areas in the region surrounding Napoleonville are discussed in Section B.2.6.1, none being within a 10-mile radius of the dome.

East of the site the cleared land in use for crops occurs on the natural levees along Bayou Lafourche and the Mississippi River. Between these waterways a natural area of swamp forest occurs.

B.3.3.6.2 Scenic Resources

The storage site is located in an area that was originally swamp and cropland but which has been significantly altered by previous industrial development. The natural aesthetic value of much of the site is fairly low due to the presence of brine producing facilities including wells, pumping stations, storage facilities, pipelines, and roads. There are wooded areas on the site itself, however, which have some natural aesthetic appeal. The area along Grand Bayou has a slightly higher aesthetic value due to the waterway and associated vegetation. Access roads through the developed area are not open to the public. The surrounding swamps and bottomland areas are inaccessible by road. The site is not visible from the nearest public road, Route 70.

The area south of the site toward the Gulf of Mexico contains many remote areas of fresh and brackish swamps and marshes with valuable scenic resources. These areas are frequently inaccessible by road and are viewed by only occasional waterborne travelers.

The areas between the storage site and Bayou Lafourche to the east are of lesser scenic appeal having been cleared in most cases. The open fields offer broad vistas of varying beauty depending on the season.

B.3.3.7 Archaeological, Historical, & Cultural Resources - Napoleonville

As a preliminary to receipt of the results of the cultural and historical resources field survey, the U.S. Army Corps of Engineers' environmental inventory (1973a) and the U.S. Department of the Interior (1977) were consulted to determine if any archaeological or historic sites occur at the Napoleonville dome.

The Napoleonville dome does not appear to contain any known sites of archaeological or historic significance. However, there are several sites within a five-mile radius of the dome.

The National Register lists two historical sites in Assumption Parish, one in and one east of the town of Napoleonville, both greater than five miles from the dome. In the U.S. Army Corps of Engineers' environmental inventory, 15 archaeological sites listed in the Louisiana State Plan are not shown because of preference by state authorities that the general public not know the exact locations of the sites. Nineteen sites of archaeological interest are shown, several of which are inside a five-mile radius from the dome. Two of those sites are north of the dome in Assumption Parish near the intersection of the boundaries of Ascension, Assumption, and Iberville Parishes. Three other sites occur south of the dome on either side of Grand Bayou and approximately half-way between Lake Verret and Route 70. There are approximately 15 sites along Grand River south of the Iberville-Assumption Parish border to the south end of Lake Verret, some of which may occur within five miles of the dome. Additionally, the Belle Rose Sugar House north of Belle Rose, and the historic town of Paincourtville are approximately five miles from the dome. Other listed sites are all farther away.

B.3.3.8 Socioeconomic Environment

B.3.3.8.1 History

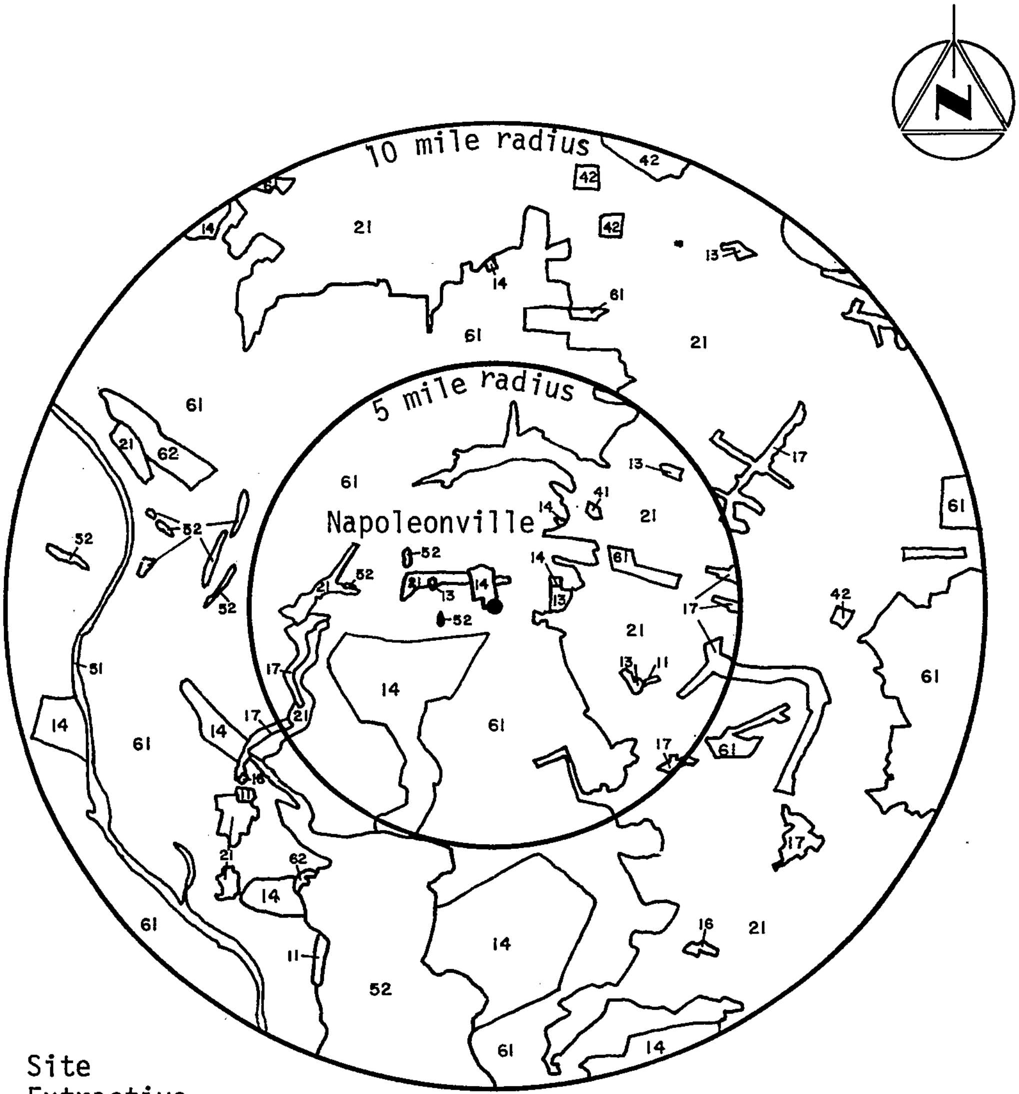
The area surrounding Napoleonville was originally settled by the French. Early French influence can be seen in the layout of property boundaries in long, narrow plots of land called arpents stretching out from waterways. The French-speaking community is the largest of t e ethnic language groups, and the area is distinguished by the predominance of French place names and family names. A basically conservative influence is exerted in the area by the families that have been established there for generations and by an active awareness of the historical significance of local landmarks.

The site itself has been in active production by several companies for brine and sulfur since 1957.

B.3.3.8.2 Land Use Patterns and Planning

The land overlying the section of the dome proposed for SPR development is currently in a mixture of uses including woods, swamp forest, and some residential and extractive use. The area just to the south of the dome is predominantly freshwater swamp with some sections of farmland. The land directly east of the dome site is wetland. Further east, toward Bayou Lafourche, the land is under agricultural use (see Figure B.3-10).

The village of Grand Bayou overlies a portion of the dome north of the site. The village is comprised of about 30 residences and a few additional scattered structures. Several sections of land over the dome are currently in use for extraction or mining. Dow Chemical, Texas Brine and Storage Company, and Shell Oil Company lease significant portions of the dome property. A few above-ground structures related to extraction and mining activities exist on and around the proposed site area. Within a ten-mile radius of the site, the land area west and north of the site is predominantly marshland. To the east and northeast of the site along Bayou Lafourche, much of the land up to the Mississippi River is in agricultural use. Some residential and commercial strip settlement has occurred along Louisiana Route 1 which runs north/south



LEGEND

●	Site
14	Extractive
13	Industrial
11	Residential
17	Strip and Cluster Settlement
16	Institutional
61	Wetland, Forested
62	Wetland, Non-Forested
21	Cropland and Pasture
41	Forest, Deciduous
42	Forest, Evergreen
43	Forest, Mixed
51, 52	Water

FIGURE B.3-10 Land use within 5 and 10 mile radius of Napoleonville dome.

about five miles east of the site. Grand Bayou flows north/south through the dome immediately adjacent to the west edge of the proposed SPR site. Lake Verret is located about six miles south of the dome.

B.3.3.8.3 Transportation Systems

The Napleonville storage site has access to surrounding population centers via Route 70 east to Route 1 which connects with Donaldsonville, Plaquemine, and Baton Rouge to the north and Thibodaux and Homa to the south. Route 69 intersects Route 70 at Grand Bayou connecting the site with White Castle and Route 1 to the north.

The area surrounding the storage site is served by the regional transportation network discussed in Section B.2.8.3, especially Route 1 east of the storage site and Route 90 to the south.

The storage site is connected to Route 70 and Grand Bayou by a short unpaved road. On the site, a network of roads has been constructed throughout the area during previous development providing access to within 3,000 feet of any point on the dome.

Grand Bayou, on the western edge of the site, is not considered commercially navigable and does not connect with the Intracoastal Waterway. Bayou Lafourche, east of the site, is navigable by small watercraft, but is not maintained for commercial navigation.

B.3.3.8.4 Population Characteristics

The project site is located in the northern part of Assumption Parish which had a population of 19,654 in 1970 (FEA, 1977). The largest urban settlement in the Parish is Napleonville, located about seven miles southeast of the project. It had a population of 1,008 persons in 1970, a 12.2 percent decrease from the population recorded in 1960 (U.S. Dpeartment of Commerce, 1973). There are a number of small areas of population cencentration with fewer than 1,000 persons along Route 1, east of the site. The town of Grand Bayou is located about a quarter of a mile north of the northern boundary of the site.

Nearby population centers outside Assumption Parish include Donaldsonville to the northeast and White Castle to the north. Donaldsonville grew fairly rapidly between 1960 and 1970 from 6,082 to 7,367, a 21.1

percent increase. White Castle, in contrast, declined by two percent during the same period to 2.206 in 1970 (U.S. Department of Commerce, 1973).

The major population centers of Baton Rouge, Thibodaux, and Morgan City in the region surrounding Napoleonville are discussed in Section B.2.8.4. The major urban areas to the north and south, Baton Rouge and Thibodaux-Houma-Morgan City respectively, have been growing at fairly rapid rates, with population increases of 14 to 25 percent between 1960 and 1970. Assumption Parish, however, has one of the lowest rates of growth in the region with only a 9.2 percent increase over the same period (U.S. Department of Commerce, 1973).

B.3.3.8.5 Housing Characteristics

Assumption Parish had 5290 year-round units in 1970. Of these units, the large majority (3384) were owner-occupied. The median value of the owner-occupied units was $8900. The Parish had a relatively low vacancy rate with only 2.9 percent of the units unoccupied (FEA, 1977).

The closest area of housing relative to the site is Grand Bayou. Only a small number of residential units are located there, however. Napoleonville, Donaldsonville, and the scattered residential development between these two communities along Route 1 provide most of the housing stock for the area. Most of the housing units in this area are owner-occupied with few rental units available. There are a few rooming houses in Napoleonville and several hotels and motels in Donaldsonville (Assumption Parish Family Services, 1977). The Napoleonville area is within commuting distance of the housing markets in Baton Rouge, Thibodaux, Houma, Morgan City, and their respective parishes (see Section B.2.8.5).

B.3.3.8.6 Economy

Manufacturing and agriculture make the greatest contribution to the local economy in Assumption Parish where the storage site is located. Most of the major manufacturing occurs outside the Parish, however, near Donaldsonville, and local workers must commute to these jobs (U.S. Department of Commerce, 1973). Agriculture within the county contributes over $7.8 million in income to the economy annually (University of New

Orleans, 1974). Sugar cane is ground and refined from October to December in Napoleonville (Assumption Parish Family Services, 1977).

The employment in Assumption Parish is dominated by the manufacturing and agriculture industries. The construction and retail and wholesale trade sectors are also major employers. Assumption Parish has a very high percentage (46.2 percent) of its labor force working in other parishes, reflecting a widespread pattern of commuting (U.S. Department of Commerce, 1977). This reflects the concentration of manufacturing employment in the parishes along the Mississippi River. Much of the manufacturing is related to petroleum and petrochemicals. The developing urban areas in Iberville and Ascension Parishes demand local laborers. Many similar characteristics are found in surrounding parishes as discussed in Section B.2.8.6.

At the storage site and in the immediate surrounding area, most of the economic activity is related to the existing brine operation and oil storage west of the Bayou. There are also a few small retail establishments in the community of Grand Bayou.

Assumption Parish has a relatively low mean-income in comparison with the rest of the state. This figure is heavily influenced by the number of families below the poverty level in the parish, however. Over 30 percent (1328) of the families in the parish in 1970 had incomes below the poverty level. The average income for these families was $2329 annually (University of New Orleans, 1977). The income in the region surrounding Napoleonville varies significantly as discussed in Section B.2.8.6.

Many reasons have been postulated for the low levels of income in this area. Among these are: 1) the fluctuating and seasonal employment demand in the oil and gas fields, construction industries and fisheries; 2) the lack of strength in trade unions relative to other areas of the state; and 3) the lower cost of living in the parish relative to urban areas in the state and nation.

B.3.3.8.7 Government

Urban Services

Police protection for the storage site would be provided by the Assumption Parish Sheriff's Department which provides service for the entire parish, excluding the town of Napoleonville which has its own police department. The Sheriff's Department, which operates out of Napoleonville, currently has 23 full-time and five part-time officers (Assumption Parish Seriff's Department, 1977).

Fire protection services for the storage site would be provided by the Tankerville Voluntary Fire Department which includes 18 active members and two fire engines. It is located about five miles west of the Napoleonville dome. Auxiliary fire services are also provided by the Napoleonville and Pierre Port Voluntary Fire Department (Tankerville Fire Department, 1977).

Hospitals and Medical Personnel

Hospitals closest to the storage site are Assumption General Hospital in Napoleonville which has 32 beds and 56 medical personnel, and Prevost Memorial Hospital in Donaldsonville which has 35 beds and 43 medical personnel. Both hospitals have emergency departments and operating rooms (Louisiana State Office of Comprehensive Health Planning, 1977). In addition, there are two hospitals in Thibodaux: St. Joseph's Hospital with 99 beds, and a recently completed facility with 101 beds. There are two operating rooms at St. Josephs's, and three in the new hospital. Ambulance service is available in Thibodaux. There are six licensed physicians, four dentists, and 19 registered and practical nurses in Assumption Parish.

Tax Revenues

The greatest tax source in Assumption Parish (the location of the proposed facilities) is the severance tax on resource extraction which approached $3 million in 1971-72. The next largest source was property tax which returned nearly $1 million on over $25 million of assessed real property value in 1971 (Table B.2-32).

B.4 SITE SPECIFIC ENVIRONMENT - ALTERNATIVE GROUPING NO. 1 - EARLY STORAGE PHASE SITES PLUS EXPANSION OF WEEKS ISLAND DOME

B.4.1 Introduction

This section details the existing environment of Weeks Island Dome subsequent to early storage development at that location. Existing environments are referenced in Sections B.3.1 and B.3.2 for Bayou Choctaw Dome and Weeks Island Dome development, respectively.

B.4.2 Weeks Island Dome Expansion Alternative

B.4.2.1 Land Features

B.4.2.1.1 Local Geology

The dominant geologic feature of Weeks Island is the salt dome that lies directly beneath it. The detailed shape of the top portions of the dome is shown on Figure B.4-1. In horizontal section, the salt plug is roughly circular. It is flattened on the top and slightly overhangs to the north and east (Figure B.4-1). On the south and west flanks of the dome, the salt slopes steeply away from the surface. The salt mine is in the southwestern quarter of the dome.

At least two major faults cut across the Oligocene-Miocene sediments adjacent to the deep portions of the dome. According to Johnson and Bredeson (1971), both of these features resulted from differential movement between the salt and the sediments, and occurred simultaneously with the deposition of these flanking sediments. Therefore, both faults are geologically old and neither penetrates the salt core. As a result of the salt diapirism, deep shale was pushed up and faulted into place as a "sheath" next to the salt core. These major faults associated with the shale sheath gradually become tangential to sedimentary bedding planes with depth.

Shear zones are also present, which separate different spines of salt within the main salt stock (Kupfer, 1974). One zone has been mapped along the southwest side of the mine workings. Another extends from the south edge of the salt stock to the approximate center. This zone was encountered as mining progressed to the north and east, and was

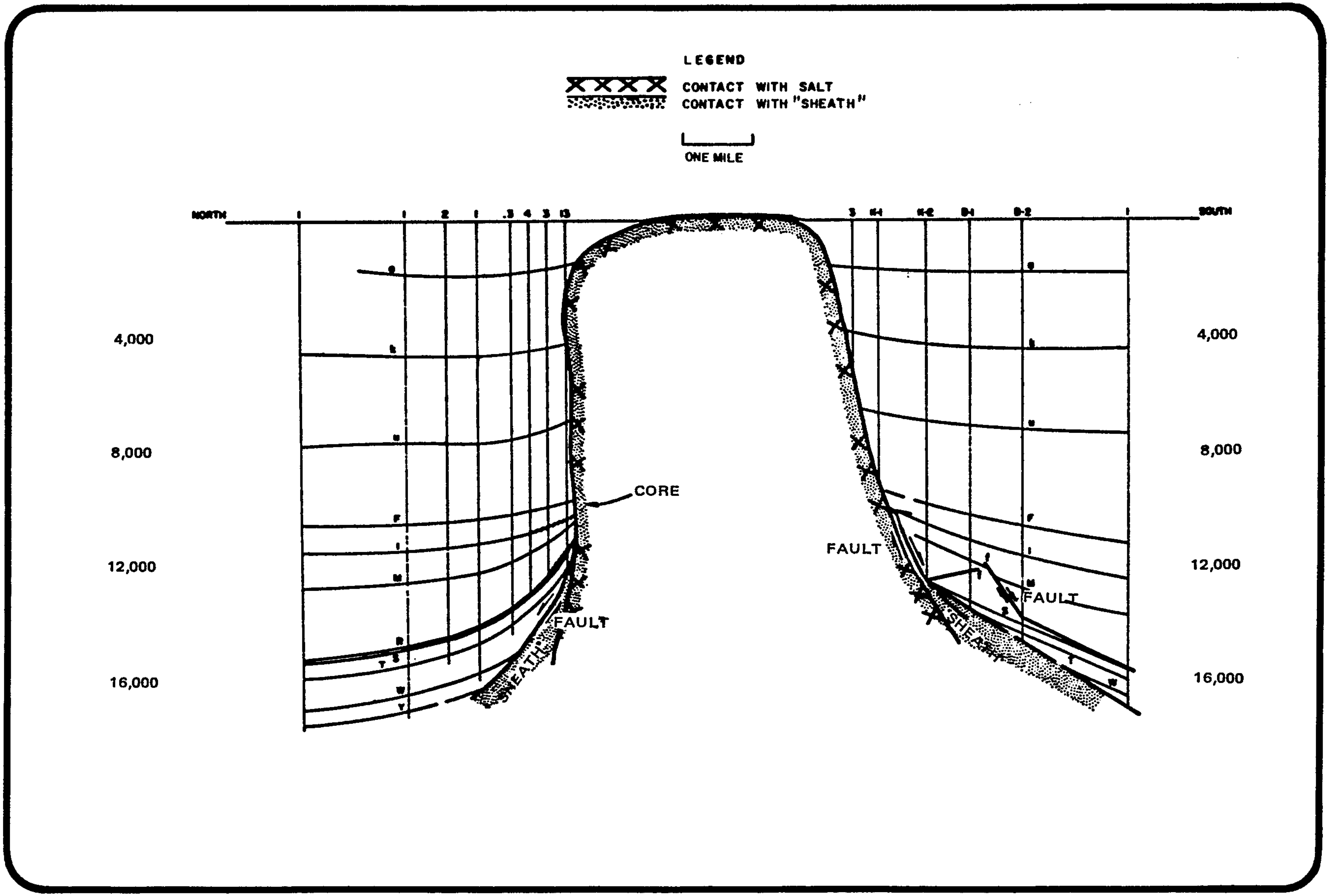


FIGURE B.4-1 Cross section of Weeks Island salt dome.

exposed for a distance of 1500 feet. Along the zone the salt is darker and has fine-grained clay-like material mingled with it. Kupfer interprets the clay-like materials in the zone to be former external sediments that were incorporated into and moved upward with the salt. Kupfer (1974) explains that evidences of shear zones include dark or impure salt, gas seeps, oil pockets, and exfoliation of the ceiling.

Kupfer has also mapped three small faults localized on the ceiling of a small storage room in the mine.

The thickness of sedimentary materials over the dome varies from about 40 to 100 feet. These materals consist principally of sands and gravels of the Pleistocene Prairie Formation that have been pushed up both topographically and stratigraphically by the rising salt (Russell, 1955). A few feet of clay or two to five feet of lignite directly overlies the salt (Howe and Moresi, 1931; Vaughn, 1925).

Exploratory drilling has not revealed the presence of caprock. Except for a few minor pockets of methane gas, no cavities are indicated above the salt.

The workings of the lower mine level are mostly stable, but continuous spalling requires periodic scaling of the walls in the active sections of the mine (FEA, 1976a). Rock bolting has been used for six years in the ceiling of the lower level at an average spacing of five feet by five feet. Some rock bolts have broken due to corrosion and stress in a few of the supported sections (FEA, 1976a).

The abandoned upper level of the mine has been closed off from the rest of the mine due to unsafe conditions. No rock bolting or other support methods were used at this level and spalling occurs in many areas (FEA, 1976a).

The rate of plastic closure of the mine is 3/4 of an inch per year for new openings and decreases after two or three years. A few upheavals occur in the mine.

At the present, the mine is dry. Several years ago a small seep occurred in the new shaft, but the seep was grouted and no seepage has occurred since.

B.4.2.1.2 Economic Geology

Weeks Island contains three mineral resources of economic importance: salt, oil, and gas. The salt, mined from the dome by the Morton Salt Company, is described as medium-grained, white crystalline, pure sodium chloride in two eight-inch-thick layers alternating with thin, dark layers containing anhydrite inclusions (Kupfer, 1962). Salt was discovered on the island in 1897, but was not mined until 1902 (Vaughn), 1925).

There are two brine wells on the island drilled to a depth of 1400 feet. These presently account for five percent of the salt operation. They are located approximately 4000 and 4500 feet northeast of the nearest mine workings. Together these wells have produced 60,000 tons of salt per year since 1948. Water used for solution mining is extracted from the Intracoastal Waterway.

Oil and gas resources occur in the strata that flank the dome. Most of this production comes from under the north flank overhang of the dome (Figure B.4-1). Oil and gas production began on the island in 1945 (Halbouty, 1967). Currently, 29 wells on or adjacent to the island are producing oil. In 1975, production of crude oils on Weeks Island was 5.04 million barrels. Cumulative production was 205.21 million barrels. An estimated 84.79 million barrels of oil reserves remain (Oil & Gas Journal, 1976).

Salt domes are also commonly capped with economic deposits of sulfur, calcite, gypsum, and anhydrite. However, at Weeks Island, caprock is absent.

Though there are exposures of sand and a few local exposures of gravel on the island, these resources are no longer marketed. A sand pit is located on the eastern side of a ridge on the east side of the island, and it formerly supplied sand to the surrounding area (Howe and Moresi, 1931). Another sand pit is located on the western edge of the island, about 1000 feet west of the mine.

B.4.2.1.3 Local Soils

Surficial materials of the island are mostly brownish-yellow loamy silts and clays ranging in thickness from several inches to 30 or 40 feet. Ferruginous sands with bands of chert pebbles are exposed on the southern parts of the ridges and in some of the deep gorges on the island.

Three soil associations occur in the area (Lytle, and others, 1959; and U.S. Department of Agriculture, 1969). Immediately overlying the dome is the Memphis-Rough Broken Land Association. These soils are primarily silty and occur on steep slopes. Adjacent to these are the soils of the Brackish Marsh-Harris Association. These are mineral and organic marsh soils that occur at or near sea level and are flooded most of the time by sea water. Inland from this association are the swamp soils. Swamp peat makes up about 95 percent of the association.

B.4.2.2 Water Environment

B.4.2.2.1 Surface Water Systems

Reference to Figures A.5-1 and A.5-2 illustrate several surface water bodies in the vicinity of the Weeks Island site. The major coastal water bodies include Weeks Bay to the west, and West Cote Blanche Bay to the south. Weeks Bay is formed by Shark Island to the south, and constitutes the northeast portion of larger Vermilion Bay. West Cote Blanche Bay is located to the south of Weeks Island. Natural drainage in the site vicinity is to the west and south into Weeks Bay and West Cote Blanche Bay. The brine diffuser pipeline would underlie West and East Cote Blanche Bays, Atchafalaya Bay and the nearshore Gulf of Mexico. These environments are discussed in Section B.2.2.1.2. A detailed study of the hydrology and chemistry of the waters in the immediate area of the brine diffusers is presented in Appendix G.

Watercourses in the immediate site vicinity include the Intracoastal Waterway to the west and south. Bayou Cypremort to the southeast and Weeks, Warehouse and Patout Bayous to the north.

B.4.2.2.2 Subsurface Water Systems

Fresh (potable) ground water is present in high capacity Pleistocene aquifers to a depth of about 600 feet in the site vicinity. The aquifer is known as the Chicot and is equivalent to the Plaquemine aquifer to the east. The salt dome penetrates the aquifer and has no caprock. A thickness of about 40 to 100 feet of sedimentary materials overlies the salt.

The piezometric surface in the Chicot aquifer is approximately at sea level near Weeks Island, and slopes gently northwestward towards the inland depression recently caused by heavy withdrawals, particularly at the city of Lake Charles. Available evidence suggests that a single local water table may not exist. Instead, the varying levels of freshwater ponds on the island, which range from about 15 to 60 feet above sea level, suggest that much, if not all of the shallow ground water is perched above impervious horizons of varying elevations.

Inland, the Chicot aquifer is composed mainly of sand and gravel with only a few localized clay layers. However, towards the Gulf, the clay beds increase in number and thickness and serve as confining beds that divide the Chicot into several distinct hydrologic units (Harder and others, 1967). In the coastal area, the most important of these is the so-called "upper sand unit" (Whitman and Kilburn, 1963). The "upper sand unit" does not outcrop in the coastal area but it is recharged by rainfall on the outcrops in Beauregard, Allen, Evangeline, Vernon, Rapides, and Avoyelles Parishes (Zack, 1971). Individual sand beds usually contain fine sand at the top, grading to coarse sand and gravel at the base.

The coefficient of permeability of the aquifer ranges from about 900 to 2000 gpd per square foot and averages about 1500 gpd per square foot. Coefficients of transmissibility of individual beds range from 75,000 to 1,000,000 gpd per foot.

Ground water use in the site vicinity is minor. One of the deeper units of the Chicot supplies the one water well that is presently being used on Weeks Island. This well is about 300 feet deep, located about 2000 feet west of the production shaft, adjacent to the edge of the salt dome. The well provides fresh water used principally to supply the cooling process in the salt works. The cooling water is then cleaned for use as drinking water and is released into the Intracostal Waterway.

B.4.2.3 Climatology and Air Quality

B.4.2.3.1 Climatology

The climatic conditions from Section B.2.3.1 are generally applicable at Weeks Island. Specifically, coastal effects are more pronounced at this site. Compared to sites further inland, Weeks Island is expected to experience: 1) higher wind speeds and more frequent southerly winds; 2) slightly warmer temperatures, especially in winter, averaging only about 12 days below freezing; 3) slightly higher humidity; 4) somewhat more rainfall particularly in summer; and 5) slightly fewer stable periods.

Because of the proximity of the Weeks Island site to the coast, additional data on tropical cyclones are presented. Damage from hurricanes results from high winds, and particularly in the coastal areas, damage results from the storm surge or tide (an abnormally high rise in the water level). In the marsh areas, extensive and prolonged inundation and pounding occurs, resulting in damage or loss of manmade structures and habitats. The storm surge at Pass Christian, Mississippi, associated with hurricane Camille in 1969, was 25 feet, and that associated with Betsy in 1965 reached nearly 20 feet at Bayou Lafourche (U.S. Department of the Army, 1972).

B.4.2.3.2 Air Quality

Generally, the air quality data presented in Section B.2.3.3 are applicable at Weeks Island. However, due to the remoteness of this site, the air normally will be less polluted than in industrial areas. Data presented for Lafayette are probably representative of the higher levels of pollution that could occur at the site under unfavorable dispersion conditions. Nevertheless, it is probable that the three hour standard for non-methane hydrocarbons is exceeded quite frequently at Weeks Island.

B.4.2.4 Background Ambient Sound Levels

An ambient sound survey was conducted on February 4 and 5, 1976 to provide preliminary sound data in the vicinity of Weeks Island. The survey, which is described in detail in the Weeks Island EIS (FES 76/77-8), disclosed the background ambient sound levels at the following location:

1. Center of Weeks Island Mine site.
2. Weeks Island, away from the site.
3. Along Intracoastal Waterway.
4. Undeveloped areas near the site.
5. Nearby noise-sensitive areas.

On Weeks Island, the major sources of noise are the Morton salt mine and chemical plant in the southeastern portion of the Island and the Shell Oil facility on the northern edge (Figure A.5-3). Other sources of noise are the highway traffic along Route 83, barge traffic in the Intracoastal Waterway, and train traffic on the Southern Pacific Railroad line. Much of the central and southern portion of the island, formerly the site of the town of Weeks, is now thickly overgrown with vegetation, with wind and birdlife as the major noise sources.

A summary of the background ambient sound levels in terms of L_d (daytime), L_n (nighttime), and L_{dn} (day/night) at the above locations is presented in Table B.4-1. (For a definition of the sound level terms used in this report, see Section B.2.4). These values may be compared with the levels identified by the EPA as being requisite to protect public health and welfare (Section B.2.4).

B.4.2.5 Species and Ecosystems

The description of the environmental setting of the area is based on the Weeks Island FES 76/77-8 and is supplemented with regional inventories, known species ranges, literature sources, topographic maps, and aerial photographs. The 100-acre fenced site and the 846 acres needed offsite (Table B.4-2), consists primarily of cleared land, marshland, bottomland forest (including lowland hardwoods), and deciduous swamp ecosystems (Figures B.4-2 and A.5-2). Some of the cleared land is associated with salt mining, while land which has been cleared for agriculture is used to produce sugar cane, corn, soybeans, sorghum, and peanuts.

TABLE B.4-1 Summary of background ambient sound levels (dB), Weeks Island site.

Location	L_d	L_n	L_{dn}
Center of Site	70	67	74
Weeks Island Away from the Site	49	46	53
Along Intracoastal Waterway	59	54	61
Undeveloped Areas	55	39	53
Noise-Sensitive Land Uses	58	39	56

TABLE B.4-2 Estimated site acreage analysis - Weeks Island[a].

Total for Fenced Site Area	100 acres
Total for Expanded Storage Site and Pipelines	946 acres
Total Area to be Developed	878 acres
Total for Cleared Land[b]	63 acres
Total for Bottomland Forest	7 acres
Total for Deciduous Swamp	15 acres
Total for Marsh	15 acres
Total for Open Water	778 acres

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Proposed Brine Disposal System (Gulf - including backup injection wells)	37.6	837.0	37.0
Cleared Land		31.0	20.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		15.0	9.0
Marsh		13.0	8.0
Open Water (total water crossings - 6)		778.0	0.0
Alternate Brine Disposal System (Gulf and wells)	8.8	125.0	80.0
Cleared Land		106.0	68.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		19.0	12.0
Marsh		0.0	0.0
Open Water (total water crossings - 0)		0.0	0.0
Alternate Brine Disposal System (Alt. Gulf Diffuser)	53.1	1208.0	34.0
Cleared Land		28.0	18.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		13.0	8.0
Marsh		13.0	8.0
Open Water (total water crossings - 6)		1154.0	0.0
Proposed Raw Water System (ICW)	0.9	9.0	6.0
Cleared Land		9.0	6.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Marsh		0.0	0.0
Open Water (total water crossings - 0)		0.0	0.0

TABLE B.4-2 continued.

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Alternate Raw Water System (Gulf)	7.5	62.0	9.0
Cleared Land		7.0	5.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		3.0	2.0
Marsh		3.0	2.0
Open Water (total water crossings - 6)		49.0	0.0
Alternate Oil Delivery (SPM in Gulf of Mexico)	61.5	1459.0	19.0
Cleared Land		0.0	0.0
Bottomland Forest		16.0	10.0
Deciduous Swamp		0.0	0.0
Marsh		15.0	9.0
Open Water (total water crossings - 1)		1428.0	0.0

[a]Based on features of USGS topographic maps (15 minute series).

[b]Cleared land includes agricultural, industrial and rural.

FIGURE B.4-2 Air photo - Weeks Island plant area.

