UNITED STATES DEPARTMENT OF ENERGY

STRATEGIC PETROLEUM RESERVE

Boeing Petroleum Services, Inc.

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FOR THE

STRATEGIC PETROLEUM RESERVE

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1. INTRODUCTION

The creation of the Strategic Petroleum Reserve (SPR) was mandated by Congress in Title I Part B of the Energy Policy and Conservation Act (P.L. 94-163), of December 22, 1975. Its purpose is to provide the United States with sufficient petroleum reserves to minimize the effects of an oil supply interruption.

The SPR consists of six Gulf Coast underground salt dome oil storage complexes (four in Louisiana and two in Texas) and a marine terminal facility (in Louisiana). The SPR used four sites with existing solution-mined caverns and an underground room-and-pillar salt mine early in the project. Additional space has since been created by solution mining at three sites. The sixth and newest storage site is in the construction phase.

The sites were originally constructed around three major inland pipeline systems capable of transporting U.S. and foreign crude oil from the Gulf Coast to refineries in the Midwest. The inland pipeline terminals planned for use by the SPR are the Phillips Terminal (Freeport, Texas), the Sunoco Pipeline Terminal (Nederland, Texas), and the Capline Pipeline Terminal (St. James, Louisiana). The sites are also capable of distributing crude oil via tankships. A new pipeline connecting the Bryan Mound site with the Texas City, Texas docks and area refineries will be completed in 1987. A second pipeline connecting the West Hackberry site to refineries in Lake Charles, Louisiana is planned to enhance distribution capabilities.

1.1 BAYOU CHOCTAW

The Bayou Choctaw site is located on the west side of the Mississippi River 12 miles southwest of Baton Rouge in Iberville Parish, Louisiana. The site consists of main and brine disposal areas which occupy approximately 168 and 200 acres respectively. The area surrounding the site is rural, with a number of people living in small settlements along the nearby highways.

The nearest communities are Addis to the northeast and Plaquemine to the southeast. Baton Rouge, the major source of housing and services for the site, is within easy commuting distance.

The habitat surrounding the site is a freshwater swamp. Elevation ranges from approximately 5 to 10 feet above sea level. Although there are no clear topographic expressions in the area, major surface subsidence has occurred creating substantial areas of bottomland hardwoods and swamp with interconnecting waterways. The site proper is normally dry and protected from spring flooding by the site's flood control levees and pumps. The collapse of a solution-mined cavern in 1954 resulted in the formation of a 12-acre lake (Cavern Lake) on the north side of the site.

Bottomland hardwood forest and deciduous swamps are predominant at the Bayou Choctaw site. The overstory vegetation at the site includes baldcypress, sweetgum, tupelo (characteristic of lowland areas), bulltongue, and spikerushes. Water oak is also present but not abundant. The deciduous swamp is the most widespread habitat type found at the site. It provides resources for a large number of wildlife. Bird species common at Bayou Choctaw are herons, ibis, egrets, woodpeckers, wood duck, thrushes, American anhinga, and American woodcock. Inhabitants of the bottomland forest and swamp include opossum, squirrels, nutria, mink, river otter, raccoon, swamp rabbit, white-tailed deer, American alligator, and snakes.

The site is located near the intersection of several major bayous and waterways. The Intracoastal Waterway (Port Allen Canal) passes in a north-south direction west of the site. The Intracoastal Waterway extends to the north and then turns eastward through the Port Allen Canal to enter the Mississippi River at Baton Rouge. In the area of the site, the Intracoastal

Waterway is part of Choctaw Bayou, a natural waterway. Smaller canals and bayous, such as the North-South Canal and the East-West Canal, enter the site area and continue to Bull Bay and the Intracoastal Waterway.

1.2 BIG HILL

The Big Hill site is located in Jefferson County, Texas, approximately 68 miles east of Houston, 23 miles southwest of Port Arthur, and nine miles north of the Gulf of Mexico. Only small unincorporated communities are located in proximity to the site. The rural area around the site is used primarily for rice farming, cattle grazing, and oil and gas production. The permanent work force is supplied in small part from the local area, with the remainder moving into the area or commuting from Beaumont or Port Arthur. During the current construction phase, much of the transient skilled labor is brought in from Houston, Galveston, or Lake Charles.

The site is situated on approximately 275 acres of land on the Big Hill salt dome with surface elevations of up to 35 feet above sea level (the highest elevations in the region). The agricultural and pasture land uses around Big Hill are typical of the region.

Less than a mile south of the dome is the northern boundary of fresh to intermediate marsh which grades into brackish and saline marsh towards the Gulf of Mexico. Wetlands do not occur within the immediate vicinity of the site. The nearby waterways include Spindletop Ditch approximately three miles south of the site, which connects to the Intracoastal Waterway located two miles further south and oriented in a northeast to southwest direction. General freshwater impoundments are located south of the site. Numerous sloughs, bayous, and lakes, including Willow Slough Marsh, Salt Bayou, Star Lake, and Clam Lake, connect with

the Intracoastal Waterway. Natural ridges (cheniers) paralleling the coastline isolate the marsh from the Gulf of Mexico.

Existing habitats in the vicinity of the site are related to agricultural use, although there are petroleum-related industrial operations on and off the salt dome. There are two ponds present on the eastern edge of the dome, one of which is on SPR property.

The upland habitat, which comprises the majority of the site, consists of many tall grasses such as bluestem, indiangrass, switchgrass, and prairie wildgrass. Fauna typical in the area include coyote, rabbits, raccoon, rodents, snakes, turtles, and numerous upland game birds and passerines. The nearby ponds and marsh south of the site provide excellent alligator habitat.

1.3 BRYAN MOUND

The Bryan Mound site is located in Brazoria County, about 65 miles due south of Houston, Texas, and three miles southwest of Freeport, Texas, on the east bank of the Brazos River Diversion Channel, near the Gulf of Mexico. The area is highly industrialized, and includes several petrochemical related facilities. Approximately 50 percent of the area population are between 20 and 55 years of age and work in the local area, although many commute in to work from outside the immediate vicinity.

The site occupies 586 acres in the southwest apex of a triangle formed by the Brazos River Diversion Channel, the old Brazos River, and the Intracoastal Waterway. A U.S. Army Corps of Engineers silt gate controls the flow of water between the Intracoastal Waterway and the Diversion Channel. The Bryan

Mound salt dome creates a surface expression in the terrain by rising about 15 feet above the surrounding wetlands. The levees protecting the town of Freeport form a second 3.4 square mile triangular pattern within the triangle formed by the rivers. A levee parallels the Diversion Channel in a southern direction from Freeport until due west of the site. The levee then turns east essentially bisecting the site.

The major water bodies near the site are Blue Lake to the north, and Mud Lake to the south. These water bodies generally define the mounded aspect of the Bryan Mound dome, which creates a surface expression in the terrain by rising approximately 15 feet above the surrounding wetlands. Although Blue Lake is within the protective triangle formed by the levee system (with excess rain water drained off by two large pump stations operated by the city of Freeport) there is some drainage through culverts southward into the Intracoastal Waterway. Mud Lake, on the other hand, is directly connected with the Intracoastal Waterway.

The marsh and prairie areas surrounding Bryan Mound are typical of those found throughout this region of the Texas Gulf Coast. Brackish marshland dominates the low-lying portions of the site in all but the northern area, where the coastal prairie ecosystem extends along the levee paralleling the Brazos River Diversion Channel. The coastal prairie is covered with medium to very tall grasses which form a moderate to dense cover for wildlife. These grasses also occur in unmowed site areas. Those areas periodically inundated by seawater are dominated by cordgrasses.

A diverse range of habitats is created by water bodies surrounding Bryan Mound. Marshes and tidal pools, such as Mud Lake and Bryan Lake, which connect with the Gulf of Mexico by

way of the Intracoastal Waterway or the Brazos River, are ideal habitats for a variety of birds, aquatic life, and mammals. The common egret, snowy egret, migratory waterfowl, great blue heron, killdeer, least tern, and black-necked stilt (the latter two being state-protected species), as well as nutria, raccoon, skunk, rattlesnakes, turtles, and frogs can be found on and in the area surrounding Bryan Mound.

Shrimp, crabs, trout, flounder, and redfish are abundant in Mud Lake during various seasons of the year. Black drum, mullet, gar, and blue crab are found in Blue Lake.

1.4 ST. JAMES TERMINAL

The St. James Terminal, consists of 6 aboveground storage tanks and two tanker docks. The tank farm area occupies 105 acres and the docks occupy 48 acres. The site is located on the west bank of the Mississippi River, approximately halfway between New Orleans and Baton Rouge, Louisiana, and approximately 1.9 miles north of the town of St. James, on Louisiana Highway 18. The area around the site is rural with a number of people living in small settlements along Highway 18, the major thoroughfare in the area. Although some of the work force may commute from New Orleans or Baton Rouge, the majority of the workers are from local labor pools.

The terminal is bounded by the Texas and Pacific Railroad to the west, commercial facilities to the north and south, and the Mississippi River levee on the east between Louisiana Highway 18 and the river. The area adjacent to the Mississippi River at the St. James docks is a freshwater wetland (batture). Much of the land area surrounding the terminal is used for pasture and sugar cane cultivation. Frogs, snakes, turtles, rabbits, raccoon, armadillo, muskrat, opossum, nutria, squirrels, egrets, ibis, and herons can be found on the site and in the surrounding areas.

1.5 SULPHUR MINES

The Sulphur Mines site (approximately 175 acres) is located in Calcasieu Parish, 1.5 miles west of the town of Sulphur, Louisiana. There has been considerable industrial activity on and near the site since the late 1800's. The greater part of the work force comes from the town of Sulphur, with the remainder from outlying communities and the major urban area of Lake Charles.

The site is divided into the quadrangular primary site area and the figure eight shaped secondary area. The secondary site area is bordered on the west, northwest, and north by water bodies. Most of these bodies of water are interconnected and drained by one creek flowing eastward from the site to Bayou D'Inde. A floodwater canal is located 1/4 mile east of the site. Changes in elevation throughout the site are minor, with most of the site 15 to 20 feet above sea level. The site proper is normally dry except in the spring season or during heavy rains when high waters sometimes flood portions of it. The lowest elevations are over the center of the dome, where subsidence has occurred as a result of prior sulfur mining activity. Much of the surrounding area is covered with a mixed pine/hardwood forest.

Mammals on site and in the surrounding area include white-tailed deer, raccoon, fox squirrel, cottontail rabbit, opossum, striped skunk, armadillo, nutria, southern flying squirrel, white-footed mouse, and bobcat. Snakes, turtles, alligator, frogs, and toads can also be found. Crappie, largemouth bass, sunfish, gar, carp, bowfin, and catfish inhabit shallow ponds on the site. Many bird species including egrets, killdeer, herons, and migratory waterfowl can be found.

1.6 WEEKS ISLAND

The aboveground facility occupies approximately seven acres and is located in Iberia Parish, Louisiana, about 14 miles south of New Iberia. The surrounding area is sparsely populated. New Iberia, the closest major urban center, supplies the greater part of the labor force. The major employment sectors within the parish are mineral production, manufacturing, construction, and agriculture.

The Weeks Island salt dome borders Vermilion Bay, which opens to the Gulf of Mexico. The Weeks Island salt mine, developed in the early 1900's by room-and-pillar mining, operated continuously until 1981, at which time operations were moved to another part of the same dome. The surface expression over the salt dome, caused by domal upthrusting, forms the "island" and includes the highest elevation (171 feet) in southern Louisiana. The area surrounding the island is a combination of swamp, marsh, bayous, manmade canals, and bays contiguous with the Gulf of Mexico.

The vegetation communities on Weeks Island are diverse. Lowland hardwood species proliferate in the very fertile loam soil base common at the higher elevations. The predominant tree species are oak, magnolia, and hickory, which extend down to the surrounding marsh. Pecan trees are also present. The coastal wetlands at the Weeks Island site include the manmade Intracoastal Waterway, saline and brackish marshes, and bayous. Gulls, terns, herons, and egrets are common in the marsh area. Mink, nutria, river otter, raccoon, and alligator are the most common inhabitants of the intermediate marshes. Others mammals found at Weeks Island are opossum, bats, squirrels, swamp rabbit, bobcat, white-tailed deer, black bear, and coyote. The water bodies surrounding Weeks Island provide a vast estuarine nursery ground for an array of commercially and recreationally important finfish and shellfish.

1.7 WEST HACKBERRY

The West Hackberry site is located in Cameron Parish 18 miles southwest of Lake Charles, Louisiana and 16 miles north of the Gulf of Mexico. Cameron Parish is the largest and least populous parish in Louisiana. The population derives its economy from fishing, shrimping, rice farming, and petroleum production. The work force at the site is derived from local residents of the Hackberry community, the towns of Sulphur and Lake Charles, in Calcasieu Parish, and from recent arrivals to the area.

The site is situated on 565 acres of land on top of the West Hackberry salt dome. The dome is covered by a distinct mounded overburden on its western portion, with elevations up to 21 feet (the highest point in Cameron Parish). The majority of the dome is approximately five feet above sea level.

Waterways near the site include Calcasieu Lake and the Calcasieu Ship Channel approximately three miles to the east, and the Intracoastal Waterway approximately four miles north of the site. Black Lake, a brackish water lake, borders the dome on the northern and western sides. Numerous canals and natural waterways, including Black Lake Bayou, connect Black Lake to Alkali Ditch and then to the Intracoastal Waterway on the eastern side of the site. Black Lake Bayou, referred to locally as Kelso Bayou, continues wandering in a generally easterly direction from Black Lake, eventually connecting with the Calcasieu Ship Channel northeast of the town of Hackberry.

The western part of Cameron Parish consists of marshland with natural ridges extending in a generally east-west direction. These ridges, or cheniers, are stranded former beach lines, which affect water flow through the marshes. The cheniers typically support grasses and trees. In many areas, lakes, bayous, and canals are concentrated so that the marsh may not seem to be

a land mass, but rather a large region of small islands. Marshland closest to the coast generally has the highest salinity levels and lowest species diversity. Vegetation found on site and in the surrounding area of the West Hackberry facility is dominated by Chinese tallow, willow, various oak species, and numerous species of marsh and upland grasses. American alligator, snakes, egrets, herons, roseate spoonbill, migratory waterfowl, red-tailed hawk, red fox, raccoon, nutria, opossum, rabbits, and white-tailed deer inhabit the area surrounding the West Hackberry site. Aquatic inhabitants of Black Lake include crabs, shrimp, drum, croaker, spot, sheepshead, mullet, gar, redfish, and catfish.

2. PROGRAM OVERVIEW

The environmental program is implemented by the management, operations and maintenance (MOM) contractor for the SPR on behalf of the Department of Energy (DOE). DOE, however, has the ultimate responsibility as owner and operator, in accordance with the understanding reached between the MOM contractor and DOE. The environmental program is designed to support the SPR through tasks aimed at avoiding or minimizing adverse environmental effects from the SPR on surrounding lands and water bodies.

The monitoring and inspection program area was developed under guidance of the SPR Programmatic Environmental Action Report, Site Environmental Action Reports, and DOE Orders. This area includes monitoring permitted National Pollutant Discharge Elimination System (NPDES) outfalls and air emissions, conducting other required federal and state inspections, and regular sampling and analysis of site-associated surface water quality. This makes possible the assessment of environmental impacts and early detection of surface water quality degradation that may occur as a result of SPR operations.

The results of the individual program areas such as air quality monitoring and reporting, NPDES compliance, and water quality monitoring for 1986 are discussed in section 3.

2.1 ASSOCIATED PLANS AND PROCEDURES

Associated plans and procedures developed to support the SPR environmental program include group-specific Spill Contingency Plans, with spill reporting procedures, site-specific Spill Prevention, Control, and Countermeasures Plans, an Underground Injection Control Plan, a Solid Waste Management Plan, and a Fugitive Emissions Monitoring Plan. Compliance with federal, state, and local laws, regulations, and permits has been accomplished by implementation of these plans and procedures.

2.2 TRAINING

Site Environmental and Emergency Response Team (ERT) personnel have received training in environmental plans and procedures. Site management personnel have been briefed on the implementation of environmental procedures, spill reporting procedures, the group-specific Spill Contingency Plans, the site-specific Spill Prevention, Control, and Countermeasures Plans, and compliance awareness. Compliance awareness training is conducted by the individual site environmental specialists at each of the SPR sites. During this training, site personnel learn about applicable regulatory requirements.

ERT personnel from all sites participated in spill response training at Lamar University. Onsite training is also provided in oil spill cleanup and control. Site response personnel are trained to rapidly and effectively contain and cleanup oil, brine, and hazardous substance spills under the special circumstances unique to each SPR site.

2.3 REPORTING

Proper operation of the SPR with respect to the environment involves several types of reports and reporting procedures. The basic reports are summarized briefly in this section.

2.3.1 Spill Reports

The spill reporting procedures described in the spill contingency plans identify the procedures for reporting spills to the MOM contractor, DOE, and appropriate regulatory agencies. Specific reporting procedures are dependent upon several key factors including the quantity and type of material spilled, immediate and potential impacts of the spill, and spill location (e.g., wetland or waterbody). Any spill considered significant at the site is first verbally reported to site management and then to MOM contractor management in New Orleans and the onsite

DOE representative. Verbal notification of the appropriate regulatory agencies follows when necessary. Written reports from the site are usually submitted after cleanup, unless otherwise directed by the DOE or appropriate regulatory agency.