The vegetation on Weeks Island is quite varied. The island itself is characterized by lowland hardwood species whose existence is made possible by the higher elevation afforded by the island's topography and the presence of very fertile loam as a soil base.

The dominant trees are live oak, magnolia, and hickory, with a conspicuous understory of yaupon, French mulberry, and immature trees. The trees are quite large, many reaching heights of 60 to 70 feet and forming a fairly closed canopy. The oak-hickory-magnolia association extends down to the surrounding marsh. There is no fringe of cypress near the marsh as is found in other lowland areas. Vines and understory plants are quite dense along roadsides and transmission line corridors. Heavy accumulations of leaf litter do not occur on the island because high temperatures and abundant rainfall aid fast decomposition. However, the litter accumulation is substantial enough to discourage heavy groundcover such as grasses and forbs. Grasses are present along roadsides and corridors.

The entire southwest portion of the island was at one time the town of Weeks. The residents were moved off the island by 1969 and the area was allowed to revegetate naturally. The result is that the areas that were once lawns, cleared fields, and streets are now almost completely covered by natural vegetation such as sweetgum, oak, magnolia, native grasses, and understory plants.

The dominant, mature trees on Weeks Island are of limited commercial importance. The hickories, magnolias, and live oaks found there are not prime marketable species. Although they can be used in the timber industry to some extent, they are not abundant or important enough to warrant a lumber harvest on the island. In addition, the serious hurricanes that struck the Louisiana coast in 1964 (Hilda) and 1965 (Betsy) inflicted great damage to the forested portions of the island. The old tall trees, which were rooted in the soft loess-type soil, were uprooted in large numbers.

Wildlife habitat types found at the Weeks Island site include deciduous swamp and bottomland forest, cleared lands (existing oil field development), and coastal wetlands (Intracostal Waterway and marshes).

Wildlife population and harvest estimates for various species by region and parish, made available by the Louisiana Wildlife and Fisheries Commission, are presented under Sections B.2.5.2.2 and B.2.5.3.1.

The deciduous swamp and bottomland forest habitat types provide resources for a large number of wildlife species (Tables B.2-15, B.2-16, B.2-18 and B.2-19). Some common bird species of the lowland hardwoods include hawks, owls, woodpeckers, thrushes, vieros, and warblers. The lowland hardwoods also provide suitable habitat for the endangered southern bald eagle.

Some common mammals expected to occur in the swamp and bottomland forest include oppossum, bats, squirrels, raccoon, swamp rabbit, bobcat, and white-tailed deer. Important commercial/recreational inhabitants include squirrels, rabbits, furbearers, and deer.

Amphibians and reptiles expected to occur at the Weeks Island site are presented in Tables B.2-15 and B.2-17.

Cleared lands provide limited habitat for wildlife. Most wildlife species found in these areas are those that have adapted to man and can survive in significantly altered habitat types. Some of these species are presented in Table B.2-15 under the cleared lands category.

The coastal wetlands found at the Weeks Island site include the Intracoastal Waterway and saline and brackish marshes. Wildlife species expected to occur in these habitats are presented in Tables B.2-15, B.2-17, B.2-18 and B.2-19. Gulls, terns, waterfowl, herons, egrets, and shorebirds are the most common birds groups found in and around the marshes. Commercially and recreationally important species present include waterfowl and furbearers. Mink, nutria, otter, and raccoon are the most common mammal species found in the intermediate marshes. The intermediate marshes of the island provide suitable habitat for the alligator, which is considered an endangered species in this area. Because Weeks Island is privately owned, its many wildlife resources are not available to the people of Louisiana.

The area surrounding Weeks Island contains many water bodies including freshwater ponds, streams, estuaries, bays, and canals.

Collectively, these water bodies are important components of a vast nursery ground for an array of commercially and recreationally important finfish and shellfish. The two barge slips, which join the Intracoastal Waterway on the western boundary of the site, are the only aquatic habitat actually on the site (Figure A.5-2).

Weeks Island contains six small freshwater ponds (the largest of which is 20-acre Plantation Lake), and two small brine ponds. Most of the ponds are used for fishing by employees of Morton Salt Company. The lakes were stocked with largemouth bass and bream prior to 1969 by the Louisiana Wildlife and Fisheries Commission; natural populations of these species remain in the larger lakes. The lakes are located at elevations of 20 to 60 feet above sea level and are estimated to be less than 10 feet deep. The bottom sediments in the ponds appeared to be fine sand and silt. For the most part, the pond water is clear, but becomes turbid with depth and toward the edges. The ponds are surrounded by a large amount of vegetation including cattail, bullrush, broomsedge, and bluestem. Although no field studies have been conducted at these ponds and no published material is available to describe their flora and fauna, they are expected to be similar to the freshwater communities discussed in the regional environmental setting.

The main estuarine water body adjacent to Weeks Island is the Vermilion Bay/West Cote Blanche Bay complex. Several oil and gas fields are located in each of the bays. The rich and productive coastal wetlands surrounding the bay complex support a large variety of plankton, benthos, and fish. This area is also rich in fish and shellfish of recreational and commercial importance. Specific aquatic communities of the area around the dome are discussed in the regional environmental setting.

In addition to the development of the site, a brine disposal, raw water, and oil delivery system will be designed, each having one or more alternatives (see Section A.5 and Figure A.5-2). Estimate of acreages of various habitat types to be used for these systems and their alternatives are provided in Table B.4-2. The environmental setting of the site areas covered by particular systems or alternates which merit discussion are found in other sections of this report.

The productivity of the habitats in the vicinity of the proposed brine disposal system to the Gulf of Mexico is higher than that of the dome since about half of the 5.5 mile on-land portion of the system would be in undisturbed swamp and marshland (Table B.4-2). Also, there would be one crossing of the Intracoastal Waterway and 32.1 miles of pipeline in undisturbed benthic habitat of the Gulf of Mexico. The biology of this area is described in the regional section of this report (Section B.2.5). The nearshore Gulf supports a large diversity of diatom and dinoflagellate phytoplankton, zooplankton (mainly copepods), benthic organisms (mainly polychaete worms) and nekton (white shrimp, seabob, bay anchovy, Atlantic croaker). A detailed discussion of the biology of the brine diffuser site is presented in Appendix G.

The alternate brine disposal system (deep well injection field) would be located almost entirely on cropland and other disturbed areas of relatively low productivity. The alternative brine diffuser site would be located in the Gulf of Mexico, further offshore than the proposed site in 20 feet of water.

The proposed 0.9 mile long raw water supply system to the Intracoastal Waterway would be located almost entirely on developed land of low productivity, and the alternate water system would be in the same habitat that was discussed for the on-land portion of the proposed brine disposal system.

B.4.2.6 Natural and Scenic Resources

Natural Resources

Weeks Island is located on the northern edge of the extensive Atchafalaya-Vermilion Bay estuarine complex. The island is surrounded by brackish, intermediate, and fresh marshes. Vegetation on the island ranges from marsh around the edge, to freshwater lakes, pasture land, and mature forests in the hills. Parts of the forests have a distinct tropical aspect, being composed of tall trees supporting biomass of various types. The value of this wetland system surrounding Weeks Island to biological organisms, particularly estuarine-dependent fish, benthos, avifauna, and mammals, is well recognized. The bays and marshes around

Weeks Island provide habitat and food supply for many aquatic species, including shrimp, crabs, and menhaden. Much of the commercial fishing industry, sport fishing, hunting, and other outdoor recreational activities owe their existence to coastal marshlands and bays (FEA, 1976b). The brine disposal pipeline right-of-way passes through these environments as well as the biologically productive nearshore Gulf of Mexico.

Most of the land overlying the dome is covered with a second growth deciduous forest of high natural resource value. On the southern and southwestern portions of the dome existing early storage development and the preceeding salt mining have disrupted the natural vegetation and wildlife to some extent. A few hundred acres of land on the eastern portion of the island along Route 83 have also been cleared for farming (primarily sugar cane) (FEA, 1976b).

The area stretching to the Gulf of Mexico south of Weeks Island is covered by brackish and intermediate marsh providing a large area of productive estuarine habitat. The natural resources in this area have been slightly disturbed by past use of this marsh for oil and gas production.

To the east of the dome (beyond the cultivated cropland) is a bottomland deciduous forest. The Intracoastal Waterway passes just to the west of the Island and is surrounded by coastal marsh extending west to the shore of West Cote Blanche Bay (FEA, 1976b).

As discussed in Section B.2.6.1, there are a number of wildlife refuges and recreational areas in the general vicinity of the storage site, although none are located within a nine mile radius of the salt dome. The closest area, Avery Island bird sanctuary, is approximately 10 miles northeast of Weeks Island. Marsh Island, located in the Gulf of Mexico about 17 miles south of Weeks Island, is a national wildlife refuge. Immediately offshore to the south of Marsh Island is an eight-acre colonial bird nesting area called Shell Keys National Wildlife Refuge. Two camping and picnic areas are located in St. Mary Parish on the east shore of East Cote Blanche Bay about 15 and 20 miles southeast of Weeks Island.

Scenic Resources

The continuity of the marshlands and prairie terraces along the Louisiana coastline is interrupted by the presence of the Five Islands, which attain elevations of 150 feet or more above sea level. These isolated topographic features are salt domes such as Weeks Island, and are of scenic interest because of the contrast they provide to the prevailing lowlands. At Weeks Island, this contrast is striking when one compares the forested hillside with the surrounding low brackish and intermediate marsh. The unique range of habitats on the island supports vegetation that is strikingly different from that of the Louisiana coast in general. In addition, despite the fact that the island has been occupied and exploited by man for a considerable number of years, it still supports a significant amount of native flora and fauna (FEA, 1976b).

The wooded areas overlying the salt dome provide a scenic area of trees and other natural vegetation. The natural aesthetic value of the western section of the Island, however, has been diminished by the past presence of salt mining and early storage development (drill pads, plant structures, pipelines, and roads). Similarly, the cleared agricultural area east of the dome reduces the naturally wooded area, but provides a broad scenic vista.

Beyond this agricultural land, to the east, is another area of bottomland deciduous forest containing natural scenic resources. The coastal estuarine areas south of Weeks Island and the offshore gulf waters are natural areas of high scenic value.

B.4.2.7 Archaeological, Historical and Cultural Resources

Weeks Island

Weeks Island has great potential for containing unknown archaeological resources due to its unique topography. Two known sites on the island (Morton Shell Mound on the northwest edge of the island, and North Hill - a camp site containing lithic materials on the northeast edge of the island) were described in Section 3.7 of the Weeks Island Mine EIS (FEA, 1977). Although the North Hill site is nearest to the project location, neither it, the Morton Shell Mound, nor any other known sites of significance were found at the surface in the area of proposed construction during the cultural resources field survey done in March of 1976. During SPR construction, a qualified archaeologist would be present to examine material taken from the upper 20 to 50 feet of the mine shafts, and to inspect and record any materials of historic interest that are unearthed.

B.4.2.8 Socioeconomic Environment

History

The history of the area of Weeks Island was largely shaped by adventurers and refugees. New Iberia was supposedly settled in the 1700's by Canary Islanders under the leadership of Bernardo de Galvez. Nicknamed "the Queen City of the Teche," it became an early important shipping center, since at the time, the Teche Bayou was only navigable to that point.

The Teche Bayou, on which New Iberia is situated, received its name from the word Deutsch, derived from an Indian name for snake. Legend has it that the Bayou was formed by the trail of a great snake. Before the Civil War, numerous wealthly planters settled along the Bayou. New Iberia was captured during the Red River Campaign in 1863 by Federal forces commanded by General Banks, but suffered little damage in the war.

Weeks Island was formerly known as Grand Cote but was renamed in 1930 in honor of David Weeks, a wealthy planter and owner of The Shadows Plantation near New Iberia. His father received the island along with thousands of acres of other land by Spanish land grant in 1792. Before the Civil War several large plantations were located on the island. A guidebook published by the Works Project Administration in 1941 advised that excellent hunting and fishing was available there for five dollars a day.

Land Use

Weeks Island dome covers approximately 2000 acres and is roughly circular with a diameter of two miles. The dome is mostly covered with a second growth deciduous forest. Parts of the island have been cleared for sugar cane, and farming is limited to a few hundred acres on the eastern portion of the storage site along Louisiana Route 83. A Shell Oil Company oil and gas production facility is located at the north edge of the island (FEA, 1977b). On the southern and southwestern portions of the dome there is some existing development (drill pads, plant structures, pipelines, and roads) from early storage development.

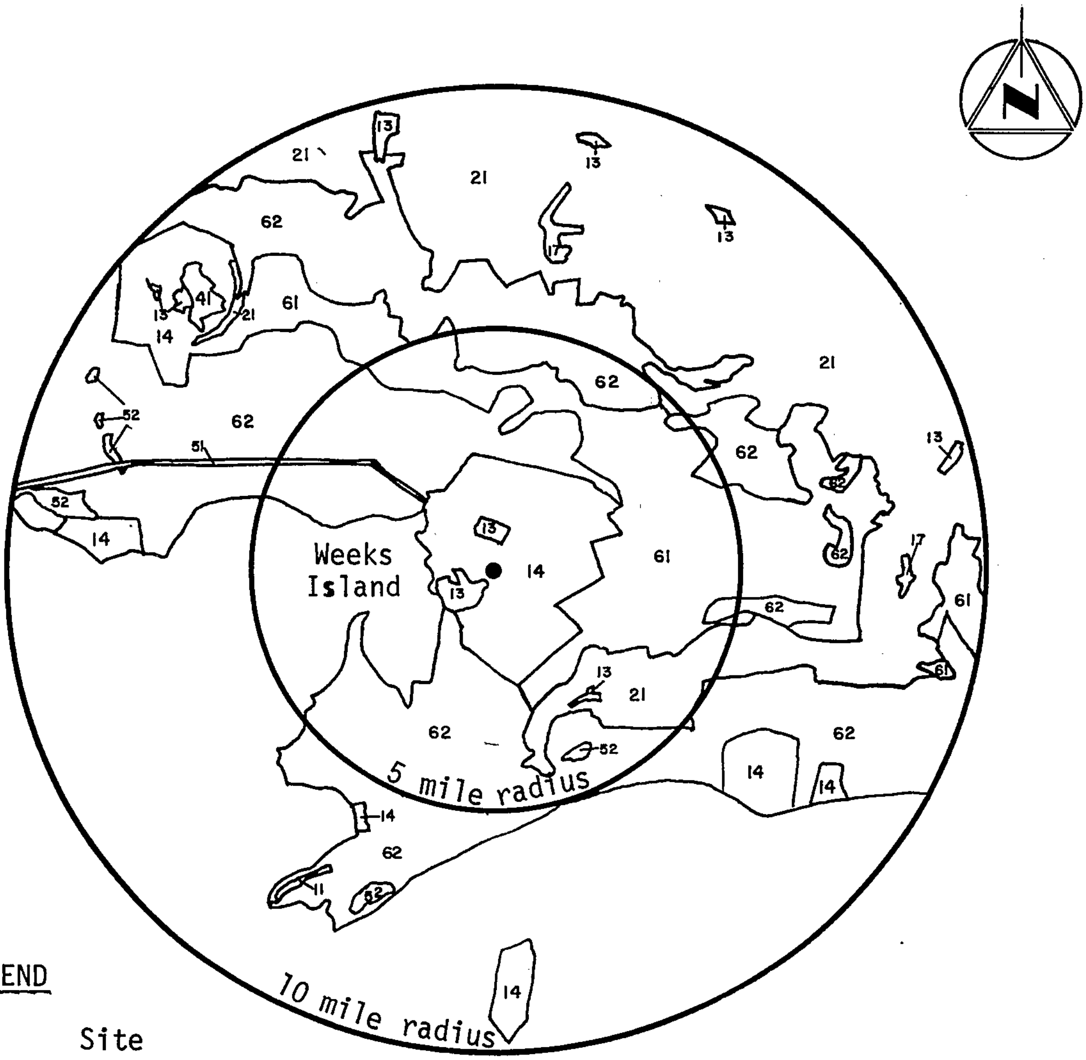
The southwest corner of the storage site contains remnants of streets and foundations of houses that once comprised the company town of Weeks, abandoned in 196869.

The area to the north and south of Weeks Island is covered by brackish and intermediate marsh. To the east of the dome (beyond the cultivated cropland) is a bottomland deciduous forest (FEA, 1976b). The Intracoastal Waterway passes just to the west of the island. Further to the west is the eastern shore of Weeks Bay. The bays are a biologically productive area and are used as fishery areas. The nearshore Gulf is used for oil and gas production and is an important shrimp fisheries region. Land use of the site area is shown in Figure B.4-3.

Transportation Systems

U.S. 90 is the major regional highway in the vicinity of Weeks Island as discussed in Section B.2.8.3. Vehicle access from U.S. 90 to the Weeks Island site is by State Highway 83 which crosses the east side of the dome. Paved roads then lead to the remainder of the island. State Highway 83 is a two-lane, medium duty road which currently has an average daily traffic count of 1,280 as it crosses Weeks Island. U.S. 90, at its junction with Route 83, has an average daily traffic count of 8,400 (Louisiana Department of Highways, 1977).

The Southern Pacific Railroad has a spur line to the island from the south. The brine disposal pipeline crosses the ICW, which is heavily travelled by commercial and pleasure vessels. Construction materials could be brought in by barge since Weeks Island is on the Intracoastal Waterway (FEA, 1976). The nearshore Gulf is also heavily used by commercial boats including shrimpers and platform utility boats.



LEGEND

●	Site
14	Extractive
13	Industrial
11	Residential
17	Strip and Cluster Settlement
16	Institutional
61	Wetland, Forested
62	Wetland, Non-Forested
21	Cropland and Pasture
41	Forest, Deciduous
42	Forest, Evergreen
43	Forest, Mixed
51, 52	Water

FIGURE B.4-3 Land use within 5 and 10 mile radius of Weeks Island site.

Population Characteristics

Weeks Island itself is virtually uninhabited. The area immediately surrounding the island is sparsely populated with an intermittent linear pattern of rural settlement following the roads and highways that traverse higher ground. There are a number of small rural communities along Route 83 north and east of the storage site and along U.S. 90. The town of Jeanerette with a population of 6,322 in 1970 is about 10 miles to the northeast of the island. New Iberia, a major urban center, is within 15 miles of the site and is expected to supply part of the labor force for the project as described in Section B.2.8.4. Estimates for 1976 put New Iberia's growing population at 31,850, up 5.6 percent from 30,147 in 1970. The city plans to extend its boundaries in the near future (New Iberia Chamber of Commerce, 1977). Lafayette City in Lafayette Parish and Morgan City, a major population center to the southeast in St. Mary Parish, are also within feasible commuting distance of the Weeks Island site (see Section B.2.8.4). Iberia Parish, in which the project is located, grew by 11 percent between 1960 and 1970 despite an out migration rate of over 10 percent. The majority (63.5 percent) of the population in the parish lives in areas classified as urban by the 1970 census (U.S. Department of Commerce, 1972b).

Housing Characteristics

Housing availability in the immediate vicinity of the Weeks Island site is limited due to the small sizes of nearby rural settlements. The city of New Iberia is most likely to be the closest major source of housing. In 1970 this city had a vacancy rate of five percent (FEA, 1976b). At present New Iberia has a shortage of housing units. Two new apartment complexes are being planned for development in the city but more are expected to be needed (New Iberia Chamber of Commerce, 1977). Single family residential development is also occurring in the city.

There were 16,595 housing units in Iberia Parish in 1970. The parish had a relatively high vacancy rate of six percent at that time. Some vacancies may be due to substandard housing or undesirable rural location. The median value of owneroccupied units in 1970 was $12,000

(FEA, 1976). The housing characteristics of neighboring St. Mary Parish are similar. More housing is available in nearby Lafayette Parish, primarily in Lafayette City.

Economy

The major employment sectors of Iberia Parish are mining, manufacturing, construction, agriculture, and wholesale and retail trade. The manufacture of food and related products provides one-quarter of the total manufacturing employment. Mining provided over 15 percent of the employment within the parish (see Section B.2.8.6). As discussed in Section B.2.8.6, a number of minerals are extracted throughout the region, the most important being petroleum and natural gas. Iberia Parish and neighboring St. Mary Parish are both important centers for salt mining (FEA, 1976b). Shrimping in the nearshore Gulf is an important economic factor to the region.

Unemployment in Iberia Parish was relatively low in 1976 with 1,075 or 4.4 percent unemployed from a civilian labor force of 24,425. Nearby Lafayette Parish has a labor force over twice this size with a comparable rate of unemployment. Employment rates in the surrounding region are discussed in more detail in Section B.2.8.6.

Government

Police and Fire Protection

Police services for the storagesite site would be provided by the Iberia Parish Sheriff's Department which covers the entire parish and has a force of 100 deputies (full and part-time) (Iberia Parish Sheriff's Department, 1977). Fire services would be provided by the New Iberia Fire Department which has a force of 53 men, five engines on-line and two engines on reserve (New Iberia Fire Department, 1977).

Hospitals and Medical Personnel

Hospitals closest to the storage site include two in New Iberia: Danterize Hospital with 82 beds and 137 medical personnel, and Iberia Parish Hospital with 94 beds and about 130 medical personnel. Both have emergency departments and operating rooms. Lasalette Memorial Hospital located in Loreauville 10 miles northeast of New Iberia has 18 beds and

16 medical personnel. In addition, there are five hospitals in Lafayette City: Acadrana Mental Health Center, 20 beds; Lafayette Charity Hospital, 250 beds; Lafayette General Hospital, 325 beds; Our Lady of Lourdes, 255 beds; and St. Ann Infirmary, 30 beds (Louisiana State Office of Comprehensive Health Planning, 1977).

Education

In 1975 the New Iberia school district, the closest district to Weeks Island, had 19 elementary schools with a total enrollment of 7,855, plus one junior high school and one senior high school. Enrollment appeared to be steady with no increasing or decreasing trends. Last year, the district did experience some problems with overcrowded facilities. Three new schools, including one elementary, one high school, and one trade school, have recently been built or are under construction (New Iberia Chamber of Commerce, 1977).

Tax Revenues

Severance taxes on resource extraction were by far the largest source of tax revenue within the county in 1971-72. Income from all property taxes within the county was less than one-third of the severance tax revenue (University of New Orleans, 1974).

B.5 SITE SPECIFIC ENVIRONMENT - ALTERNATIVE GROUPING NO. 2 - EARLY STORAGE PHASE SITES PLUS EXPANSION OF BAYOU CHOCTAW DOME PLUS IBERIA DOME

B.5.1 Introduction

Section B.5 details the existing environment at Bayou Choctaw dome subsequent to early storage development and the existing environment at Iberia Dome. Existing environments for the remaining sites in the Capline Group are referenced in Sections A.3.1 and B.3.2.

B.5.2 Bayou Choctaw Dome Expansion Alternative

B.5.2.1 Land Features

B.5.2.1.1 Local Geology

The Bayou Choctaw salt dome is a nearly circular, shallow piercement dome.

A geologic structure map contoured on top of the salt (Figure B.5-1), and the geologic cross sections A-A' and B-B' (Figures B.5-2 and B.5-3), show the shape of the top of the salt mass. This information is derived from the data yielded from some 30 drill holes reported to have penetrated the salt.

Salt geometry shows a sharp piercement structure, almost circular in plan, with a broad irregular top of caprock at a depth of 500 to 1200 feet below sea level. The shallowest known salt occurrence is at -645 feet near the center of the dome, and the greatest depth to the top of salt is at -9327 feet on the extreme eastern flank. The sides of the dome show steeply dipping contacts, with the east side dipping at about 79 degrees and gradually increasing to vertical. Overhang is demonstrated on the west side of the dome with at least 10 holes penetrating the salt interval in this area. The shape of this salt overhang significantly decreases the area available for solution mined storage cavern construction. The lateral extent of the undercut of the salt on the west side is not known and a program of investigation should be accomplished prior to any construction on the west perimeter of the dome.

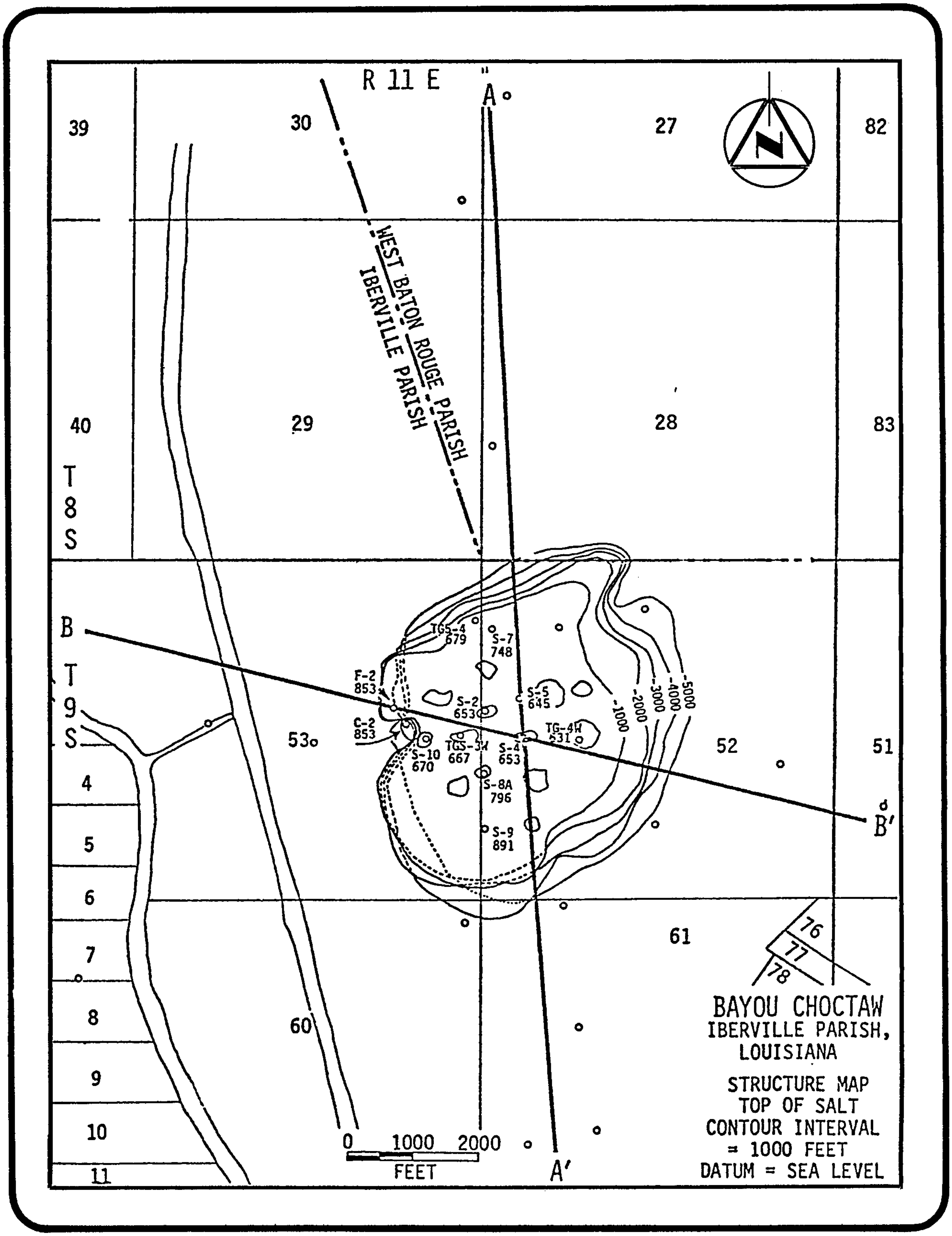


FIGURE B.5-1 Structure map - top of salt - Bayou Choctaw dome.

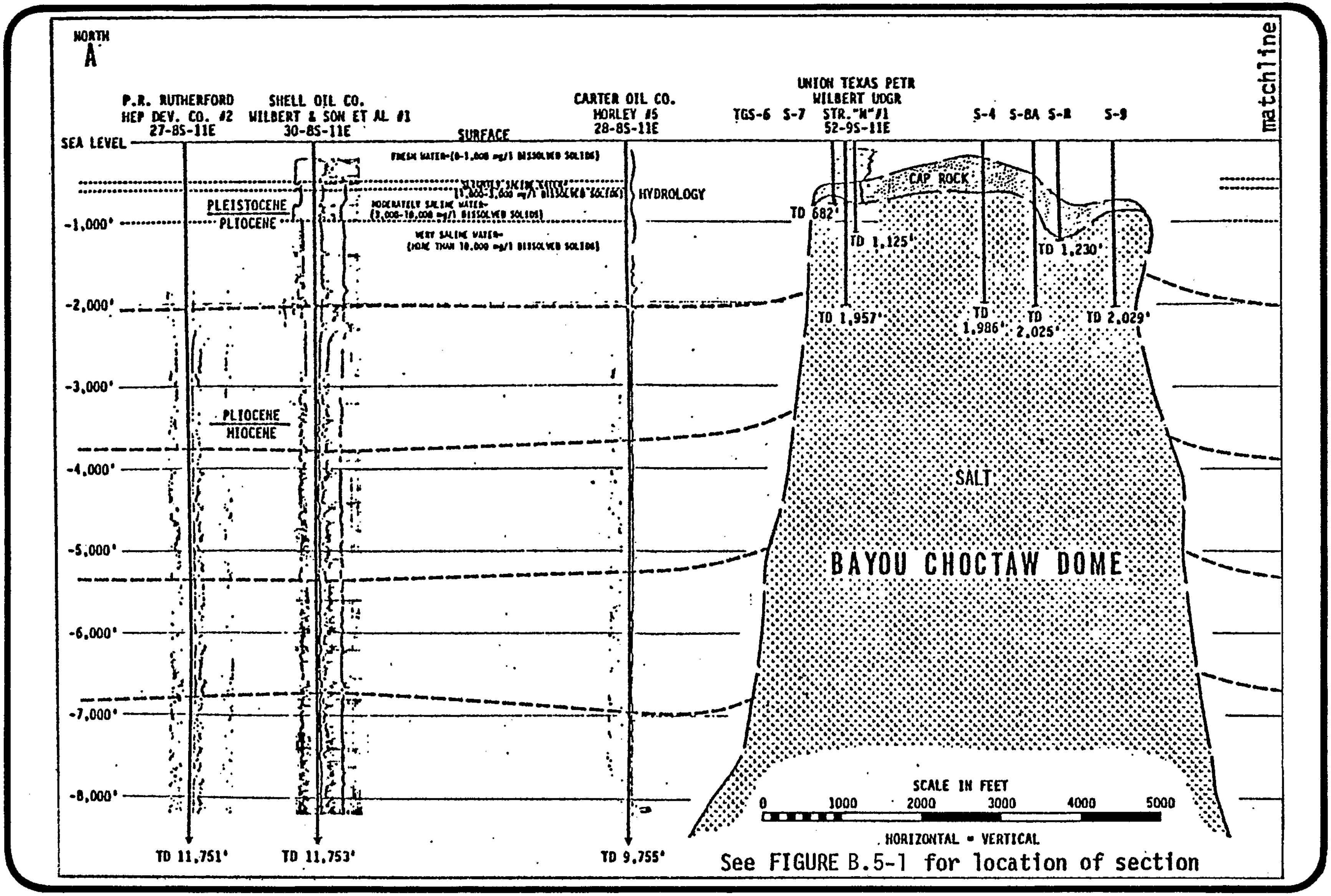


FIGURE B.5-2 Geologic cross section (north/south) Bayou Choctaw dome.

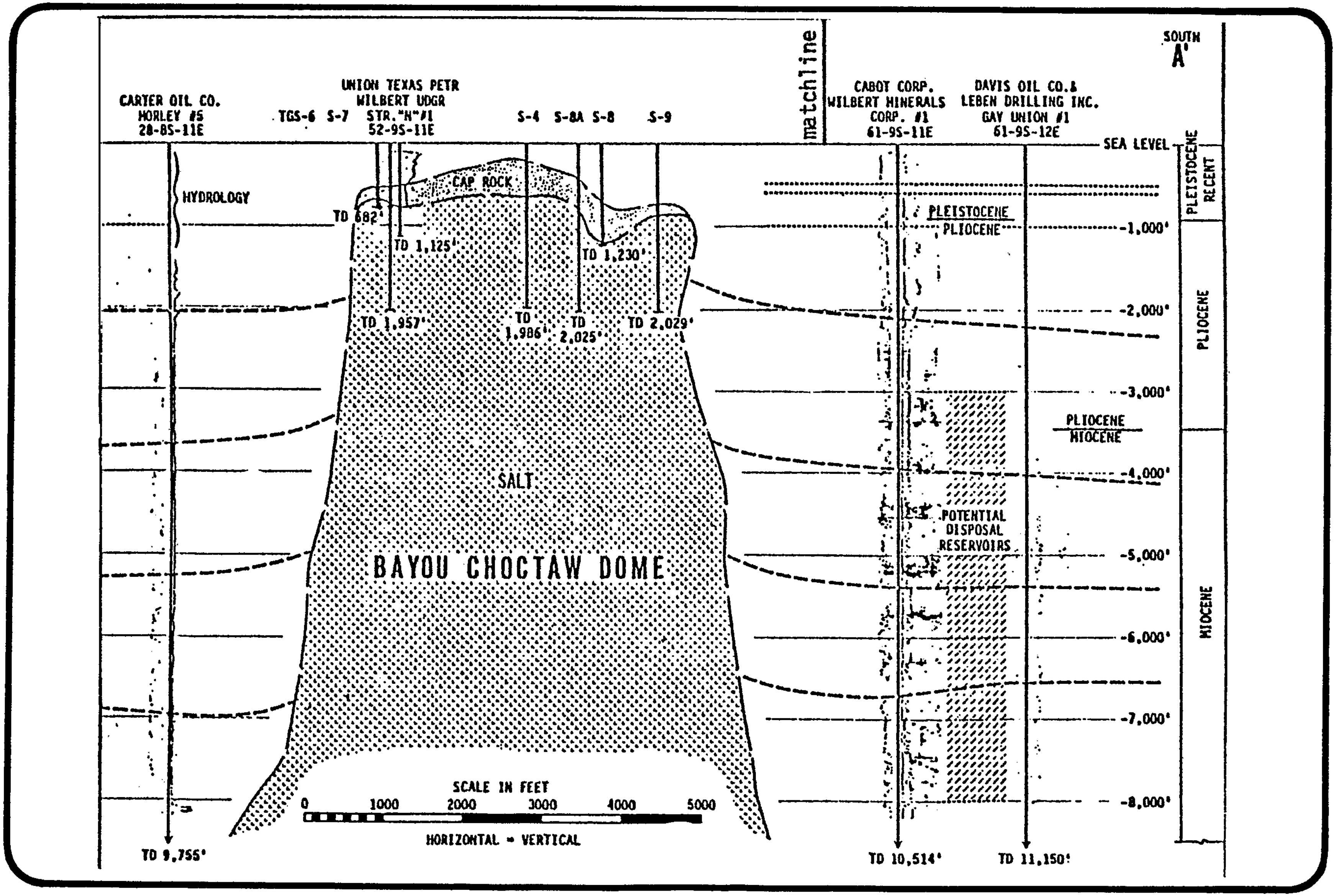


FIGURE B.5-2 continued.

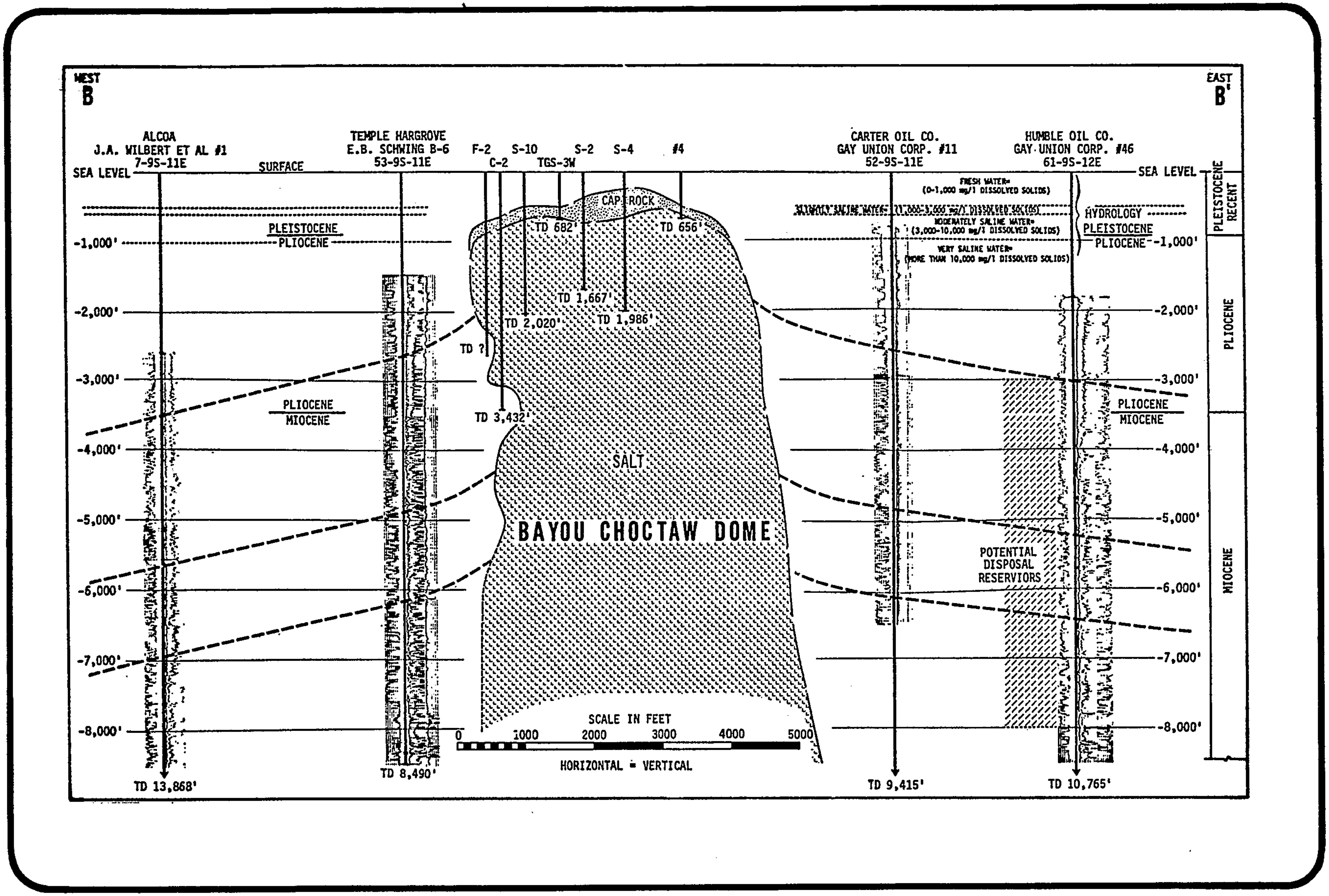


FIGURE B.5-3 Geologic cross section (east/west) Bayou Choctaw dome.

No information is available at this time concerning the quality of the salt mass. However, it is probable that finely bedded and disseminated anhydrite is present in amounts of perhaps three to seven percent. Incorporated portions of sandstone and shale, through which the piercement structure has passed, is found in the outer portions of the salt.

Pleistocene and Recent age unconsolidated and partially consolidated sediments overlie the dome caprock with as little as 237 feet to as much as 839 feet of sands and muds. Figures B.5-2 and B.5-3 are geologic cross sections which portray the salt stock and show the relationship of the overlying and deeper adjacent beds to the dome.

Unconsolidated and partially consolidated sands and shales of Pliocene and Miocene age underlie the Pleistocene sediments and extend downward to about -9500 feet. The thickness of the Miocene age formations in the Bayou Choctaw area is estimated to be about 6000 feet with the base of the Miocene probably at about -9000 feet elevation. In the immediate vicinity of the dome these sediments have been forced upward by the salt piercement structure as shown on the cross sections.

Faulting around the dome, within the Miocene and overlying Pliocene formation, is thought to be extensive and complex. Studies of numerous domes in the Gulf Coast area generally show a series of regional east-west trending, south dipping, down-to-the-coast faults. Also, in the immediate area of the dome it is expected that where sufficient drilling has been done a characteristic fault pattern will be exposed. This pattern exhibits primary, normal, radial faulting with subsidiary, arcuate, concentric, normal faults between the radial faults. Greatest throw is generally at depth and becomes progressively smaller upward. It is believed that faulting generally dies out short of the shallow, slightly saline aquifers, and therefore does not affect them.

The composition of the caprock overlying the Bayou Choctaw salt dome is not known. Studies of other domes suggest that a topmost zone of calcite several tens of feet thick can be present. A zone of gypsum generally somewhat thicker than the calcite may be found below the calcite. A zone of anhydrite, varying in thickness but possibly several times as thick as the upper zones, is usually below the gypsum.

An analysis of records of drill holes penetrating caprock and salt of the Bayou Choctaw dome indicates a highly irregular caprock surface and thickness. Geologic cross section A-A' (Figure B.5-2) shows a caprock thickness of some 470 feet in an isolated area. General caprock thickness seems to vary from 200 to 400 feet. It appears that the caprock completely overlies the central salt stock but is not draped over the sides. Voids or sedimentary rock inclusions are reported to have been encountered in some of the caprock drilling. Geologic cross sections A-A' and B-B' (Figures B.5-2 and B.5-3) show the lateral extent of the caprock as interpreted from available subsurface data.

B.5.2.1.2 Economic Geology

The first oil production at Bayou Choctaw is reported to have been in 1931. It appears that production has occurred all around the dome. However, the greatest density of drilling has been on the southeast and north flanks. Interpretation of salt structure maps and geologic cross sections suggests that oil and gas occur on the flanks of the dome in Miocene and Oliogocene sediments faulted or pinched out against the sides of the dome.

Examination of records in the Louisiana State Department of Conservation shows that oil or gas production currently occurs from two deep zones with tops at -11,592 and -11,287 feet.

No known oil or gas production is located over the top of the dome in the area proposed for the storage facility.

Reports indicate that the salt mine cavity in the Bayou Choctaw dome was washed out to the top surface of the salt by the brine operation. It was not being used as a storage facility at the time. Other similar caverns, originally formed for brine production, currently are being used for storage in the Bayou Choctaw dome and apparently are working satisfactorily.

B.5.2.1.3 Local Soils

Clayey soils of the Sharkey-Swamp association overlie and are adjacent to the Bayou Choctaw salt dome in the parishes of Iberville and West Baton Rouge. The Sharkey-Swamp association is characterized by level to depressed clayey soils on lands adjacent to the natural levees of the Mississippi River. These soils are flooded frequently and support a woodland wildlife habitat.

To the east of the dome approximately four miles, the Commerce-Convent soil association occurs on top of the levees. The Commerce-Convent association consists of nearly level, somewhat poorly drained, alkaline loamy soils on the crests of natural levees. These soils often support cropland or urban and industrial uses.

The preceeding soil descriptions, developed by the U.S. Department of Agriculture Soil Conservation Service (1971), describe the samples of the range of typical soils to be found in and around the Bayou Choctaw site and possible areas of impact.

B.5.2.2 Water Environment

B.5.2.2.1 Surface Water Systems - Bayou Choctaw

Figures A.6-1 and A.6-2 illustrate several surface water bodies in the general vicinity of the Bayou Choctaw site. These include the Mississippi River, the Port Allen Canal, Choctaw Bayou, Bull Bay, Bayou Bourbeaux, and numerous small drainage canals.

The Port Allen Canal, which is synonymous with the portion of the Intracoastal Waterway under consideration, is connected to the Mississippi River by the Port Allen Locks located at Mississippi River Mile Point 228.5 at Baton Rouge. The locks are located approximately 14 waterway miles north of the Bayou Choctaw salt dome. The section of the canal extending from the locks to the dome area is trapezoidal in cross section, with a bottom width of 120 feet and a top width of 200 feet. Water depth is controlled at approximately 12 feet; however, fluctuations in depth do occur. The maximum design discharge of the locks is 3,500 cfs. The resulting velocity of water at a 12-foot depth in a trapezoidal channel of the above dimensions is 1.82 feet per second.

In the site vicinity, the Intracoastal Waterway (Port Allen Canal) closely follows the alignment of Choctaw Bayou.

Smaller water courses in the immediate site vicinity include Bayou Bourbeaux and Bull Bay. As may be seen on Figures A.6-1 and A.6-2, Bayou Bourbeaux flows generally southeasterly to join Bull Bay in the site vicinity. No volumetric flow data are available for these waterways. Water flow is typically sluggish (low velocity) and intermittent. Factors controlling water quantity include seasonal variations in precipitation, seasonal variations in flow of the Mississippi and Atchafalaya Rivers, and the regulated flow in the Port Allen Canal. Bull Bay joins Choctaw Bayou and the Intracoastal Waterway a short distance southwest of the site, as may be seen on Figures A.6-1 and A.6-2.

A pond was created in the site vicinity, adjacent to Bayou Bourbeaux, when Cavern No. 7 collapsed. The surface area of the pond is approximately 12 acres; its depth is 85 feet. Assuming a conical shape, the volume of the lake is approximately 110 million gallons.

Drainage from the land area encompassing the bayous and canals is toward the Port Allen Canal (westerly). However, due to minor variations in the slope of the land, the dominance of the volumetric flow rates in the Mississippi and the Atchafalaya Rivers, and the Port Allen Canal, flow direction is variable. These bodies of water determine the direction of flow in smaller connecting portions of the Intracoastal Waterway, as well as the bayous and canals. Therefore, under certain conditions, backflow into the bayous and canals in the vicinity of the dome occurs. These waters are also affected by the tidal action of the Gulf of Mexico. Navigation and flood control have been the impetus for the development of this portion of the Intracoastal Waterway.

B.5.2.2.2 Subsurface Water System

The Bayou Choctaw salt dome is located in the east-central portion of Iberville Parish, Louisiana, and penetrates the Plaquemine aquifer. The base of the Plaquemine aquifer is at a depth of about 900 feet in the site vicinity with highly saline water (greater than 10,000 mg/l dissolved solids) occurring below a depth of about 1000 feet. The depth to salt is about 650 feet and the top of the caprock is at a depth of about 450 feet. The base of the fresh water (less than 1000 mg/l dissolved solids) is about 400 feet below sea level in the vicinity of the dome (Rollo, 1960).

Aquifers in the vicinity of the Bayou Choctaw dome are capable of delivering large quantities of slightly to moderately saline water to properly completed wells. Aquifer porosities are on the order of 40 percent with permeabilities in the range of 1000 to 2000 gpd per foot. Well yields of 5000 gpm or more may be anticipated.

The Bayou Choctaw dome is near several significant users of ground water. The Plaquemine aquifer is a source of fresh water for several municipalities in both Iberville and West Baton Rouge Parishes. Pertinent data are provided by Whiteman (1972). These data indicate at least 2.2 million gallons per day are drawn from the aquifer in Iberville Parish and at least 0.725 million gallons per day are drawn in West Baton Rouge Parish. The water wells serving the municipalities of Plaquemine (1.65 million gallons per day) and Addis (0.1 million gallons per day) are specifically significant because these wells are located within five miles of the Bayou Choctaw site.

In addition, an aquifer in the Baton Rouge area known as the 2800-foot sand is a major source of fresh water in that area. This aquifer occurs at a depth of about 4000 feet and contains saline water in the vicinity of Bayou Choctaw dome. The rather abrupt southern limit of fresh water in the Miocene deposits is the extent to which flushing of connate water has proceeded downdip (Rollo, 1960).

B.5.2.3 Climatology and Air Quality

B.5.2.3.1 Climatology

The climatic conditions from Section B.2.3.1 are generally applicable to Bayou Choctaw. Specifically, climatological summaries from Baton Rouge are more representative due to the proximal location of this station to the site. Compared to sites nearer the coast, Bayou Choctaw is expected to experience: 1) lower wind speeds, including a higher frequency of calms; 2) slightly cooler weather, especially in winter, with about twice as many days below freezing; 3) slightly lower humidity; 4) somewhat less rainfall, especially in summer; and 5) a slightly higher frequency of stable periods.

Tropical cyclones, including hurricanes, lose strength rapidly as they move inland. The greatest concern at Bayou Choctaw is potential damage from wind or flooding due to excessive rainfall.

B.5.2.3.2 Air Quality

Generally, the air quality data presented in Section B.2.3.3 are applicable at Bayou Choctaw. However, since the site is 15 miles away from the nearest industrial center (Baton Rouge), the air quality at Bayou Choctaw normally will be less polluted than in industrial areas. Data presented for Carville are probably indicative of the low levels expected at this site. The one exception is non-methane hydrocarbons, with levels in excess of the three-hour standard recorded in remote areas of southern Louisians.

B.5.2.4 Background Ambient Sound Levels

Ambient sound levels at Bayou Choctaw are typical of a secluded, essentially flat, moderately forested area. Sounds are dominated by wind in the trees, insects, crickets, birds, and other wildlife. Noise levels measured at undeveloped areas on Weeks Island in coastal Louisiana indicated day/night weighted sound levels, L_{dn}, are slightly above 50 dBA (FES 76-8). A similar sound level is estimated at the undeveloped areas along the pipeline route.

Noise levels near small communities may be estimated based on measurements made at similar land use areas near Weeks Island (FES 77-8). Daytime and nighttime sound levels were measured at 58 dBA and 39 dBA, respectively. Day/night sound levels are estimated at 56 dBA.

At the proposed site of Bayou Choctaw, the ambient sound levels are significantly higher than other areas of the pipeline route due to ongoing industrial activity. Using acoustical engineers' ambient measurements made at similar locations, day/night weighted sound levels are estimated at 70 dBA.

The estimated background ambient sound levels at Bayou Choctaw and along the proposed pipeline are summarized in Table B.5-1.

TABLE B.5-1 Summary of background ambient sound levels (dB) estimated for Bayou Choctaw.

Location	L_d	L_n	L_{dn}
Center of Site	70	60	70
Noise-Sensitive Land Use Areas (Small Communities)	58	39	56
Undeveloped Areas	55	39	53

B.5.2.5 Species and Ecosystems

The description of the environmental setting of the area is based on the Bayou Choctaw FES 76-5, and is supplemented with regional inventories, known species ranges, literature sources, topographic maps, aerial photographs, and a field inspection of the site. The 27-acre site and the 90 acres offsite (Table B.5-2) consist primarily of deciduous swamp, cleared land (with existing oil field development and limited agricultural use), and freshwater wetland (creeks, bayous, and marshes) ecosystems (Figures B.5-4 and A.6-2). Agricultural areas to the east of the Bayou Choctaw site produce sugar cane, corn, sorghum, wheat, soybeans, and peanuts.

The bottomland forest and deciduous swamp ecosystems predominate at the Bayou Choctaw site. The foremost overstory vegetation at the site consists of bald cypress and water tupelo (both hydrophytic species characteristic of these lowland ecosystems). Species of the supportive understory strata include, but are not limited to, black willow, water ash, and pumpkin ash. Water oak is also represented but is not an abundant species. The understory and groundcover vegetation of the site includes greenbriar, palmetto, blackberry, trumpet vine, Virginia creeper, holly, and grape. Many members of the dominant overstory species are also well represented in the understory. A network of improved gravel roads currently exists in the site area. The banks of these roads are planted or revegetated to grass species including Bermuda grass, wild rye, and panic grasses.

The deciduous swamp is the most significant and characteristic habitat type found at the site. This habitat type provides resources for a large number of wildlife species (Tables B.2-15, B.2-17, B.2-18, and B.2-19). Wildlife population and harvest estimates for various species by region and parish, made available by the Louisiana Wildlife and Fisheries Commission, are presented in Sections B.2.5.2.2 and B.2.5.3.1. Some common bird species of the botto land forest and swamp include herons, egrets, woodpeckers, wood duck, woodcock, thrushes, vireos, and warblers. Two important recreational species likely to occur on site are the wood duck and woodcock. Bottomland areas such as

TABLE B.5-2 Estimated site acreage analysis - Bayou Choctaw[a].

Total for Fenced Site Area	27 acres
Total for Storage Site Expansion and Pipelines (area to be developed)	117 acres
Total for Cleared Land[b]	64 acres
Total for Bottomland Forest	0 acres
Total for Deciduous Swamp	50 acres
Total for Open Water	3 acres

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Proposed Brine Disposal System (Wellfield expansion)	3.9	36.0	25.0
Cleared Land		3.0	2.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		32.0	23.0
Open Water (total water crossings - 4)		1.0	0.0
Alternate Brine Disposal System (Gulf and wells)	122.1	1252.0	426.0
Cleared Land		139.0	89.0
Bottomland Forest		9.0	6.0
Deciduous Swamp		232.0	145.0
Marsh		298.0	186.0
Open Water (total water crossings - 49)		574.0	0.0
Alternate Brine Disposal System (Well field along Raw Water Pipeline ROW)	2.6	10.0	7.0
Cleared Land		10.0	7.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings - 0)		0.0	0.0
Proposed Raw Water System (Mississippi River)	5.4	54.0	33.0
Cleared Land		53.0	33.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings - 1)		1.0	0.0
Alternate Raw Water System Well Field along crude oil pipeline ROW)	4.7	13.0	8.0
Cleared Land		12.0	8.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Open Water (total water corssings - 2)		1.0	0.0

TABLE B.5-2 continued.

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Alternate Raw Water System (ICW)	1.0	8.0	6.0
Cleared Land		8.0	6.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings - 0)		0.0	0.0
Alternate Raw Water System (Gulf)	98.3	723.0	422.0
Cleared Land		133.0	85.0
Bottomland Forest		9.0	6.0
Deciduous Swamp		232.0	145.0
Marsh		298.0	186.0
Open Water (total water crossings - 49)		51.0	0.0

[a]Based on features of USGS topographic maps (15 minute series).

[b]Cleared land includes agricultural, industrial and rural.

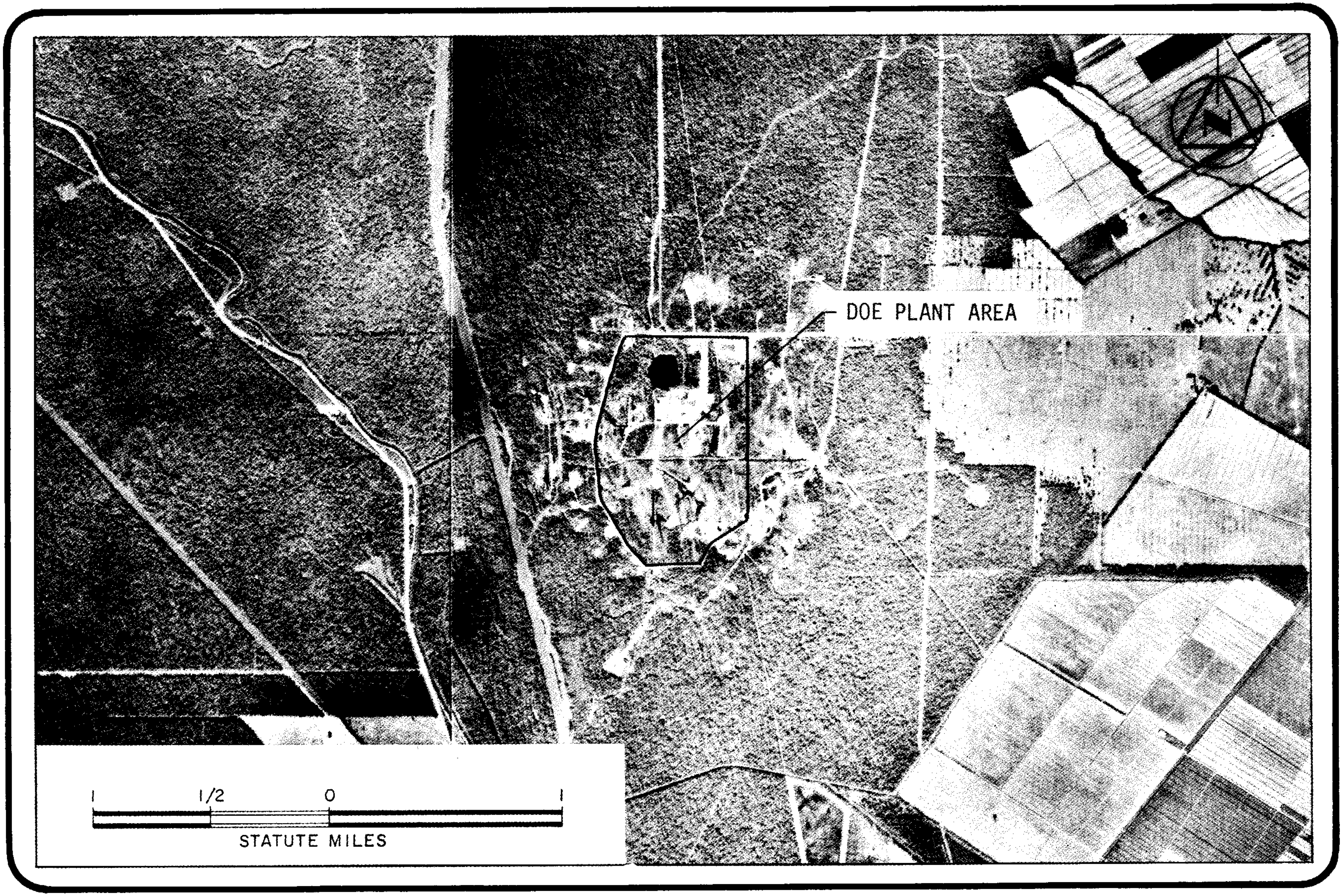


FIGURE B.5-4 Air photo - Bayou Choctaw plant area.

those present on the site, provide essential nesting and wintering habitat for both species. The bottomland swamps also provide suitable habitat for the endangered southern bald eagle.

Some common mammals expected to occur in the bottomland forest and swamp include opossum, squirrels, nutria, mink, raccoon, swamp rabbit, and white-tailed deer. Important commercial/recreational inhabitants include squirrels, rabbits, furbearers, and deer.

Amphibians and reptiles expected to occur at the Bayou Choctaw site are presented in Table B.2-15 and B.2-17. The bottomland swamp provides important habitat for the alligator, which is considered an endangered species in this area.

Cleared lands provide limited habitat for wildlife. Most wildlife species found in these areas are those that have adapted to man and can survive in significantly altered habitat types. Some of these species are presented in Table B.2-15 under the cleared lands category.

The freshwater wetlands found at the Bayou Choctaw site consist of a vast swamp area connected by a canal-bayou-swamp complex to the Port Allen Canal portion of the Intracoastal Waterway (Figures B.5-4 and A.6-2). Wildlife species expected to occur in these habitats are presented in Tables B.2-15, B.2-17, B.2-18, and B.2-19. Commercially and recreationally important species present include waterfowl, furbearers, squirrel, swamp rabbits, and deer. The most apparent constituent of the swamp complex at the Bayou Choctaw dome is the aquatic macrophyte community. Plants which often dominate the freshwater marshes in southern Louisiana include bulltongue, maidencane, and spikerushes (accounting for 66 percent of marsh vegetation). Giant cutgrass, elephant's ear, various pond weeds, and black willow also dominate the marsh-creek interface along the Intracoastal Waterway. A blanket of duckweed covers much of the water surface on the site during warm parts of the year.

Freshwater marshes are most diverse habitats (Chabreck, 1970), and are among the most productive natural ecosystems in the world, with mean net productivity of organic materials as high as 2,000 grams dry weight per year (Whittaker, 1972). Since the Bayou Choctaw dome is in a temperate, nutrient enriched area, this level of production should be indicative of specific production in the vicinity of the proposed facility.

Emergent marsh vegetation serves as the most important producer in the organic detritus cycle. More plant biomass is produced than is consumed by the herbivores, and as this material dies and decomposes, it furnishes food for a wide variety of detritus-feeding organisms. In freshwate marshes, this organic matter is incorporated into the soil, and is developed into peat, consisting of approximately 80 percent organic matter.

Several groups of organisms feed directly on the aquatic marcophytes or on the detritus which macrophytes produce upon decay. The diet of nutria, common animals in the swamp-bayou complex around Bayou Choctaw dome, consists almost entirely of macrophytes. Crayfish and some other aquatic invertebrates also feed heavily on detritus.

The majority of phytoplankton likely to be encountered in the standing waters around the site include green algae, blue-green algae, and diatoms (Chabreck, 1970), which are usually most abundant in the spring. Copepods are likely to be the most abundant zooplankter; however, cladocerans, rotifers, and ostracods may also be abundant (U.S. Army Corps of Engineers, 1975b).

Benthic macroinvertebrate and fishery data specific to the site are not available. However, the characteristics of these communities are probably not much different than those discussed for the regional environmental setting.

In addition to the development of the site, a brine disposal, raw water, and oil delivery system will be designed, each having one or more alternatives (see Section A.6 and Figure A.6-2. Estimates of acreages of various habitat types to be used for these systems and their alternatives are provided in Table B.5-2. The environmental setting of these systems and alternatives is composed of the same general habitat types discussed with respect to the Bayou Choctaw dome site area. There are, however, some differences and/or similarities between the environmental setting of the site area and the areas covered by particular systems or alternates.

The productivity of the habitats in the vicinity of the proposed deep well injection brine disposal system is higher than that of the dome since most of the habitats near the brine disposal system are undisturbed.

The environmental setting of the alternative brine disposal system to the Gulf of Mexico with backup wells encompasses an area more than 122 miles long, including a 23.6-mile section in the Gulf. This area is characterized by the same ecosystems as discussed in the regional setting of the Capline Group (Section B.2.5) and for Chacahoula, since the same brine disposal pipeline would be used (Section B.6.2.5 and Appendix G). A major portion of this route to the Gulf would be through relatively undisturbed swamps and marshlands, and would require crossing many streams. It should be noted also that this route would cross about 9 miles of leased oyster grounds, a major portion which is considered a seed oyster reservation. The seed oyster reservation (at Bay Junop) is one of two in the region. The pipeline would also cross Bayou Penchant, which is one of the few streams in the region to be evaluated as good for fishing (U.S. Army Corps of Engineers, 1973a).

The alternative deep well injection brine disposal system will parallel the proposed raw water supply system pipeline that goes from the site to the Mississippi River and covers a total of 2.6 miles. Most of the area used by these systems is located on cropland or other developed land, and would not use much of the highly productive bottomland forest and deciduous swamp discussed for the Bayou Choctaw site area.

The primary raw water supply system (previously considered as an alternate in the Bayou Choctaw FES 76-5) would require a 4.3 mile pipeline to the Mississippi River and one minor water crossing at Bayou Bourbeauz. For the most part, this route is located on cropland or other developed land and would not use much of the highly productive bottomland forest and deciduous swamp described for the site area.

Many of the groups of aquatic organisms discussed in the regional setting are present in the Mississippi River. Phytoplankton densities are probably lower and benthic macroinvertebrates are likely to be less diverse than in the Mississippi. Additionally, sportfish are not likely to be as abundant, and fish (such as darters) which prefer small streams and riffle areas, are scarce or absent. Zooplankton, fish eggs, fish larvae, and small fish, particularly drum and shad, may be abundant near the shore and in backwater areas. Bayou Bourbeaux may support a small community of aquatic organisms similar to those discussed in the regional environmental setting.

The alternate raw water supply system from wells would be built in the same highly productive undisturbed bottomland forest and deciduous swamp habitats as proposed for the primary deep well injection brine disposal system.

The alternate raw water supply system to the Intracoastal Waterway (Port Allen Canal), which would be about one mile long, would run along the eastern shoreline of Bull Bay through an area of relatively undisturbed forest and deciduous swamp similar to that discussed for the site area. The aquatic biota inhabiting the area in the vicinity of the proposed intake structure may be expected to be similar to that of Grand Bayou and other freshwater biota discussed in the regional environmental setting.

An alternate raw water supply system has also been proposed for the Gulf of Mexico using the same route as the alternate brine disposal system to the Gulf of Mexico. The raw water system would therefore involve the same habitats as the brine disposal system except for the benthic habitats of the Gulf (since there would be only 2 miles of offshore construction for the raw water system).

B.5.2.6 Natural and Scenic Resources

Natural Resources

The Bayou Choctaw dome is located completely within a backwater swamp on the eastern margin of the Atchafalaya Basin and to the west of the natural levee of the Mississippi River. A general description of the backwater swamp and other natural resource areas characteristic of the entire region is given in Section B.2.6. To the north, west, and south of the storage site, freshwater wooded swamps and marshlands are most prevalent, while to the east and northeast, cleared land predominates. The Intracoastal Waterway runs north/south approximately two-thirds of a mile west of the dome. The marsh-canal interface along this waterway is an area of abundant natural resources, providing a diverse and productive freshwater marsh habitat (FEA, 1976a).

The dominant vegetation at the site consists of bald cypress and water tupelo trees, although sedges and panic grasses are also common. Resident wildlife consists of wading birds, small furbearers, rabbits, deer, and squirrels (FEA, 1976a).

Many of the natural resources on the Bayou Choctaw dome have been cleared or disturbed by the development of the early storage site. Directly south of the early storage facility is a deciduous swamp and forest area interspersed with brine disposal wells and drill pads.

To the east and northeast approximately one mile from the storage site is an area of agricultural development following the natural levee of the Mississippi River.

Regional wildlife areas and existing state parks in the region surrounding the Bayou Choctaw dome are discussed in Section B.2.6.1, none being within a 10-mile radius of the main storage area. The proposed Iberville State Park, however, would be located approximately 10 miles southwest of the central storage area. In addition, there are six historic sites and four small recreational sites within a five-mile radius of the dome. One historic site is less than a mile northwest of the storage site (FEA, 1976a). Proposed state parks in the vicinity of the Bayou Choctaw storage site are shown in Figure B.5-5. Smaller recreational and historical sites are shown in Figure B.5-6.