2.3.2 Discharge Monitoring Reports

Wastewater discharges from SPR sites are authorized by the Environmental Protection Agency (EPA) through the NPDES Program. Depending on site specific permit requirements, discharge sample analyses are reported to the state and EPA monthly (Bryan Mound and West Hackberry), quarterly (Bayou Choctaw, Saint James, Sulphur Mines, and Weeks Island), and semiannually (Big Hill). Included in the report is an explanation of the cause and actions taken to correct any noncompliance or bypass.

2.3.3 Other Reports

The MOM contractor provides several other reports to, or on behalf of, DOE as required. These reports include:

a. Fugitive air emissions for Bryan Mound (quarterly);

b. Emission Inventory Questionnaire Status update for St. James Terminal, Sulphur Mines, and Weeks Island (annually);

c. Air Quality Construction Status Report for West Hackberry (semi-annually);

d. Permit Tracking System review and update (quarterly);

e. Monthly Noncompliance and Spill Report with an annual summary for all sites;

f. Environmental Audit Reports for each site (annually);

g. Water Usage for Bryan Mound and Big Hill (annually);

h. Raw Water Usage and Brine Discharge Data for Bryan Mound and West Hackberry (monthly); and

i. Special study reports, as required.

2.4 OIL SPILLS: RECAPITULATION

In 1986, the total amount of oil moved (received, delivered, and transferred internally) was in excess of 74.5 million barrels. This amount includes approximately 383,000 barrels removed from the Bryan Mound and Bayou Choctaw facilities as a result of the 1985 test sale. During 1986, 5 oil spills of one or more barrels occurred for a total of 7,753 barrels or 0.01% of the total volume moved. This represents a 56% reduction in the total number of incidents as compared to 1985. One spill was due to a power failure, two to equipment failures, and two to operator/maintenance error. The total number of spills per year has dropped consistently since 1982. Although less oil was spilled during 1985 (537 barrels) than 1986, the cavern 111 wellhead failure incident at West Hackberry accounted for 99.7% of the total amount spilled during 1986.

2.5 BRINE SPILLS: RECAPITULATION

The SPR disposed 101.6 million barrels of brine (saturated sodium chloride solution) during 1986. Approximately 84.6% of the brine was disposed in the Gulf of Mexico via the Bryan Mound (38.8%) and West Hackberry (45.8%) brine disposal pipelines. The remainder was disposed in saline aquifers via injection wells at the West Hackberry (13.5%), Bayou Choctaw (1.5%), and Sulphur Mines (0.4%) sites. Six spill incidents of one or more barrels occurred (compared to 16 in 1985 and 17 in 1984) for a total of 1,734 barrels, or less than 0.002% of the total volume of brine disposed. Of this amount, 97.9% of the brine was spilled during two incidents; one at Bryan Mound (317 barrels) and the other at West Hackberry (1,380 barrels). No observed environmental impact resulted from either of these spills.

2.6 WASTEWATER DISCHARGE COMPLIANCE

In 1986, a total of 9,225 analyses were performed to monitor wastewater discharge quality from the SPR in accordance with NPDES and corresponding state permits. Although 17 noncompliances were reported, the SPR was in compliance with permit requirements for approximately 99.8% of the analyses performed. Twelve of the noncompliances involved site sewage treatment plants, three resulted from failure to take samples, and two were associated with brineline operations. A special study to identify and resolve SPR sewage treatment plant problems that may cause permit noncompliances was initiated and completed during 1986. The resulting SPR Sewage Treatment Plant Analysis Final Report recommended 27 actions to assure continued permit compliance as well as maintenance of each treatment plant.

2.7 SPECIAL ENVIRONMENTAL ACTIVITIES

During 1986, there was one major spill. In July, a failed cavern 111 wellhead component at West Hackberry sprayed approximately 7,500 barrels of crude oil onto the well pad (5,157 barrels), adjacent marshland, and surface waters of Black Lake (2,343 barrels). The quick response and effectiveness of the site ERT and cleanup crews ameliorated the impact of this spill. Subsequent ongoing monitoring in Black Lake (section 3.8.2.7) confirmed that the impact was short-lived and limited to the area surrounding the well pad.

A recovery task force, consisting of experienced personnel having specialized expertise in various aspects of recovery operations, was appointed during 1986. The team will respond immediately to emergencies such as major spills to assist with coordinating manpower, procuring equipment, and developing cleanup strategies.

All SPR underground storage tanks (UST) were registered in accordance with Texas and Louisiana UST programs. The SPR is complying with the conditions and criteria of the EPA Interim Prohibition until final requirements are approved for implementation.

Brine ponds at SPR facilities in Louisiana were registered in accordance with Louisiana Statewide Order No. 29-B during 1986.

A National Environmental Policy Act (NEPA) evaluation of crude oil distribution enhancements at the St. James Terminal was conducted as a preliminary requirement before proceeding with the work. A NEPA evaluation was also performed for the repair and replacement of the West Hackberry brine disposal pipeline. Neither activity was found to require further action under NEPA.

In accordance with DOE Order 5480.14, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Phase II, confirmation sampling of selected SPR sites was initiated and is scheduled for completion in early 1987.

Efforts to record all SPR permits issued from the Corps of Engineers with appropriate local county or parish Registrars of Deeds were initiated in 1986. This activity will be performed on a continuing basis to assure compliance with Title 33 of the Code of Federal Regulations.

The Environmental Programs and Procedures Manual, and six site-specific Spill Prevention, Control, and Countermeasures Plans were updated. The Spill Contingency Plans were also updated and reformatted by site groups. This version treats brine, hazardous substance, and offsite pipeline spill contingencies along with oil spills. A new Environmental Permits Manual was published.

3. ENVIRONMENTAL PROGRAM

3.1 INTRODUCTION

A primary goal of the MOM contractor is to ensure that all SPR activities are conducted in accordance with sound environmental practices. Effective environmental monitoring provides a mechanism for assessing the impact of SPR activity on air, surface water, and ground water. Site monitoring programs were developed as management tools for the purpose of allowing control and mitigation of unwarranted environmental impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

During 1986, air emissions were monitored through measurements and calculations from operating data. Volatile hydrocarbons arising from valves, pumps, tanks, tankers, and brine ponds are the predominant type of air emissions from SPR facilities. The quantity of hydrocarbon emissions is generally dependent on the volume of oil throughput, with minimal emissions occurring during periods of static storage. Small amounts of hydrogen sulfide are associated with some crude oils handled and stored by the SPR. Dust emissions from most site roads have been mitigated through paving or application of dust control agents.

During 1986, the surface waters of the Bayou Choctaw, Bryan Mound, Sulphur Mines, and West Hackberry SPR sites were sampled and monitored for general water quality. Surface water quality monitoring was not conducted at St. James Terminal or Weeks Island because of the lack of surface waters on these two sites. Surface water quality monitoring at Big Hill will be initiated at the onset of site operations there.

3.1.1 Water Discharge Permit Monitoring

The water discharge permit monitoring program fulfills the requirements of the EPA NPDES, and corresponding state programs. All SPR point source discharges are conducted in compliance with these federal and state programs.

SPR personnel conducted point source discharges from all sites during 1986. These discharges are grouped as:

a. brine discharge to the Gulf of Mexico,
b. stormwater runoff from tank, well, and pump pads
c. effluent from package sewage treatment plants.

Parameters monitored varied by site and discharge. Table 3-1 identifies frequency of specific parameters measured at each SPR site. The variations in data are discussed by site following the water quality monitoring discussions.

3.1.2 Environmental Permits

The active environmental permits required by regulatory agencies to construct and maintain the SPR are discussed by site. The discussion of site permits includes the number and type of noncompliances (if any) experienced at each site.

3.1.3 Hydrology and Ground Water Monitoring

Ground water monitoring is performed at three of the SPR sites. Bayou Choctaw, West Hackberry, and Bryan Mound have monitoring wells which are periodically sampled. Various indicator parameters are monitored depending upon the individual site, although well monitoring is not required by any federal or state regulations or permits.

Background information is not available on the construction and installation of the existing monitoring wells which presents problems when interpreting data. The ground water characteristics of each site are discussed within each site section.

3.1.4 Radioactivity

There are no radioactive process effluents from any SPR facility. Only sealed sources of radioactive material are in use.

A total of 126 SGH Model Nos. 5190, 5191, and 5202 nuclear density gauges are located on pipelines within the Bayou Choctaw, West Hackberry, Sulphur Mines, and Bryan Mound sites. The gauges are used for monitoring densities (oil and brine) in pipelines. Each gauge unit contains between 100 and 400 millicuries (mCi) of cesium 137. Wipe tests are performed every three years as recommended by the manufacturer. No radiation leakage has been detected to date. The MOM contractor is a general licensee under the manufacturer, Texas Nuclear.

Princeton Gamma Tech Model 100 sulfur analyzers are used in the Bryan Mound, West Hackberry, and St. James laboratories for analyzing sulfur concentrations in oil samples. The radioisotope within the analyzer contains 50 mCi of iron 55. No radiation leakage from the analyzer has been detected from semiannual wipe tests. The MOM contractor is a general licensee under Princeton Gamma Tech.

There are three self-luminating signs, Brandhurst, Inc. Model No. B100N10, located at Bayou Choctaw. Each unit contains 8.7 Ci of tritium. Results from wipe tests performed immediately after the signs were installed were negative. Additional leak tests are not required. The MOM contractor is a general licensee under Braudhurst.

3.2 BAYOU CHOCTAW

The Bayou Choctaw site will be used to store 66 million barrels of crude oil. Currently, there are four solution-mined caverns with two additional caverns in development. Raw water is provided from Cavern Lake and brine is transported via pipeline to 12 brine disposal wells located approximately two miles south of the site. There is a 36-inch crude oil pipeline connecting the site to the St. James Terminal.

3.2.1 Air Quality

During 1986, Bayou Choctaw operated in accordance with air quality regulatory requirements. Operational data was collected during the past year in order to update the existing Emissions Inventory Questionnaire, which is to be submitted to the Louisiana Department of Environmental Quality in early 1987. Total emissions from the facility were calculated to be less than 10 tons/year (a "nonsignificant facility" as classified by the state). There were no configurational changes which would have resulted in additional air emissions during 1986. Bayou Choctaw is located in a nonattainment area for ozone.

3.2.2 Surface Water Quality Monitoring

Samples collected once monthly at each monitoring station from May through December 1986 were used to monitor surface water quality. Specific monitoring stations are identified in Figure 3-1. Parameters monitored in the Bayou Choctaw surface waters included pH, salinity, total suspended solids (TSS), temperature, dissolved oxygen (DO), five-day biochemical oxygen demand (BOD_5), and oil and grease. A discussion of each parameter follows.

3.2.2.1 Hydrogen Ion Activity

The hydrogen ion activity, or pH, was slightly basic (pH greater than 7.0) in most cases. The pH ranged from 6.5 to 8.9 falling below 7.0 in 28% of the samples analyzed. Medium pH level was 7.5. This moderately basic pH is characteristic of slightly hard natural waters, with inorganic carbon predominantly in the carbonate ion form. The degree of toxicity or solubility of many compounds, such as hydrogen sulfide and aluminum, is enhanced by a low pH. Thus, a slightly basic pH is beneficial to the aquatic environment in terms of reducing the toxicity of certain indigenous or contaminating compounds. Additionally, moderately hard natural waters generally have increased buffering capacity which protects against pH fluctuations.

The pH ranged from 7.1 to 8.8, 7.0 to 8.2, 6.6 to 8.4 and 6.8 to 8.6 during 1982, 1983, 1984, and 1985 respectively. The 1982 through 1986 data have remained relatively constant in terms of median pH and range. The slight fluctuations observed are attributed to a variety of environmental and seasonal factors such as variations in rainfall or aquatic system flushing.

3.2.2.2 Salinity

Salinity means at stations A, B, C, and D were 0.0, 7.9, 3.1, and 0.3 respectively. Salinity at Station A remained below 0.2 parts per thousand (ppt) throughout 1986. At Station B, salinity ranged from 1.2 ppt in May to 30 ppt in July with levels above 5 ppt only during June through August. Stations C and D were nonzero during May through December (except May and November when D was zero). Station B, located in the North-South Canal, is a surface drainage ditch crossing SPR property, but receiving no SPR discharges. The elevated salinities observed at station B were noted during periods of low or no flow and were not due to SPR activities.

Station C, located on the East-West Canal to the southeast of the brine pond, has historically shown a slightly elevated level of salinity (up to 4.1 ppt during 1986). This is partially attributed to station proximity to the brine pond, the wastewater treatment outfall, flood control system discharges, and residue from brining activities conducted by prior tenants of Bayou Choctaw. Station D salinities (up to 0.5 ppt) are strongly influenced by Bull Bay and the Intracoastal Waterway. Salinities at stations B, C, and D generally reached highest concentrations during 1985 than during previous years or 1986. These high concentrations were attributed to long periods of dry weather which reduces flushing activity.

3.2.2.3 Total Suspended Solids

Average annual TSS levels at stations A, B, C, and D were 20.4 5.9, 38.2, and 48.7 milligrams per liter (mg/l) respectively. The highest TSS level (88.0 mg/l) was observed during October at control station D which is located away from all SPR outfalls. The lowest level (2.0 mg/l) was noted at station B during September. No SPR outfall exceeded the permit limitation for TSS during 1986. Data from Station C, which monitors the receiving waters from the sewage treatment plant, indicated no measurable impact of TSS on these receiving waters.

3.2.2.4 Temperature

Temperatures ranged from 11°C at station B during December to 30°C at stations B and C during September and July respectively. Temperatures for all stations averaged 22.9°C between May and December. Temperatures above 20°C were consistently observed at all stations, except during October through December. The temperature range varied by 19°C in 1986 as compared the 20.5, 19.5, 20.0 and 13.0°C ranges observed during 1982, 1983, 1984, and 1985 respectively. Thus, ambient temperatures during 1986 were similar to all years when monitoring was performed with the

exception of 1985, which had unusually moderate weather conditions. Temperature fluctuations are attributed solely to meteorological conditions since Bayou Choctaw produces no thermal discharges.

3.2.2.5 Dissolved Oxygen

The DO ranged from 1.1 mg/l at station D during October to 15.4 mg/l at station B during the same month. Levels were below 5.0 mg/l at stations A, B, C, and D on 6, 1, 5, and 6 occasions respectively from May through December. The sewage treatment plant which discharges in the vicinity of station C had no BOD_5 or other noncompliances throughout the monitoring period. The DO levels at station C ranged between 3.1 and 5.3 mg/l. Mean DO levels at stations A, B, C, and D were 3.6, 9.4, 5.3 and 4.0 mg/l respectively. Lower DO levels were noted at stations A and D which are located away from all SPR outfalls. This observation would attribute DO fluctuations to natural causes such as surface water flushing, meteorology (wind and rain), and primary productivity (as an oxygen source).

3.2.2.6 Biochemical Oxygen Demand

The observed five-day BOD_5 ranged from 0.4 to 10.0 mg/l mean BOD_5 levels at stations A, B, C and D were 3.4., 1.9, 5.1 and 3.5 mg/l respectively. Such data are typical for backwater areas and are consistent with the ranges observed during previous years (<1.0 mg/l to 7.2 mg/l). These data indicate low organic loading in the Bayou Choctaw surface waters supporting the contention that the observed depressed DO levels, discussed above, are not due to organic decomposition, which may originate from an inefficient sewage treatment plant.

3.2.2.7 Oil and Grease

Oil and grease levels were below detectable levels (<5 mg/l) at all monitoring stations throughout 1986. This is consistent with data collected since 1982. In fact, the only detectable level ever found was during January 1985 at station A and was attributed to industrial activities occurring upstream of the SPR on Bayou Bourbeaux. These data favorably reflect onsite housekeeping and effective site spill prevention control and response efforts.

3.2.2.8 General Observations

Based on the above discussion, the following general observations are made regarding the quality of Bayou Choctaw surface waters.

a. The surrounding surface waters continue to be slightly basic, which is normal for the area.

b. The observed salinities were generally low. Elevated salinities observed at station B, during the summer of 1986 were attributed to non-SPR activities or unknown natural phenomena. The slightly elevated salinities observed at other stations were apparently representative of ambient surface water conditions.

c. The consistently high TSS levels observed reflect ambient surface water conditions at Bayou Choctaw. Such conditions reduce the depth of the photic zone and tend to smother invertebrates, thus limiting variety at the base of the food chain. These conditions are not attributed to SPR operations, but rather appear indigenous to the area as demonstrated by consistently high TSS observations over a five year period at both site and control stations.

d. Low levels of DO were observed on one or more occasions at each station. This phenomenon is attributed to low flow

and minimal flushing typically observed at these stations during summer months.

e. The consistently low BOD_5 and nondetectable oil and grease levels observed during 1982, 1983, 1984, 1985 (except during January 1985), and 1986 suggest that site oil spills and wastewater treatment plants are effectively managed, minimizing the impact on the Bayou Choctaw environs.

3.2.3 Water Discharge Permit Monitoring

The major permit monitoring is related to water discharges regulated under the EPA (NPDES) permit and a corresponding permit issued by the Louisiana Department of Environmental Quality (LDEQ) Office of Water Resources. Discharges are from two package sewage treatment plants and stormwater runoff from well pads and pump pads (containment areas).

Parameters monitored for these discharge permits are described below.

Location/Discharge	Parameter	Compliance Range
sewage treatment plants	flow	(report only)
	BOD_5	$\leq$45 mg/l
	TSS	$\leq$45 mg/l
	pH	6.0 - 9.0 units
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	pH	6.0 - 9.0 units

A total of 288 analyses (73.6% for sewage and 26.4% for stormwater discharges) were conducted on permitted outfalls to monitor NPDES and state permit compliance during 1986. The one noncompliance (Table 3-2) in 1986 involved a high BOD_5 level in the site sewage treatment plant. All other required analyses conducted on the site discharges were within permit limitations resulting in a 99.6% compliance level for 1986.