Several existing or proposed regional recreational areas are located south and southwest of the storage site between the Bayou Choctaw dome and the Gulf of Mexico. These include the proposed Lake Verret State Park in Assumption Parish, Edward Douglas White State Park in Lafourche Parish, and the Bayou Penchant Scenic Waterway in Terrebonne Parish (see Section B.2.6).

Scenic Resources

The storage site is located in an area that was largely wooded, but is now heavily developed for early storage. Manmade facilities associated with early storage, including buildings, roads, wells, drill pads, and pipelines, detract from the surrounding natural aesthetic quality of the site, especially at the central storage area. Some of

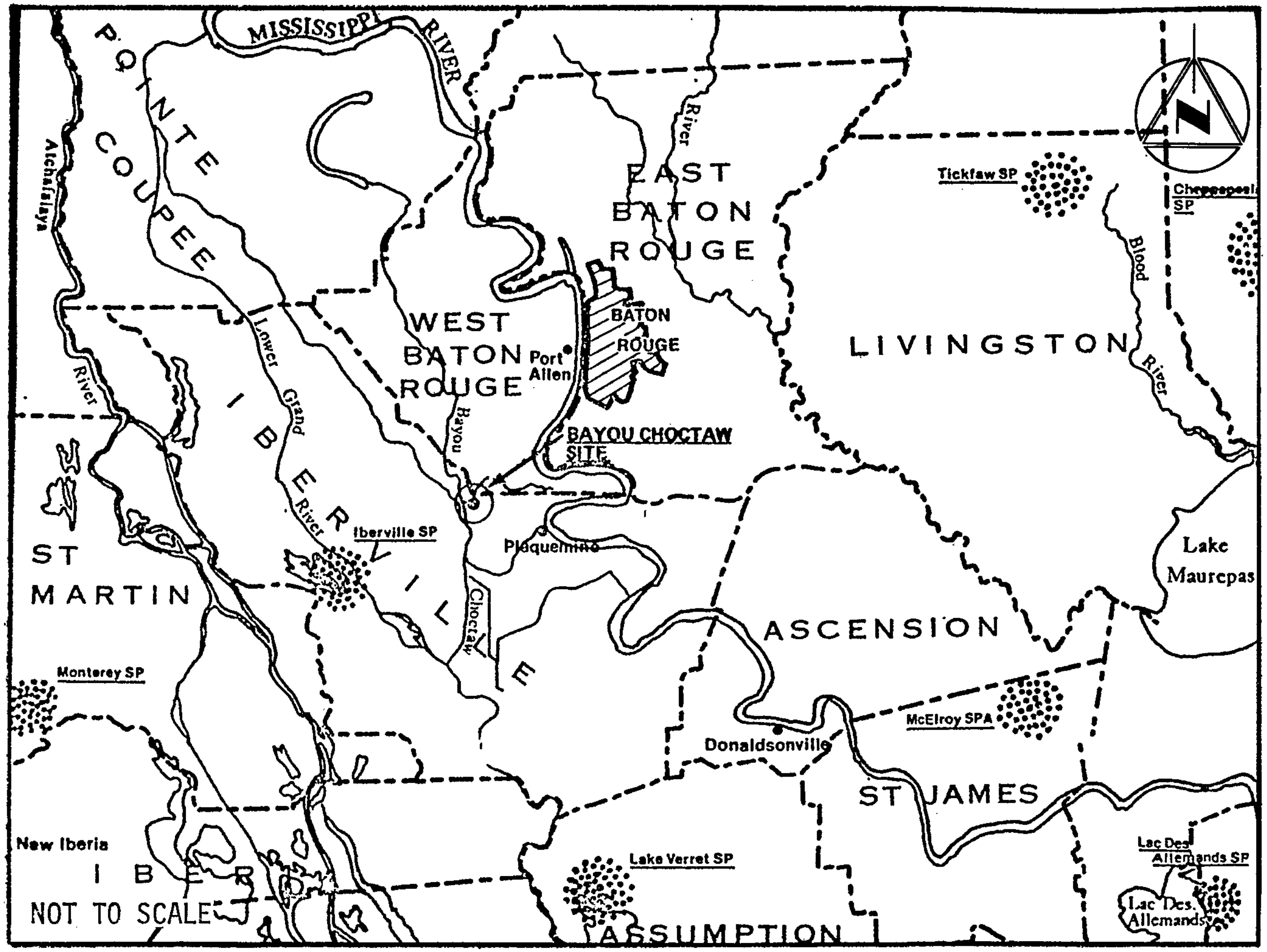


FIGURE B.5-5 Proposed parks in the vicinity of Bayou Choctaw site.

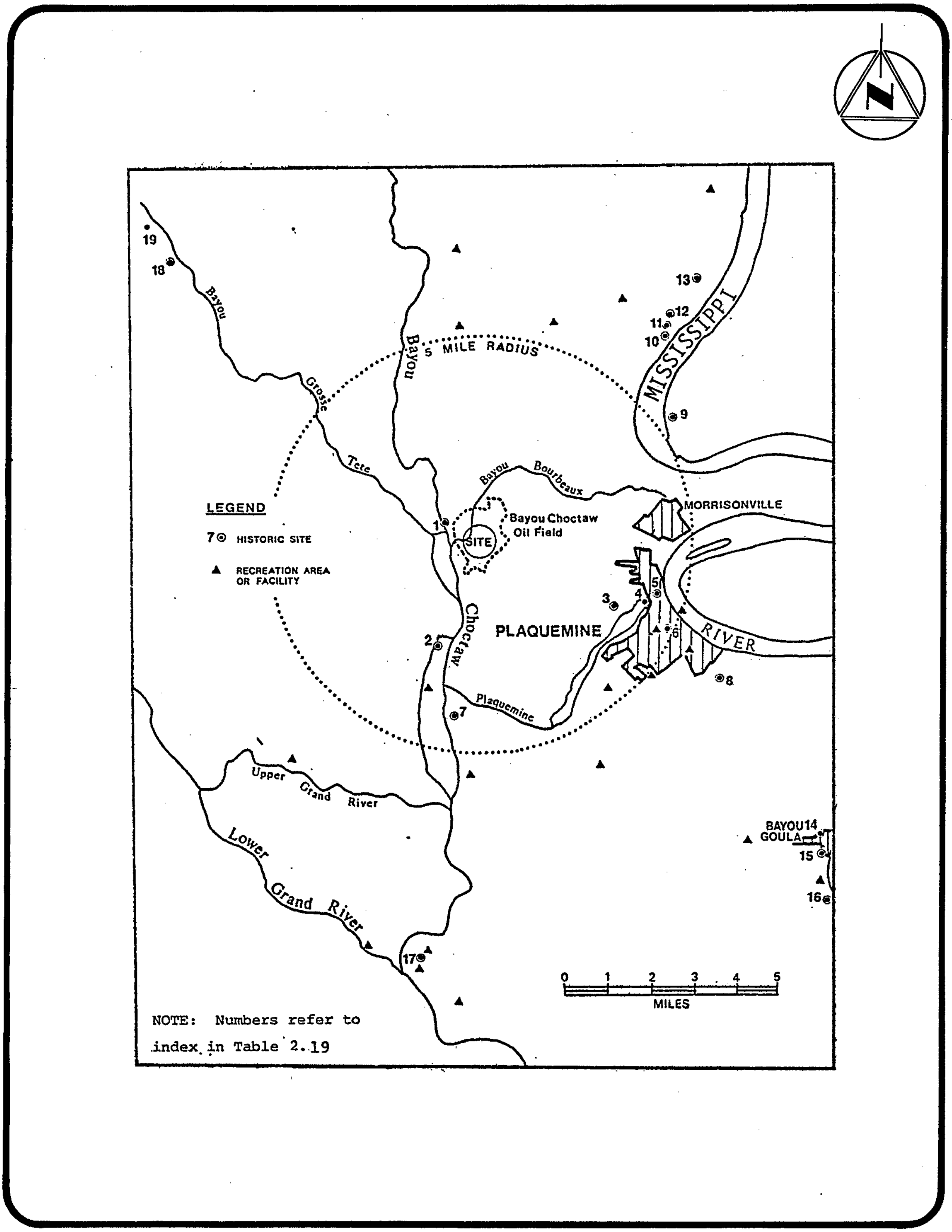


FIGURE B.5-6 Historic sites and recreational areas.

these facilities such as the brine disposal wells, however, are spaced far enough apart to be fairly well camouflaged by interspersed natural vegetation and trees. There are no public roads in the immediate area, making site visibility low to the general public (FEA, 1976a).

Just west of the storage site, along the Intracoastal Waterway, is a heavily vegetated marsh area. Plant species such as bulltongue, maindencane, and spikerushes dominate the canal-marsh interface (FEA, 1976a).

The area south of the storage site is currently a brine disposal field for early storage. The 10 wells and drill pads located there are widely spaced and require only small patches of cleared land. In between these individual facilities, the natural deciduous bottomland forest provides some scenic appeal to the area (see Section A.6.2).

The cleared agricultural land roughly one mile east and northeast of the Bayou Choctaw dome consists of crops, pastures, and fallow fields on a natural levee bordering the Mississippi River (FEA, 1976a). The general characteristics of cultivated land bordering the natural levees throughout the entire region are discussed in Section B.2.6.1.

Cropland, because of the uniformity in vegetation, does not support as diverse fauna as do other ecosystems. Nonetheless, the wide open spaces do provide broad scenic vistas during certain seasons. Bayou Bourbeaux runs east to west crossing the agricultural area northeast of the storage site.

B.5.2.7 Archaeological, Historical & Cultural Resources

Bayou Choctaw

The Bayou Choctaw dome does not appear to contain any known sites of archaeological or historic significance.

Iberville Parish has four historic sites listed in the National Register (U.S. Department of the Interior, 1977): one in Rosedale, one in the St. Gabriel vicinity, the Bayou Plaquemine Lock in Plaquemine, and the St. Louis Plantation one mile south of Plaquemine on Route 405.

The first two sites are greater than five miles from the Bayou Choctaw dome, and the latter two sites are within approximately three to five miles of the dome.

According to the U.S. Army Corps of Engineers environmental inventory (1973a), 46 sites listed in the Louisiana State Plan are not shown because of preference by state authorities that the general public not know the exact locations of the sites, and 23 sites of archaeological interest are shown. None of the shown archaeological sites are located on the dome. The closest site is an Indian village on Route 77 approximately four miles south of the dome. Other listed sites are all farther away.

B.5.2.8 Socioeconomic Environment

B.5.2.8.1 History

The area surrounding the dome followed the general settlement pattern described for the region in Section B.2.8.1. The small communities near the storage site have a unique heritage compared to towns of the same size in other regions of the country. Early French influence can be seen in the layout of property boundaries in long, narrow plots of land called arpents, stretching out from waterways. The French-speaking community is the largest enthnic language group, and the area is distinguished by the predominance of French place names and family names. A basically conservative influence is exerted in these small communities by families that have been established there for generations and by an active awareness of the historical significance of local landmarks (FEA, 1976a).

The site itself was not developed until the 1930's. Since that time, the site has been developed for brine feedstock and petroleum storage.

B.5.2.8.2 Land Use Patterns and Planning

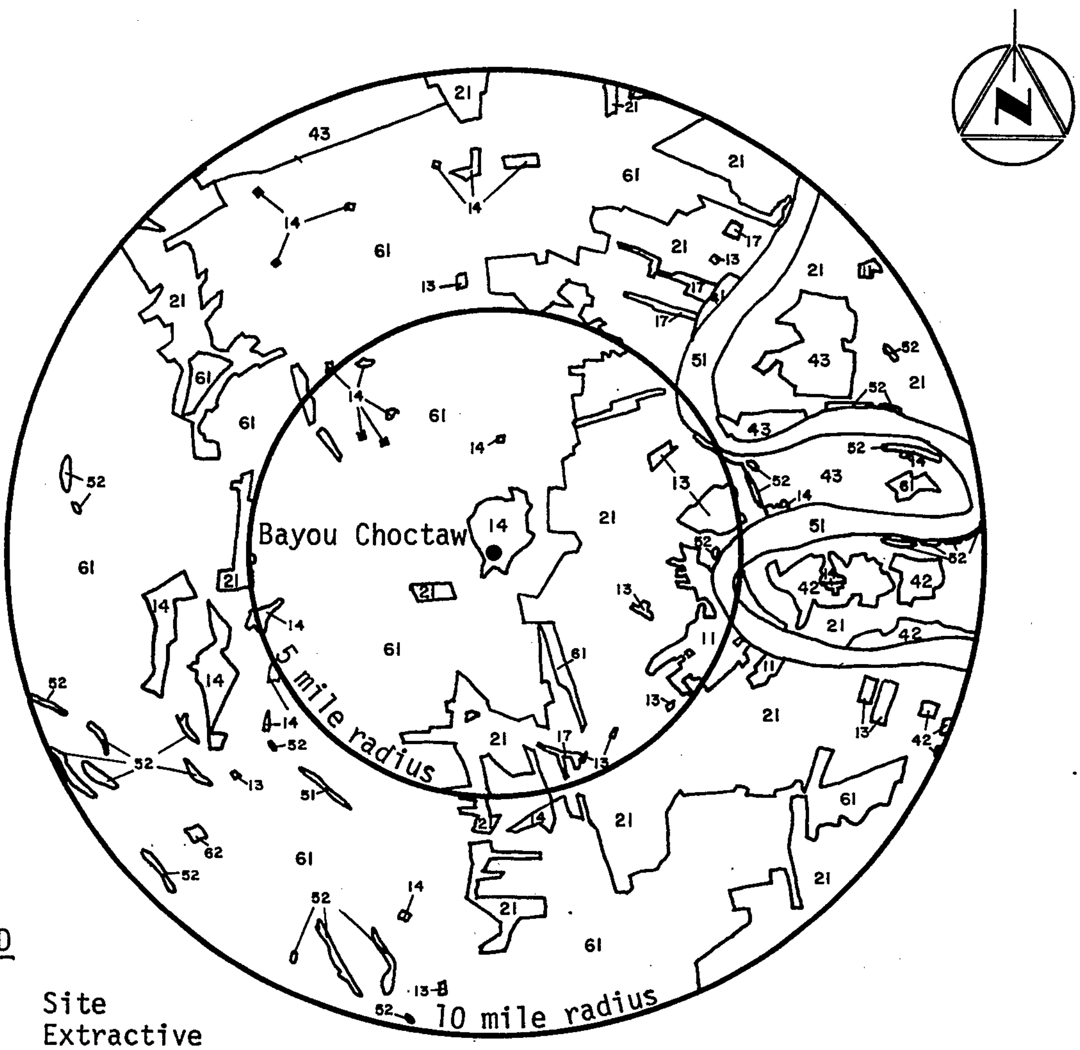
The Bayou Choctaw salt dome is entirely located within the fresh backwater swamp to the west of the natural levee of the Mississippi River. Since its discovery in 1931 by Standard Oil of Louisiana, the

Bayou Choctaw salt dome oil and gas fields have been in continuous production. In addition, early storage development has brought increased use of the area for storage wells and associated facilities. The Allied Chemical Corporation was the principal user of the Bayou Choctaw dome and occupied the site from 1934 until early storage development.

The area within the 2000-foot contour of the dome is currently the site of the early storage plant facilities. About 6500 feet to the south is a brine disposal field containing 10 deep injection wells which are widely spaced in an area that is covered with woods. The Intracoastal Waterway runs north/south approximately two-thirds of a mile west of the dome. The area between the central storage site and this waterway is covered by swamp and marsh. The area south of the dome, between the Choctaw site and the Gulf of Mexico is predominately swampland and marsh area. Lake Verret is located in this area roughly 20 miles south of the Bayou Choctaw dome. "Basic" land uses within the large region surrounding the Bayou Choctaw storage site are discussed in Section B.2.8.2 No farming activity exists on the proposed storage site; however, one mile to the east, agricultural development of the natural levees has been continuous for at least 100 years. The primary crop on these natural levees is sugar cane, though in some areas cotton, soybeans, and truck crops are planted (FEA, 1976a).

Except for the development of early storage, no other operative developments exist at the Bayou Choctaw salt dome. Residential development associated with the farms on the natural levees is present one or two miles to the east. Most residences are confined to the natural levees. The residential communities near the salt dome are Plaquemine and Morrisonville on the Mississippi River. Land use within a five and 10-mile radius of the site is shown in Figure B.5-7.

The potential development of the immediate vicinity in and around the Bayou Choctaw salt dome is restricted to activities such as mineral or fuel extraction and/or storage, inasmuch as the physical environment places severe constraints on the types of land use that are feasible for backwater swamp and coastal marshes. Recent studies have clearly



LEGEND

●	Site
14	Extractive
13	Industrial
11	Residential
17	Strip and Cluster Settlement
16	Institutional
61	Wetland, Forested
62	Wetland, Non-Forested
21	Cropland and Pasture
41	Forest, Deciduous
42	Forest, Evergreen
43	Forest, Mixed
51, 52	Water

FIGURE B.5-7 Land use within 5 and 10 mile radius of the Bayou Choctaw site.

delineated the impacts of swamp and marsh development and have shown that in the long run, the so-called "land reclamation projects" are for the most part long term failures. The reasons for these failures and the low potential for development results from the undesirable engineering properties of flood basin deposits.

It is therefore unlikely that the land would be developed for purposes other than those relating to oil, gas, salt extraction, and/or storage of petroleum products (FEA, 1976a).

B.5.2.8.3 Transportation Systems

The Bayou Choctaw storage site has access to surrounding population centers via a good quality county road to Route 1, which is a major multi-land highway running north to Baton Rouge. Route 1 to the south connects the site with Plaquemine and Donaldsonville. The section from Plaquemine to Donaldsonville is a secondary two-lane highway.

Numerous service roads cross the storage site to existing early storage facilities. On-site canals connect the facilities with the Intracoastal Waterway and the Mississippi River. Regional transportation facilities serving the site are described in Section B.2.8.3.

B.5.2.8.4 Population Characteristics

The storage site is located in Iberville Parish near its border with West Baton Rouge Parish. The area immediately surrounding the site is definitely rural, with a number of people living in small settlements along highways connecting towns with major intersections. There are 15 to 20 villages within a 10-mile radius of the storage site which had 1970 populations of less than 1000.

Most commercial and retail businesses servicing the area are located in Baton Rouge, population 165,963. Baton Rouge is the capital of Louisiana, a major industrial center and port city. The population of Baton Rouge grew 8.9 percent in the years between 1960 and 1970, and it is the third largest city in the state. The largest urban settlement in Iberville Parish is Plaquemine which had a 1970 population of 7,739 and is located about four miles southeast of the dome. Plaquemine was built at the locks which enabled goods traveling from the waterways of the Atchafalaya Basin and west to enter the Mississippi River and vice versa. It is the parish seat of Iberville Parish. Nearby population centers also include Port Allen to the north (in West Baton Rouge Parish) population 5728, and Donaldsonville to the south, population 7367. The influx of industry to the area during the past decade has encouraged young people to stay rather than move to the larger cities. Plaquemine's population, however, grew by only .7 percent between 1960 and 1970 (FEA, 1976a).

Iberville Parish, in which the site is located, grew very slowly between 1960 and 1970, increasing its population by only 2.7 percent. West Baton Rouge Parish, on the other hand, borders the growing Baton Rouge metropolitan area and grew by 14 percent over the same period.

B.5.2.8.5 Housing Characteristics

The number of housing units in Iberville Parish was 9096 in 1970. The majority of these units (5202) were owner-occupied with a median value of $10,300. The overall vacancy rate was fairly low at 3.6 percent (FEA, 1976a).

The availability of housing for sale or rent was severely limited in the area west of the Mississippi River near the site. There is a greater availability in the communities east of the Mississippi.

Baton Rouge, a major source of housing with a total of 56,379 year-round units, had a low vacancy rate (1.3 percent) in owner-occupied units in 1970, but a much larger vacancy rate (14.2 percent) in rental units (U.S. Dept. of Commerce, 1972b). The Bayou Choctaw site is within easy commuting distance of Baton Rouge (see Section B.2.8.5).

B.5.2.8.6 Economy

There are over 125 manufacturing plants in Baton Rouge and its suburbs which dominate the economy of areas surrounding the Bayou Choctaw site. The manufacturing industry provides the greatest number of jobs to the surrounding parishes. Chemical plants dominate the manufacturing field and employ the greatest number of workers. Second in number of plants is the manufacture of goods relating to construction. The construction industry itself is the second largest employer in the area.

This area is particularly well suited for manufacturing due to (1) an abundance of fresh water provided by the Mississippi River; (2) convenient shipping facilities via the port at Baton Rouge and the confluence of four railroad systems; and (3) close proximity to mineral resources that provide raw materials for the production of organic and inorganic chemical compounds.

Shipping is an important sector of the Baton Rouge economy. The volume of cargo handled at the Port of Baton Rouge has steadily increased. In 1974 the port handled an estimated 53.5 million tons. About 800 vessels used the public port facilities that year.

A number of minerals are commercially extracted in the area. These include salt, and gravel, lime, cement, and natural clays, but the most important are petroleum, natural gas, and natural gas liquids. This industry is particularly important to Iberville Parish where the value of its mineral production in 1971 exceeded $67,000,000.

The arable land in this region is used both as pasture for grazing cattle and for raising a limited variety of cash crops. The major crop in terms of acreage harvested is sugar cane, followed by soybeans and corn.

Lumbering is an important industry in Iberville Parish where there are about 279,300 acres of commercial forest. Several lumber companies and wood product industries are located there.

Employment

There is a relatively high rate of unemployment in Iberville Parish (9.5 percent). This may be accounted for by the effects of an unsteady job market in some of the plants and a lack of skills among a sizeable proportion of the labor force. (This situation may improve somewhat in the future because of avocational school being build in Plaquemine.) Although nearby East Baton Rouge Parish has a low unemployment rate (5.2 percent), the pool of available workers is larger there (FEA, 1976a).

The occupational distribution of labor force is given in Section B.2.8. The largest number of workers in the area are in the following occupational groups: (1) contract construction, (2) manufacturing, and (3) retail trade. In Iberville and East Baton Rouge Parishes, there is a large proportion of workers employed in various service industries (11.3 percent and 19.0 percent, respectively). Similar characteristics are found in surrounding parishes as discussed in Section B.2.8.6.

The number and proportion of workers who commute out of their home parishes is high in this area. The widespread pattern of commuting reflects the concentration of jobs in Baton Rouge and the growth of manufacturing plants along the Mississippi north and south of that city, and developing areas in Iberville and Ascension Parishes (FEA, 1976a).

Income

The number of households with an income less than the national poverty level is high in Iberville Parish (30.3 percent). Mean income of families is $7567. This reflects a situation in which a large part of the indigenous population of the parish derives its income from social security benefits and public assistance, while many higher-paying positions in industries that have come into the parish have been taken by people living outside of it who have more skills. Furthermore, the slow rate of housing development in Iberville Parish has inhibited the immigration of workers and their families (FEA, 1976a).

A similar but less pronounced situation existed in West Baton Rouge Parish in 1970. The existence of a proportionately large working force in East Baton Rouge Parish was reflected in its low rate of poverty level households (13.6 percent) and its mean family income ($10,842) (FEA, 1976a).

B.5.2.8.7 Government

Urban Services

Police protection for the proposed storage site would be provided by the Iberville Parish Sheriff's office operating from Plaquemine, the parish seat. Plaquemine itself has a separate police force of 24 officers, including radio operators. Fire protection for the storage site would be available from Plaquemine's municipal fire department which has three stations and a total of six fire engines. These are manned by a staff of 16 paid firemen supervised by a fire chief and assistant fire chief, and a number of volunteer firemen in the area.

Addis, which is north of the site in West Baton Rouge Parish, has a volunteer fire department with one engine.

Baton Rouge has a police force of 444 officers in uniform (513 personnel in the police department), and a fire department with a total of 379 paid firefighters (FEA, 1976a).

Hospitals

The hospital closest to the storage site is the Rhodes J. Spedale General Hospital in Plaquemine, which has 60 beds and nearly 100 personnel. There are three hospitals in Baton Rouge offering general medical and surgical services: Baton Rouge General Hospital with 387 beds, the Earl K. Long Memorial Hospital with 238 beds, and Our Lady of the Lake Hospital with 400 beds (FEA, 1976a).

Tax Revenues

The largest single source of revenues in Iberville Parish is the severance tax on mineral extraction (which equaled $3.1 million in 1971). Property taxes were also a major source of revenue in 1971, providing approximately $2.3 million. In West Baton Rouge Parish, state sales taxes provided the largest single revenue source followed by severance taxes (University of New Orleans, 1974).

B.5.3 Iberia Dome Alternative Site

B.5.3.1 Land Features

B.5.3.1.1 Local Geology

The Iberia salt dome is a shallow piercement dome almost circular in plan and with a relatively short, spiked top at about 950 feet below sea level. Sides of the dome show steeply dipping contacts which gradually decrease from about 71 degrees in the southwest portion to 60 degrees on the northwest flank of the dome. A geologic structure map contoured on top of the salt (Figure B.5-8) and the geologic cross section (Figure B.5-9) show the shape of the salt mass.

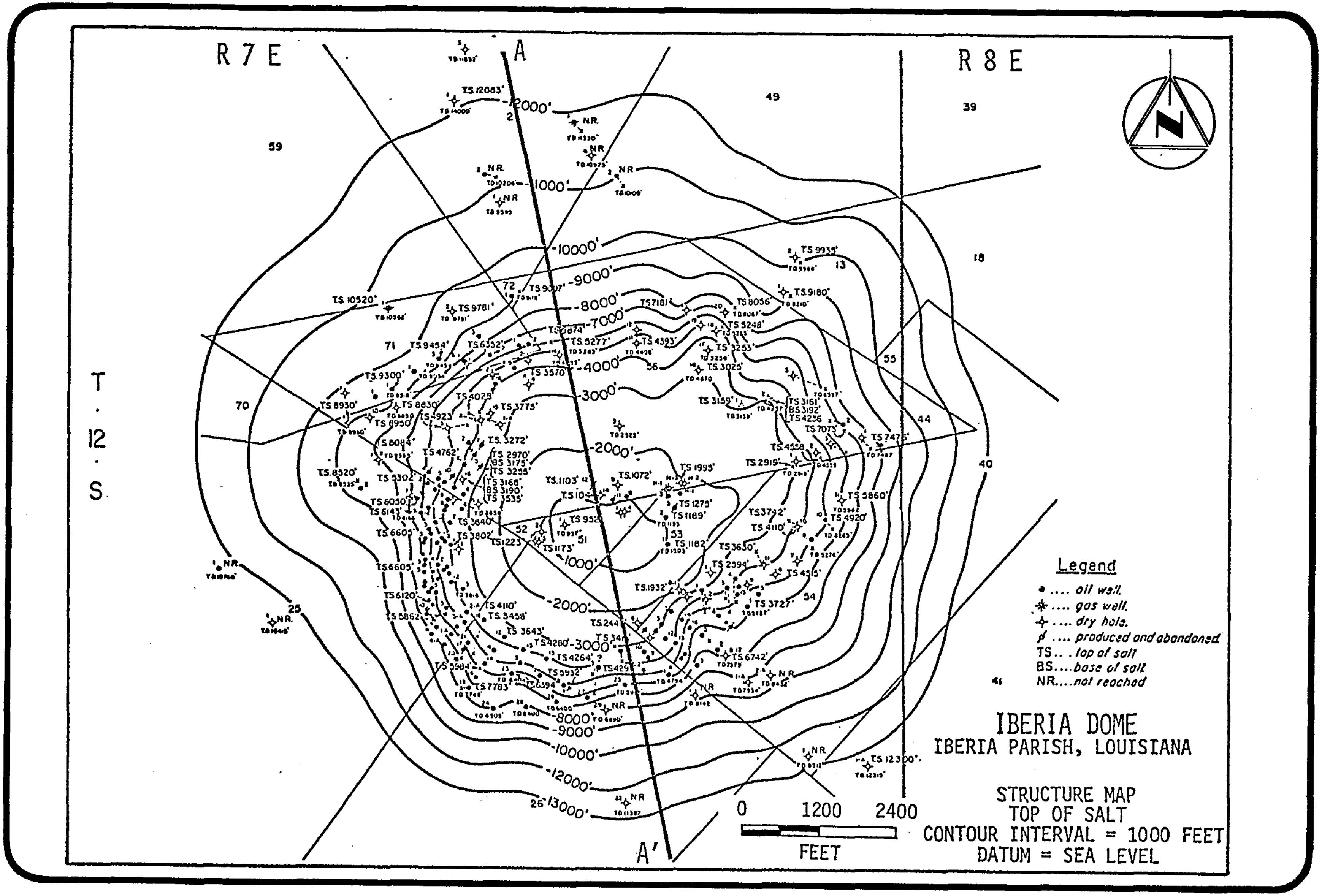
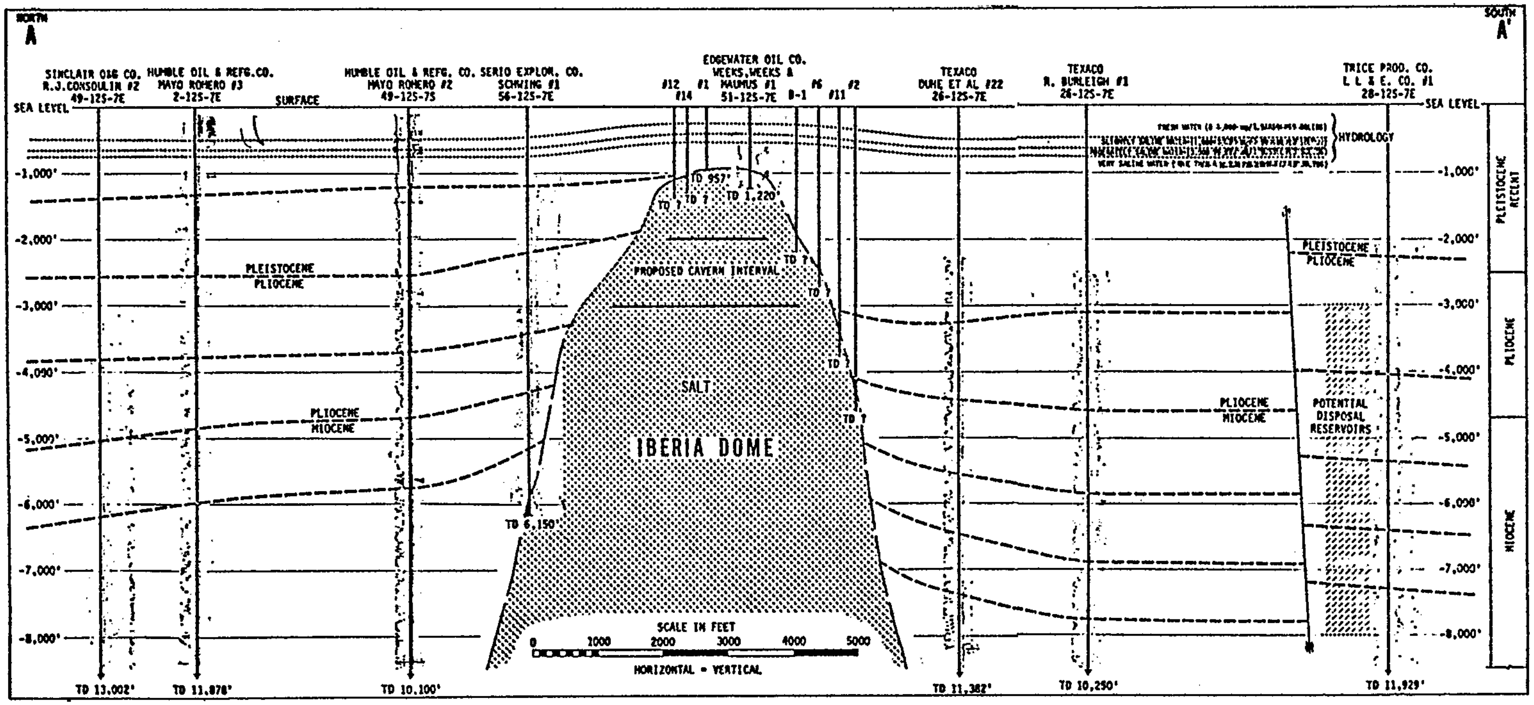


FIGURE B.5-8 Structure map - top of salt - Iberia dome.



B.5-9 Geologic cross section (north/south) Iberia dome

The shallowest known salt is encountered at -950 feet in a well drilled in the west half of Section 51 of T-12-S, R-7-E. The greatest depth to the top of salt is -12,300 feet, on the southeast flank of the dome in the center of Section 50 of T-12-S, R-7-E.

The length of the east-west axis of the dome above the -2000 foot salt contour appears to be slightly more than 3100 feet, while the north-south axis is less than 2500 feet. However, the east-west axis above the -3000 foot depth salt contour is 5200 feet long, and the north-south axis is 3400 feet. Therefore, no difficulty is foreseen in locating the crude oil storage facility within the salt mass below the -3000 foot salt contour.

Quality of the salt mass is unknown at this time. However, finely bedded and disseminated anhydrite will probably be present in amounts of perhaps three to seven percent. Incorporated portions of sandstone and shale through which the piercement structure has passed occur in outer portions of the salt.

Pleistocene and Recent age unconsolidated sediments composed of muds and sands overlie the dome, with an estimated maximum thickness of 1000 feet. Figure B.5-9 is a cross section which depicts the salt stock and shows the relationship of the overlying and deeper adjacent beds to the dome.

Unconsolidated and partially consolidated sands and shales of Pliocene and Miocene age underlie the Pleistocene sediments and extend downward to a depth of approximately -13,500 feet. Thickness of Miocene age formations in the Iberia area is estimated to be between 8500 and 9000 feet with the base of the Miocene probably at about -13,500 feet elevation. These sediments have been forced upward in the immediate vicinity of the dome by the salt piercement structure, as shown on the cross section in Figure B.5-9.

Faulting around the dome within the Miocene and overlying Pliocene is extensive and complex. Figure B.5-10 is a structure map which

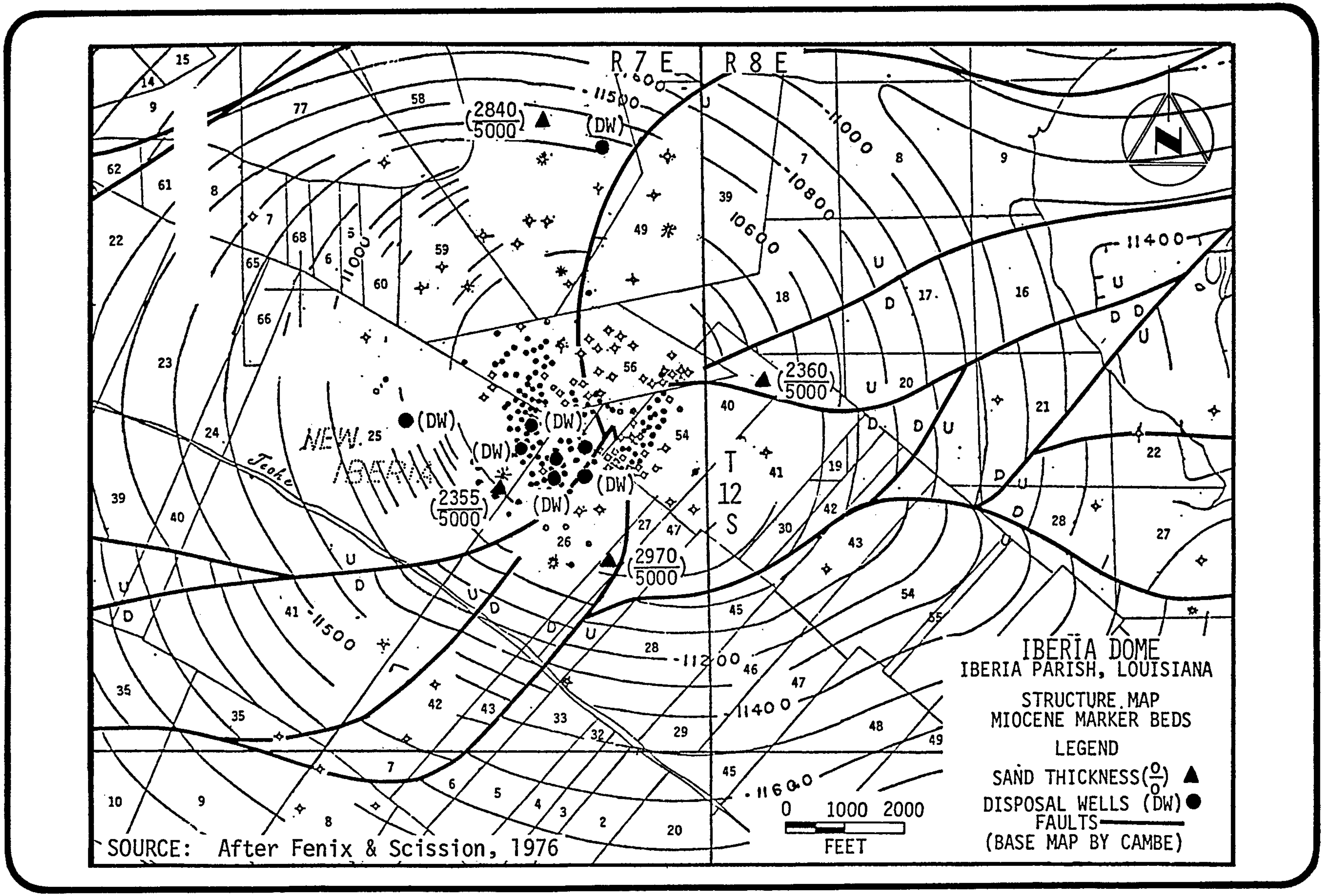


FIGURE B.5-10 Structure map - Miocene marker beds - Iberia dome.

shows general major northeasterly trending faults within the area which are interpreted to divide into several branches. Additionally, a series of radial faults are interpreted on the northeast and southwest sides of the dome.

Composition, extent, thickness, and configuration of Iberia dome caprock are unknown at the present time. It may be assumed that caprock is present and that it has a composition typical of other salt domes in the area: an uppermost layer of calcite ($CaCO_3$), a layer of gypsum ($CaSO_4.2H_2O$), and a bottom zone of anhydrite ($CaSO_4$). However, it is possible that no caprock exists. None is shown on the New Orleans Geological Society structure map (Fenix and Scisson, 1976) of the top of salt (Figure B.5-8) or on the geologic cross section of the dome (Figure B.5-9).

When caprock is present, it is usually intensely fractured and faulted due to upward pressure exerted by the rising salt stock. During periods when the salt is not rising as fast as it is dissolving, caprock may be partially unsupported and fall along new or preexisting fault plans, thus creating the brecciation commonly encountered during drilling.

Caprock faulting and fracturing, aided by the leaching effect of percolating ground waters, results in the formation of vuggy to cavernous porosity and associated high permeabilities. As a result, severe drilling fluid loss is often encountered while drilling in the caprock interval.

B.5.3.1.2 <u>Economic Geology</u>

The dome's first oil production occurred in 1917 from the No. 1 Bolivar well, owned jointly by Gulf Oil and New Iberia Oil Company. Since that time, it appears that production has commenced all around the dome except in the northeast quadrant. The greatest density of drilling, however, is on the south and west flanks.

Although no attempt was made to acquire detailed petroleum production data, interpretation of the salt structure map and geologic cross sections suggests that oil and gas occur on the flanks of the dome in Miocene or earlier sediments that are faulted or pinched out against the sides of the dome.

Louisiana State Department of Conservation records show that oil and gas production occurs in numerous zones ranging from -3608 feet in Texaco's No. 30 Duhe in Section 26 of T-12-S, R-7-E, to -10,452 feet in Petroleum Corporation's No. 1 Rochen in Section 25 of T-12-S, R-7-E.

Some oil and gas production is situated over the top of the dome in the area proposed for the storage facility, but it is not known if these wells are active at this time.

B.5.3.1.3 Local Soils

The Iberia-Baldwin soil association includes level, poorly drained, clayey soils which occur on broad flats east of the natural levee of Bayou Teche (U.S. Department of Agriculture, 1969). Bordering this association are the soils of the Sharkey-Swamp association. These are clayey bottomland soils which occur on low flats subject to flooding. The 2000-foot salt contour lies primarily within the Iberia-Baldwin association.

B.5.3.2 Water Environment

B.5.3.2.1 Surface Water Systems

Figure A.6-1 illustrates several surface water bodies in the vicinity of the Iberia site. Tete Bayou is located approximately 0.2. miles north of the site, and flows generally easterly to Lake Fausse Pointe about five miles further downstream. Bayou Teche is located about 1.5 miles south of the site, and was discussed in Section B.2.2.1 as a regional surface water body.

B.5.3.2.2 Subsurface Water Systems

The Iberia salt dome is located in central Iberia Parish, Louisiana, and has little or no surface expression. The base of the fresh water (less than 1000 mg/l dissolved solids) is about 500 feet below sea level in the vicinity of the dome (Rollo, 1960) and the top of the caprock is at a depth of about 950 feet. The depth to salt is about 1050 feet. The base of the Pleistocene aquifer is at a depth of about 2000 feet in the site vicinity with highly saline water (greater than 10,000 mg/l dissolved solids) occurring below a depth of about 750 feet. This aquifer is known locally as the Chicot and is equivalent to the Plaquemine aquifer to the east.

Aquifers in the vicinity of Iberia dome are capable of delivering large quantities of slightly to moderately saline water to properly completed wells. Aquifer porosities are on the order of 40 percent with permeabilities in the range of 1000 to 2000 gpd per foot. Well yields of 5000 gpm or more may be anticipated.

Ground water use in the vicinity of Iberia Dome is minor, being primarily for domestic consumption. The Chicot aquifer is used extensively for irrigation of rice in Lafayette Parish to the north and for municipal supply to the city of Lafayette.

B.5.3.3 Climatology and Air Quality

In general, the site specific data given in Section B.3.2.3 for Weeks Island are applicable at Iberia. Specifically, at Iberia, coastal effects are less pronounced and existing air quality is expected to be somewhat more polluted than at Weeks Island.

B.5.3.4 Background Ambient Sound Levels

It is important to measure or estimate prefacility ambient sound levels in order to properly assess the potential noise impact due to construction and operation of the SPR project. Although no site-specific ambient sound data were available for the Iberia candidate site, data from ambient sound surveys conducted at the Cote Blanche candidate SPR site FES 76-7) and the Weeks Island candidate site (FES 76-8) were used to estimate baseline sound levels at the Iberia site. Areas around the Iberia site are principally agricultural in nature. Sound levels are dominantly insect and animal noises, wind, and traffic on local roads. Day/night equivalent sound levels in the area are estimated to be 53 dB.

B.5.3.5 Ecosystems and Species

The description of the environmental setting of the Iberia site area is based on regional inventories, known species ranges, literature sources, topographic maps, and aerial photographs. The area is characterized by a lowland physiography with numerous swamps, marshes, lakes, and bays. Though some native vegetation is found to the north and east of the site (Figures B.5-11 and A.6-7), the vegetation in the immediate vicinity (Table B.5-3) has largely been diverted to agricultural production.

The principal type of ecosystem within the vicinity of the dome site is cleared land used for petroleum development and agricultural cultivation of sugar cane, soybeans, peanuts, and grain crops.

The northeastern portion of the site is situated within the bottomland forest and deciduous swamp ecosystems. Overstory vegetation at the site primarily consists of bald cypress and water tupelo (hydrophytic species which characterize the area). In addition to the overstory, components of the supportive vegetation strata include black willow, hackberry, water ash, and pumpkin ash. Some water oak is also found, but is not common. The understory vegetation of the site includes greenbriar, palmetto, blackberry, Virginia creeper, and holly. Overstory regenerates are common in the understory and ground cover. Several roadways crossing the area have roadbanks planted in Bermuda grass, wild rye, and panic grasses.

Wildlife habitat types found at the Iberia site include deciduous swamp and bottomland forest, cleared lands (existing oil field development areas, and agriculture lands), and freshwater wetlands (creeks, bayous, and marshes). Wildlife population and harvest estimates for

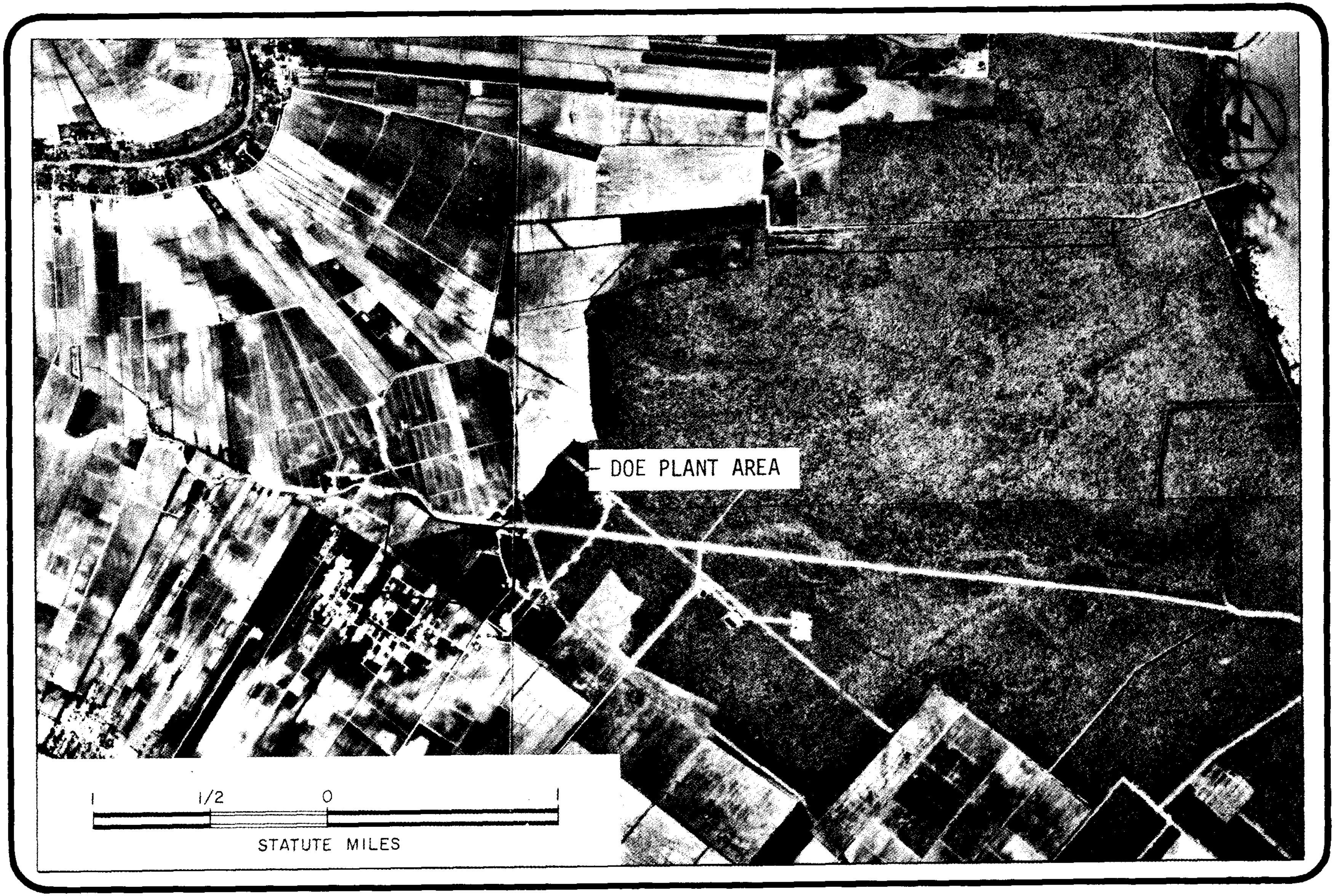


FIGURE B.5-11 Air photo - Iberia plant area.

TABLE B.5-3 Estimated site acreage analysis - Iberia[a].

Total for Fenced Site Area	160 Acres
Total for Storage Site and Pipelines	401 Acres
Total Area to be Developed	290 Acres
Total for Cleared Land [b]	202 Acres
Total for Bottomland Forest	8 Acres
Total for Deciduous Swamp	40 Acres
Total for Marsh	39 Acres
Total for Open Water	1 Acres

SYSTEM	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Proposed Brine Disposal System (wells)	4.4	55.0	36.0
Cleared Land		48.0	31.0
Bottomland Forest		7.0	5.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings 0)		0.0	0.0
Alternate Brine Disposal System (Gulf and wells)	54.1	979.0	126.0
Cleared Land		122.0	77.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		66.0	41.0
Marsh		13.0	8.0
Open Water (total water crossings 8)		778.0	0.0
Proposed Raw Water System (Bayou Teche)	1.5	16.0	11.0
Cleared Land		16.0	11.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings 0)		0.0	0.0
Alternate Raw Water System (Lake Fausse Point)	7.3	72.0	45.0
Cleared Land		69.0	43.0
Bottomland Forest		3.0	2.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings 0)		0.0	0.0

TABLE B.5-3 continued.

SYSTEM	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Alternate Raw Water System (Gulf)	22.1	246.0	124.0
Cleared Land		117.0	74.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		66.0	41.0
Marsh		14.0	9.0
Open Water (total water crossings 8)		49.0	0.0
Alternate Raw Water System (wells)	3.7	10.0	6.0
Cleared Land		9.0	6.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		0.0	0.0
Open Water (total water crossings 1)		1.0	0.0
Proposed Oil Delivery System (Weeks Island)	14.6	170.0	106.0
Cleared Land		90.0	56.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		40.0	25.0
Marsh		39.0	25.0
Open Water (total water crossings 7)		1.0	0.0
Alternate Oil Delivery (Pipeline to St. James)	39.0	448.0	207.0
Cleared Land		68.0	42.0
Bottomland Forest		87.0	54.0
Deciduous Swamp		177.0	111.0
Marsh		0.0	0.0
Open Water (total water crossings 26)		116.0	0.0

[a]Based on features of USGS topographic maps (either 7½ or 15 minute series).

[b]Cleared land includes agricultural, industrial and rural.

various species by region and parish, made available by the Louisiana Wildlife and Fisheries Commission are presented under Sections B.2.5.2.2 and B.2.5.3.1.

The deciduous swamp and bottomland forest ecosystems provide resources for a large number of wildlife species (Tables B.2-15, B.2-17, B.2-18, and B.2-19). Some common bird species of the bottomland forest and swamp include herons, egrets, woodpeckers, wood duck, woodcock, thrushes, vireos, and warblers. Two important recreational species likely to occur onsite are the wood duck and woodcock. Bottomland areas such as those present on the site, provide essential nesting and wintering habitat for both species. The bottomland swamps also provide suitable habitat for the endangered southern bald eagle.

Some common mammals expected to occur in the bottomland forest and swamp include opossum, squirrels, nutria, mink, raccoon, swamp rabbits, furbearers, and deer.

Amphibians and reptiles expected to occur at the Iberia Site are presented in Tables B.2-15 and B.2-17. Bottomland forest and swamp species expected to occur at the site include the western cottonmouth, broad-banded water snake, dwarf and dusky salamanders, and upland chorus frog. The bottomland swamp also provides an important habitat for the alligator (considered an endangered species in this area), as well as several species of commercial importance including snapping turtles and bullfrogs.

The only aquatic habitat in the vicinity of the Iberia dome is Tete Bayou which crosses the northern side of the dome (Figure A.6-7). Drained by Lake Fausse Pointe, Tete Bayou are expected to be similar to other freshwater areas discussed in the regional environmental setting (Section B.2.5).

In addition to the storage facility development at the site, a brine disposal, raw water, and oil delivery system would be designed, each having one or more alternatives (see Section A.6.5.3 and Figure A.6-7. Estimates of acreages of various habitat types to be used for these systems and their alternatives are provided in Table B.5-3. The environmental setting of these systems and alternatives is composed of the same general habitat types discussed with respect to the storage site area on the dome. There are, however, some differences and similarities in the environmental setting of the dome and the environmental setting of particular systems on their alternates which merit discussion.

Most of the land in the vicinity of the proposed brine disposal system is under cultivation (Table B.5-3), and therefore productivity is expected to be quite similar to productivity of the cultivated dome site area. In addition to the discussion of local habitats in the Iberia dome site, the regional description of habitats in Section B.2.5 is applicable to the Gulf of Mexico because the alternative system would be about 52.2 miles long, 32.1 of which would be in the Gulf.

The productivity of the habitats to be crossed by this system is much higher than in the vicinity of the dome since a major part of the 20.1 miles of on-land pipeline would cross productive marsh and swampland areas (Table B.5-3). There would be major water crossings at Bayou Teche (fresh water) and the Intracoastal Waterway (saline water), and 32.1 miles of pipeline would be in the Gulf of Mexico (crossing undisturbed benthic habitat). The aquatic environments of Bayou Teche and the Intracoastal Waterway in the vicinity of the pipeline crossings are probably low in species diversity (especially diversity of pollution-intolerant species) because the Bayou Teche crossing is just downstream of the wastewater discharge from the city of New Iberia, and the Intracoastal Waterway crossing is in an area rendered turbid and disturbed by barge traffic. The smaller creeks and bayous along the Gulf brine disposal route may have a higher species diversity than the major waterways since many of them are not subject to the environmental stresses discussed for the major waterways.

The proposed raw water system, which would be connected to Bayou Teche, about 1.5 miles south of the Iberia storage site, would not involve any highly protective terrestrial habitats since most of the route is through cropland (Table B.5-3). The only aquatic habitat to be entered by the system would be Bayou Teche where the intake structure would be located. As stated before, this area of Bayou Teche is not expected to be high in species diversity since it is just downstream from the wastewater discharge of the city of New Iberia.

The alternative raw water source from Lake Fausse Pointe (about six miles to the east) would use very little productive terrestrial habitat since most of the pipeline route would be though cropland similar to that described for the dome. Aquatic productivity of Lake Fausse Pointe may be expected to be relatively high since large portions of the lake are relatively shallow and there has been very little development around the lake and adjoining swamp. Although there are no data available specifically for Lake Fausse Pointe, its aquatic biota may be characterized by data for Lake Verret. The aquatic biota of the two lakes may be similar since they are both about the same size and are located in the Atchafalaya Basin (Lake Verret is about 20 miles east of Lake Fausse Pointe). A fishery survey of Lake Verret (1973-1975) collected at least 24 species of fish (Table B.5-4), the most abundant being the bluegill sunfish. The most abundant game fish was the largemouth bass, and the most abundant commercial fish were the blue and channel catfish. Total standing crops for the 1973 and 1975 samples were 165.8 pounds per acre and 150.2 pounds per acre, respectively (Mangum, 1977).

The alternate raw water system to the Gulf of Mexico would use the same route as the alternate brine disposal system and therefore, the on-land environmental setting would be the same. Since there is only 2 miles of offshore pipeline involved with this raw water system, there would be no disturbance of the offshore benthic habitats. Other offshore habitats related to the intake structure would be the same as those discussed in the regional setting (Section B.2.5) and for Weeks Island since the same brine disposal pipeline would be used (Section B.4.2.5 and Appendix G). A variation of this raw water system which may also be considered is an intake structure at Weeks Island on the Intracoastal Waterway where water quality (and aquatic productivity) would be lower, and about five miles less pipeline right-of-way through marshland would be required. A well field (along the same route as the proposed oil

TABLE B.5-4 Fish collected from Lake Verret, 1973-1975[a].

Spotted gar	Flier
Gizzard shad	Red ear sunfish
Threadfin shad	Warmouth sunfish
Small mouth buffalo	Spotted sunfish
Big mouth buffalo	Bluegill
Carp	Longear sunfish
Blue catfish	White crappie
Black bullhead	Black crappie
Yellow bullhead	Freshwater drum
Channel catfish	Striped mullet
Mad tom	Miscellaneous minnows

[a]Mangum, 1977

pipeline) is also being considered as an alternative raw water system. This 3.7 mile long system would be limited to cropland habitat similar to that discussed for the dome (Table B.5-3). Aquatic habitat that would be required for this system would involve only one major stream-crossing at Bayou Teche (discussed with respect to the brine disposal system to the Gulf of Mexico).

The proposed (14.6-mile long) oil delivery system to Weeks Island would use cropland habitat for a majority of its length; however, about five miles of the pipeline would be in marshland habitat (Table B.5-3). Aquatic habitat that would be required for this system would involve only one major stream crossing at Bayou Teche (discussed with respect to the brine disposal system to the Gulf of Mexico). The alternative oil delivery system would be a 39-mile long pipeline to the Weeks Island-St. James pipeline near Napoleonville. Nearly all of this pipeline route is characterized by undisturbed bottomland forest and deciduous swamp of the kind discussed for the Bayou Choctaw site (Section B.5.2.5). This highly productive habitat in the heart of the Atchafalaya Basin also includes several major water bodies such as Lake Fausse Pointe, the Atchafalaya River, and Bayou Plaquemine. Many other smaller creeks and bayous would be crossed by this route, all being characterized by freshwater aquatic biota discussed in the regional setting (Section B.2.5).

B.5.3.6 Natural and Scenic Resources

Natural Resources

Iberia dome contains a large amount of natural salt resources which are presently undeveloped. Most of the land overlying the dome is under agricultural production with a few patches of tree-covered land. There is little marshy area or ponded water at the site.

Two-thirds of the dome is covered with agricultural land, as is most of the area to the north, south, and west of the storage site. Sugar cane is a major crop in these areas. The southeast third of the dome is covered with a large wooded area containing mostly small trees with occasional stands of large mature trees. This wooded area continues as forested wetland for many miles to the northeast, east, and southeast, and is part of the large Atchafalaya River Basin. The Atchafalaya Basin contains abundant natural resources associated with the productive marsh habitat and is interspersed with numerous lakes and waterways (U.S. Department of Transportation, 1976).

The agricultural area immediately south of the storage site ultimately gives way to low-lying swamps and marshes of varying vegetation and water depth, which surround Weeks Island located 14 miles southwest of the Iberia dome.

There are several natural water bodies relatively close to the storage site. A meander of Bayou Teche lies approximately 1.5 miles to the south and a similar distance to the north. The smaller, 50-foot wide, Bayou Tete crosses the site from west to east, and connects with Lake Fausse Pointe 4.2 miles east of the dome. Lake Fausse Pointe opens onto the Gulf of Mexico 50 miles south of the confluence of Bayou Tete and Lake Fausse Pointe.

None of the wildlife or recreational areas discussed in Section B.2.6.1 are in the immediate vicinity of the Iberia Storage dome. Lake Fausse Pointe, a natural swamp area, is only 4.2 miles to the east as discussed above. The next closest recreational area is a bass fishing lake, called Spanish Lake, about 10 miles northwest of the site.

Scenic Resources

The agricultural land which surrounds the Iberia dome and stretches to the southeast and northwest produces a flat, relatively monotonous landscape. Depending on the time of year, however, these agricultural areas can provide scenic vistas of broad open spaces.

The scenic value of the storage site is already somewhat lessened by the presence of manmade facilities. Numerous small roads crisscross the dome and a fair amount of oil and gas production has occurred, especially on the south and west flanks of the dome. State Route 182 (formerly U.S. 90) and the paralleling Southern Pacific Railroad line run northeast to southwest of the storage site.

The natural area of trees and wetland which covers the southeast third of the dome is an area of high scenic value. The large areas of forested wetland which continue to the east (forming the Atchafalaya River Basin) are also of high aesthetic value, containing many water bodies and marsh vegetation undisturbed by man. Lake Fausse Pointe, a natural swamp and water body east of the dome, is an area of great natural aesthetic value.

A similar swamp and forested wetland lies south of the cultivated land which surrounds the Iberia dome. This marsh area surrounds Weeks Island, and is of high scenic value.

B.5.3.7 Archaeological, Historical, and Cultural Resources

Iberia Dome

The Iberia dome does not appear to contain any known sites of archaeological or historic significance.

Iberia Parish has five historic sites listed in the National Register: three in New Iberia, one on Jefferson Island, and one two miles west of Jeanerette in Patoutville. All of these are outside of a five mile radius around the dome.

According to the U.S. Army Corps of Engineers' environmental inventory (1973a), 22 sites listed in the Louisiana State Plan are not shown because of perference by state authorities that the general public not know the exact locations of the sites, and 57 sites of archaeological interest are shown. None of the shown archaeological sites are located on the dome. The closest sites are three on the edge of Lake Fausse Pointe near the St. Mary and Iberia Parish border, one of which could be as close as two to three miles from the dome. Other listed sites are all farther away.

B.5.3.8 Socioeconomic Environment

Land Use Patterns and Planning

Iberia dome is located in the south central portion of Louisiana in an area of mixed agricultural and wetland land uses. This coastal and inland marsh region is described in Section B.2.8.2.

The la᷊d area overlying the dome is small, about 160 acres, and is within the -200 foot salt contour. The southeast one -third of the dome is tree-covered and the remaining area is mostly cultivated land. A small bayou, Bayou Tete, crosses the storage site from east to west. Some development due to oil and gas production has occurred on the south and west flanks of the dome.

A large area of land to the east, northeast, and southeast of the storage site is forested wetland. Lake Fausse Pointe is located in this area, 4.2 miles east of the dome. The remaining areas to the north, west, and south of the dome are under agricultural use. The city of New Iberia is located about five miles northwest of the storage site, and Highway 182 passes the site about 1.5 miles to the southwest. A meander of Bayou Tete lies approximately 1.5 miles to the south, and also a similar distance to the north.

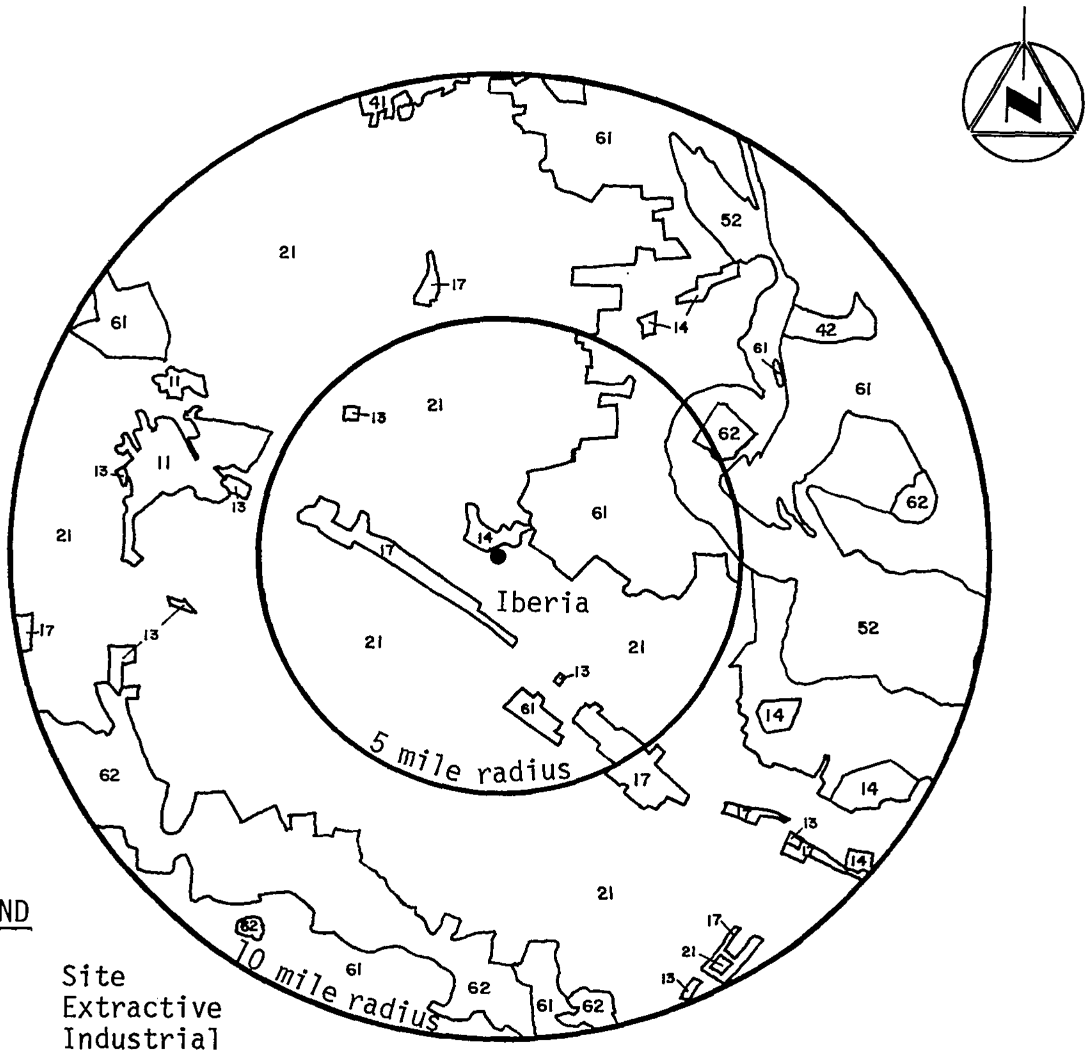
The agricultural area south and southwest of the dome extends for about seven miles. Beyond this is an area of swamp and marsh extending to the Gulf of Mexico. Land uses within a five- and ten-mile radius of storage site are shown in Figure B.5-12.