3.2.4 Active Permits

Table 3-3 lists the active permits at Bayou Choctaw. The Cavern Engineering Department obtains individual work permits from the Louisiana Underground Injection Control Division for each well workover performed. State inspectors regularly visit the site to observe drilling operations and document well certifications.

3.2.5 Ground Water

The Plaquemine Aquifer is the main source of fresh water for the site and several surrounding municipalities. It is located approximately 60 feet below the surface and extends to a depth of 500 to 600 feet. The upper 60 feet of sediments consist of Atchafalaya clay. The interface of freshwater and saline water occurs at a depth of 400 to 500 feet below the surface. Ground water in the Plaquemine Aquifer communicates with the Mississippi River flowing away from it during the high river stage and towards the river in the low stage.

At the Bayou Choctaw facility, two monitoring wells are located near the brine pond. There are no well logs or other background information on these monitoring wells to facilitate data interpretation, thus ground water was not sampled during 1986.

3.2.6 Other Significant Environmental Activity

Additional spill response equipment, including a boom storage trailer to enhance mobilization, was procured to strengthen spill response capabilities. A shallow draft boat was also acquired to facilitate boom deployment and sample collection in shallow water areas. Slide gates were installed on culverts to prevent off site brine, oil, and fire fighting foam contamination in case of a major spill or fire. Phase II CERCLA testing was initiated during 1986. Samples from the drill cuttings mud pit near brine disposal well #1 were negative for EP toxicity. The only other area suspected of being hazardous was

an unused cavern (#10). Preliminary tests performed indicate the cavern may have hazardous contents due to its high pH (13.7) and lead levels (89.7 mg/l). More intensive sampling of the cavern and development of action plans are scheduled for Phase III CERCLA in 1987.

3.3 BIG HILL

The Big Hill site is planned for the storage of 140 million barrels of crude oil in 14 caverns. Raw water will be provided via a 48-inch pipeline from the Intracoastal Waterway; brine will be disposed via a 48-inch pipeline approximately five miles offshore in the Gulf of Mexico; and crude oil will be transported between the site and the Sunoco Terminal in Nederland by a 36-inch pipeline.

Drilling and construction commenced in 1983 at the site. Leaching and crude oil storage is anticipated in 1987 with the completion of the raw water and brine disposal pipelines.

3.3.1 Air Quality

The Big Hill facility operated in accordance with applicable air quality regulatory requirements. This included sprinkling plant roads with water and dust abatement chemicals to control fugitive dust emissions. Hydrocarbon emission monitoring is not required until crude oil storage is initiated.

3.3.2 Surface Water Quality Monitoring

At the onset of leaching and oil storage operations, selected locations will be established as monitoring stations to assess site-associated surface water quality and to provide early detection of any surface water quality degradation that may occur as a result of SPR operations. Parameters such as pH, salinity, alkalinity, temperature, total organic carbon, (TOC),

dissolved oxygen (DO), total dissolved solids (TDS), and total suspended solids (TSS) will be monitored.

3.3.3 Water Discharge Permit Monitoring

The NPDES permit obtained from the EPA and the discharge permit from the Texas Water Commission (TWC) have provisions for the sewage treatment plant, brine disposal pipeline, hydroclone, and stormwater discharges. Figure 3-2 shows the planned outfalls and proposed monitoring locations.

Only stormwater runoff from the five completed well pads was monitored during 1986. Parameters measured in stormwater effluent are described below.

Location/Discharge	Parameter	Compliance Range
stormwater	oil and grease	$\leq$15 mg/l
	TOC	$\leq$75 mg/l
	pH	6.0 - 9.0 units

In addition to two currently operating oil/water separators, there are design plans for four more separators to discharge stormwater runoff from well pads and pump pads to site drainage ditches. Each separator will become a discharge monitoring station.

Brine discharges to the Gulf of Mexico (outfall 001) will be monitored for flow, oil and grease, TSS, TDS, and pH when the pipeline becomes operational. The site sewage treatment plant (outfall 004) was constructed in 1986, but will remain out of service until permit modifications are received from the state. The discharge point for the sewage treatment plant will go directly into the 10-acre site pond. This pond will discharge infrequently because evaporation and rainfall rates are fairly equal. Pond overflow would be expected only during excessive rainfall and would flow south-southeast. Normal site drainage

will flow downslope toward the southeast, south, and southwest leading to the marshes south of the site.

A total of eight analyses were performed to monitor NPDES and state discharge permit compliance during 1986. No noncompliances were observed. All required analyses conducted on the site discharges were within permit limitations resulting in a 100% compliance level for 1986.

3.3.4 Active Permits

The Big Hill site is under construction. Permits are listed in Table 3-4. There were no spills or noncompliances during 1986. The first discharge monitoring report was provided to the EPA and TWC for the October through December reporting period. The Corps of Engineers permit for the brine disposal pipeline, crude oil pipeline, and raw water intake structure was extended to June 30, 1988 in order to coincide with the expected completion of construction. The U.S. Fish and Wildlife Service permit for construction of the brine disposal line across McFaddin National Wildlife Refuge was revised to include a pipeline completion date of July 31, 1988. Additional permits required for pipeline construction at highway and ditch crossings, as issued by the State of Texas or Jefferson County, are of such short duration that application will be made approximately three months prior to construction of the specific pipeline crossing.

3.3.5 Ground Water

The three major subsurface hydrological units in the Big Hill area are the Chicot, Evangeline, and Burkville aquifers. The major source of fresh water is the Chicot Aquifer which lies over the Big Hill salt dome. Fresh water in the upper Chicot Aquifer at Big Hill is limited from near the surface to a depth of -100 feet mean sea level.

The town of Winnie uses fresh water from the upper Chicot Aquifer. Beaumont and Port Arthur draw ground water from the lower Chicot Aquifer.

No ground water monitoring was conducted at Big Hill during 1986.

3.3.6 Other Significant Environmental Activity

A preoperation survey was performed at the Big Hill site and surrounding area to characterize pertinent environmental and ecological parameters as required by DOE Order 5484.1. Detailed maps that depict major soil associations, predominant vegetation species and communities, and existing disturbances in the area were developed. Follow-up surveys are planned every two years beginning in late 1987 or more frequently should a major environmental incident occur in the area. Such surveys will be useful for monitoring SPR impact, if any, on the surrounding environment.

Phase II CERCLA testing was initiated. Samples collected from the fresh water mud pit and the three saline mud pits at the site were negative for EP toxicity. Procedures to sample twenty-eight cavern wells for hazardous substances were developed during 1986 with actual sampling and analyses to commence in 1987.

3.4 BRYAN MOUND

The Bryan Mound site is planned for a total capacity of 226 million barrels of crude oil in 20 solution-mined caverns. Appurtenant facilities include a 36-inch brine disposal pipeline extending 12.5 miles into the Gulf of Mexico; a raw water intake structure adjacent to the site on the Brazos River Diversion Channel, two 30-inch crude oil pipelines connecting the site to the Jones Creek Tank Farm three miles northwest of the site, and

the Phillips docks four miles northeast of the site. Construction of a 40-inch crude oil pipeline from the site to Arco Refinery in Texas City commenced in 1986.

3.4.1 Air Quality

The Bryan Mound facility, located in a nonattainment area for ozone, operated in accordance with all air quality regulatory requirements throughout 1986. The ongoing fugitive emissions monitoring program detected no leaks of hydrocarbon vapors from valves or pump seals. Hydrocarbon emissions from surge tanks were 1.6 tons per year during 1986, or 26.8% of permitted limits (6.1 tons per year). The reduced rate is attributed mainly to the tank cleaning operations that commenced in early 1986. Cleaning was performed in accordance with requirements of the Railroad Commission of Texas, and the Texas Air Control Board (TACB). The TACB inspection conducted during 1986 found no deficiencies in SPR air quality compliance.

3.4.2 Surface Water Quality Monitoring

The surface waters surrounding the Bryan Mound site were monitored throughout 1986. Blue Lake was sampled once monthly at each station except during April, May, and November. Mud Lake was sampled once at each station during June and then monthly from September through December. The reduced sampling frequency in Mud Lake was due to limited access caused by low tides at certain times during the year.

Specific surface water monitoring stations are identified in Figure 3-3. Stations A through C and E through G are located along the Blue Lake shoreline to monitor effects of site runoff. Station D, located farther away from the site in Blue Lake, serves as a control. Stations H and I are located along the Mud Lake shoreline to monitor effects of site runoff. Station J, located away from the shoreline in Mud Lake, serves as a control.

Specific parameters monitored in the Bryan Mound surface waters include pH, alkalinity, salinity, temperature, DO, TOC, chemical oxygen demand (COD), nitrite, nitrate, orthophosphate, total iron, calcium, and magnesium. The parameters are discussed and compared to 1982 through 1985 monitoring data.

3.4.2.1 Hydrogen Ion Activity

The hydrogen ion activity, or pH, was moderately basic, ranging from 8.0 in March and December to 9.9 in August in Blue Lake and 7.5 in September to 8.4 in June in Mud Lake. Median pH levels in Blue Lake and Mud Lake were 8.7 and 8.5, respectively. The consistently basic conditions indicate natural waters devoid of carbon dioxide and generally hard in regard to mineral content. Marine and estuarine waters, such as those in Blue Lake and Mud Lake, are typically basic and high in mineral content. The pH may fluctuate directly with the rate of carbon dioxide uptake as related to low primary productivity (lower pH) during cool periods and high primary productivity (higher pH) during warm periods.

During 1982, 1983, 1984, and 1985 the pH measurements in Blue Lake and Mud Lake ranged from 7.7 to 10.1, 7.7 to 10.2, 7.2 to 9.9, and 7.9 to 9.8 respectively, in general agreement with the 1986 data. Thus, pH fluctuations in the Bryan Mound surface waters appear to be the result of seasonal weather and tidal variations rather than site activity.

3.4.2.2 Alkalinity

Alkalinity, the capacity of water to neutralize an acid, generally reflects the activity of calcium carbonate ($CaCO_3$) in water. The alkalinity in Blue Lake ranged from 50 mg/l in August to 181 mg/l as $CaCO_3$ in March, while the alkalinity in Mud Lake ranged from 99 mg/l in December to 167 mg/l as $CaCO_3$ in June. Mean alkalinity leels were 81.1 and 122.2 mg/l for

Blue Lake and Mud Lake respectively. These levels of alkalinity, which provide some buffering capacity in the Bryan Mound waters, are in general agreement with data from previous years.

3.4.2.3 Salinity

Mean salinity levels were 8.1 and 9.0 ppt in Blue Lake and Mud Lake respectively. The salinity in Blue Lake ranged from 4.0 ppt in late December to 13.0 ppt in August. Salinities were highest (10.0 to 13.0 ppt) from June through September. Salinities were generally higher in 1986 and 1983 than during 1982, 1984, and 1985. Salinity fluctuations are attributed to meteorologically induced conditions rather than site operations, since salinities observed at control sample points consistently equal that found along the site shoreline.

The salinity in Mud Lake ranged from 1.0 ppt in December to 12 ppt in September. Mud Lake salinities were generally higher from 1982 through 1985 than during 1986. The wider salinity variations in Mud Lake relative to Blue Lake are primarily attributed to the strong tidal and wind influence on the Lake and its more direct link with the Gulf of Mexico.

3.4.2.4 Temperature

The temperature in Blue Lake ranged from 11°C in December to 33°C in August. The temperature in Mud Lake ranged from 10°C in December to 32°C in June. No measurements were taken from January through August except during June in Mud Lake limiting the comparisons that can be made with previous years. Mean temperature readings during 1986 were 22.5 and 25.5°C in Blue Lake and Mud Lake respectively. Temperature variation within each lake among sampling periods was generally limited to 1° or 2°C suggesting no measurable site induced thermal effects.

Comparable temperatures were observed during previous years. Blue Lake ranged from lows of 17°C in December 1982, and 9°C in January 1983 and 1984 to highs of 33°C in August 1982, and 32°C in July 1983 and September 1984. Mud Lake ranged from lows of 16°C in December 1982, 15°C in February 1983, 22°C in April 1984, and 9°C in December 1985 to highs of 31°C in June 1982, 32°C in July 1983, 29°C in July 1984, and 30°C in June and July 1985.

3.4.2.5 Dissolved Oxygen

Mean DO concentrations were 8.8 and 8.1 mg/l in Blue Lake and Mud Lake respectively. The DO concentration in Blue Lake ranged from 5.5 mg/l in August to 14.0 mg/l in September. The lowest level was found at the control station (station D). The DO in Mud Lake ranged from 7.5 mg/l in November (no sampling from January through August except during June) to 9.0 mg/l in June. These DO ranges are generally beneficial to the aquatic organisms inhabiting these lakes. Fluctuations in DO levels were partially attributed to the inverse relationship between salinity/temperature and DO as well as seasonal fluctuations in primary productivity, and meteorological factors such as wind driven mixing.

3.4.2.6 Total Organic Carbon

The TOC concentration in Blue Lake was relatively low, averaged 8.4 mg/l and ranged from 6.5 to 11.3 mg/l throughout 1986. Concentrations were slightly higher at station D, the control station, indicating that elevated concentrations are not caused by site activity, but rather natural phenomena. The elevated concentrations attributed to natural phytoplankton blooms from 1982 through 1984 were not observed in 1985 or 1986.

The TOC concentration in Mud Lake remained low, averaged 8.4 mg/l and ranged from 3.8 mg/l in September to 6.6 mg/l in October (observations made during June, September, October, and December only). The low TOC levels observed in both lakes are consistent with healthy conditions and a stable oxygen demand.

It is interesting to note that the 'red tide', an unusually high abundance of toxic red alge, caused substantial fish kills and numerous other problems along the eastern Texas gulf coast during the spring and summer of 1986. The absence of fish kills indicated that neither Blue Lake nor Mud Lake were substantially affected by the alga. Fish kills were noted in the Brazos River Diversion Channel near the Bryan Mound raw water structure, an area not routinely sampled for water quality.

3.4.2.7 Chemical Oxygen Demand

The COD in Blue Lake averaged 63.1 mg/l and ranged from 9.9 mg/l in September to 196.5 mg/l in August. The highest level was at station D, the control point for the lake. The levels observed during 1986 were slightly higher than 1985 (25 to 90 mg/l), but considerably lower (by a factor of 2) during 1982 through 1984. Elevated levels during the warmer summer months of 1986 were similar to those noted during previous years.

The COD in Mud Lake averaged 33.1 mg/l and ranged from 9.2 mg/l in September to 124.3 mg/l in December. Levels were generally lower than observed in previous years (1982 through 1985) and to that observed in Blue Lake during 1986. Variation in COD between the lakes is attributed to the tidal and morphological differences.

3.4.2.8 Macronutrients

The macronutrients, nitrate, nitrite, and orthophosphate, were monitored in Blue Lake and Mud Lake throughout 1986. These parameters provide an indication of eutrophication in natural waters.

Nitrate is a necessary nutrient to the metabolism of plants. The nitrate concentration in Blue Lake averaged 3.3 mg/l and ranged from nondetectable during June to 8.8 mg/l in August. The nitrate concentration in Mud Lake averaged 3.2 mg/l and ranged from nondetectable in June to 4.4 mg/l in June (at a different station) and September. These concentrations are low for contact waters, but sufficiently high to ensure the production of protein during primary production. Nitrite concentrations were very low in both lakes, ranging from nondetectable concentrations to 0.33 mg/l. Average nitrite concentrations were 0.07 and 0.06 mg/l in Blue Lake and Mud Lake respectively. Such low concentrations are consistent with expectations for natural waters.

Phosphate is a necessary nutrient to plant metabolism, functioning in biochemical energy transfer. Phosphate is generally found in small quantities in natural waters and is a common limiting factor to plant growth (primary production). Phosphate in Blue Lake averaged 2.3 mg/l and ranged from 0.1 mg/l in February and March to 6.0 mg/l during July. Mud Lake phosphate levels averaged 0.7 mg/l and ranged from 0.1 mg/l in April to 0.9 mg/l in October. The elevated phosphate levels observed during 1983 and 1984 were attributed to resident and migratory waterfowl populations rafting in open water areas. Waterfowl moved from the open water sample stations in 1985 but still congregate in the marshy northwest corner of Blue Lake due to unusual hunting pressure. This change in habitat use has affected the level of observable phosphate. Stability of other

parameters, such as DO, TOC, and COD, throughout 1986 is consistent with these phosphate observations.

3.4.2.9 Cations

Total iron, calcium, and magnesium cations were monitored throughout 1986. Total iron averaged 0.4 mg/l and was observed at less than 1.0 mg/l in over 92% of the samples for Blue Lake. A maximum of 1.8 mg/l was observed in March. Mud Lake iron concentrations ranged from 0.1 to 1.3 mg/l. The low iron levels in both lakes are typical for natural waters but sufficient to support indigenous organisms. The iron levels observed in Mud Lake (average 0.5 mg/l during 1986) were high during previous years (1982, 1983, 1984, and 1985 observations average 2.6, 1.7, 4.3 and 4.3 mg/l respectively). The iron levels in Mud Lake are attributed to its basin geochemistry, morphology, and the water intrusion from the Intracoastal Waterway.

Calcium and magnesium, essential micronutrients to plants and animals, are commonly the principal contributors to water hardness. Calcium concentrations averaged 143 mg/l and ranged from 90 mg/l (December) to 203 mg/l (August) in Blue Lake. Calcium concentrations averaged 295 mg/l and ranged from 59 mg/l (December) to 714 mg/l (September) in Mud Lake. Magnesium ranged from 128 mg/l (December) to 356 mg/l (September) in Blue Lake and 43 mg/l (December) to 424 mg/l (September) in Mud Lake. Average magnesium concentrations were 223 and 234 mg/l in blue Lake and Mud Lake respectively. Concentrations of calcium and magnesium observed in Blue Lake during 1986 were similar to previous year's observations. The concentrations of these micronutrients in Mud Lake have steadily increased for unknown reasons since 1982.

3.4.2.10 Additional Water Quality Monitoring

A water sample collected from the Brazos River Diversion Channel at the Bryan Mound raw water structure during 1986 was analyzed for background asbestos levels and compared to asbestos levels found in a each sample collected from the two original storage caverns. Asbestos levels in the channel were 63.5 fibers/ml versus 30.3 fibers/ml in cavern 5 and none in cavern 4. The high background levels are attributed to upstream contamination by industrial and natural sources.

Visual surveys of adjacent water bodies were performed periodically to monitor those phenological events and environmental perturbations that may affect the SPR either directly or by association. As a result of these surveys, the SPR provided the first report of red tide in the Freeport area to the Brazoria County Extension Service. Such reports reflect positively and enhance the relationship between the SPR and local governmental agencies. The surveys have also provided site personnel with a better awareness of the surrounding environment that led to participation in a beach cleanup program with several local industries and organizations.

3.4.2.11 General Observations

Based on the above discussions, the following general observations are made regarding the quality of Bryan Mound surface waters.

a. The observed pH was moderately basic but stable in Blue Lake and Mud Lake. This is consistent with the observed alkalinity and relative water hardness data. These factors would tend to buffer any pH related pollution incidents.

b. Salinity levels in Blue Lake and Mud Lake were slightly higher than 1985. The elevated levels were attributed to

meteorologically induced conditions rather than site operations.

c. Levels of TOC, DO, and COD remained moderate and fairly constant throughout the year. These data, in combination with nonfluctuating macronutrient data for Blue Lake indicate stable continued primary production.

d. Mud Lake experiences more acute changes in water quality than Blue Lake. The more direct link of Mud Lake with the Gulf of Mexico and the frequent wind and tidal induced flushing are responsible for dramatic seasonal changes in water quality.

3.4.3 Water Discharge Permit Monitoring

Water discharges at Bryan Mound are regulated and enforced through the EPA NPDES Permit Program and the similar TWC discharge permit program for state waters. The three categories of discharges are brine to the Gulf of Mexico; stormwater discharges from the tank farm, well pads, and pump pads; and a site sewage plant that became operational in early 1986.

Parameters measured from the three discharges are described below.

Location/Discharge	Parameter	Compliance Range
brine discharge to Gulf (EPA only)	flow	1.1 MMBD (nozzle exit velocity $\geq$ 20 f/s)
	oil and grease	$\leq$15 mg/l
	TDS	(report only)
	TSS	(report only)
	pH	6.0 - 9.0 units
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	TOC (EPA only)	$\leq$75 mg/l
	pH	6.0 - 9.0 units
	COD (TWC only)	$\leq$200 mg/l
sewage treatment plant	flow	$\leq$0.006 MGD
	BOD_5	$\leq$45 mg/l
		$\leq$0.7 lbs/day (Texas only)
	TSS	$\leq$45 mg/l
		$\leq$0.7 lbs/day (Texas only)
	chlorine (TWC only)	$\geq$ 1.0 mg/l
	pH	6.0 - 9.0 units

A total of 4,059 analyses were performed on permitted outfalls for the purpose of monitoring NPDES and state discharge permit compliance during 1986. The brine discharges to the Gulf of Mexico accounted for 24.3% of these analyses. Most analyses (59.6%) were performed on stormwater and pump pad discharges. There were only five noncompliances during 1986 (Table 3-5) resulting in a 99.9% site compliance performance level.

The Bryan Mound site has a second TWC permit for the appropriation of state waters for the leaching program, site utility, and fire protection systems. The permit requires a yearly report of the quantity of water used. In 1986, the site appropriated 4,565 acre-feet of water from the Brazos River Diversion Channel. A total of 117,085 acre-feet of water has been

appropriated to date for site activities which represents 54.5% of the total volume permitted.

3.4.4 Active Permits

Table 3-6 lists the active permits for the Bryan Mound site. Construction of a potable water line from a City of Freeport tie-in to the site was completed under permits from the COE, Texas Department of Highways and Public Transportation (TDH&PT), and Brazoria County. Operation of a sewage treatment plant (permitted by TWC #02271) began in 1986.

3.4.5 Ground Water

The Chicot and Evangeline Aquifers provide fresh and slightly saline water to the Bryan Mound area. Fresh water for Brazoria County is obtained from the upper portions of the Chicot Aquifer. Fresh water occurs in the upper 80 feet of the aquifer over the salt dome with slightly saline water from -80 to approximately -225 feet. However, the wells drilled on site for rig water supply brackish water.

There are three monitoring wells (P1, P2, and P3) on site. Locations of these wells are identified in Figure 3-3. The monitoring wells have been sampled since 1982, generally on a monthly basis. During 1986, sampling was limited to January through March due to manpower constraints. There are no well log histories for these wells.

For three months in 1986, the pH of well P1 ranged from 6.08 to 6.18. Salinity averaged 141 ppt and ranged from 97 ppt in March to 270 ppt in early January. COD averaged 42.3 mg/l and ranged from 34.8 mg/l in February to 50.5 mg/l in March. P2 exhibited a low pH of 6.75 in February ranging to 6.91 in January. Salinity averaged 96 ppt and ranged from 8 ppt in late January to 270 ppt in early January. COD averaged 57.0 and ranged from

46.0 mg/l in February to 67.5 mg/l in the previous month. The pH for P3 ranged from 6.45 to 6.50. Salinity averaged 85.4 ppt and ranged from 23 ppt in late January to 266 ppt in early January. COD averaged 74.2 mg/l and ranged from 52.7 mg/l to 108 mg/l.

The interconnection of the aquifers and their proximity to the salt dome may contribute to salinity variation. Well installation and logging data is necessary to properly interpret the existing monitoring data. Monitoring of these wells will continue in order to establish a benchmark for future study.

3.4.6 Other Significant Environmental Activity

The site sewage treatment plant became fully operational without any noncompliances occurring after initial plant stabilization. Spill response capabilities were strengthened through procurement of additional equipment. The equipment includes more marsh boom and a shallow draught mud boat to facilitate boom deployment and sample collection in shallow water areas. More rapid analysis of stormwater samples began in mid-1986 with the acquisition of a new infrared spectrophotometer. This reduction of analysis time will reduce stormwater retention time, which is favored by site operations and maintenance personnel. Phase II CERCLA testing was conducted in 1986. Test results for EP toxicity in the mud pit and asbestos in caverns 4 and 5 were negative. A recently discovered tarry area was also sampled. Small amounts of five priority pollutants were detected, but EP toxicity results were inconclusive. More intensive sampling of the pit is planned for 1987.

3.5 ST. JAMES TERMINAL

The St. James Terminal has six above-ground storage tanks (total capacity two million barrels) and two tanker docks. The terminal is connected to both Weeks Island and Bayou Choctaw.

3.5.1 Air Quality

St. James Terminal operated in accordance with all air quality permit and regulatory requirements during 1986. Oil movements of approximately 1.9 million barrels were limited to pipeline transfer operations and a single ship loading conducted as part of a test sale of SPR crude oil. Hydrocarbon emissions were well below the levels projected in the Emission Inventory Questionnaire. Seals on all six external floating roofs were visually inspected during 1986 to assure compliance with state air quality regulations. The seals are scheduled for repair/replacement during 1987. St. James is located in a nonattainment area for ozone.

3.5.2 Surface Water Quality Monitoring

St. James Terminal is located in a low-lying agricultural area beyond of the west levee of the Mississippi River. All precipitation is effectively drained from the terminal and surrounding sugar cane fields by a series of ditches.

The two St. James docks are located on the west bank of the Mississippi River. They are curbed with all runoff pumped to the stormwater treatment system and retention pond. The site retention pond, which also collects stormwater runoff from the six crude oil storage tank containment areas, is discharged intermittently through outfall 001 (Figure 3-4) into the Mississippi River. Two wastewater treatment plants, which serve the site control and maintenance buildings, discharge as state outfalls 002 and 003 through outfall 001 into the Mississippi River.

At St. James, the Mississippi River has a large flow volume, and rapid currents providing a strong assimilative capacity. The intermittent nature of discharges from site outfalls, the characteristic hydrographic features of the Mississippi River, and an ongoing state-conducted water quality monitoring program limit the value of a site-directed water quality monitoring program in the Mississippi River or around the site.

3.5.3 Water Discharge Permit Monitoring

The stormwater from the site retention pond (outfall 001) is the only water discharge regulated by EPA under the NPDES permit. The LDEQ has also issued a water discharge permit which includes outfall 001 with 002 and 003. The latter two are outfalls from the two site package sewage treatment plants. All individual discharges are through a common pipe to the Mississippi River.

Parameters measured from the outfalls are described below.

Location/Discharge	Parameter	Compliance Range
retention pond	flow	(report only)
	oil and grease	$\leq$15 mg/l
	pH	$\geq$6.0 - 9.0 units
	TOC	$\leq$55 mg/l (EPA)
		$\leq$50 mg/l (state)
sewage treatment plants	flow	(report only)
	BOD_5	$\leq$45 mg/l
	TSS	$\leq$45 mg/l
	pH	$\geq$6.0 - 9.0 units

A total of 75 analyses (44.0% for stormwater and 56.0% for stormwater discharges) were performed on permitted outfalls to monitor NPDES and state discharge permit compliance during 1986. One noncompliance (Table 3-7) in 1986 involved a high BOD_5 level in the main site package sewage treatment plant (outfall 002). All other required analyses conducted on the site discharges were within permit limitations resulting in a 98.7% compliance level for 1986.

3.5.4 Active Permits

Table 3-8 lists the active permits at St. James Terminal.

3.5.5 Ground Water

The Chicot Aquifer is the principal regional aquifer at St. James. The upper strata of the Chicot Aquifer is in direct hydrologic contact with the Mississippi River. Most of the ground water contained in this aquifer is slightly brackish. In the St. James area only the uppermost units contain fresh water.

3.5.6 Other Significant Environmental Activity

Construction of the St. James crude oil laboratory was completed in 1986. It is the only SPR laboratory equipped to analyze oil components. Slide gates were installed in culverts to mitigate off site contamination with oil, or fire fighting foam in case of a major spill or fire. The oil/water separator for stormwater from the diked tank area was overhauled. A rope skimmer was also added to the collection sump to pretreat stormwater before entering the separator. Additional spill response equipment including a boom storage trailer was acquired to strengthen response capabilities. A tanker was loaded without an environmental incident as part of the SPR crude oil test sale. The investigation under Phase I CERCLA did not reveal any potentially hazardous waste at the site.

3.6 SULPHUR MINES

Sulphur Mines stores 26 million barrels of crude oil in five existing solution-mined caverns three of which form a single gallery. The site is connected to the Sunoco Terminal in Nederland by way of a 16-inch crude oil pipeline which connects to the West Hackberry 42-inch line at the Gulf Intracoastal Waterway. Brine disposal is via injection into four brine disposal wells located approximately two miles southwest of the site.

3.6.1 Air Quality

Sulphur Mines operated in accordance with all air quality permit and regulatory requirements during 1986. No configurational or operational changes affecting emission rates occurred at Sulphur Mines. No air quality monitoring was required or conducted during 1986. This SPR site is located in a nonattainment area for ozone.

3.6.2 Surface Water Quality Monitoring

Samples collected once monthly at each monitoring station were used to monitor surface water quality. Specific monitoring stations are identified in Figure 3-5. Station C was not monitored during 1986. Specific parameters monitored in the Sulphur Mines surface waters were pH, salinity, TSS, temperature, oil and grease, and DO. These data are summarized and compared to data collected since 1982.

3.6.2.1 Hydrogen Ion Activity

The median pH was 7.3 ranging from a low of 4.9 at station A in June to a high of 9.8 at station D in March. The pH has increased slightly each year as compared to 1982 (6.0), 1983 (6.1), 1984 (6.4), and 1985 (7.2). The minimum and maximum pH occurred during June and March respectively during 1982, 1983, and 1984. In 1985, low and high values occurred in August and February. The pH was slightly more acidic at station A with a median pH of 6.3. Stations B, D, E, F, and G were neutral to slightly basic with an overall respective median pH of 7.7.

Low pH is characteristic of natural waters dominated by the carbon dioxide and bicarbonate forms of inorganic carbon. Such waters may generally be characterized as soft in regard to mineral content. Outfall 004, the site sewage treatment plant which discharges upstream of station A, was within compliance for pH as well as all other parameters throughout 1986. Thus,

the low pHs are not attributed to the sewage plant. Contamination of stormwater runoff by residual sulfur from past mining activities is considered the primary cause for relatively acidic surface waters in the area. Frasch mining activity occurred in the area from 1896 to 1924 and again in the late 1960's.

3.6.2.2 Salinity

The salinity of the surface waters at Sulphur Mines averaged 1.3 ppt and ranged from nondetectable to 3.5 ppt. Salinity levels were lowest at station F (averaged 0.2 ppt). These levels are consistent with data from previous years. These waters are part of the local flood control canal system and are distinct from the local Sulphur Mines surface drainage. The highest salinities were observed at station G (averaged 2.2.). This subsidence area drains an area where considerable Frasch sulfur mining activity occurred.

3.6.2.3 Total Suspended Solids

Monthly TSS levels averaged 26.1 mg/l and ranged from 2.3 mg/l to 364.0 mg/l during 1986. Less than 25% of the data exceeded a 15.0 mg/l benchmark by approximately 12 mg/l. These data are consistent with previous years. All site point source discharges were within permit limitations for TSS throughout 1986. The generally high and variable TSS levels observed in the surrounding waters are not attributed to any point source discharge from the site.

3.6.2.4 Temperature

The observed temperatures of the Sulphur Mines surface waters were generally conducive to supporting aquatic life throughout 1986. Maximum station temperatures as high as 31°C were observed from July through September, while the minimum temperatures (as low as 15°C) were observed during January and

December. The average temperature for all stations was 23°C. Slightly warmer temperatures were observed during 1986 as compared to temperatures observed each year since 1982.

3.6.2.5 Oil and Grease

Oil and grease levels were below detectable levels (<5 mg/l) at all monitoring stations throughout 1986. These data reflect favorably on the site spill prevention, control, and response efforts during 1986.

3.6.2.6 Dissolved Oxygen

Dissolved oxygen monitoring was performed only at station A throughout 1986. This station is located in a relatively stagnant drainage ditch that receives effluent from the site package sewage treatment plant. The DO levels averaged 7.5 mg/l and ranged from 3.6 mg/l during May to 15.0 mg/l during July. The sewage plant operated in compliance throughout 1986. The DO levels were higher in 1986 than during 1985 when six BOD_5 non-compliances occurred. Although the sewage plant effluent may have been contributory, the low DO levels are related to natural organic loading, algal proliferation, and limited flushing caused by low rainfall.

3.6.2.7 General Observations

Based on the above discussion, the following general observations are made regarding the quality of Sulphur Mines surface waters.

a. The generally consistent temporal and spatial pH distribution from 1982 through 1986 suggests that the slightly acidic water quality conditions at Sulphur Mines are attributable to geochemical and meteorological conditions.

b. The small increase in water temperature observed during 1986 relative to 1984 and 1985 is attributed to meteorological variation since the SPR conducts no thermal discharges.

c. The higher DO levels observed during 1986 as compared to 1985 were attributed to natural factors as well as low BOD_5 levels in effluent from the site sewage treatment plant.

3.6.3 Water Discharge Permit Monitoring

The six water discharge points at Sulphur Mines are regulated through the EPA NPDES program. Five of the discharges are stormwater runoff from the well and pump pads (outfalls 001, 002, 003, 005, and 006). The sixth (outfall 004) is the effluent from the package sewage treatment plant.

Parameters analyzed from the stormwater and wastewater discharges are described below.

Location/Discharge	Parameter	Compliance Range
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	pH	$\overline{6}$.0 - 9.0 units
sewage treatment plant	flow	(report)
	BOD_5	$\leq$45 mg/l
	TSS	$\overline{\leq}$45 mg/l
	pH	$\overline{6}$.0 - 9.0 units

A total of 507 analyses were conducted on permitted outfalls to monitor NPDES compliance during 1986. Approximately 53% of the analyses performed were for monitoring stormwater runoff with the remainder for sewage treatment plant effluent analyses. There were no noncompliances during 1986.

3.6.4 Active Permits

Table 3-9 lists the active permits at Sulphur Mines. The brine disposal wells are routinely exercised, and all state underground injection control certifications are current. The required one-time work authorizations for the individual wells were obtained by the Cavern Engineering Department. State inspectors regularly visit the site to observe underground injection operations.

3.6.5 Ground Water

The main aquifers in the vicinity of Sulphur Mines are the Chicot, Evangeline, and Jasper. The Chicot Aquifer provides a fresh water source for public and industrial use to the towns of Hackberry, Lake Charles, and Sulphur. The Evangeline and Jasper Aquifers are saline. The Evangeline Aquifer is used for salt water disposal in the Lake Charles area.

There are no ground water monitoring wells on the Sulphur Mines site.

3.6.6 Other Significant Environmental Activity

Water collecting in the brine pond underdrain system was monitored and analyzed. The pH was relatively constant (range 4.7 to 6.5). Salinity levels averaged 173 ppt and ranged between 105 and 300 ppt. The increasing salinities indicated a leak either in the pond liner or associated valving. Reduced salinities are anticipated with maintenance of valves and the repair of the brine pond liner in December 1986. Phase II CERCLA testing was initiated in 1987. Test results for EP toxicity in the mud pits near brine disposal wells 3 and 4 were negative. In cooperation with the U.S. Soil Conservation Service, a program for revegetating barren soil areas at the site was initiated.