Transportation Systems

The Iberia dome is 1.5 miles northeast of State Route 182 (formerly U.S. 90) and the paralleling Southern Pacific Railroad line, and is reached by existing roads serving the petroleum activity which skirts the edge of the dome. Agricultural roads cross the storage site, but would provide only limited access. Access from the site II five miles west to New IBeria is by Routes 87 or 182 on either side of Bayou Teche. Access 22 miles northwest to Lafayette is via U.S. 90. The average daily traffic count on Route 87 at Route 86 was 2220 in 1976 (Louisiana Department of Highways, 1977). The regional transportation routes in the area are discussed in Section B.2.8.3.

Population

The population center nearest to th site is the small village of Oliver, located about two miles to the west on Route 87. The residents are employed primarily in agriculture or salt mining (New Iberia Chamber of Commerce, 1977). Two other nearby urban settlements are New Iberia,



LEGEND

●	Site
14	Extractive
13	Industrial
11	Residential
17	Strip and Cluster Settlement
16	Institutional
61	Wetland, Forested
62	Wetland, Non-Forested
21	Cropland and Pasture
41	Forest, Deciduous
42	Forest, Evergreen
43	Forest, Mixed
51, 52	Water

FIGURE B.5-12 Land use within a 5 and 10 mile radius of the Iberia site.

located five miles northwest of the storage site, and Jeanerette, the smaller of the two, which had a population of 6,322 in 1970.

New Iberia is a major urban center and is expected to supply part of the labor force for work at the storage site. Estimates for 1976 put New Iberia's growing population at 31,850, up 5.6 percent from 30,147 in 1970. The city plant to extend its boundaries in the near future (New Iberia Chamber of Commerce, 1977).

Major cities outside Iberia Parish include Lafayette City in Lafayette Parish and Morgan City in St. Mary Parish. These urban centers are within feasible commuting distance of the Iberia dome, and are expected to be major sources of labor for work at the storage site. Their population characteristics are discussed in Section B.2.8.4.

Iberia Parish, in which the storage site is located, grew by 11 percent between 1960 and 1970 despite an out migration of over 10 percent. The majority (63.5 percent) of the population in the parish lives in areas classified as urban by the 1970 census (U.S. Department of Commerce, 1972b). The neighboring Lafayette and St. Mary Parishes both had larger absolute populations in 1970.

Housing

The city of New Iberia is the closest major source of housing. In 1970 the city had a vacancy rate of five percent (FEA, 1976b). At present, New Iberia has a shortage of housing units. Two new apartment complexes are being planned for development in the city, but more are expected to be needed. Single family residential development is also occurring in the city (New Iberia Chamber of Commerce, 1977).

There were 16,595 housing units in Iberia Parish in 1970. The parish had a relatively high vacancy rate of six percent at the time. Some vacancies may be due to sub-standard housing or undesirable rural location. The median value of owner-occupied units in 1970 was $12,000 (FEA, 1976). Similar housing conditions were present in neighboring St. Mary Parish, as discussed in Section B.2.8.5. In nearby Lafayette Parish, there was a much greater number of year-round housing units

(32,057) in 1970, contained mostly in the large urban center, Lafayette City (see Section B.2.8.5).

Economy

In Iberia Parish the major employment sectors are mining, manufacturing, construction, agriculture, and wholesale and retail trade. Mining is of substantial importance in Iberia Parish and in neighboring St. Mary Parish where this activity accounted for approximately 20 percent of each parish's real earnings and approximately 12 to 13 percent of the employment in 1970. These parishes are important centers for salt mining although extraction of other minerals including petroleum, natural gas, and natural gas liquids is also significant.

The economy of the area in the vicinity of the site is greatly influenced by the city of New Iberia, which is a major source of local employment for both blue and white collar workers. Median income in New Iberia was $7,289 in 1970 (U.S. Department of Commerce, 1972b).

New Iberia is the major source of retail stores and services near the Iberia site. Limited services are also available in Jeanerette about six miles southeast of the site.

Government

Police and Fire Protection - Police services for the site would be provided by the Iberia Parish Sheriff's Department, which covers the entire parish and has a force of 100 deputies (full and part time) (Tyler, 1977). Fire services would be provided by the New Iberia Fire Department which has a force of 53 men, five engines on-line and two engines in reserve (Deroven, 1977).

Hospitals and Medical Personnel - Hospitals closest to the site include two in New Iberia: Danterize Hospital with 82 beds and 137 medical personnel, and Iberia Parish Hospital with 94 beds and about 130 medical personnel. Both have emergency departments and operating rooms. Lasalette Memorial Hospital, located in Loreauville 10 miles northeast of New Iberia, has 18 beds and 16 medical personne. In addition, there are five hospitals in Lafayette City: Acadrana Mental

Health Center, 20 beds; Lafayette Charity Hospital, 250 beds; Lafayette General Hospital, 325 beds; Our Lady of Lourdes, 255 beds; and St. Ann Infirmary, 30 beds (Chustz, 1977).

Education - In 1975 the New Iberia School District, the closest district to the site, had 19 elementary schools with a total enrollment of 7,855 plus one junior high school and one senior high school. Enrollment appeared to be steady, with no increasing or decreasing trends. Last year, the district did experience some problems with overcrowded facilities. Three new schools, including one elementary, one high school, and one trade school, have recently been built or are under construction (Herbert, 1977).

Tax Revenues - Severance taxes on resource extraction were by far the largest source of tax revenue within the parish in 1971-72. Income from all property taxes within the county was less than one-third of the severance tax on revenue (University of New Orleans, 1974).

B.6 SITE SPECIFIC ENVIRONMENT - ALTERNATIVE GROUPING NO. 3 - PHASE SITES PLUS CHACAHOULA DOME

B.6.1 Introduction

This section details the existing environment at Chacahoula dome preparatory to development as an SPR site. Existing environments at the remaining sites in the Capline Group are referenced in Sections B.3.1 and B.3.2.

B.6.2 Chacahoula Dome Alternative Site

B.6.2.1 Land Features

B.6.2.1.1 Local Geology

The Chacahoula salt dome is a shallow piercement dome. Structure maps contoured on top of the caprock and salt (Figures B.6-1 and B.6-2) and the accompanying geologic cross sections (Figures B.6-3 and B.6-4) define the top of the caprock and salt mass. The contours are interpreted from data yielded by some 60 drill holes which reportedly penetrated both caprock and salt.

Salt geometry shows a sharp, elliptical piercement structure which has a broad, rounded top, with the long axis about 10 degrees north of east and an axial ratio of nearly 2.5 to 1. Sides of the dome show steeply dipping salt contacts, with the south and west sides dipping about 80 degrees and the north side dipping 70 degrees and 75 degrees. On the east side, some overhang of the salt is indicated below the -8000-foot level (Figures B.6-2 and B.6-3).

The shallowest known salt occurrence is an isolated high point near the center of Section 72 of T-15-S, R-15-E at a depth of -1100 feet. The area enclosed within the -2000-foot contour is approximately two square miles, while the area enclosed by the -3000-foot contour appears to contain a little over three square miles.

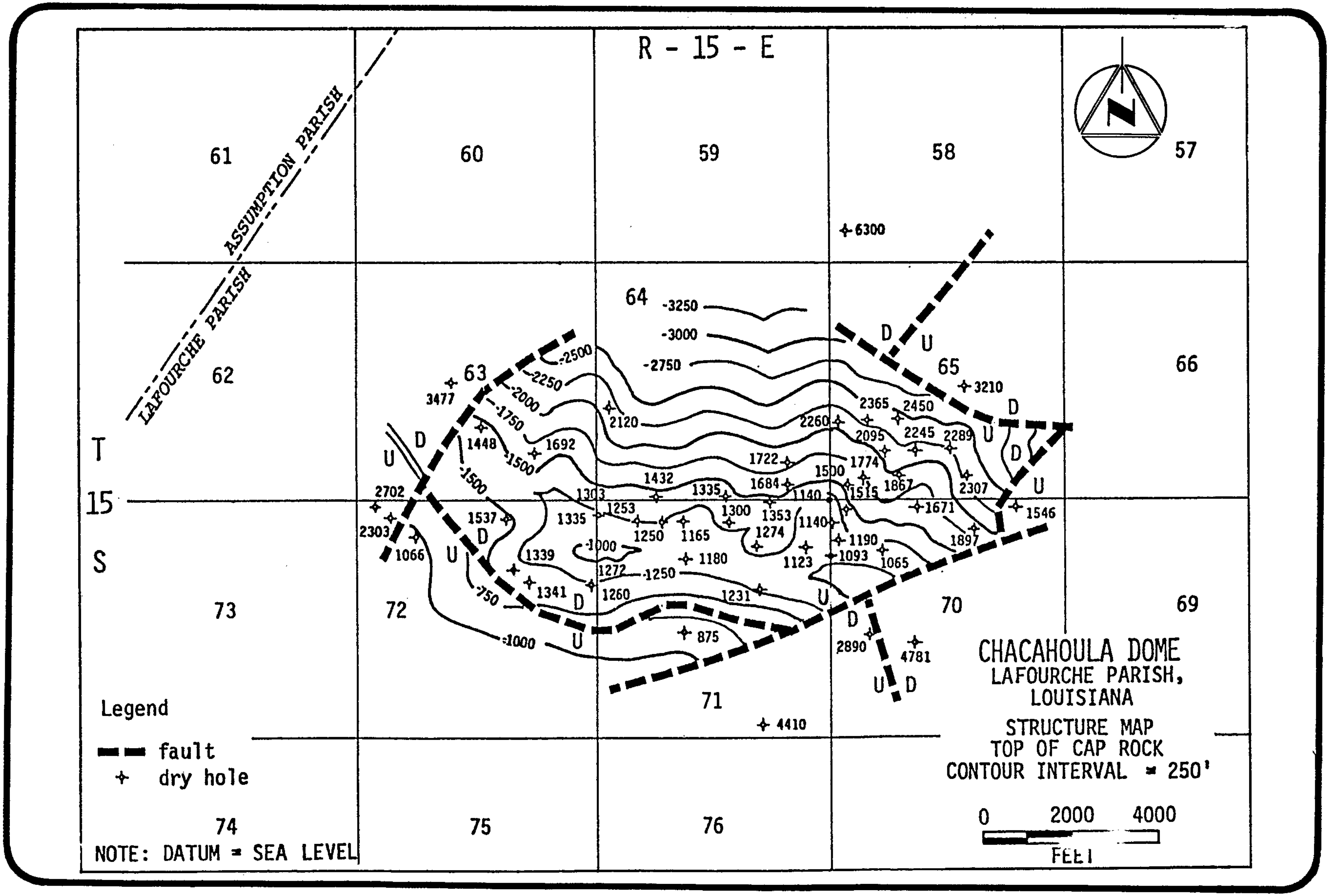


FIGURE B.6-1 Structure map - top of caprock - Chacahoula dome.

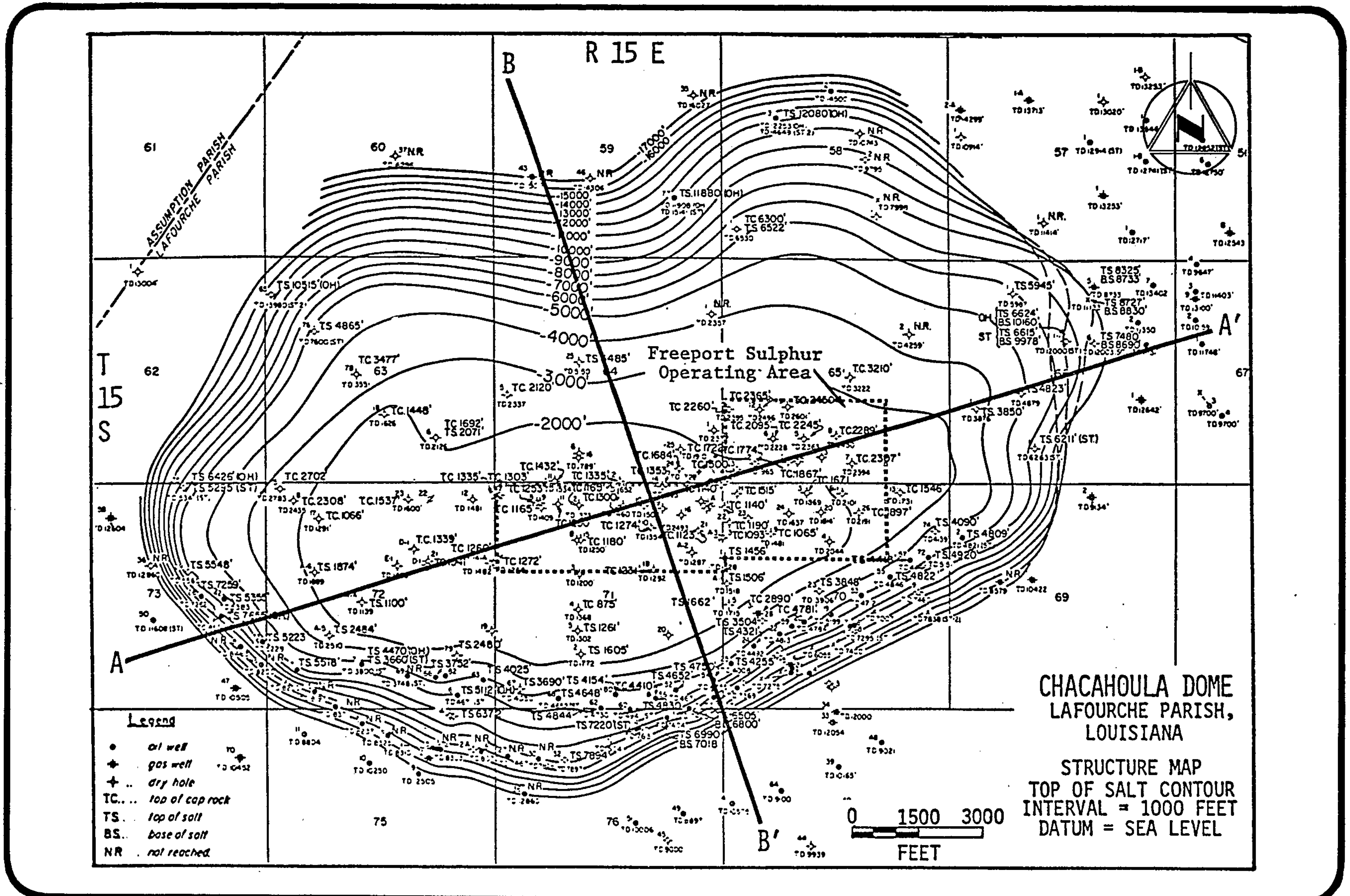


FIGURE B.6-2 Structure map - top of salt- Chacahoula dome.

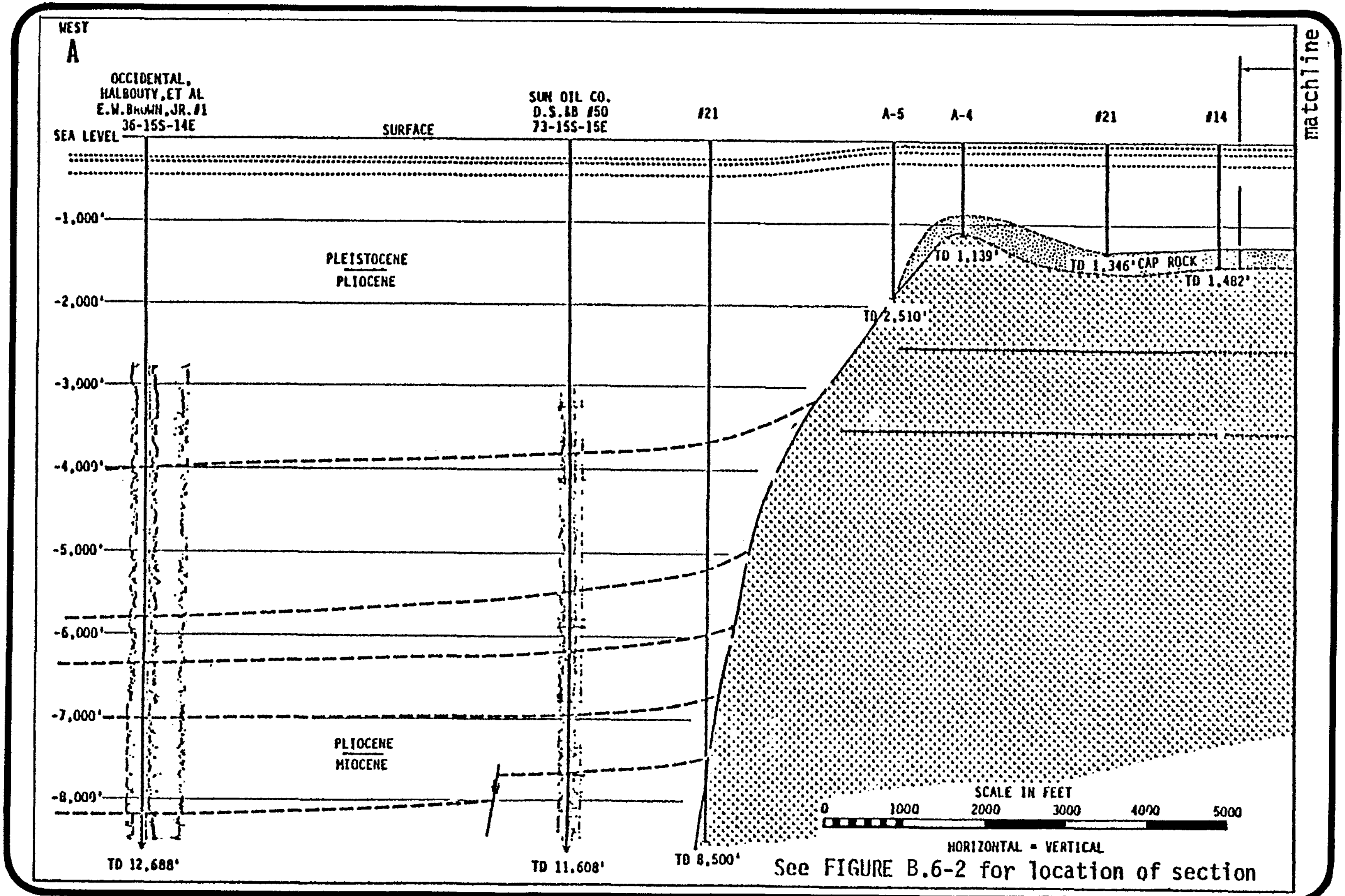


FIGURE B.6-3 Geologic cross section (east/west) Chacahoula dome.

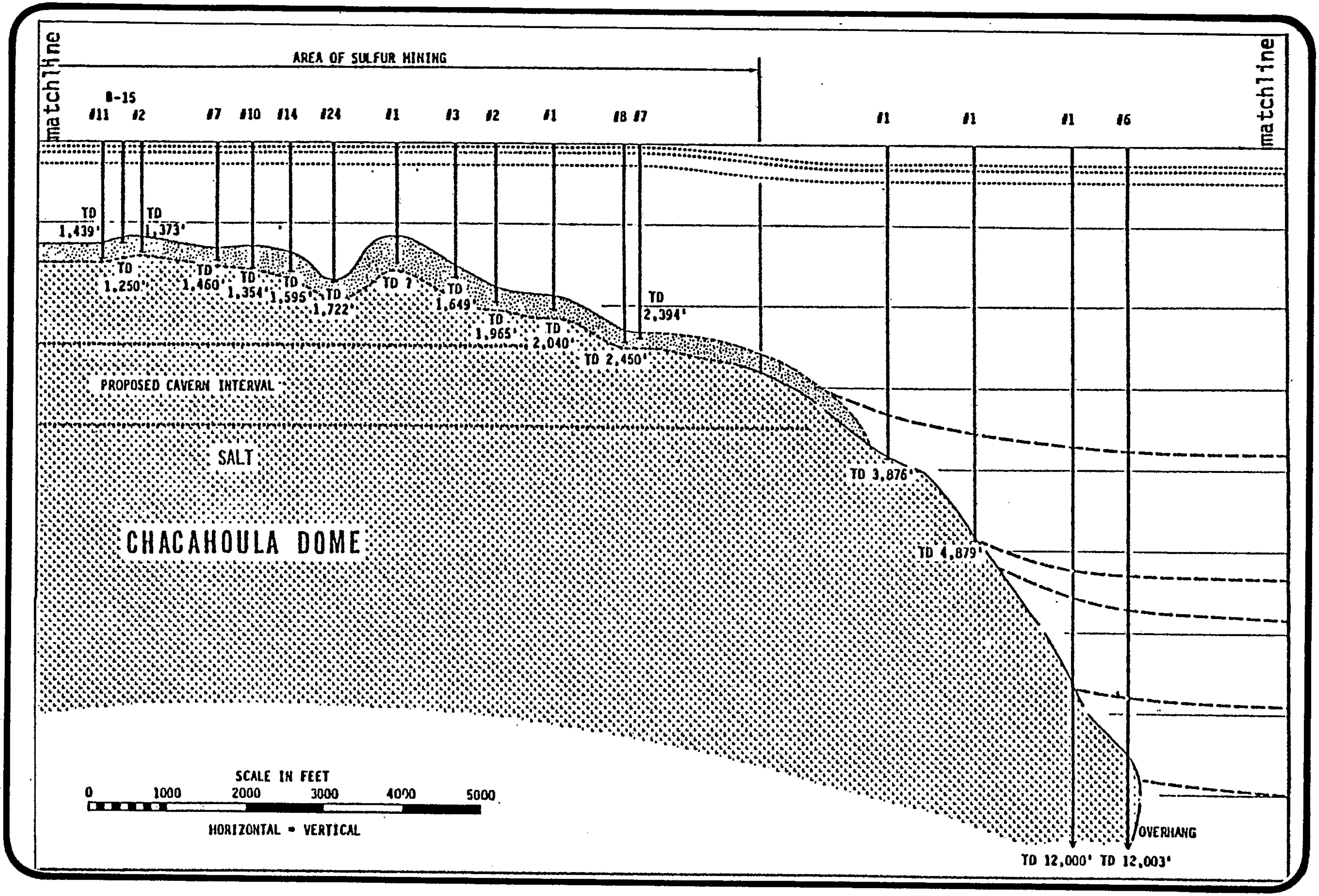


FIGURE B.6-3 continued.

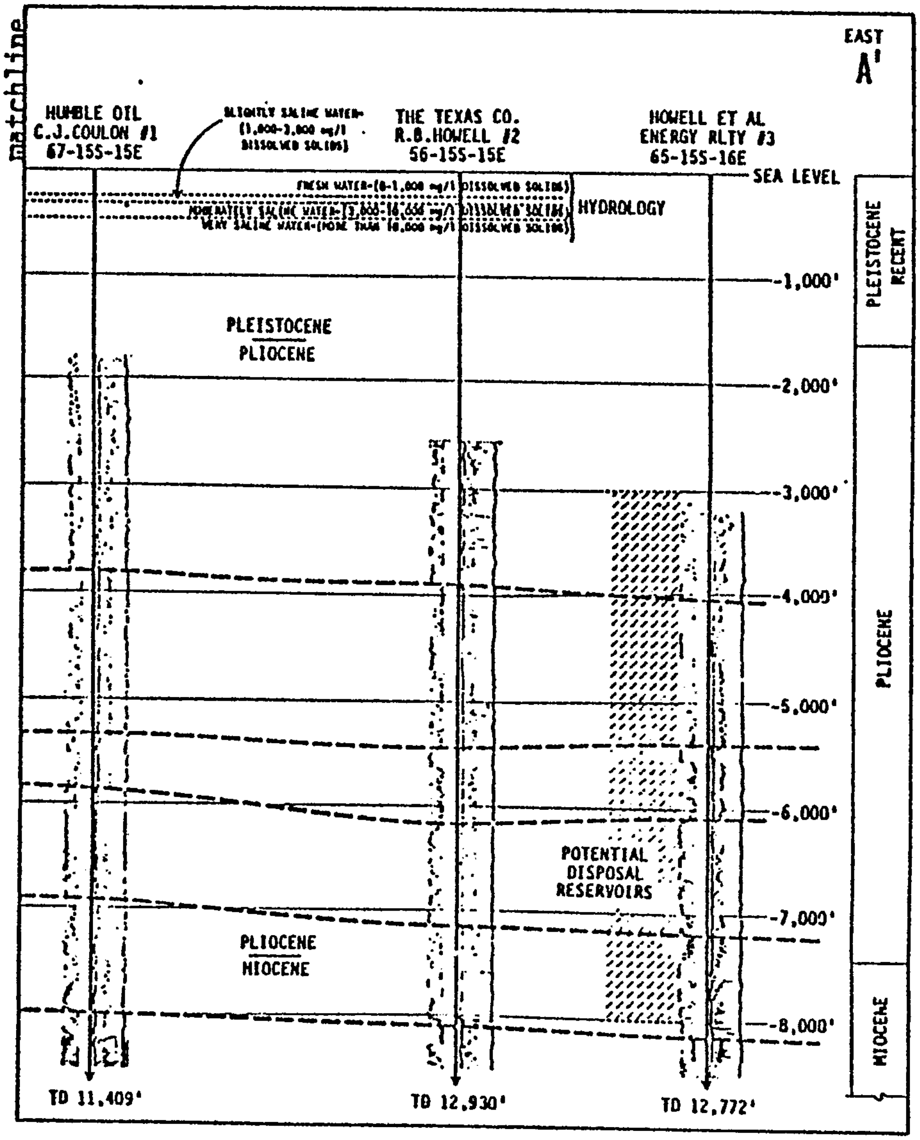


FIGURE B.6-3 continued.

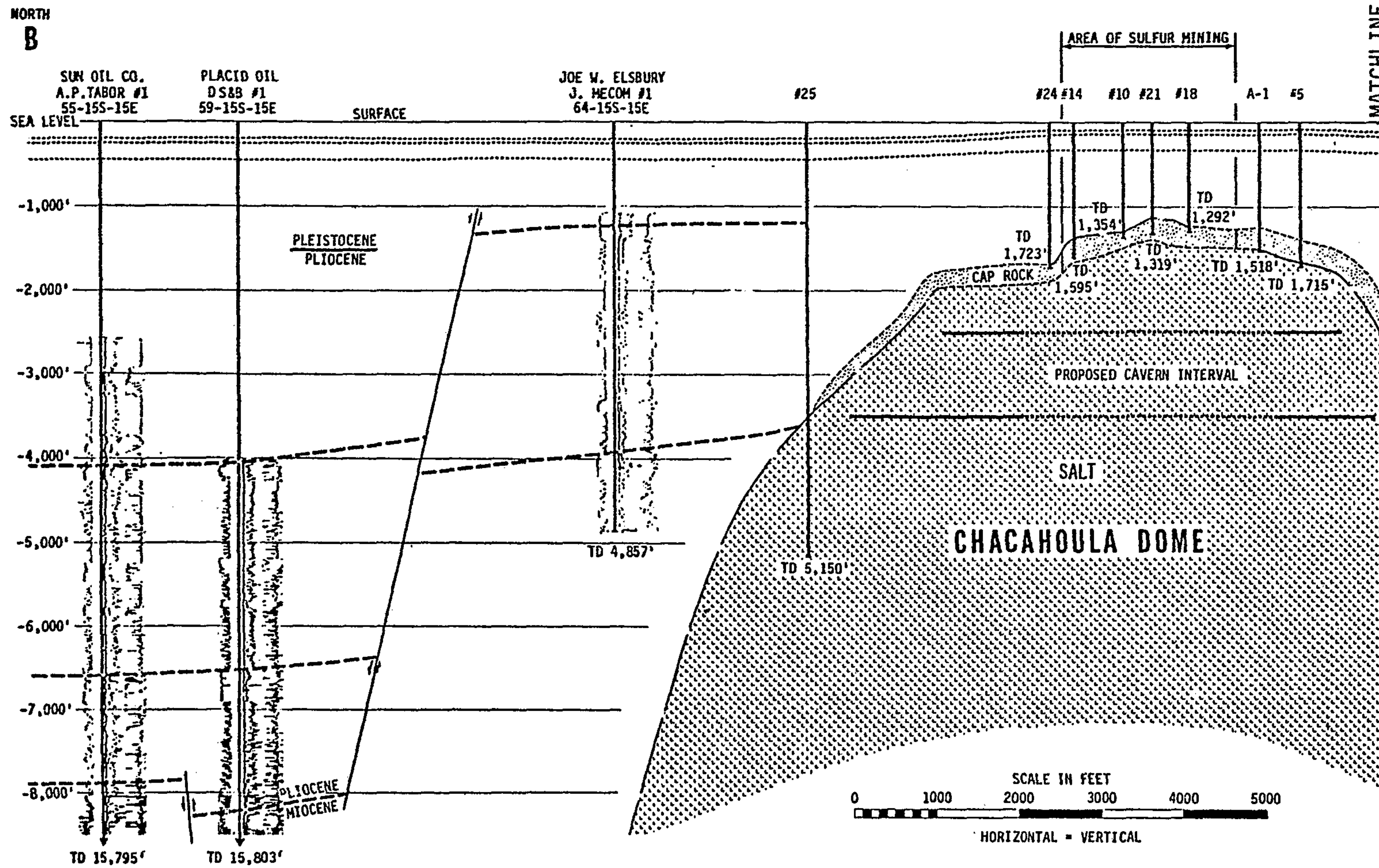


FIGURE B.6-4 Geologic cross section (north/south) Chacahoula dome.

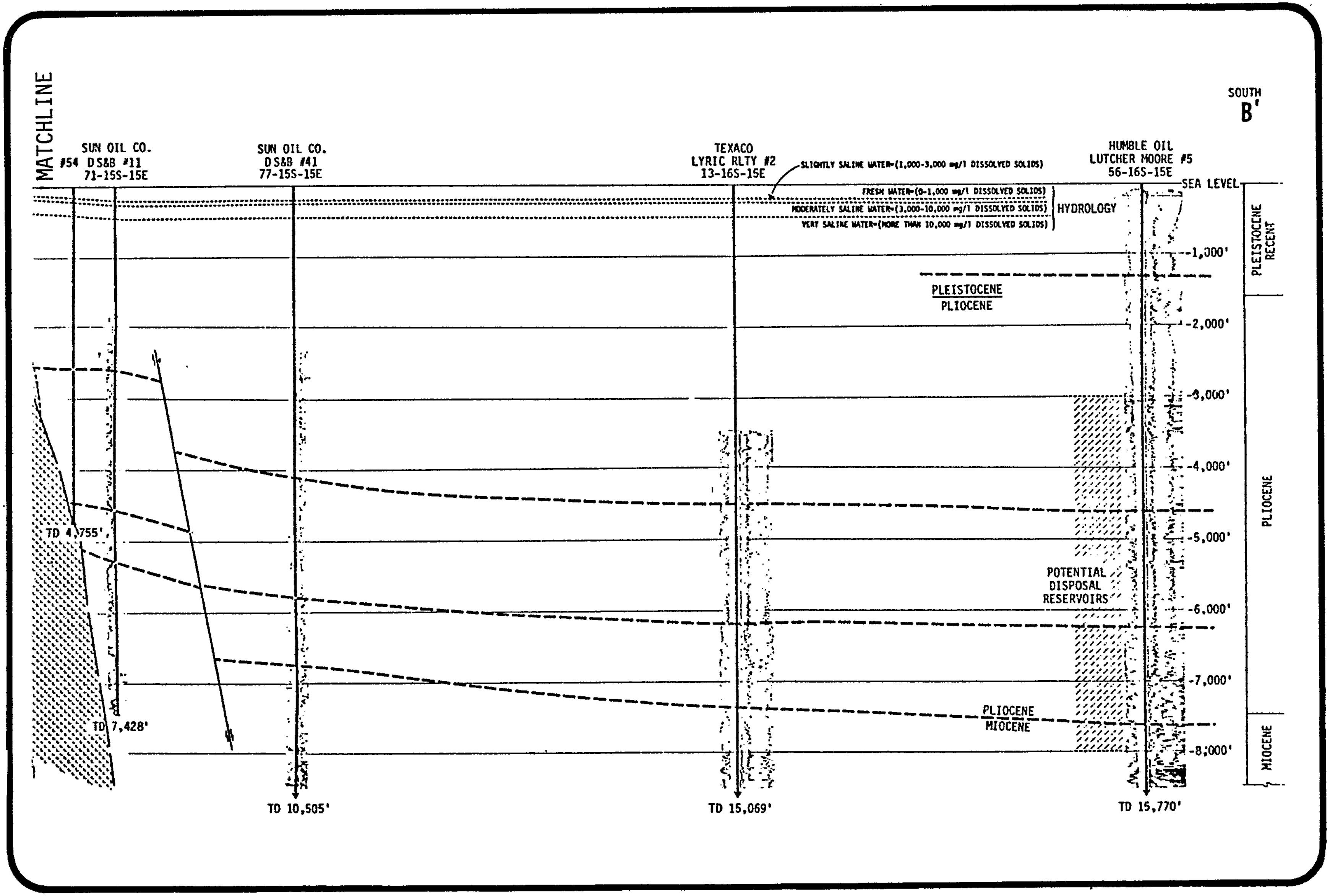


FIGURE B.6-4 continued.