3.7 WEEKS ISLAND

The Weeks Island site consists of a large mechanically excavated (room and pillar type) salt mine with a 73-million barrel crude oil storage capacity. In addition to normal site facilities, there is a 68-mile long 36-inch crude oil pipeline connecting the site to the St. James Terminal.

3.7.1 Air Quality

Weeks Island operated in accordance with all air quality permit and regulatory requirements during 1986. Equalization piping connecting boreholes (gas pressure relief vents) in the mine was completed. This piping will reduce emissions by equalizing hydrocarbon vapors throughout the mine instead of venting to the atmosphere. The vapor recovery unit was removed from service due to high maintenance costs. The unit was originally installed to provide economic benefits through reclamation of a portion of the nonhalogenated hydrocarbon vapors from the waste gas stream prior to combustion by the site flare. However, it was never used. No other configurational or operational changes affecting emission rates occurred at Weeks Island. Air quality monitoring was neither required nor conducted during 1986.

3.7.2 Surface Water Quality Monitoring

The Weeks Island site is located on the Weeks Island salt dome approximately 100 feet above sea level. The surrounding topography is of rather sharp relief with several small lakes. None of the SPR outfalls discharge directly into these lakes. Other surface waters at this site are intermittent in nature, draining rapidly and thoroughly after any precipitation. The site outfalls 01A, 01B, and 002 (Figure 3-6) discharge small volumes into surface drainage at a substantial distance from receiving waters. The lack of potentially impacted surface waters precludes the need for surface water quality monitoring at the Weeks Island site.

3.7.3 Water Discharge Permit Monitoring

The water discharges at Weeks Island are regulated and enforced in accordance with the EPA NPDES permit program. There are two separate outfalls (01B and 002) one for each package sewage treatment plant. Outfall 01A consists of stormwater runoff collected in an onsite retention pond.

The various parameters analyzed from the monthly samples of all three discharges are listed below with their maximum limits.

Location/Discharge	Parameter	Compliance Range
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	pH	$\overline{6}$.0 - 9.0 units
sewage treatment plant	flow	(report only)
	BOD_5	$\leq$45 mg/l
	TSS	$\overline{\leq}$45 mg/l
	fecal coliforms	$\overline{\leq}$400 colonies/100 ml
	pH	$\overline{6}$.0 - 9.0 units

A total of 116 analyses (82.8% for sewage and 17.2% for stormwater discharges) were conducted on permitted outfalls to monitor NPDES compliance during 1986. There were four noncompliances in 1986, all associated with BOD_5 levels in the two site sewage treatment plants (Table 3-10). On an individual analysis basis, the site experienced a compliance performance level of 96.5%

3.7.4 Active Permits

The active permits for Weeks Island are indicated in Table 3-11. All applicable permits for activities at the facility are current.

3.7.5 Ground Water

The Chicot formation is the principal aquifer in the Weeks Island area. The aquifer surface is at approximately sea level near Weeks Island and slopes slightly northwest towards a cone of depression attributed to heavy withdrawals in the Lake Charles area. Some of the upper sand layers in the Chicot Aquifer contain fresh water above 300 to 600 feet below the surface. The fresh water sand layers provide water for the local area.

There are no ground water monitoring stations at Weeks Island.

3.7.6 Other Significant Environmental Activity

Additional spill response equipment, including a boom storage trailer to facilitate boom deployment was acquired to strengthen response capabilities. Results from Phase I CERCLA indicate an absence of hazardous waste at the facility. Although several recirculation and drawdown exercises were performed, no spills occurred at the facility.

3.8 WEST HACKBERRY

The West Hackberry site is planned for storage of 219 million barrels of crude oil in 22 solution-mined caverns. Brine is transported and disposed by injection into eight active brine disposal wells located approximately two miles southeast of the site or through a 36-inch pipeline at an area seven miles south of Holly Beach. A series of 55 brine diffuser nozzles are operated to promote brine dispersion in the Gulf of Mexico. Raw water is brought to the site via pipeline from the Intracoastal Waterway and crude oil is transported between the site and the Sunoco Terminal in Nederland via a 42-inch crude oil pipeline.

3.8.1 Air Quality

West Hackberry operated in accordance with all air quality permit and regulatory requirements during 1986. No new air quality data was collected or developed. There were no construction or configurational changes which would have resulted in additional emissions during 1986. The facility is located in a nonattainment area for ozone.

3.8.2 Surface Water Quality Monitoring

West Hackberry surface water quality was monitored by sampling once monthly at each station throughout 1986 except during November when no samples were collected. Specific monitoring stations are indicated and identified in Figure 3-7. Specific parameters monitored in the West Hackberry surface waters include

pH, salinity, TSS, temperature, TOC, and oil and grease. Oil and grease was not monitored at station D. The TOC was monitored only at station E corresponding to the NPDES permit requirement regarding site discharges. Each parameter is discussed in the following sections.

A water column sample and a benthic interstitial water sample were collected at monthly intervals from each monitoring station established in Black Lake (Figure 3-8) adjacent to cavern 111 in response to the crude oil spill of July 1986. These analyses were performed to monitor the effects of the spill on the lake.

3.8.2.1 Hydrogen Ion Activity

The pH ranged from 7.3 to 8.2. The median pH was 7.6. Less variation in pH was observed during 1986 than any year since 1983. The upper range of the monthly pH, on a station basis, exceeded 8.0 for 38% of the observations, which is higher than 1985 (20%), 1984 (22%), and 1983 (23%) observations but less than the 45% recorded in 1982. Natural waters low in or devoid of carbon dioxide are medium hard to hard, with regard to mineral content, and characteristically slightly basic. Some compounds, such as hydrogen cyanide and hydrogen sulfide, increase in toxicity with the degree of dissociation, resulting in increasing aquatic toxicity with reduced pH. In this regard, a mildly basic pH is beneficial to aquatic life and consistent with an environmentally sound ecosystem.

3.8.2.2 Salinity

Salinity averaged 6.8 ppt and ranged from 0.2 to 21.0 ppt for stations A through F. Stations A, B, and C (Black Lake) ranged from 2.9 to 21.0 ppt with the highest levels (21.0 ppt) occurring in September. The Black Lake data compare well with a steady increase in salinity observed from May through November in both 1982 and 1985. Comparisons among stations for each month were consistent.

Wind, tide, and rainfall contributed to the salinity variation in Black Lake. The broad salinity range observed in Black Lake is perhaps more conducive to supporting euryhaline organisms or those with sufficient motility to avoid salinity stresses with such seasonal changes.

Salinities at station D, the southeast drainage ditch, averaged 4.4 ppt and ranged from 0.9 ppt to 10.0 ppt, which is consistent with data collected during previous years. Monthly salinity values at station E, runoff from the high pressure pump pad, averaged 2.1 ppt and ranged from 0.9 to 21.0 ppt. Station E is generally less saline than Black Lake and fluctuates independently of Black Lake stations suggesting there is little or no impact from this SPR runoff.

3.8.2.3 Total Suspended Solids

TSS averaged 32.4 mg/l and ranged from 1.0 to 225.5 mg/l. The lowest range occurred at station E (1.0 to 22.0 mg/l) which averaged 5.9 mg/l. Similar ranges were found at stations A (averaged 27.9 mg/l), B (averaged 22.5 mg/l), and C (averaged 23.8 mg/l) in Black Lake (7.0 to 47.5 mg/l). Slightly higher levels were observed at station F (10.0 to 83.5 mg/l). Average levels at this station were 31.5 mg/l. The highest range was found at station D (9.5 to 225.5 mg/l), which averaged 12.0 mg/l.

Elevated TSS levels occurred in the three lake stations from January through April and during July. This phenomenon is attributed to wind and wave driven mixing in the shallow lake. The slightly elevated levels of July are also attributed to oil spill cleanup activities. The TSS level at station E was elevated during February and October when all three lake stations were high. This suggests that the high pressure pump pad did not significantly contribute to the higher levels of suspended solids in the lake. The consistently high TSS levels at station F (raw

water intake structure on the Intracoastal Waterway) correspond to expected data based on channel size and vessel traffic. The 1986 TSS data was similar to previous year's data suggesting that occurrence of relatively high TSS levels are typical for this water body.

3.8.2.4 Temperature

The temperature in Black Lake averaged 24.2°C and ranged from 9.0 to 34.0°C. The highest temperatures were recorded during July. The temperature ranges were consistent with previous years, except 1985 when the ranges were less (14.2 to 27.0°C). These data are consistent with observations at other sites indicative of regional climatic effects.

3.8.2.5 Oil and Grease

Oil and grease levels were below detectable levels (<5 mg/l) at all stations throughout 1986. This lack of detectable levels at the Black Lake monitoring stations A, B, and C indicates that any impact from the cavern 111 crude oil spill on the lake was minimal and short-lived.

3.8.2.6 Total Organic Carbon

TOC is an NPDES permit-required parameter for discharges from the high pressure pump pads as well as other stormwater discharges. Surface water quality monitoring involving TOC included station E only, the drainage area for the high pressure pump pad. The TOC levels at this station averaged 1.7 mg/l and ranged from nondetectable to 5.3 mg/l. These low levels indicate that effluent from the pad did not contribute substantially to TOC loading in the lake. These low TOC levels are generally acceptable for an area dominated by industrial runoff. The small fluctuation in TOC is likely related to activity on the pump pad and algal growth in the ditch.

3.8.2.7 Additional Monitoring in Black Lake

Five additional stations (Figure 3-8) were monitored in the Black Lake area surrounding the cavern 111 well pad. The monitoring was conducted in response to a wellhead component failure that resulted in an estimated spill of 2,343 barrels of crude oil and an unknown quantity of aqueous fire fighting foam (AFFF) into Black Lake and along the shoreline and adjacent marsh. Dissolved oxygen, pH, salinity, oil & grease, and TOC were sampled at the top and bottom of the water column at each station to identify residual impacts. Core samples from select stations were also collected in an effort to identify the presence of oil residues in the benthos. Sampling was performed weekly at each station from mid July through October and then monthly in November and December. Visual surveys were also performed to determine the residual impact, if any, on indigenous flora and fauna.

Water quality monitoring data collected from lake monitoring stations were consistent with control stations after cleanup was completed. Oily residues at the mud line have persisted at relatively high levels in samples from stations 3 and 4, and at lower concentrations at the other stations. Vegetation recovery was faster than originally anticipated with the exception of a few oil intolerant species and a few individual plants that had been saturated with oil. No residual effects were observed on indigenous fauna, including aquatic organisms. Results to date indicate the overall impact from the spill was confined and short-lived.

3.8.2.8 General Observations

The following observations are made, based on the above discussion, concerning operational impacts on the West Hackberry aquatic environs.

a. Runoff from the high pressure pump pad was of lower salinity than the Black Lake receiving waters. This demonstrates continuing good control of brine leaks and spills as has been observed since 1982.

b. TSS levels have fluctuated widely at all stations since 1982. High levels of TSS in Black Lake did not appear to be related to site discharges or runoff, but to natural phenonmena.

c. Oil and grease levels were nondetectable in Black Lake throughout 1986.

d. The observed impact from the cavern 111 oil spill incident was confined and short-lived.

3.8.3 Water Discharge Permit Monitoring

The water discharges at the West Hackberry site are regulated and enforced in accordance with the EPA NPDES permit program. The Louisiana Stream Control Commission (currently the Office of Water Resources in LDEQ) authorized discharge of stormwater and sanitary wastewater effluents.

The three categories of discharges at West Hackberry are brine disposal, sewage treatment plant effluent, and stormwater runoff from well and pump pads. The various parameters analyzed from these discharges are listed below with their maximum limits.

Location/Discharge	Parameter	Compliance Range
brine discharge	flow	≤1.088 MMBD (nozzle exit velocity > 25 f/s)
	oil and grease	≤15 mg/l
	TSS	(report only)
	TDS	(report only)
	pH	6.0 - 9.0 units
sewage treatment plant	flow	(report only)
	BOD_5	≤15 mg/l
	TSS	≤45 mg/l
	fecal coliform	(report only)
	pH	6.0 - 9.0 units
stormwater	flow	(report only)
	oil and grease	≤15 mg/l
	TOC	≤75 mg/l
	pH	6.0 - 9.0 units

A total of 4,172 analyses were conducted on permitted outfalls to monitor NPDES compliance during 1986. Discharges from the sewage treatment plant and brine disposal pipeline accounted for 1.3% and 29.3% respectively of total analyses performed. The majority of the analyses (69.4%) involved well and pump pad runoff.

Permit noncompliances were identified on six occasions (Table 3-12). There was no indication that any noncompliance adversely affected the surrounding environment based on data from the surface water quality monitoring program. These 1986 noncompliances, on a per analysis basis, resulted in a site compliance performance level in excess of 99.8%.

3.8.4 Active Permits

Active permits for West Hackberry are listed in Table 3-13.

3.8.5 Ground Water

There are three shallow aquifers found in the vicinity of the West Hackberry site. The Chicot Aquifer, which lies closest to

the surface in the Hackberry area, is predominantly fresh water with salinity increasing with proximity to the coast. The Evangeline Aquifer lies under the Chicot and the Jasper Aquifer.

The majority of the ground water pumping from the Chicot Aquifer takes place in the Lake Charles area. The pumping is so great that the ground water gradient has been reversed locally, flowing from the south to the north. The fresh/saline water interface is approximately 700 feet below the surface.

There are four monitoring wells (Figure 3-7) on the West Hackberry site. These monitoring wells have been sampled monthly since 1982. Well log histories and background information on construction and installation are lacking for most wells.

Monitoring well PB1 showed a slight increase in ground water salinity during 1986. Average salinity values in wells PB1, P8, and P11 were 14.4, 1.1, 2.8 and 3.4 ppt respectively. Salinity ranged from 0.9 ppt in July at P8 to 21.5 ppt at PB1 during the same month. Samples were not collected in November and December. Salinity in monitoring wells P8, P9, and P11 showed only slight fluctuations during 1986. The ground water pH values observed from the monitoring wells P8, P9, and P11 ranged from 6.2 to 7.3, which is consistent with 1985 data. The pH in ground water monitoring well PB1 ranged from 3.4 during May to 4.7 during January and April.

3.8.6 Other Significant Environmental Activity

Sampling and monitoring of several apparently stressed oak trees located near the property line continued in an effort to assess their general health. The presence of abundant new growth indicates the trees are recovering. Numerous environmental

assessment surveys were performed in the Black Lake area as a result of the crude oil spill from cavern 111 (Section 3.8.2.7). A shallow draft boat and additional crude oil containment boom were added to the emergency response equipment to facilitate access for oil cleanup and sampling in shallow waters as necessary. Additional laboratory equipment was acquired to expedite stormwater analyses. A site beautification program was implemented with excellent results in improving site appearance. Results from Phase I CERCLA indicated an absence of past hazardous waste disposal on the West Hackberry site.

3.9 CONCLUSION

No adverse environmental impact resulting from SPR activities was observed during 1986. The SPR continues to maintain an excellent environmental record.