Quality of the salt mass is largely unknown at this tme. However, disseminated anhydrite is probably present in amounts of perhaps three to seven percent. Incorporated portions of sandstone and shale through which the piercement structure has passed occur in outer portions of the salt.

Up to 1500 feet of unconsolidated and partially consolidated muds, sands, and shales of Recent and Pleistocene age overlie the central portion of the dome. Figures B.6-3 and B.6-4 are cross sections which show the relationship of overlying and deeper adjacent beds to the salt mass.

Unconsolidated and partially consolidated sands and shales of Pliocene age underlie the Pleistocene and extend downward to about -7500 feet below sea level. Sand, shale, and limestone formations of the Miocene are found below -7500 feet, probably reaching depths in excess of -20,000 feet. The salt piercement has forced these sediments upward in the immediate vicinity of the dome, as shown in the above mentioned cross sections.

Faulting within the Miocene and overlying Pliocene formations adjacent to the dome is extensive and complex. A structure map constructed on a Miocene marker bed (Figure B.6-5) shows several major northeasterly trending faults which apparently control the northeasterly trend of the longer axis of the dome. Salt emplacement has been affected by these structural weaknesses. In addition, a series of radial faults are believed to exist in sediments around the perimeter of the dome.

Caprock overlying the dome is primarily composed of anhydrite, with gypsum and calcite probably present. Sulfur is a minor constituent of the caprock. Average caprock thickness is reported to be approximately 225 feet, and depth ranges from -875 feet near the center of Section 71 to a maximum recorded depth of -6300 feet in the southwest corner of Section 58.

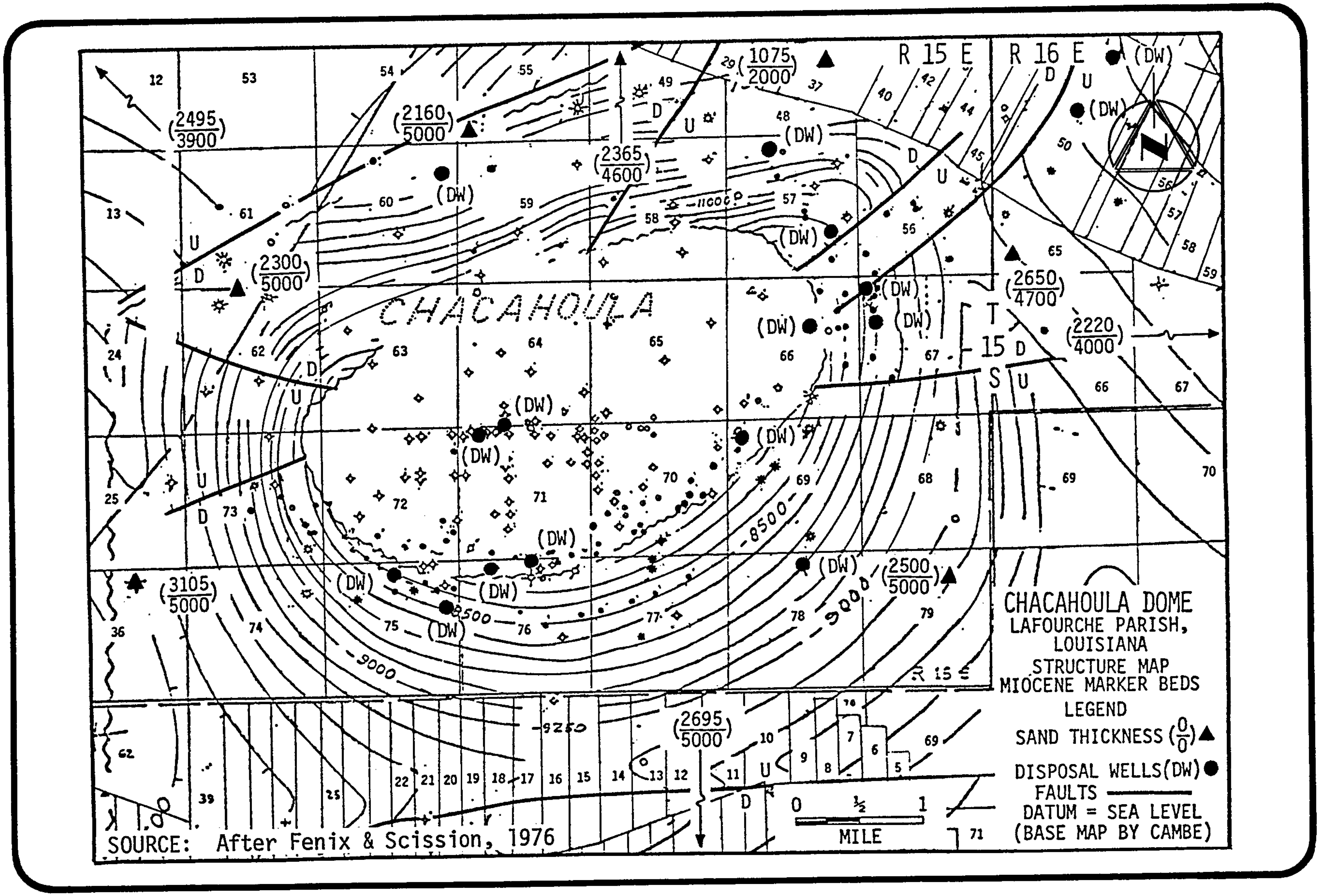


FIGURE B.6-5 Structure map - Miocene marker beds - Chacahoula dome.

The caprock apparently does not cover the entire salt mass, since several drill holes around the periphery of the dome encountered salt without caprock. Geologic sections A-A' and B-B' (Figures B.6-3 and B.6-4) show the lateral extent of the caprock, while Figure B.6-1 shows caprock structure as interpreted from available subsurface data. In other wells, caprock thickness can only be inferred since the entire caprock interval was not penetrated.

Caprock is usually intensely fractured and faulted due to upward pressures exerted by the rising salt stock. During periods when the salt is not rising as fast as it is dissolving, caprock may be partially unsupported and fall downward along new or preexisting fault planes, thus creating the brecciation commonly encountered during drilling. Some of this faulting is depicted by Figure B.6-1, and almost certainly more faulting exists than is indicated by this structural picture.

Caprock faulting and fracturing, aided by the leaching effect of percolating ground waters, results in the formation of vuggy to cavernous porposity and associated high permeabilities. As a result, severe drilling fluid loss is often encountered in drilling the caprock. Moreover, at the Chacahoula dome, sulfur mining operations have extracted at least 1.2 million tons or some 19.6 million cubic feet of sulfur from the caprock.

B.6.2.1.2 Economic Geology

Sun Oil Company recorded the first petroleum discovery on the flanks of the Chacahoula dome in September 1938 at its No. 2 Dilbert, Stark, Brown well. Since that time, Louisiana state production records show that other discoveries have come from Miocene age sands located on and adjacent to the flanks of the piercement structure.

Present oil or gas production occurs all around the dome (Figure B.6-3), with most oil production centered on the south and east flanks, and gas production concentrated mainly on the structure's north and west sides.

Known depths of production zones vary from -8855 feet in the No. 33 Dilbert, Stark, Brown well in Section 77, T-15-S, R-15-E, to -12,636 feet in Grande's No. 1 Energy Realty well in Section 65, T-15-S, R-16-E. No oil or gas production is known to have been found over the top of the dome in the area proposed for the storage facility.

Over 300 sulfur exploratory and production wells were drilled in Chacahoula salt dome caprock by Freeport Sulphur Company, which recovered about 1.2 million tons of sulfur in its seven and one-half years of operation. The area below which sulfur production is reported to have taken place is shown in Figures A.7-3, B.6-3 and B.6-4. Freeport's sulfur production at Chacahoula indicates subsurface removal of approximately 19.62 million cubic feet (3.5 million barrels) of material. The area reportedly mined for sulfur is 24.6 million square feet. Calculations show that a sulfur body having this areal extent would have an average thickness of 0.8 feet and would supply the above mentioned volume of material.

No surface subsidence was reported during sulfur production nor is subsidence apparent on the present surface. Therefore, it is believed that the possibility of severe surface subsidence is minimal.

B.6.2.1.3 Local Soils

The Chacahoula dome in Lafourche Parish, and the adjacent radius of approximately three miles is within backwater swamp area where undrained swamp soils predominate. Adjacent to the dome to the north, the back slope of the natural levee of Bayou Lafourche consists of soils of the Sharkey-Tunica association. Typically, the Sharkey-Tunica soils are poorly drained, level to nearly level, clayey soils that occur in depressions on natural levees and on broad flat plains at the base of natural levees of the Mississippi River and its distributaries. These soils are used for cropland and pasture land.

On the crest of the levee of Bayou Lafourche, the Commerce-Mhoon soil association occurs. It consists of alkaline soils that occur at higher elevations than the Sharkey-Tunica soils. Commerce-Mhoon soils support crops and urban development (U.S. Dept. of Agriculture, 1972).

To the west of the dome, in Assumption Parish, swamp soils predominate (U.S. Dept. of Agriculture, 1970a). In Terrebonne Parish to the south, swamp soils are present except along a tributary to Bayou Lafourche, where Sharkey-Tunica soils occur at the base of the levee, and Commerce-Mhoon soils form the crest of the levee (Lytle and others, 1960).

B.6.2.2 Water Environment

B.6.2.2.1 Surface Water Systems

Figures A.7-1 and A.7-2 illustrate several local surface water bodies in the vicinity of the Chacahoula site. Bubbling Bayou is the most prominent of these, located approximately one-half mile south of the site. Chacahoula Bayou is located approximately three miles to the south, and flows westerly to the Intracoastal Waterway. Numerous other small bayous and canals are located in the general site vicinity, with natural drainage prevailing to the south and west. The brine diffuser pipeline would underlie 23.6 miles of the Gulf of Mexico. This environment is discussed in Section B.2.2.1.2. A detailed study of the hydrography and chemistry of the waters in the immediate region of the brine diffuser is presented in Appendix G.

B.6.2.2.2 Subsurface Water Systems

The Chacahoula salt dome is located in northwestern Lafourche Parish, Louisiana, and penetrates the Plaquemine aquifer. The base of the Plaquemine aquifer is at a depth of about 1400 feet in the site vicinity with highly saline water (greater than 10,000 mg/l dissolved solids) occurring below a depth of about 450 feet. The depth to salt is about 1100 feet and the top of the caprock is at a depth of about 875 feet at its highest point. The base of the fresh water (less than 1000 mg/l dissolved solids) is about 250 feet below sea level in the vicinity of the dome (Rollo, 1960).

B.6.2.3 Climatology and Air Quality

Generally, the site-specific data given in Section B.3.3.3 for Napoleonville are applicable at Chacahoula. Specifically, at Chacahoula, coastal effects are expected to be slightly more pronounced and existing air quality somewhat less polluted than at Napoleonville.

B.6.2.4 Background Ambient Sound Levels

It is important to estimate prefacility ambient sound levels in order to properly assess the potential noise impact due to construction and operation of the SPR project. Data from ambient sound surveys conducted at the Cote Blanche candidate SPR site (FES 76-6) and the Weeks Island candidate SPR site (FES 76-8) were used to estimate baseline sound levels at the Chacahoula site because no site-specific ambient sound data were available for the Chacahoula site. Areas around the Chacahoula site have similar land uses to the Napoleonville SPR site, such as marshland and low density population areas. Ambient sound levels at the Chacahoula site are dominated by industrial activities, while ambient sound in neighboring areas is dominated by insect and animal noises, wind, and traffic on local roads. Day/night equivalent sound levels at the center of the site, at noise-sensitive land use areas (small communities), and at undeveloped areas are estimated at 74 dB, 56 dB, and 53 dB, respectively.

B.6.2.5 Ecosystems and Species

The description of the environmental setting of the Chacahoula site area is based on regional inventories, known species ranges, literature sources, topographic maps, aerial photographs, and a field inspection of the site. The 1653-acre storage site (Table B.6-1) is dominated by deciduous swamp and marsh, though there are some developed areas in the central part of the site (Figures B.6-6 and A.7-2). The vegetation of the site area is largely determined by precipitation, relief, soil type, salinity, and temperature. Many swamps, marshes, lakes, and bays characterize the lowland coastal plain physiography of the region.

The Chacahoula storage site is within the deciduous swamp ecosystem. Overstory vegetation at the site is primarily bald cypress and water

TABLE B.6-1 Estimated site acreage analysis - Chacahoula[a].

Total for Fenced Site Area	450 acres
Total for Storage Site and Pipelines	1653 acres
(Area to be Developed)	1394 acres
Total for Cleared Land[b]	100 acres
Total for Bottomland Forest	0 acres
Total for Deciduous Swamp	422 acres
Total for Marsh	298 acres
Total for Open Water	574 acres

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Proposed Brine Disposal System (Gulf and Wells)	65.9	969.0	248.0
Cleared Land		6.0	4.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		93.0	58.0
Marsh		298.0	186.0
Open Water (total water crossings - 26)		572.0	0.0
Alternate Brine Disposal System (wells)	18.1	222.0	140.0
Cleared Land		0.0	0.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		221.0	140.0
Marsh		0.0	0.0
Open Water (total water crossings - 4)		1.0	0.0
Alternate Brine Disposal System (Alt. Diffuser Location)	62.7	933.0	245.0
Cleared Land		6.0	4.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		88.0	55.0
Marsh		298.0	186.0
Open Water (total water crossings - 26)		541.0	0.0
Proposed Raw Water System (Bayou Lafourche)	6.5	20.0	12.0
Cleared Land		9.0	6.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		10.0	6.0
Marsh		0.0	0.0
Open Water (total water crossings - 3)		1.0	0.0
Alternate Raw Water System (wells)	10.2	88.0	46.0
Cleared Land		53.0	29.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		34.0	17.0
Marsh		0.0	0.0
Open Water (total water crossings - 2)		1.0	0.0

TABLE B.6-1 continued.

System	Total Miles of Pipeline	Acreage for Construction	Acreage for Operation
Alternate Raw Water System (Mississippi River)	21.9	55.0	34.0
Cleared Land		22.0	14.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		32.0	20.0
Marsh		0.0	0.0
Open Water (total water crossings - 10)		1.0	0.0
Alternate Raw Water System (Gulf)	42.4	148.0	62.0
Cleared Land		2.0	1.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		22.0	14.0
Marsh		75.0	47.0
Open Water (total water crossings - 26)		49.0	0.0
Proposed Oil Delivery System (to St. James)	21.9	214.0	134.0
Cleared Land		85.0	54.0
Bottomland Forest		0.0	0.0
Deciduous Swamp		128.0	80.0
Marsh		0.0	0.0
Open Water (total water crossings - 10)		1.0	0.0

[a]Based on features of USGS topographic maps (15 minute series).

[b]Cleared land includes agricultural, industrial and rural.

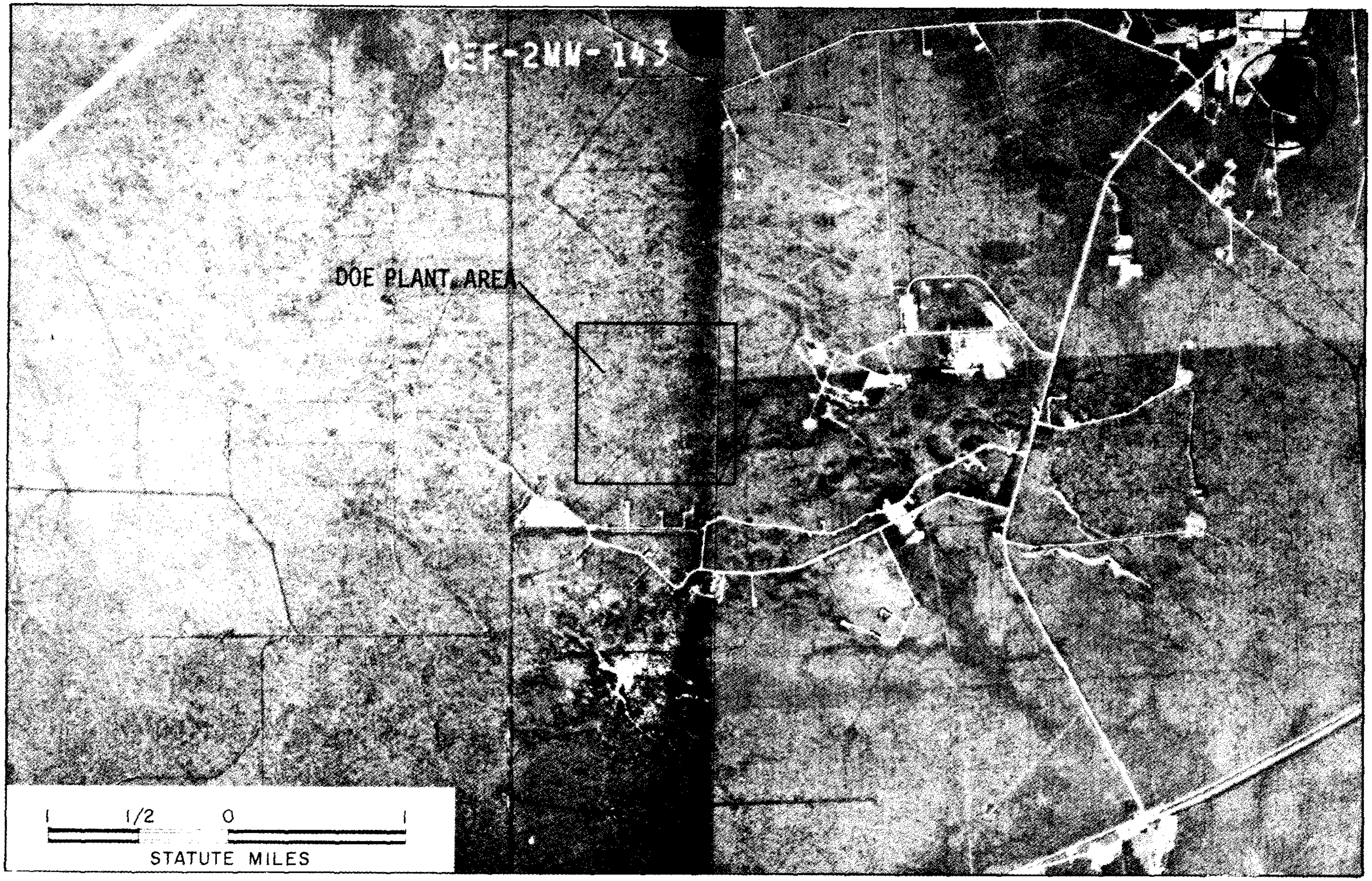


FIGURE B.6-6 Air photo - Chacahoula plant area tupelo (both hydrophytic species characteristic of the area). In addition to the dominant overstory, components of the subdominant overstory include black willow, water ash, and pumpkin ash. Some water oak is also found but is not in abundance.

Understory vegetation of the site includes, but is not limited to, greenbriar, palmetto, blackberry, trumpet vine, Virginia creeper, holly, and grape. In addition, regenerates of the overstory vegetation are found within the understory and ground cover strata. Several roadways crossing the area have road banks planted in Bermuda grass, wild rye, and panic grasses.

Wildlife habitat types found at the Chacahoula site include deciduous swamp, cleared lands (existing oil field development), and freshwater wetlands (creeks, drainage canals, and swamps). Wildlife population and harvest estimates for various species by region and parish, made available by the Louisiana Wildlife and Fisheries Commission, are presented under Sections B.2.5.2.2 and B.2.5.3.1.

The essentially undeveloped deciduous swamp and is by far the most significant and characteristic habitat type (in terms of surface acreage) found at the site. This habitat type provides resources for a large number of wildlife species (Tables B.2-15, B.2-17, B.2-18, and B.2-19). Some common bird species of the swamp include herons, egrets, woodpeckers, wood duck, woodcock, thrushes, vireos, and warblers. Two important recreational species likely to occur on-site are the wood duck and woodcock. Swampland areas such as those present on the site provide essential nesting and wintering habitat for both species. The deciduous swamps also provide suitable habitat for the endangered southern bald eagle.

Some common mammals expected to occur in the deciduous swamp include opossum, squirrels, nutria, mink, raccoon, swamp rabbit, bobcat, and white-tailed deer. Important commercial or recreational inhabitants include squirrels, rabbits, furbearers, and deer.

Amphibians and reptiles expected to occur at the Chacahoula site are presented in Tables B.2-15 and B.2-17. Some common swampland inhabitants include the western cottonmouth, yellow-bellied water snake, broad-headed skink, dwarf and dusky salamander, cricket frog, and green treefrog. The swamp also provides important habitat for the alligator, which is considered an endangered species in the Chacahoula area. Commercially important herpetofauna species which are expected to occur in the swamp include the common snapping turtle, alligator snapping turtle, and bullfrog.

Cleared lands provide limited habitat for wildlife. Cleared lands at the site include wellheads and pads, and existing site facilities (buildings, etc.). Most wildlife species found in these areas are those that have adapted to man and can survive in significantly disturbed habitats. Some of these species are presented in Table B.2-15 under the cleared land category.

The freshwater wetlands found at the Chacahoula site include small creeks, drainage canals, and swamps. Wildlife species expected to occur in these habitats are presented in Tables B.2-15, B.2-17, B.2-18, and B.2-19. Commercially and recreationally important species present include watefowl, furbearers, and turtles and frogs.

Contributing to the aquatic environment at the Chacahoula dome, there is a vast swamp area with an interconnecting canal-bayou-lake complex. Bubbling Bayou, which flows through the center of the dome (Figure A.7-2) drains most of the dome area. Although natural drainage appears to be westerly to Black Bayou via Donner Canal, Bubbling Bayou has been observed flowing east at Route 309.

The most apparent constituent of the swamp complex at the Chacahoula dome is the aquatic macrophyte community. Plants which often dominate the freshwater swamps in southern Louisiana include bulltongue, maidencane, and spikerushes (accounting for 66 percent of swamp vegetation). Giant cutgrass, elephant's ear, various pond weeds, and black willow also dominate the marsh/creek interface along Bubbling Bayou in many places. A blanket of duckweed covers much of the water surface on the site during warm parts of the year.

Freshwater swamps are most diverse habitats (Chabreck, 1970), and are among the most productive natural ecosystems in the world, with mean net productivity of organic materials as high as 2000 grams dry weight per square meter per year (Whittaker, 1972). Since the Chacahoula dome is in a temperate, nutrient enriched area, this level of production should be indicative of specific production in the vicinity of the proposed facility.

Emergent swamp vegetation serves as the most important producer in the organic detritus cycle. More plant biomass is produced than is consumed by herbivores, and as this material dies and decomposes, it

Emergent swamp vegetation serves as the most important producer in the organic detritus cycle. More plant biomass is produced than is consumed by the herbivores, and as this material dies and decomposes, it furnishes food for a wide variety of detritus-feeding organisms. In freshwater swamps, this organic matter is incorporated into the soil, and is developed into peat consisting of approximately 80 percent organic matter.

Several groups of organisms feed directly on the aquatic macrophytes or on the detritus which macrophytes produce upon decay. The diet of nutria, common animals in the swamp-bayou complex around the Chacahoula dome, consists almost entirely of macrophytes. Crayfish and some other aquatic invertebrates also feed heavily on detritus.

The majority of phytoplankton likely to be encountered in the standing waters around the site include green algae, blue-green algae, and diatoms (Chabreck, 1970), which are usually the most abundant in the spring. Copepods are likely to be the most abundant zooplankter; however, cladocerans, rotifers, and ostracods may also be abundant (U.S. Army Corps of Engineers, 1975b).

Benthic macroinvertebrate and fishery data specific to the site are not available. However, the characteristics of these communities are probably not much different from those discussed for the regional environmental setting. In addition to the development of the site, a brine disposal, raw water, and oil delivery system would be designed, each having one or more alternatives (except for the oil delivery system) (see Section A.7.5.3 and Figure A.7-2). Estimates of acreages of various habitat types to be used for these systems and their alternatives are provided in

Table B.6-1. The environmental setting of these systems and alternatives is composed of the same general habitat types discussed with respect to the Chacahoula dome site area. There are, however, some differences and similarities in the environmental setting of the dome and the environmental setting of particular systems or their alternates.

The environmental setting of the proposed brine disposal system to the Gulf of Mexico encompasses an area about 64 miles long, including a 23.6-mile section in the Gulf. This area is characterized by the same ecosystems as discussed in the regional setting of the Capline Group (Section B.2.5). A major portion of the brine disposal route would be through relatively undisturbed swamps and marshlands, and would require crossing many streams. The pipeline would cross near areas which are considered to be seed oyster reservations. Nearby seed oyster reservations are located at Caillou Bay and Lake Mechant (Louisiana State Planning Office, 1977). The pipeline would also cross Bayou Penchant, which is one of the few streams in the region to be evaluated as good for fishing (U.S. Army Corps of Engineers, 1973a). The nearshore Gulf supports a large diversity of diatom and dinoflagellate phytoplankton, zooplankton (mainly copepods), benthic organisms (mainly polychaete worms) and nekton (white shrimp, brief squid, bay anchovy, Atlantic croaker). A detailed study of the biology of the brine diffuser site is presented in Appendix G.

The alternative brine disposal system to an injection well field would not require extensive habitat modification since most of the system would be on cropland (Table B.6-1). The only sensitive (relatively undisturbed) terrestrial habitat involved would be along the 3.6-mile long right-of-way from the dome to the well field. This system would not require any major waterway crossings; therefore, the only aquatic habitat to be crossed by this system would be swamps areas and creeks between the dome and the injection well field. These areas are characterized by flora and fauna discussed for the environmental setting of the dome storage site. The alternate brine diffuser site would be located in the Gulf of Mexico 14 miles south of Caillou Bay in 23 feet of water.

The proposed oil delivery system to St. James (21 miles long) is dominated by deciduous swamp and bottomland forest habitat similar to that discussed for the dome, which covers about 60 percent of the right-of-way. The other major terrestrial habitat type associated with this oil delivery system is cropland (Table B.6-1). The major waterway crossings would include Bayou Lafourche, Baker Canal East, Bayou Verret, and St. James Canal. The aquatic communities of these bayous and canals are probably not much different from those discussed for the regional environmental setting in Section B.2.5. Fish populations may be expected to be similar to those of Grand Bayou (Section B.3.3.5).

The proposed raw water supply system to Bayou Lafourche 6.5 miles long) would follow the same route as the proposed oil delivery system, with about half of the water supply route in deciduous swamp habitat (similar to those discussed for the dome), and half in cropland (Table B.6-1). The major waterway associated with this sytem is Bayou Lafourche, where the intake structure would be located. The aquatic community of Bayou Lafourche is probably similar to that discussed for the regional setting in Section B.2.5. The fish populations are probably similar to those in Grand Bayou, as discussed in Section B.3.3.5.

The alternative raw water system to the well field would involve the same habitats (Table B.6-1) as the proposed oil delivery system, but with only one major waterway crossing at Bayou Lafourche since the system would be only 10.2 miles long. The alternate raw water system to the Gulf of Mexico would follow the same route as the proposed brine disposal system; however, it would only include 2 miles offshore. The habitats involved in the vicinity of this alternate system are discussed in Sections B.2.5 and B.3.3.5 with respect to the proposed brine disposal system and the regional environmental setting.

B.6.2.6 Natural and Scenic Resources

The storage site is located in a freshwater swamp forest typical of the region. The area is natural, quiet, and relatively high in aesthetic value. Present development of the site is limited to structures southeast of the site and scattered wellheads which cover only five percent of the land. Aesthetic quality of the center of the site is very high. Access roads in the area are not well travelled and the number of potential viewers of activities on the site is small. The site is currently being used unofficially for recreational purposes.

The area surrounding the site is currently in use for several kinds of recreation, including hunting and fish. About 8000 hunting licenses are sold in each of the two parishes bordering the Gulf of Mexico, Lafourche Parish and Terrebonne Parish. This amounts to about one license for every eight people in Lafourche Parish and just slightly less than that, one license per 10 people in Terrebonne Parish. In Assumption and St. James Parishes, the number of hunting licenses sold is much smaller, although the ratio of license holders to total population remains fairly high. A separate license is required for big game hunting. Between 700 and 800 of these licenses have been issued in each of Lafourche and Terrebonne Parishes. Sportfishing occurs on the numerous lakes, bayous, bays, and Gulf which are along the brine disposal pipeline right-of-way.

The recreation and wildlife resources of the new area are both numerous and vast (see Section B.2.6). Between St. James, Chacahoula, the Atchafalaya River, and Caillou Bay, only a few designated or developed historical, recreational, or natural resource areas exist. Those that are of concern due to their proximity to potential pipeline rights-of-way or other impact areas are the Edward Douglas White State Park northwest of Thibodaux in Lafourche Parish, the Bayou Penchant Scenic Waterway in Terrebonne Parish, and an untitled proposed park or wildlife area in the Isles Derneires in southernmost Terrebonne Parish. None of the above listed sites or areas are in the area of the salt dome; however, Bayou Penchant in Terrebonne Parish is in the pathway of the proposed pipeline right-of-way for deep water disposal of the salt brine (FEA, 1977).

B.6.2.7 Archaeological, Historical, and Cultural Resources

The Chacahoula dome does not appear to contain any known sites of archaeological or historic significance.

Lafourche Parish has one historic site listed in the National Register (U.S. Department of the Interior, 1977), the Edward Douglas White house in the Thibodaux vicinity. Terrebonne Parish, which borders the southern edge of the Chacahoula dome area, also has only one historic site listed. That site is in the Houma vicinity.

According to the U.S. Army Corps of Engineers' environmental inventory (1973a), 19 sites in Lafourche Parish and 10 sites in Terrebonne Parish are not shown because of preference by state authorities that the general public not know the exact locations of the sites. In Terrebonne Parish, no archaeological sites are shown to be near the Chacahoula dome. In Lafourche Parish, 48 archaeological sites are listed, including the Leighton Plantation House outside of a five-mile radius from the dome, and a site that is just west of the dome adjacent to the Assumption Parish border and straddling the Lafourche-Terrebonne Parish border. Although this site does not appear to be on the Chacahoula dome, the exact location of the site is not clear from the inventory. Other listed sites are all farther away than five miles.

B.6.2.8 Socioeconomic Environment

History

Since its discovery in 1926 by the Gulf Oil Corporation, the Chacahoula salt dome oil and gas fields have been in continuous production. For seven years sulfur was extracted and the sulfur works are still visible. Oil and gas bearing strata were discovered in 1930 by the Sun Oil Company, and oil or gas production has continued all around the dome since its discovery. Sulfur production ended in 1962.

The communities which would be affected by the project are basically of two cultural types. One is representative of a way of life that has existed in the area for decades and is based on agriculture and commerce. These are the towns where families that have been established for generations own substantial portions of the land, and exert a conservative influence on community growth and civic affairs. The majority of the citizens are of French heritage. Their ethnic consciousness combined with the stability and small size of the communities tends to accentuate the cultural differences between those who have been raised there and those who have recently moved into the community. This pattern can be found to some extent in many small towns and neighborhood throughout southern Louisiana. Thibodaux, Napoleonville, and many of the villages close to the project area are representative of this cultural pattern.

The other type of community is one which previously may have been like those just described, but which has grown rapidly since about 1950.

This sudden expansion has been largely due to the development of the oil and gas industry. A relatively higher proportion of the population has migrated into the town from other states, and the people are generally more inclined to move in and out of different neighborhoods. This has resulted in a declining ethnic awareness and a greater acceptance of further growth with its concomittant changes in the appearance of the town itself and in the characteristics of social life and civic affairs. Within the area which would be affected by the proposed project, Morgan City is this type of community, and to a lesser extent, Houma.

Land Use

The Chacahoula salt dome is entirely within the fresh backwater swamp to the west and southwest of the natural levee of Bayou Lafourche. Other than the uses of the sulfur and oil and gas industries, the swamp is undisturbed at the storage site. Drainage of the swamp and clearing of the forest has not occurred except where roadway and pipeline rights-of-way or canals have been necessary. The land remains a deciduous swamp forest. Logging may periodically occur where mature stands exist, but accurate information on this use is not readily available. It appears that logging of the area has not occurred recently. Most of the oil producing wells are located on the south and east flanks of the dome, and most of the gas producing wells are on the north and west flanks of the dome. Associated with these wells are a number of access roads.

Three to five miles to the west, northeast, and north, agricultural development of the natural levees has been continuous for the last 100 years. The primary crop on these natural levees is sugar cane, though in some areas cotton, soybeans, and truck crops are planted. Where the proposed pipeline would cross the natural levees of Bayou Lafourche, the belt of agricultural development is five to six miles wide. Between the natural levee of Bayou Lafourche and the oil terminal at St. James on the natural levee of the Mississippi, lies an eight-mile stretch of swamp forest similar to that overlying the Chacahoula salt dome.