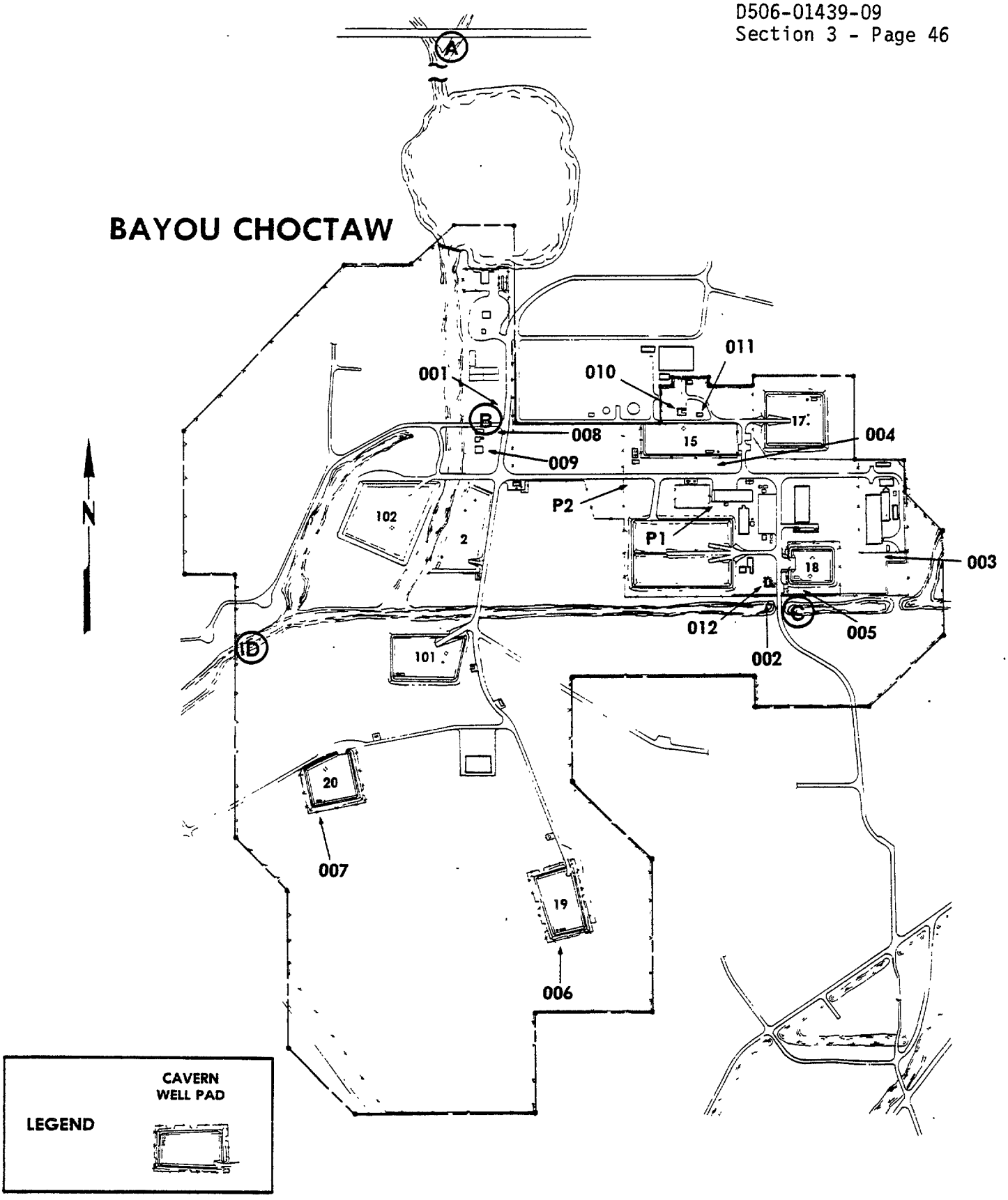

Figure 3-1 (Sheet 1 of 2). Bayou Choctaw Environmental Monitoring Stations

Discharge Monitoring Stations

001	Discharge from the Sewage Treatment Plant at the Trailer Complex
002	Discharge from the Sewage Treatment Plant at the Administration Building
003	Discharge Point from the Oil/Water Separator at the High-Pressure Pump Pad/Meter Prover
004	Stormwater from Well Pad 15
005	Stormwater from Well Pad 18
006	Stormwater from Well Pad 19
007	Stormwater from Well Pad 20
008	Northern Mini-Leach Fuel Tank Pad
009	Southern Mini-Leach Fuel Tank Pad
010	Weak Brine Pump Pad
011	Weak Brine Fuel Tank Pad
012	Emergency Generator Fuel Tank Pad

Water Quality Monitoring Stations

A	Canal North of Cavern Lake at Freeport Road
B	North-South Canal at Bridge to Well Pads 10, 11, and 13
C	East-West Canal at Intersection of Road to Brine Disposal Wells
D	East-West Canal at Well Pad 10

Ground Water Monitoring Stations

P1	Southwest Corner Maintenance Building
P2	North of Brine Pond

Figure 3-1 (Sheet 2 of 2). Bayou Choctaw Environmental Monitoring Stations

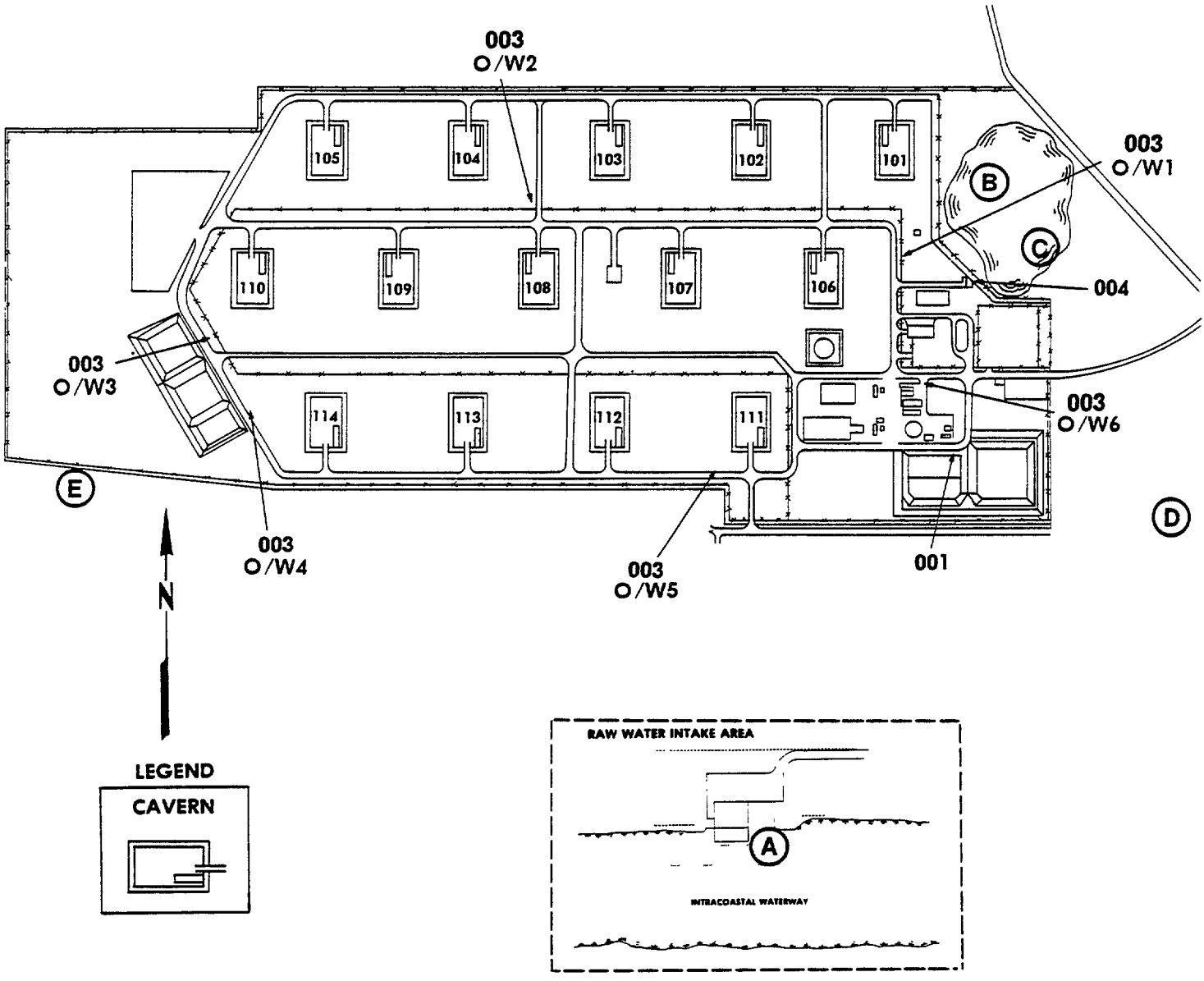

Figure 3-2 (Sheet 1 of 2). Big Hill Environmental Monitoring Stations

Planned Discharge Monitoring Stations

001 Brine Disposal

002 Hydroclone and Blowdown at Raw Water Intake Structure

003 Stormwater Discharges
- O/W1 Stormwater from Well Pads 101, 102, 106, 107
- O/W2 Stormwater from Well Pads 108, 109, 110
- O/W3 Stormwater from Well Pads 111, 112
- O/W4 Stormwater from Well Pads 113, 114
- O/W5 Stormwater from Well Pads 103, 104, 105
- O/W6 Stormwater from Pump Pads
- O/W7 Stormwater from Meter Pads

004 Discharge from Sewage Treatment Plants

Proposed Water Quality Stations

A Gulf Intracoastal Waterway
B Ten-Acre Pond
C Ten-Acre Pond
D Ditch Southeast of Site
E Ditch Southwest of Site

Figure 3-2 (Sheet 2 of 2). Big Hill Environmental Monitoring Stations

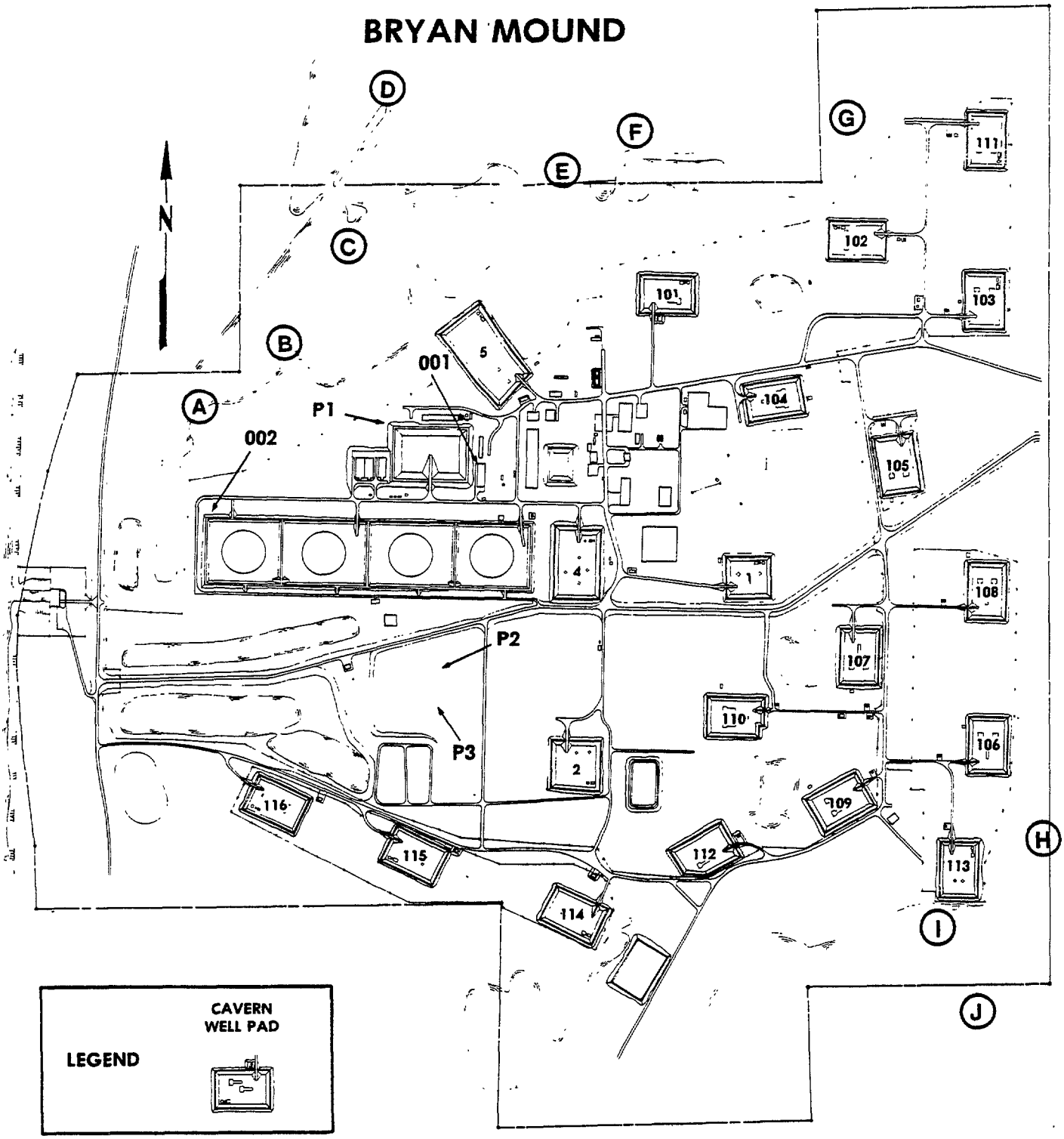

Figure 3-3 (Sheet 1 of 2). Bryan Mound Environmental Monitoring Stations

Discharge Monitoring Stations

001 Brine Disposal

001 Stormwater Runoff from Surge Tank Area (Corresponds to TX Water Comm. Permit No. 02271 Discharge 001)

002 Discharge from the Sewage Treatment Plant

Stormwater Discharges

Stormwater Runoff from Well Pads 1, 2, 4, 5, and 101-116

Stormwater Runoff from the High-Pressure Pump Pad

Water Quality Monitoring Stations

A Blue Lake
B Blue Lake
C Blue Lake
D Blue Lake - Control Point 1
E Blue Lake
F Blue Lake
G Blue Lake
H Mud Lake
I Mud Lake
J Mud Lake - Control Point 2

Ground Water Monitoring

P1 Northwest Corner Brine Pond
P2 Between Laydown Yard & Levee Road
P3 Laydown Yard

Figure 3-3 (Sheet 2 of 2). Bryan Mound Environmental Monitoring Stations

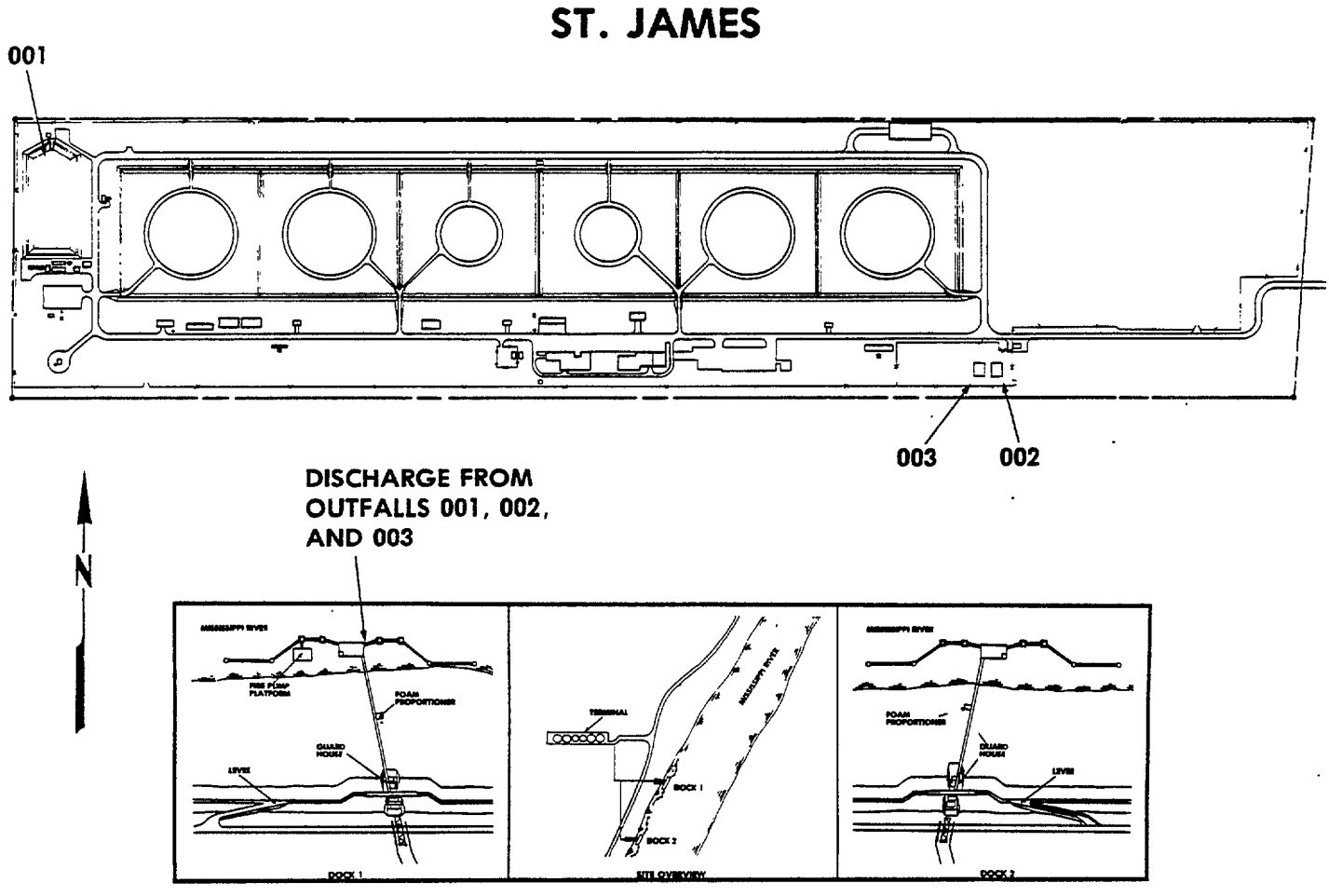

Figure 3-4 (Sheet 1 of 2). St. James Terminal Environmental Monitoring Stations

Discharge Monitoring Stations

001 Discharge from Retention Pond

002* Discharge from Package Sewage Treatment Plant

003* Discharge from Package Sewage Treatment Plant

* State discharge permit outfall numbers.

Figure 3-4 (Sheet 2 of 2). St. James Terminal Environmental Monitoring Stations

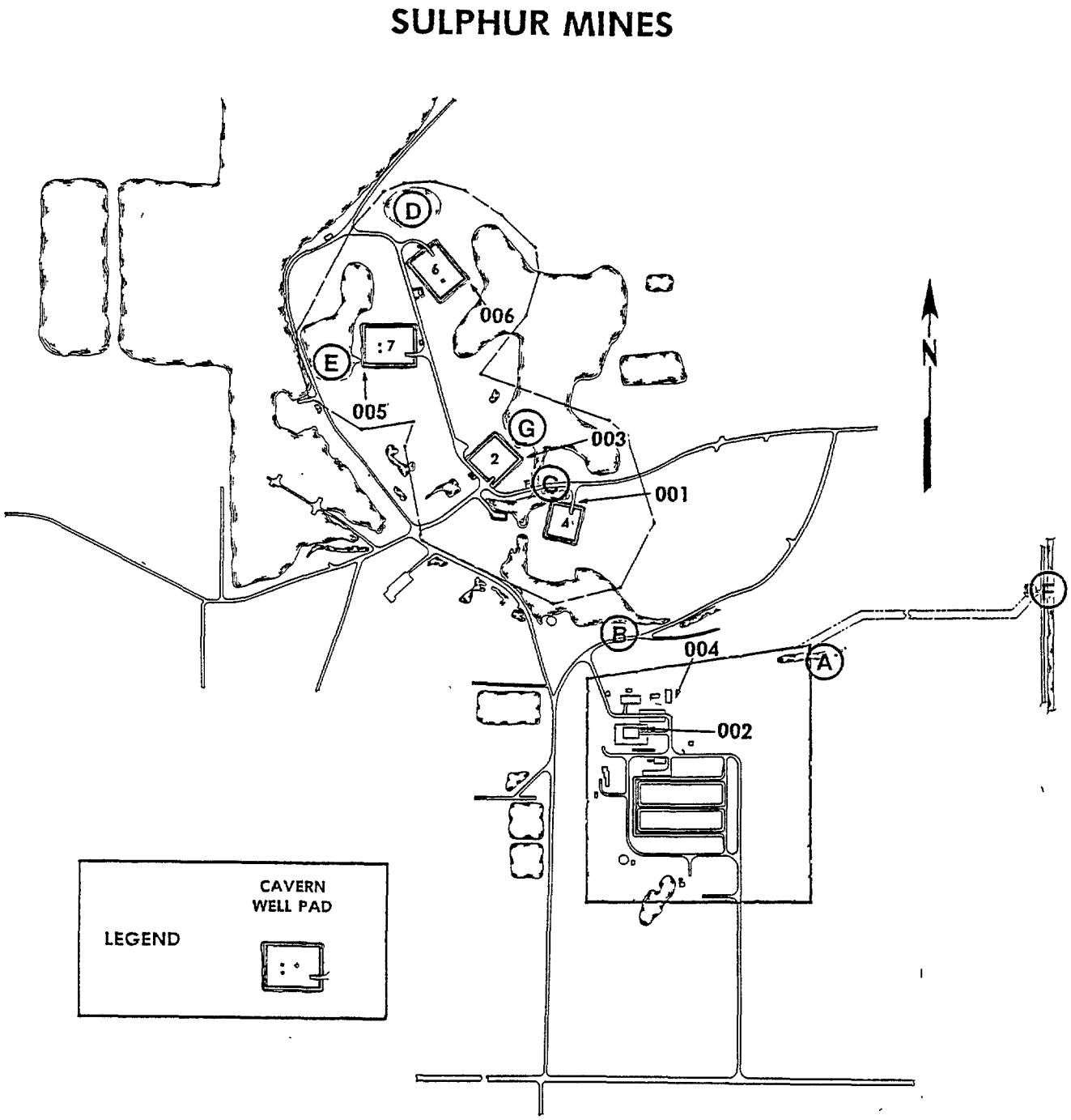

Figure 3-5 (Sheet 1 of 2). Sulphur Mines Environmental Monitoring Stations

Discharge Monitoring Stations

001 Stormwater Runoff from Well Pad 4
002 Stormwater Runoff from Pump Station
003 Stormwater Runoff from Well Pad 2
004 Discharge from Sewage Treatment Plant
005 Stormwater Runoff from Well Pad 7
006 Stormwater Runoff from Well Pad 6

Water Quality Monitoring Stations

A Drainage Ditch at Northeast Corner of Primary Site
B Creek North of Primary Site
C Subsidence Area (Pump)
D Impoundment North of Cavern 6
E Impoundment West of Cavern 7
F Intake Structure
G Subsidence Area

Figure 3-5 (Sheet 2 of 2). Sulphur Mines Environmental Monitoring Stations

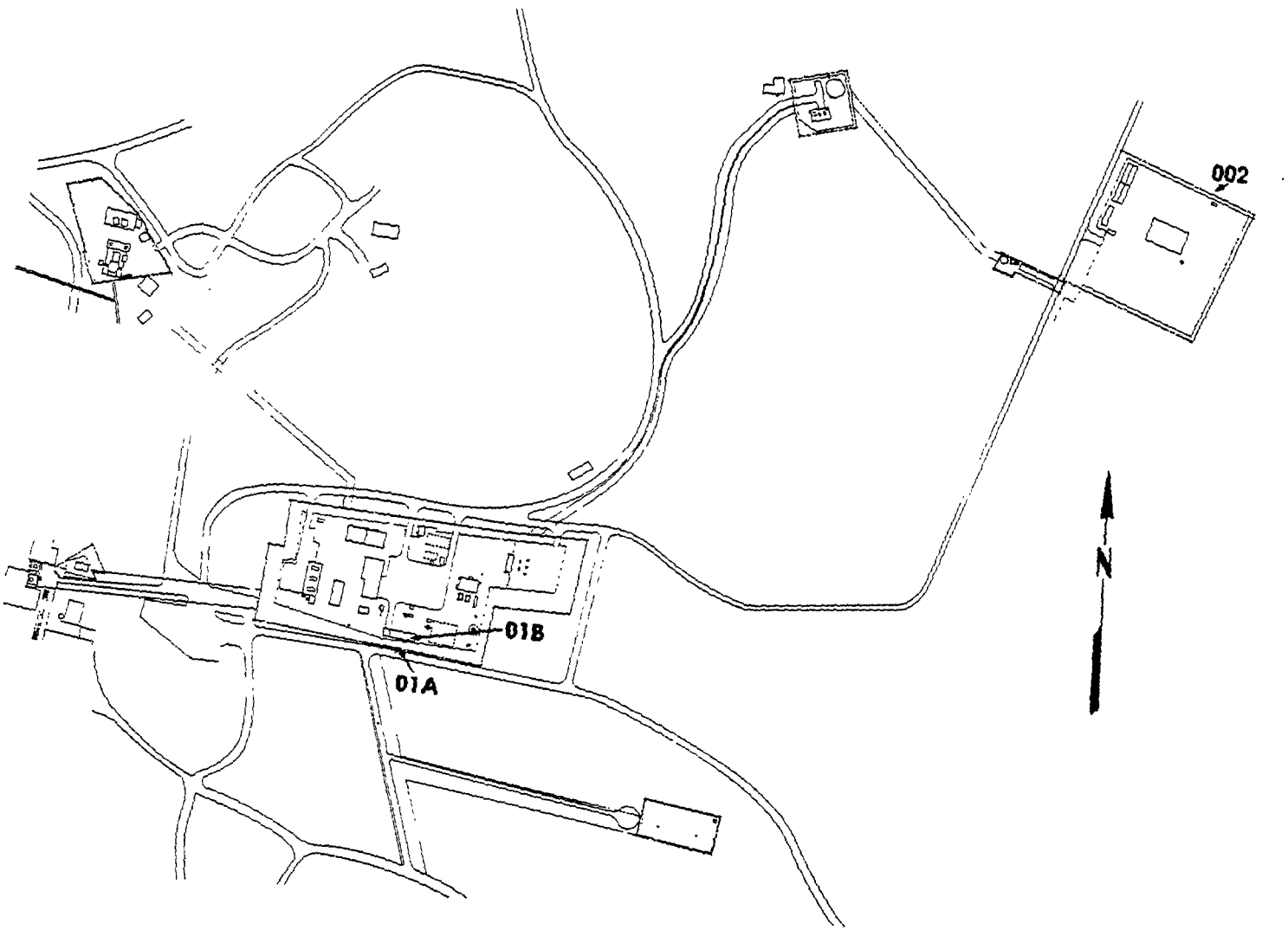

Figure 3-6 (Sheet 1 of 2). Weeks Island Environmental Monitoring Stations

Discharge Monitoring Stations

01A	Stormwater Runoff
01B	Discharge from Sewage Treatment Plant
002	Discharge from Sewage Treatment Plant

Figure 3-6 (Sheet 2 of 2). Weeks Island Environmental Monitoring Stations

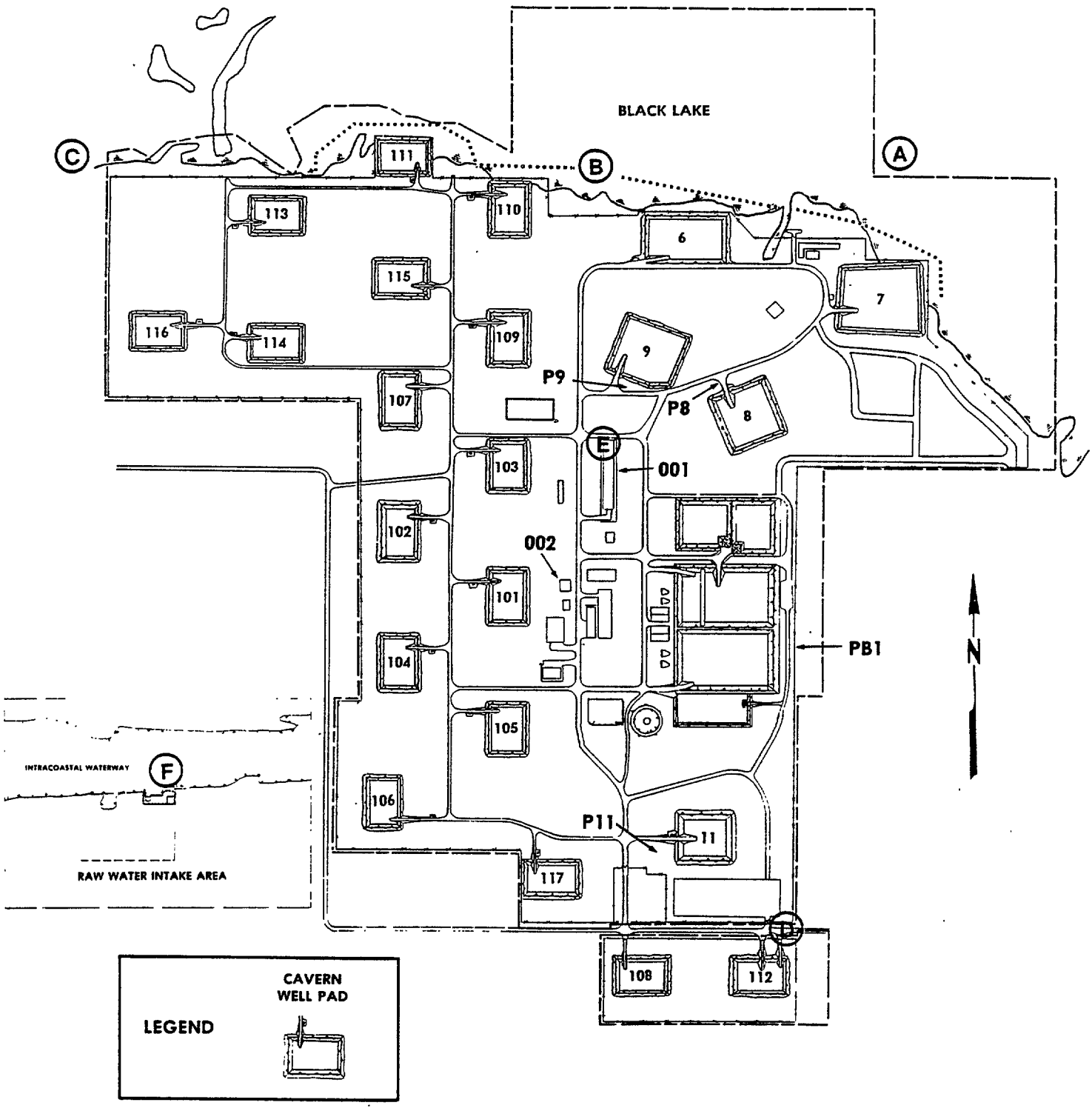

Figure 3-7 (Sheet 1 of 2). West Hackberry Environmental Monitoring Stations

Discharge Monitoring Stations

001	Brine Disposal
002	Discharge from Sewage Treatment Plant
	Stormwater Discharges
	Stormwater and Pump Flush from High-Pressure Pump Pad
	Stormwater Runoff from Well Pads 6-9, 11, and 101-117

Water Quality Monitoring Stations

A	Black Lake
B	Black Lake
C	Black Lake
D	Southeast Drainage Ditch
E	High-Pressure Pump Pad
F	Raw Water Intake Structure

Ground Water Monitoring Stations

PB1	East of Brine Pond #1
P8	North of Cavern 8
P9	South of Cavern 9
P11	West of Cavern 11

Figure 3-7 (Sheet 2 of 2). West Hackberry Environmental Monitoring Stations

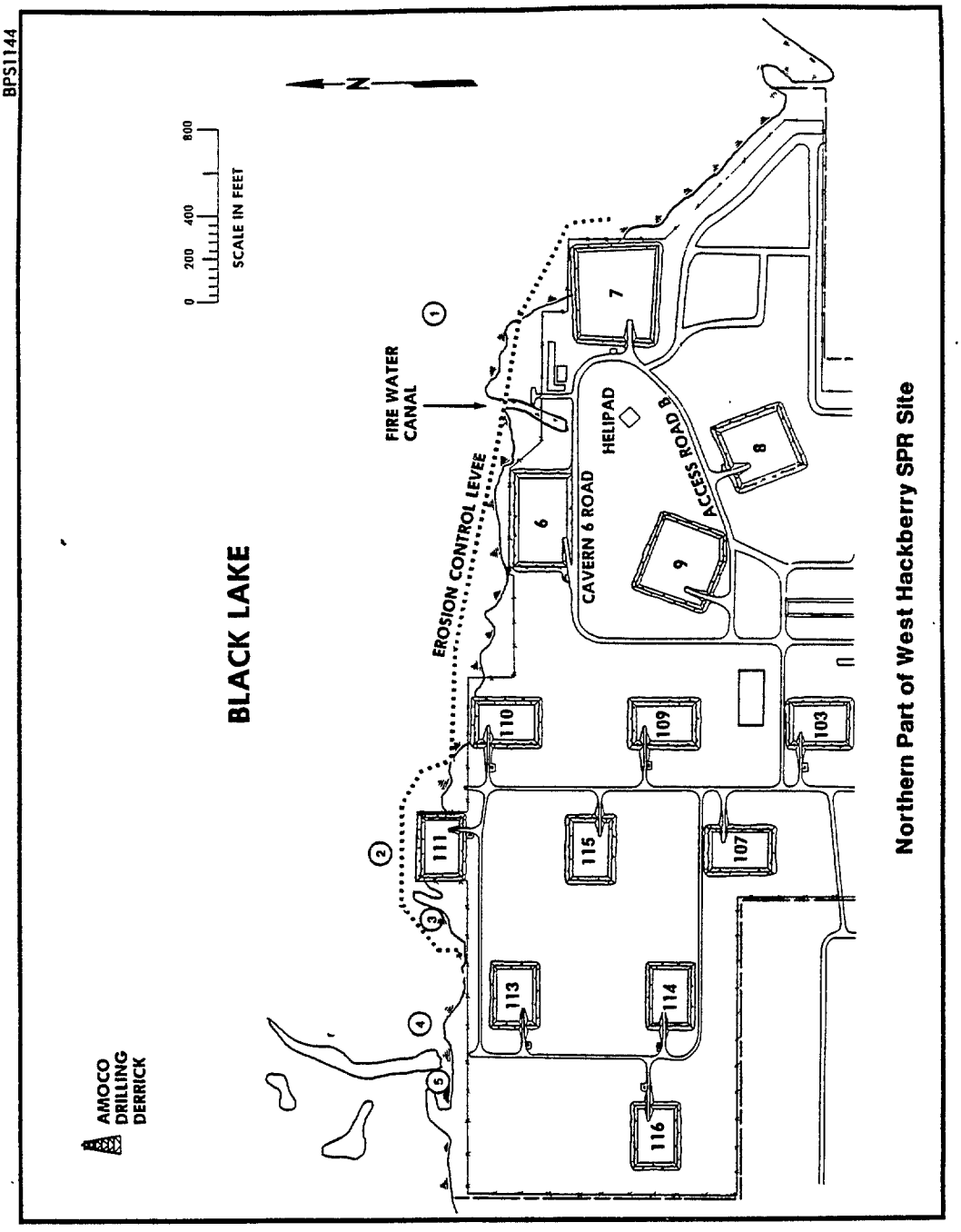

Figure 3-8. Black Lake Interstitial and Water Column Monitoring Stations

PHYSICO-CHEMICAL PARAMETERS	SAMPLE IDENTIFICATION AND FREQUENCY BY SITE															
	DAILY					WEEKLY		MONTHLY						QUARTERLY	
	BC	BM	SJ	SM	WH	BM	SM	BC	BM	SJ	SM	WI	WH	BM	SJ
pH	003-012	001 101-116, 1,2, 4,5 TX-001 002	001	001 002 003 005 006	001 6-9, 11 101-117 HPP		004	001 002 A-D	A-J		A-G	01A 01B 002	002 A-F	106-110	002 003
SALINITY		001			001 HPP			A-D	A-J		A-G		A-F		
SPECIFIC CONDUCTIVITY								A-D	A-J		A-G		A-F		
TEMPERATURE		001			001			A-D	A-J		A-G		A-F		
TOTAL DISSOLVED SOLIDS					001	001					A-G		A-F		
TOTAL SUSPENDED SOLIDS					001	001	004	001 002 A-D	002*		A-G	01B 002	002 A-F		002 003
CHLORIDE	010 011														
DISSOLVED OXYGEN					001**			A-D	A-J			A-F			
BOD_5							004	001 002 A-D	002*			01B 002	002		002 003
COD		002 TX-001 1,2, 4,5, 101-116							A-J						
OIL & GREASE	003-012	001 002 101-116 1,2, 4,5, TX-001	001	001 002 003 005 006	001 6-9, 11 101-117 HPP			A-D			A-G	01A	A-C E-F	106-110	
TOC			001		6-9 11 101-117 HPP	001		A-D	A-J				E	106-110	
FECAL COLIFORM												01B 002	002		
RESIDUAL CHLORINE		002													
FLOW	001-012	TX-001 001 002 1,2, 4,5, 101-116	001	001 002 003 005 006	HPP 001 6-9		004	001 002		002 003		01A 01B 002	002		

* Sampling performed twice per indicated period.
** Sampling performed 5 days/week.