Except for the caretaker's residence, there are no other residences at the Chacahoula salt dome. Residential development associated with the farms on the natural levees is present several miles to the east, northeast, and north. Most residences are confined to the natural levees.

The potential development of the immediate vicinity of the Chacahoula salt dome is restricted to activities involving mining or fuel extraction and/or storage because the physical environment places severe constraints on the types of land use that are feasible for backwater swamp and coastal marshes. The nearshore Gulf is an important shrimp fisheries region.

At the present time, no regional plans or pertinent zoning regulations relating to land use are available or in effect (FEA, 1977). Land use of the site area is shown in Figure B.6-7.

Transportation Systems

Access to the project site is available via road and canal. The site is connected to the regional transportation system, discussed in Section B.2.8.3, via Route 309 which intersects Route 1 seven miles north of the site, and State Highway 20, two miles south. Several unpaved roads in the area of the dome come close to the southern and northeastern periphery of the proposed storage site. There are currently no roads on the storage site.

The Donner Canal is located just west of the proposed site and connects with Black Bayou, an important local waterway. Bubbling Bayou crosses the southern portion of the storage site.

The Chacahoula dome is located two miles north of the unincorporated residential area of the same name on Route 309. The site is also within easy commuting distance from Thibodaux, Houma, and Morgan City. New Orleans is more distant but still within reasonable commuting distance via divided highways and well maintained two-lane roads.

The brine disposal pipeline crosses several waterways. The ICW is travelled heavily by commercial and pleasure vessels as is the nearshore Gulf.

Population

The Chacahoula dome is located in Lafourche Parish, which had a population of 68,941 in 1970. This was a 24.5 percent increase over the

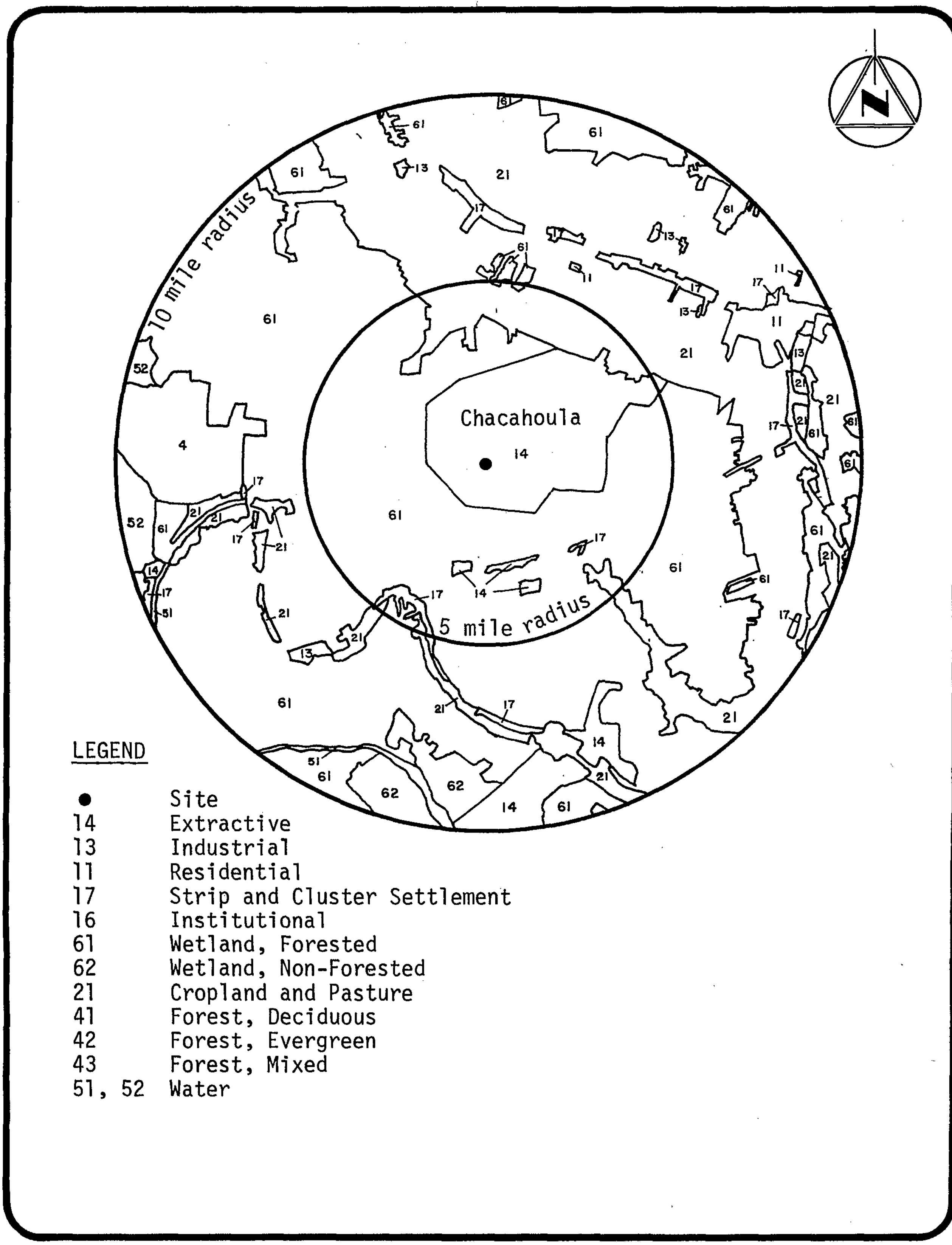


FIGURE B.6-7 Land use within a 5 and 10 mile radius of the Chacahoula site.

recorded 1960 population, showing a substantial rate of increase despite a lack of immigration. Although the project site is located in the northwestern corner of Lafourche Parish, the project would have an impact on the adjacent parishes - Terrebonne, Assumption, and St. Mary - as well as Lafourche. Thibodaux, Houma, and Morgan City are the major towns in this area. These form a rough triangle connected by Interstate Highway 90, Louisiana Route 20, and Louisiana Route 24. A number of unincorporated communities having a population of less than 1000 lie along these main roads.

Thibodaux is the parish seat of Lafourche Parish and is about 10 miles from the site via Routes 1 and 309. The 1970 census reported the Thibodaux population to be 14,925, indicating a growth rate of 11.4 percent since the 1960 count.

Houma could be expected to provide some of the labor for the project. It is about 22 miles from the site via Routes 24 and 20. Census statistics for Houma reported a population of 30,922 in 1970, indicating an increase of 37.1 percent since 1960. The population is estimated to have reached 33,280 in the city limits as of 1975 and to be 46,890 if suburbs are included. Houma is the parish seat of Terrebonne Parish and is the major population center of this oil and natural gas area (U.S. Department of Commerce, 1973).

Much of the equipment and supplies for the project could be expected to come from Morgan City, as well as a portion of the labor. Morgan City is a fast-growing community which is severely limited in land area. It is the fourth largest seaport in Louisiana. Located on a natural levee area that cuts across the lower Atchafalaya Basin, this highly industrialized area is wedged between low-lying wetlands and has extended itself eastward along Interstate Highway 90. The 1970 population of Morgan City was reported as 16,585, an increase of 22.5 percent from 1960. The 1975 estimates project a population of 17,500 in Morgan City itself, or about 40,000 for the urban area which includes Morgan City, Berwick, Amelia, and surrounding communities (FEA, 1977).

There is no resident population at the site itself. The closest small population center is the unincorporated area of Chacahoula, consisting of approximately 25 homes at the junction of Routes 309 and 30.

The population growth of this area has been largely due to the development of oil and natural gas resources and the migration of workers into the area from other parts of the country. Recent interest in offshore drilling has brought an influx of workers to Morgan City, which has grown substantially since the 1970 census. The greatest future expansion of population in the area is expected in Lafourche and Terrebonne Parishes where less than half of the area is dry land (only about 411 square miles of dry land exists in Lafourche Parish, out of a total of 1141 square miles). This expansion is expected to result in an intensified urban development along the dry land corridors that connect the major towns (FEA, 1977).

Housing

The housing availability in Thibodaux, Houma, and Morgan City in 1970 is shown in Table B.6-2. As can be seen in the table, the vacancy rate in units for sale is much lower than for rental units. The rental vacancy rates shown include a number of housing units that do not have plumbing facilities; i.e., piped hot and cold water in the structure, flush toilets, and bathub or shower. The vacancy rate would be further reduced if only units with complete plumbing units were shown (FEA, 1977). Overall there are few housing units available in these rapidly growing areas.

Lafourche Parish had 19,091 housing units in 1970, 12,754 of which were owner-occupied. The median value of the owner-occupied units was $12,500, well below the state average of $14,600. The number of year-round housing units rose dramatically in Lafourche Parish between 1960 and 1970, with an increase of 26 percent.

Government

Police and Fire

Police and fire protection for the site would be provided by Thibodaux, located about 15 miles from the site. Thibodaux has 21 full-time city police officers, plus two meter maids and collectors and 11 school guards. This amounts to one full-time officer per 714 city inhabitants. There

TABLE B.6-2 Housing Availability in Thibodaux, Houma, and Morgan City, 1970.

	THIBODAUX	HOUMA	MORGAN CITY
Year-Round Housing Units	4,269	9,194	4,974
Owner-Occupied	2,300	5,347	2,707
Renter-Occupied	1,722	3,352	1,960
For Sale	10	55	38
Homeowner Vacancy Rate	0.4	1.0	1.4
For Rent	137	311	151
Rental Vacancy Rate	7.4	8.5	7.2
With all Plumbing Facilities	78	285	135
Mobile Homes or Trailers	118	437	353
Owner-Occupied	96	334	212
Renter-Occupied	22	103	41

Source: FEA, 1977

is also a specially trained unit of about 35 citizens who may be called upon for an emergency situation or for riot control.

Thibodaux boasts the largest all-volunteer fire department in Louisiana. There are approximately 550 trained men who are divided into eight separate companies, each with its own station and equipment.

There is a small volunteer fire department in Schreiver, just four miles south of Thibodaux and about 10 miles east of the project site, one at Gibson about 10 miles southwest, and another at Amelia, 17 miles southwest.

Hospitals and Medical Personnel

There are two hospitals in Thibodaux: one with 99 beds, and a recently completed facility with 101 beds. Ambulance service is also available in Thibodaux. Terrebonne General Hospital in Houma has 200 beds, an intensive care ward and an emergency care unit. In Morgan City, there is Lakewood Hospital, with 100 beds, and a staff of about 240 people. It has operating facilities and an emergency care department (FEA, 1977).

The available hospital and medical personnel for the parishes surrounding the site tend to be located in the population centers of 10,000 or more. Lafourche Parish reported the following licensed medical personnel in 1971: 43 physicians, 24 dentists, 112 registered nurses, and 56 practical nurses (FEA, 1977).

Economy

The petroleum industry ranks as the primary income-producing industry in the Lafourche-Terrebonne Parish area surrounding the project. Production in this area peaked in 1970 and has since begun to show a decline. Petrochemical production, associated with petroleum production, is the leading source of income in nearby St. James Parish.

Other manufacturing in the area includes sugar refining in Lafourche and St. James Parishes. There are three refineries in Thibodaux alone. The manufacture of products related to oil production is important to the area's economy, especially in Houma and Morgan City. Shipbuilding and fishing are also important industries in the area, with Houma and Morgan City having major port facilities. Sugar cane and cattle production, the predominant local agricultural activities, are very limited due to the extensive wetlands in the area unsuitable for production. Shrimping in the nearshore Gulf is an important economic factor in this region.

The rate of unemployment is generally low in this part of the State. In Lafourche and Terrebonne Parishes, where there are the greatest number of workers in the oil and gas industry, the unemployment rate in 1976 was very low, 4.1 percent and 4.6 percent, respectively. Some nearby areas such as St. James Parish have somewhat higher unemployment rates (7.0 percent). The leading sources of employment are in manufacturing, mining, construction, and a category which combines agriculture, forestry, and fisheries. Lafourche and Terrebonne Parishes have a substantial number of persons in occupational groups which might be drawn on by the project such as craftsmen, operators, and laborers (FEA, 1977).

Both Lafourche and Terrebonne Parishes have mean family incomes well above the state average of $7527. The average in Lafourche was $8728 in 1969, while in Terrebonne it was $9081. Despite the general level of wealth in the immediate area surrounding the project, there remains a substantial portion (15 percent) of the population living below the poverty level. The nearby parishes of St. Mary and Assumption have much lower mean family incomes and much higher proportions of their populations below the poverty level (U.S. Department of Commerce, 1973).

Education

The educational services available in the area surrounding the project are shown in Table B.6-3. The pupil-teacher ratio in the area appears to meet the standards discussed in Section B.2.8.7.

TABLE B.6-3 Education in the public and private schools in Thibodaux, Houma, and Morgan City.

	Thibodaux		Houma		Morgan City	
Type of Schools:	Public	Private[a]	Public	Private[a]	Public	Private[a]
Elementary	4	2	32	5	7	2
Secondary[b]	4	1	6	1	2	1
Number of Pupils	5753	1376	21,796	1218	4196	1001

[a] Includes church-supported schools.

[b] Both junior high schools and senior high schools are counted.

Source: FEA, 1977.

B.7 REFERENCES

Assumption Parish Family Services, 1977, Philip Vitale, Administrator, Personal communication (April 15).

Assumption Parish Sheriff's Department, 1977, Enola Vedros, Secretary, Personal communication (March 15).

Aycock, R., 1975, Personal communication, In Final environmental statement - Gulf Intracoastal Waterway; Petit Anse, Tigre and Carlin Bayous; and Bayou Grosse Tete, La., Prepared by U.S. Army Corps of Engineers, New Orleans, La., 1976.

Barrett, B.B., and others, 1971, Cooperative Gulf of Mexico estuarine study, Louisiana, Phase III, Sedimentology, Louisiana Wildlife and Fisheries Commission, New Orleans, p. 131-191.

Batemen, H., 1975, Personal Communication, In Final environmental statement - Gulf Intracoastal Waterway; Petit Anse, Tigre and Carlin Bayous; and Bayou Grosse Tete, La., Prepared by U.S. Army Corps of Engineers, New Orleans, La., 1976.

Blair, and others, 1968, Vertebrates of the United States, McGraw-Hill Inc., N.Y., 616 p.

Bodenlos, A.J., 1970, Cap-rock development and salt-stock movement, In Geology - technology gulf coast salt, Louisiana State University, School of Geoscience, p. 73 - 86.

Burk, Kevin, 1975, Atlantic evaporites formed by evaporation of water spilled from Pacific, Tethan, and southern oceans, Geology, vol. 3, no. 11, p. 613-161, illus.

Cade, J.T., and others, 1971, DDE residues and eggshell changes in Alaskan falcons and hawks, Science, 1972, p. 995-997.

Carsey, J., 1950, Geology of Gulf coastal area and continental shelf, American Association of Petroleum Geologists, Bull. 34, p. 361-385, illus.

Chabreck, R.H., 1970, Marsh soils and vegetative types in the Louisiana coastal marshes, unpublished dissertation, Louisiana State University, Baton Rouge, Louisiana.

_______, 1972, Vegetation, water and soil characteristics of the Louisiana coastal region, Bull. 644 of the Louisiana State University Agricultural Experiment Station, 72 p.

_______, 1976, Atchafalaya Wilderness Center. environmental statement - Preliminary Report., Albert Switzer & Assoc. Inc. and Perry Segura & Assoc. (for Atchafalaya Basin Division, Louisiana).

Cockerham, W.L. and others, 1973, Soil survey, St. James and St. John the Baptist Parishes, Louisiana, U.S. Dept. of Agriculture, Soil Conservation Service, in cooperation with Louisiana Agriculture Experiment Station, Baton Rouge.

Coffman, Jerry L. and Carl A. Von Hake, 1973, Earthquake history of the United States, U.S. Dept. of Commerce, NOAA, Environmental Data Service, Pub. 41-1, revised edition.

Dames & Moore, 1975, Environmental analysis - Louisiana offshore oil port, Dames & Moore, prepared for LOOP, Inc., New Orleans, Louisiana (October).

Day, J.W., Jr., and others, 1973, Community structure and carbon budget of a salt marsh and shallow bay estuarine system, Louisiana State University, Center for Wetland Resources, Pub. LSU-SG-72-04, Baton Rouge, La.

Douglas, N.H., 1974, Freshwater fishes of Louisiana, Claitors Publishing Div., Baton Rouge, Louisiana, 443 p.

Fenix and Scisson, Inc., 1976, Final report, project 1, Investigation of new leached caverns in salt domes, Tulsa, Oklahoma.

Fontenot, B., 1975, Personal communication, In Final environmental statement - Gulf Intracoastal Waterway; Petit Anse, Tigre and Carlin Bayous; and Bayou Grosse Tete, La., Prepared by U.S. Army Corps of Engineers, New Orleans, La., 1976.

Gary, D. L., 1974, The commercial crawfish industry in south Louisiana, Center for Wetland Resources, Louisiana, State University, Baton Rouge, La., 59 p.

Gresham, G., 1963, Atchafalaya basin crisis, Louisiana Conservationists, July-August.

Gunter, G., 1961, Some relations of estuarine organisms to salinity, Limnological Oceanography, vol. 6, p. 182-190.

Halbouty, M.T., 1967, Salt domes - Gulf region, United States and Mexico, Gulf Publishing Co., Houston, 425 p., illus.

Harder, A.H. and others, 1967, Effects of groundwater withdrawals on water levels and salt-water encroachment in southwestern Louisiana, Louisiana Dept. of Conservation, Louisiana Geological Survey and Louisiana Dept. of Public Works, Water Resources Bull., no. 10.

Holzworth, C.G., 1972, Mixing heights, wind speeds, and potential for urban air pollution throughout the contiguous United States, U.S. EPA, Office of Air Programs, AP-101 (January).

Howe, Henry V. and Cyril K. Moresi, 1931, Geology of Iberia Parish, Louisiana Dept. of Conservation, Geological Bull., no. 1.

Howe, H.V. and others, 1938, Reports on the geology of Iberville and Ascension Parishes, Louisiana Geological Survey, Geological Bull. No. 13 (August).

Iberia Parish Sheriff's Department, 1977, Major Tyler, Executive Assistant, Personal communication (March 16).

Jaworski, E., 1972, The blue crab fishery, Barataria Estuary Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana, 112 p.

Johnson, H.A. and D.H. Bredeson, 1971, Structural development of some shallow salt domes in Louisiana Miocene productive belt, American Association of Petroleum Geologists Bull., vol. 55, p. 204-226.

Jones, P.H., A.N. Turcan, Jr., and H.E. Skibitzke, 1954, Geology and ground water resources of southwestern Louisiana, Louisiana Department of Conservation, Geological Bull. 30, Baton Rouge.

Juneau, C.L., Jr., 1975, An inventory and study of the Vermilion Bay - Atchafalaya Bay complex, Louisiana Wildlife and Fisheries Commission, Oysters, Water Bottoms, and Seafoods Division, Tech. Bull. No. 13, 153 pp.

Killebrew, C., 1975, Personal communication, In Final environmental statement - Gulf Intracoastal Waterway; Petit Anse, Tigre and Carlin Bayous; and Bayou Grosse Tete, La., Prepared by U.S. Army Corps of Engineers, New Orleans, Louisiana, 1976.

King, Philip B., 1969, Tectonic map of North America, U.S.G.S., Washington, D.C.

Kupfer, Donal H., 1962, Structure of Morton Salt Company mine, Weeks Island salt dome, Louisiana, Amer. Assoc. of Petroleum Geologists Bull., vol. 46, no. 8, p. 1460-1467 (August).

_______, 1970, Mechanism of intrusion of Gulf Coast salt, In Geology - Technology Gulf Coast salt, Louisiana State University, School of Geoscience, p. 25-66.

_______, 1974, Shear zones in the Gulf Coast delineate spins of movement, Gulf Coast Association of Geological Societies, Transactions, vol. 24, p. 197-209.

Lantz, K.E., 1974, Natural and controlled water level fluctuation in a backwater lake and three Louisiana impoundments, Louisiana Wildlife and Fisheries Commission, Fisheries Bulletin No. 11.

Lindall, W., Jr., and Hall, Jr., 1970, Fishery resources, National Marine Fisheries Service, Commerical Fisheries Work Unit, Biology Laboratory, St. Petersburg Beach, Report, p. 163-188.

Long, 1965, Groundwater in the Geismar-Gonzales area, Ascension Parish, Louisiana Dept. of Conservation and Louisiana Dept. of Public Works, Water Resources Bull. No. 7.

Louisiana Department of Employment Security, 1977, Oliver Robinson, Chief of Research and Statistics, Personal communication (March 25).

Louisiana Department of Highways, 1977, Edward Wagner, Head Highway Transport Engineer, Traffic and Planning division, Personal communication (April 15).

Louisiana State Board of Education, 1977, Peter Shell, Research Data Collection, Personal communication (March 16).

Louisiana State Office of Comprehensive Health Planning, 1977, Glen Chustz, Assistant Health Planning Officer, Personal communication, (March 16).

Louisiana State Planning Office, Coastal Resources Program, 1977, Unique Ecological Features of the Louisiana Coast, Baton Rouge, Louisiana (March).

Louisiana State University, 1975, Environmental assessment of a Louisiana offshore oil port, Louisiana State University, Center for Wetlands Resources, prepared for LOOP, Inc.

Louisiana Stream Control Commission, 1973, Louisiana water quality criteria, La. Stream Control Commission (August 14).

Louisiana Wildlife and Fisheries Commission, 1975, 1974-75 Small game surveys, Baton Rouge, La.

_______, 1976a, Waterfowl population estimates for Louisiana's coastal marshes below W.S. Highway 90, December 13-16, 1976, Baton Rouge, La.

_______, 1976b, 1975-76 Waterfowl survey, Baton Rouge, La.

_______, 1976c, 1975-76 Dove survey, Baton Rouge, La.

_______, 1976d, 1975-76 Deer kill survey, Baton Rouge, La.

Lowery, G.H., Jr., 1974, The mammals of Louisiana and its adjacent waters, Louisiana State University Press, Baton Rouge, La., 565 p.

_______, 1975, Louisiana birds, Louisiana Wildlife and Fisheries Commission, Louisiana State University Press.

Lytel, S.A., and others, 1959, Soil survey St. Mary Parish, Louisiana, U.S. Department of Agriculture, Soil Conservation Service in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Series 1952, no. 3.

_______, 1960, Soil survey, Terrebonne Parish, Louisiana, U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Series 1952, no. 1.

Mangum, A., 1977, Personal communication, letter from the U.S. Soil Conservation Service, Alexandria, Louisiana (14 February).

Miller, R.R., 1972, Threatened freshwater fishes of the United States, Trans. Amer. Fish. Soc., no. 2, p. 239-252.

Murray, G.E., 1961, Geology of the Atlantic and Gulf Coastal province of North America, Harper & Brothers, Publishers, N.Y., 692 p.

National Audubon Society, 1973, The blue list for 1974, Amer. Birds, Nat. Audubon Society, vol. 27, p. 943-945.

New Iberia Chamber of Commerce, 1977, Evelyn Hedert, Secretary of the Chamber of Commerce, Personal communication (April 14).

New Iberia Fire Department, 1977, Mr. Derovin, Assistant Chief, Personal communication (March 16).

Nichols, J.D., and R.H. Chabreck, 1973, A survey of furbearer resources of the Atchafalaya River flood plain in Louisiana, Twenty-seventh Annual Conf., Southeastern Association of Game and Fish Commission.

Odum, E.P., 1971, Fundamentals of ecology, Third edition, W.B. Saunders Co., Philadelphia, Pa.

Oil and Gas Journal, 1976, Here are the big U.S. reserves, Oil and Gas Journal, p. 119-120 (January 26).

Palmisano, A.W., 1972, Habitat preference of waterfowl and fur animals in the northern Gulf Coast marshes, Proc. Coastal Marsh and Estuary Mangt. Symp., Louisiana State University, Div. Continuing Education, 27 p.

Penn, G.H., Jr., 1959, An illustrated key to the crawfishes of Louisiana with a summary of their distribution within the state (Decapoda, Astacidae), Tulane Studies in Zoology, vol. 7(1), p. 3-20.

Rainwater, E.H., and R.P. Zingula, eds., 1962, Geology of the Gulf Coast and central Texas and guidebook of excursions, Houston Geological Society.

Richardson, Robert L., and others, 1973, Background concentrations of hydrocarbons in the atmosphere of the northwest Gulf of Mexico, Texas Air Control Board, Air Quality Evaluation Program, Austin, Texas.

Rollo, J.R., 1960, Groundwater in Louisiana, Louisiana Geological Survey and Louisiana Dept. of Public Works, Water Resources Bull. No. 1, (August).

Russell, Richard J., 1955a, A field guide covering physiography and geology along U.S. Highway 90 from New Orleans to Lafayette, Geological Soc. of Amer. field trip to salt mines of Iberia Parish, Louisiana, and Supplemental to discussions of the salt occurrences given in Guide to Southeastern Geology (Russell, ed.), p. 538-548.

St. Amant, L.S., 1959, Louisiana wildlife inventory and management plan, Louisiana Wildlife and Fisheries Commission, New Orleans, Louisiana, 329 pp.

Simmons and Thomas, 1962, In Final environmental statement: USDI, Proposed 1976 Outer Continental Shelf, oil and gas general lease sale no. 41, Gulf of Mexico, vol. 1.

Snow, L., 1973, Habitat management series for endangered species: southern bald eagle and northern bald eagle, U.S. Dept. of the Interior, Bureau of Land Management, Report No. 5.

Sprunt, A., 1954, Florida bird life, Coward-McCann Inc., New York.

Tankerville Fire Department, 1977, Clay Berbiero, Fire Chief, Personal communication (March 16).

Thom, H.C.S., 1963, Tornado probabilities, Monthly Weather Review, p. 730-736 (October - December).

_______, 1968, New distributions of extreme winds in the United States, Amer. Soc. of Civil Engineers, Journal of the Structural Division, Proceedings, p. 1787-1801 (July).

U.S. Army Corps of Engineers, 1972, History of hurricane occurrences along coastal Louisiana, U.S. Army Corps of Engineers, New Orleans District (August).

U.S. Army Corps of Engineers, 1973a, Inventory of basic environmental data - south Louisiana, Mermentau River basin to Chandeleur Sound with sepcial emphasis on the Atchafalaya Basin.

_______, 1973b, Report on Gulf Coast deep water port facilities, Texas, Louisiana, Mississippi, Alabama, and Florida, Lower Mississippi Valley Division, Vicksburg, Mississippi.

_______, 1975a, Atchafalaya Basin usage study, New Orleans, La., 85 p.

_______, 1975b, Gulf Intracoastal Waterway, Petit Anse, Tigre and Carlin Bayous, and Bayou Grosse Tete, Louisiana, Draft environmental statement.

_______, 1975c, Inventory of basic environmental data - New Orleans - Baton Rouge metropolitan area, U.S. Army Corps of Engineers, New Orleans District (March).

_______, 1977, Status of Gulf Intracoastal Waterway and other navigable waterways, Hydrographic Bulletin no. 1, U.S. Army Corps ofEngineers, New Orleans District (January).

U.S. Department of Agriculture, 1969, General soil map, Iberia Parish Louisiana, U.S. Department of Agriculture, Soil Conservation Service, Alexandria, Louisiana, in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana.

_______, 1970a, General soil map Assumption Parish, Louisiana, U.S. Department of Agriculture, Soil Conservation Service, Alexandria, Louisiana, in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana.

_______, 1970b, General soil map, St. Martin Parish, Louisiana, U.S. Department of Agriculture, Soil Conservation Service, Alexandria, Louisiana, in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana.

_______, 1971, General soil map, Iberville Parish Louisiana, U.S. Department of Agriculture, Soil Conservation Service, Alexandria, Louisiana, in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana.

_______, 1972, General soil map, Lafourche Parish, Louisiana, U.S. Department of Agriculture, Soil Conservation Service, Alexandria, Louisiana, in cooperation with Louisiana Agricultural Experiment Station, Baton Rouge, Louisiana.

U.S. Department of Commerce, 1964, Climatology of the United States No. 86-14, Climatic summary of the United States - Supplement for 1951 through 1960, Louisiana, Weather Bureau, Washington, D.C.

_______, 1969, Severe local storm occurrences 1955-1967, Office of Meteorological Operations, Weather Analysis and Predicting Division, Silver Springs, Maryland.

_______, 1971, STAR data, New Orleans, Baton Rouge, and Lake Charles, 1966-1970, NOAA, Environmental Data Service, Asheville, North Carolina.

_______, 1972a, Gulf Coast shrimp data, current fisheries statistics, NOAA, U.S. Dept. of Commerce, NMFS.

_______, 1972b, County and City Data Book, Social and Economic Statistics Administration, Brueau of the Census.

_______, 1973, Characteristics of the Population, vol. 1, part 20, U.S. Census Bureau (January).

_______, 1974, Local climatological data, New Orleans, Baton Rouge and Lake Charles, NOAA, Environmental Data Service, Asheville, North Carolina..

_______, 1977, Analysis of brine disposal in the Gulf of Mexico: Capline section, draft report, NOAA (May).

U.S. Department of the Interior, 1973, Threatened wildlife of the United States, Washington, D. C.

_______, 1974, United States list of endangered fauna, Washington, D.C.

_______, 1975a, Endangered and threatened species - plants, Federal Register, vol. 40 (PartV), no. 127, p. 27823-27924.

_______, 1975b, Endangered or threatened wildlife and plants; reclassification of the American alligator and other amendments, Federal Register, vol. 40(188), p. 44412-44415.

_______, 1976a, Endangered and threatened species - plants, Federal Register, vol. 41 (Part IV), no. 117, p.24524-24572.

_______, 1976b, Endangered and threatened wildlife and plants, Federal Register, Vol. 41 (Part IV), No. 208, 27 October 1976.

_______, 1977a, Final environmental impact statement; proposed Outer Continental Shelf oil and gas lease sale, Gulf of Mexico, OCS sale no. 471, Bureau of Land Management, New Orleans.

_______, 1977b, National register of historic places, Federal Register, vol. 42, no. 21, p. 6198-6362 (February 1).

U.S. Department of Transportation, 1976, Draft environmental impact/4(f) statement LOOP deepwater port license application, Deepwater Port Project, Office of Marine Environment and Systems, Washington, D.C., U.S. Coast Guard.

U.S. Environmental Protection Agency, 1971, National ambient air quality standards, Federal Register, vol. 36, p. 22384 (November 25).

_______, 1974a, Information on levels of environmental noise requisite to protect public health and welfare with an adequate margin of safety, EPA 550/9-74-004.

_______, 1974b, Significant deterioration of air quality, 40 CFR 52.21.

_______, 1976a, Request for revision to Louisiana implementation plan, Federal Register, vol. 41, p. 29478 (July 16).

_______, 1976b, Proposed EPA revision to the Texas state implementation plan, Environmental Reporter, Current Development, vol. 7, no. 29, p. 1065-1083 (November 19).

_______, 1976c, EPA draft preamble to interpretative ruling of new source review requirements, Environmental Reporter, Current Developments, vol. 7, no. 29, p. 1091-1095 (November 19, 1976).

_______, 1976d, National emissions data system (February 7, 1976).

_______, 1976e, National ambient air quality standards as amended, Federal Register, vol. 41, p. 52686 (December 1).

U.S. Geological Survey, 1977, Water resources data for Louisiana, water year 1976, Baton Rouge, Louisiana.

U.S. National Marine Fisheries Service, 1974, Louisiana landings, 1970-74.

University of New Orleans, 1974, Statistical abstract of Louisiana, Division of Business and Economic Research, College of Business Administration, Fifth edition.

Vaughn, Francis E., 1925, The five islands, Louisiana, Amer. Assoc. of Petroleum Geologists Bull., vol. 9, no. 4, p. 756-758, 774-787, 792-797.

Whiteman, C.D., Jr., 1972, Groundwater in the Plaquemine-White Castle area, Iberville Parish, Louisiana, Louisiana Geological Survey and Louisiana Dept. of Public Works, Water Resources Bull. no. 16.

Whitfield, M.S., Jr., 1975, Geohydrology of the Evangeline and Jasper aquifers of southwestern Louisiana, Louisiana Geological Survey and Louisiana Dept. of Public Works, Water Resources Bull. no. 20.

Whitman, Harry M. and Chabot Kilburn, 1963, Ground-water conditions in southwestern Louisiana, 1961 and 1962, with a discussion of the Chicot Aquifer in the coastal area, Louisiana Dept. of Conservation, Geological Survey and Dept. of Public Works, Water Resources Pamphlet, no. 12.

Whittaker, R.H., 1972, Communities and ecosystems, MacMillan Company, New York.

Zack, Allen L., 1971, Ground-water pumpage and related effects, southwestern Louisiana, 1970, with a section on surface-water withdrawals, Louisiana Dept. of Conservation, Geological Survey and Dept. of Public Works, Water Resources Pamphlet, no. 27.

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