NOTE: Water Quality Stations (lettered stations) are sampled for possible detection of any adverse environmental condition on and in the waters surrounding the SPR sites.

Table 3-1. Physicochemical Parameters

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
001	BOD_5	81.5 mg/l / 45.0 mg/l	Two blower motors failed followed by heavy loading that further burdened the treatment capabilities of the plant.

Table 3-2. 1986 Noncompliances/Bypasses at Bayou Choctaw

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0053040	EPA	Water	8/9/81	3/12/83	(1)
WP0179	LDEQ	Water	7/22/83	7/21/88	
055708	LDNR	Drilling	10/1/85	1/1/86	(2)
None	LDNR	Injection	1/11/83	Open	(3)
LMNOD-SP (Bayou Plaquemine) 17	COE	Constr. Maint.	9/26/77 9/26/77	9/25/80 9/25/87	(4), (10)
LMNOD-SP (Bull Bay) 3	COE	Constr. Maint.	1/30/79 1/30/79	1/29/82 1/29/89	(5), (10)
LMNOD-SP (Iberville Wetlands) 17	COE	Constr.	11/06/78	9/25/87	(6), (10)
LMNOD-SE (Iberville Wetlands) 31	COE	Constr.	11/6/78	5/31/86	(7), (10)
LMNOD-SE (Iberville Wetlands) 102	COE	Constr.	10/6/83	10/5/86	(8), (10)
LMNOD-SE General Permit	COE	Constr.	8/31/85	8/31/90	(9), (10)

(1) Submitted for renewal (2/2/83).
(2) Amended permit to drill for minerals for Cavern 17.
(3) Letter of financial responsibility to plug, and abandon injection wells.
(4) Install and maintain 36-inch crude oil pipeline.
(5) Dredge and maintain Bull Bay.
(6) Excavate and fill to construct road between site and brine disposal wells.
(7) Construct a warehouse, bank, and culvert across roadway.
(8) Excavate and fill to construct and maintain well pad 101.
(9) Excavate and fill to construct and maintain well pad 17.
(10) Recorded with applicable Registrar of Deeds.

* COE - U.S. Army Corps of Engineers
EPA - Environmental Protection Agency
LDEQ - Louisiana Department of Environmental Quality.
LDNR - Louisiana Department of Natural Resources.

Table 3-3. Active Permits at Bayou Choctaw

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
TX0092827	EPA	Water	1/18/84	1/17/89	
SWGCO-RP 16536	COE	Constr.	1/11/84	12/31/88	(1)
P-7	F&WS	Constr. Operate	Z/31/86 7/31/86	7/31/88 7/29/2036	(2)
83-ASW-178-NRA	FAA	Constr.	4/1/83	12/1/84	(3)
C-9256	TACB	Air	5/17/83	Open	(4)
02937,8&9	RCT	Operate	11/28/83	Open	(5)
0048186 0048296	RCT	Operate	5/9/83 6/23/83	Open Open	(6)
02638	TWC	Water	6/27/83	6/26/88	(7)
4045	TWC	Water	11/11/83	5/8/88	(8)

(1) Completion of raw water, brine disposal, and crude oil pipeline extended. Amended to install offshore pipeline by trenching.
(2) Completion of pipeline construction extended.
(3) Expired. Renewal submitted.
(4) Under construction. Conversion to operations permit should be made 7 months prior to site reaching full status.
(5) Valid until ownership changes, system changes, or other physical changes are made in the system.
(6) Permits to create, operate, and maintain an underground hydrocarbon storage facility consisting of 14 caverns.
(7) Corresponds to TX0092827
(8) Permit expires after consumption of 239,000 acre-feet of water or end of project.

* FAA - Federal Aviation Agency
F&WS - U.S. Fish and Wildlife Service
RCT - Railroad Commission of Texas
TACB - Texas Air Control Board

Table 3-4. Active Permits at Big Hill

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
001	ALL	A WEEKEND SAMPLE NOT COLLECTED	
002	BOD_5	65.0 mg/l / 45.0 mg/l	Initial sewage treatment plant stabilization.
002	BOD_5	69.5 mg/l / 45.0 mg/l	Initial sewage treatment plant stabilization.
002	TSS	56.0 mg/l / 45.0 mg/l	Initial sewage treatment plant plant stabilization.
002	TSS	50.0 mg/l / 45.0 mg/l	Initial sewage treatment plant stabilization.

Table 3-5. 1986 Noncompliances/Bypasses at Bryan Mound

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
TX0074012	EPA	Water	2/3/84	2/2/89	
SWGCO-RP-12347(1)	COE	Dredging	2/22/78	12/31/94	(1)
SWGCO-RP-16177	COE	Constr.	9/7/82	Open	(2)
3-67-782 (Docket#)	RCT	Injection	8/21/78	Open	(3)
P001447 & 8	RCT	Constr.	7/3/85	Open	(4)
001447	RCT	Operate	10/30/84	Open	(5)
001448	RCT	Operate	10/30/84	Open	(5)
3-70-377 (Docket#)	TWC	Injection	12/18/78	Open	(3)
3681A	TWC	Water	7/30/79	Open	(6)
02271	TWC	Water	2/3/84	2/2/89	(7)
C-6176B	TACB	Air	7/20/79	Open	(8)
82-8475	TDH&PT	Constr.	1/1/83	Open	(9)

(1) Maintenance dredging of raw water intake extended.
(2) Date extended for completion of potable water line.
(3) Approval of oil storage and salt disposal program.
(4) Authority to construct anhydrite pit.
(5) Authority to operate brine ponds.
(6) Permit expires after consumption of 367,088 acre-feet of water or project ends.
(7) Corresponds with TX0074012.
(8) Modification to existing permit submitted for converting to an operations permit.
(9) Corresponds with SWGCO-RP-16177.

* TDH&PT - Texas Department of Highways and Public Transportation

Table 3-6. Active Permits at Bryan Mound

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
002	BOD_5	53.0 mg/l / 45.0 mg/l	Unknown, but suspect the disposal of floor wax stripping compounds into site drains resulted in a sewage treatment plant upset.

Table 3-7. 1986 Noncompliances/Bypasses at St. James Terminal

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0054674	EPA	Water	5/26/80	Open	(1)
LMNOD-SP (Mississippi River) 998	COE	Constr.	3/20/78	3/19/88	(2)(3)
WP 0929	LDEQ	Water	9/26/84	9/26/89	
983	LDEQ	Air	7/25/78	Open	(4)

(1) Expiration extended indefinately pending issuance of new permit in response to March 15, 1986 renewal application.
(2) Amended to install riprap and buoy mooring.
(3) Permit and all amendments recorded with Registrar of Deeds in St. James Parish.
(4) Requires annual construction report.

Table 3-8. Active Permits at St. James Terminal

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LMNOD-SP (LTCS)20	COE	Constr.	7/24/78	7/24/88	(1)
LA0055786	EPA	Water	4/12/80	Open	(2)
1042	LDEQ	Air	9/26/78	Open	(3)
None	LDOTD	Water	12/14/83	12/31/86	(4)
None	LDNR	Injection	1/11/83	Open	(5)
None	LDNR	Injection	7/20/78	Open	(6)

(1) Renewal submitted 8/13/85 for erosion control work on the Intracoastal Waterway. Recorded permit and amendments with applicable Parish Registrars of Deeds.
(2) Expiration extended indefinately pending issuance of new permit in response to March 1985 renewal application.
(3) Requires annual operating report.
(4) Water purchase agreement (renewed annually).
(5) Letter of financial responsibility to close, plug, and abandon any and all injection wells.
(6) Approval for use of salt dome cavities for storage of liquid hydrocarbons.

* LDOTD - Louisiana Department of Transportation and Development

Table 3-9. Active Permits at Sulphur Mines

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
002	BOD_5	56.0 mg/l / 45.0 mg/l	Unknown, but suspect the disposal of floor wax into site drains resulted in a sewage treatment plant upset.
01B	BOD_5	77.0 mg/l / 45.0 mg/l	Unknown, but suspect the disposal of floor wax into site drains resulted in a sewage treatment plant upset during February 1986.
01B	BOD_5	98.0 mg/l / 45.0 mg/l	Unknown, but suspect the disposal of floor wax into site drains resulted in a sewage treatment plant upset. One week after initial February 1986 sample taken.
002	BOD_5	48.0 mg/l / 45.0 mg/l	Aeration timer switch failed in "on" position causing accelerated digestion and eventual depletion of the organic residuum needed to sustain a sufficient bacteria population.

Table 3-10. 1986 Noncompliances/Bypasses at Weeks Island

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0056243	EPA	Water	6/30/79	10/13/87	
LMNOD-SP (Atchafalaya Floodway) 251	COE	6/12/78	Maint.	6/1/88	(1)
1105	LDEQ	Water	1/30/78	Open	(2)
SDS-8 (Order #1)	LDNR	Injection	2/16/79	Open	(3)
None	LDEQ	Water	7/12/79	Open	

(1) Recorded permit and amendments with applicable Parish Registrars of Deeds.
(2) Requires annual operating report.
(3) Approval for use of salt dome cavities for storage of liquid hydrocarbons.

Table 3-11. Active Permits at Weeks Island

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
002	Fecal Coliform		NO SAMPLE TAKEN
002	BOD_5	17.5 mg/l / 15.0 mg/l	Cause unknown, but problem corrected by increasing effluent retention, introducing a microbial stimulant into the sewage plant, and by using formulated seed during BOD_5 tests.
001	All		No sample taken.
001	Oil & Grease	150.0 mg/l / 15.0 mg/l	Lubricant contamination at the sampling port.
001	Dissolved oxygen	Nondetectable / Detectable*	Excessive oxygen scavenger used.
001	pH	5.98 / 6.0 - 9.0	Naturally low pH levels in the raw water used for leaching.

* Applicable only when using oxygen scavenger.

Table 3-12. 1986 Noncompliances/Bypasses at West Hackberry

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0053031	EPA	Water	8/22/84	8/21/89	
LMNOD-SP (LTCS)26	COE	Dredging	2/8/79	2/7/89	(1)
LMNOD-SP (Black Lk)31	COE	Dredging	10/26/82	10/25/92	(2)
LMNOD-SP (Black Lk)43	COE	Constr.	7/26/84	7/25/87	(3)
LMNOD-SP (Gulf of Mexico) 2574	COE	Constr.	5/29/86	8/31/87	(4)
None	LDNR	Injection	8/7/79	Open	(5)
971198-9	LDNR	Injection	10/6/83	Open	(6)
None	LDEQ	Water	3/30/79	Open	
1048	LDEQ	Air	10/26/78	Open	(7)

(1) Maintenance dredging for raw water intake.
(2) Maintenance dredging for fire water canal.
(3) Construction of erosion control dike completed in 1986.
(4) Amended to install parallel pipeline at Mile 9.
(5) Approval to create 16 additional salt dome cavities.
(6) Approval to construct and operate wells 117A and B.
(7) Requires semi-annual status-of-construction report.

Table 3-13. Active Permits at West Hackberry

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4. QUALITY ASSURANCE

The SPR sites undergo periodic evaluation throughout the year in the form of internal audits as well as audits by outside federal and state agencies. The Bryan Mound and West Hackberry laboratories participated in the sixth annual EPA Discharge Monitoring Report Quality Assurance Study during 1986. The SPR also continued conducting its own internal laboratory quality assurance study through analysis of blind samples on a semi-annual basis. The structured laboratory quality assurance program has continued through the systematic application of acceptable accuracy and precision criteria at all SPR laboratories. Compliance with this and other environmental program requirements was reviewed and evaluated at each site by means of internal annual audits and audits at select sites by state and federal environmental agencies.

4.1 EPA DISCHARGE MONITORING REPORT QUALITY ASSURANCE STUDY

The EPA entered the sixth year of its Discharge Monitoring Report Quality Assurance program. Through this program EPA provides analytical laboratories of major NPDES dischargers blind samples of permit parameters for analysis. The permittee analyzes these samples and submits the data to EPA for evaluation of analytical accuracy relative to the performance of EPA referee laboratories. The Bryan Mound and West Hackberry laboratories each participated in this program during 1986 for the sixth time in as many years. The Big Hill facility participated in the Quality Assurance study for the first time through the Bryan Mound laboratory.

The analytical data submitted to EPA by the Bryan Mound laboratory for Big Hill and Bryan Mound was well within acceptance limits. West Hackberry data fell outside of the acceptance criteria for two parameters. These excursions resulted from an equipment failure which contaminated the sample during preparation. EPA declined to provide additional samples when advised of this contamination. Unconditional acceptability is defined as falling within $\pm$ 1.5 standard deviations of the statistically correct

value. Those values falling within ± 2.0 to 1.5 standard deviations are acceptable with warning. The EPA results for Big Hill, Bryan Mound, and West Hackberry, expressed as variation in standard deviations are:

Parameter	Big Hill	Bryan Mound	West Hackberry
pH (std. units)	0.0	0.0	+4.8
TSS (mg/l)	N/A	+0.9	-0.8
Oil and Grease (mg/l)	+0.1	+0.1	-0.8
TOC (mg/l)	+0.1	+0.1	-0.3
COD (mg/l)	N/A	-0.1	N/A
BOD_5 (mg/l)	N/A	-0.9	-4.1
Residual Cl^- (mg/l)	N/A	-0.2	N/A

4.2 SPR LABORATORY INTERNAL QUALITY ASSURANCE PROGRAM

The SPR conducts an internal Quality Assurance program modeled after the EPA Program (paragaph 4.1) using EPA-supplied blind samples. This program, directed at the Bayou Choctaw (BC), Bryan Mound (BM), and West Hackberry (WH) laboratories, consists of periodic analysis of blind samples supplied by the SPR project management office. The analytical results of each laboratory are evaluated by the SPR project management office for acceptability under the same criteria as used by the EPA.

The results of the 1986 SPR Laboratory Quality Assurance program, performed during March and November, are as follows.

	March*		November		
	BM	WH	BC	BH	WH
pH (std. units)	-1.0	+1.3	-0.9	-1.0	0.0
Oil and Grease (mg/l)	-0.3	+0.5	+1.1	+0.6	+0.9
TOC (mg/l)	-0.5	-0.6	0.0	+1.1	-0.2
COD (mg/l)	-1.1	N/A	N/A	+1.2	N/A
BOD_5 (mg/l)	+0.1	+0.1	+0.1	+1.3	-0.4
TDS (mg/l)	+0.8	+1.6	N/A	-0.4	-1.5
TSS (mg/l)	+1.5	-0.8	-0.6	+0.5	+0.2
Conductivity (mho)	N/A	-0.4	+1.2	-0.3	N/A
Alkalinity (mg/l as $CaCO_3$)	+0.4	N/A	N/A	-0.6	N/A

*Bayou Choctaw did not participate in this program during March due to temporary suspension of onsite laboratory activities.

All data fell within the $\pm$ 1.5 standard deviation unconditional acceptability criterion, with the exception of one data point which fell within the $\pm$ 2.0 to 1.5 standard deviation warning range.

The low variation in standard deviations observed throughout 1986 at all SPR laboratories and for all parameters demonstrates the high reliability of all analyses performed by the SPR laboratories.

4.3 SPR LABORATORY ACCURACY AND PRECISION PROGRAM

The SPR Laboratory quality assurance program is based on the U.S. EPA Handbook for Analytical Quality Control in Water and Waste Water Laboratories (EPA-600/4-79-019). This program focuses on the use of analyses of field and laboratory spikes, standard

recoveries, split samples, and blanks at regular intervals to determine the accuracy and precision of analyses.

The EPA quality control document advocates use of quality control charts to maintain and evaluate accuracy and precision data. The SPR has developed software for the Hewlett-Packard 41CX handheld computer to allow rapid and exact determinations of accuracy and precision without the necessity of quality control chart preparation. This software has been implemented at each SPR laboratory. During 1986, regulatory auditors have examined the SPR laboratories' precision and accuracy data and found this data, the program, and methodology in order.

4.4 ENVIRONMENTAL DEPARTMENT AUDITS

The MOM contractor conducts an annual environmental audit at each site. Each audit is conducted over a one to two-day period followed by an outbriefing with site management and preparation of a formal audit report with specific recommendations as appropriate. Audit areas include environmental records, laboratory procedures and records, site housekeeping, operating procedures, training, environmental response equipment, and permit regulatory compliance. A general field inspection of the site environs is also conducted to assess the general site conditions, changes attributable to site impacts, and the effects of planned and proposed site construction modifications.

The 1986 environmental audit at each SPR site showed the overall implementation and execution of the SPR Environmental Program to be outstanding. An especially noteworthy observation during these audits was the high level of environmental awareness exhibited among all site personnel. MOM contractor management has placed a high priority on fulfilling the intent and conditions of the SPR Environmental Program.

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LIST OF ACRONYMS

BOD_5	five day biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curies
COE	United States Army Corps of Engineers
COD	chemical oxygen demand
DO	dissolved oxygen
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
ERT	Emergency Response Team
FAA	Federal Aviation Administration
F&WS	United States Fish and Wildlife Service
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development
mCi	millicuries
mg/l	milligrams per liter
MOM	Management, Operations, and Maintenance
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
ppt	parts per thousand
RCT	Railroad Commission of Texas
SPR	Strategic Petroleum Reserve
TACB	Texas Air Control Board
TDH&PT	Texas Department of Highways and Public Transportation
TDS	total dissolved solids
TOC	total organic carbon
TWC	Texas Water Commission
UST	underground storage tank(s)

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