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UNITED STATES DEPARTMENT OF ENERGY

STRATEGIC PETROLEUM RESERVE

Boeing Petroleum Services, Inc.

1988 ANNUAL

ENVIRONMENTAL MONITORING REPORT

FOR THE

STRATEGIC PETROLEUM RESERVE

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BOEING PETROLEUM SERVICES, INC.

850 South Clearview Parkway

New Orleans, Louisiana 70123

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ABBREVIATIONS AND ACRONYMS

BC	Bayou Choctaw
BH	Big Hill
BM	Bryan Mound
BOD_5	five day biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curies
CM	Centimeter
COE	United States Army Corps of Engineers
DO	dissolved oxygen
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
ERT	Emergency Response Team
F&WS	United States Fish and Wildlife Service
Kg	Kilogram
LDEQ	Louisiana Department of Environmental Quality
LDHHR	Louisiana Department of Health and Human Resources
LDNR	Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development
LDWF	Louisiana Department of Wildlife and Fisheries
m/sec	meters per second
mCi	millicuries

ABBREVIATIONS AND ACRONYMS
(continued)

m	meters
m^3	cub meters
mg/l	milligrams per liter
MMB	Million Barrels
M&O	management and operating
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
pH	Negative logarithm of the hydrogen ion concentration (Acidic to basic on a scale of 0 to 14, 7 is neutral)
ppt	parts per thousand
RCT	Railroad Commission of Texas
SJ	St. James
SM	Sulphur Mines
SPR	Strategic Petroleum Reserve
TACB	Texas Air Control Board
TDH	Texas Department of Health
TDH&PT	Texas Department of Highways and Public Transportation
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
TWC	Texas Water Commission
UIC	Underground Injection Control
UST	underground storage tank

ABBREVIATIONS AND ACRONYMS
(continued)

USCG	United States Coast Guard
VOC	volatile organic compound
WH	West Hackberry
WI	Weeks Island

EXECUTIVE SUMMARY

This report, provided annually in accordance with DOE Order 5400.1, summarizes monitoring data collected to assess Strategic Petroleum Reserve (SPR) impacts on the environment. The report serves as a management tool for mitigating such impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

Included in this report is a description of each site's environment, an overview of the SPR environmental program, and a recapitulation of special environmental activities and events associated with each SPR site during 1988. The active permits and the results of the environmental monitoring program (i.e., air, surface water, ground water, and water discharges) are discussed by site. The quality assurance program is presented which includes results from laboratory and field audits and studies performed internally and by regulatory agencies.

In general, findings indicate that no adverse environmental impact resulted from any SPR activities during 1988. It was also concluded that the SPR continues to maintain an excellent environmental record.

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), a marine terminal facility (in Louisiana), and an administrative facility (in Louisiana). Figure 1-1 is a regional map showing the relative location of SPR facilities. The SPR uses five sites with solution-mined caverns and a sixth underground room-and-pillar salt mine. Additional space is being created by solution mining.

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 ARCO Terminal (Texas City, 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. The ARCO pipeline connecting the Bryan Mound site with the Texas City, Texas, docks and area refineries was completed in 1987. A second pipeline connecting the West Hackberry site to refineries in Lake Charles, Louisiana, to enhance distribution capabilities will be completed in 1989. Access to additional dockage was completed in 1988 for the St. James Terminal with the installation of a short segment of pipeline connecting the nearby Shell Capline facility. An additional tie in to the Koch pipeline has also been completed.

1.1 BAYOU CHOCTAW

The Bayou Choctaw site is located on the west side of the Mississippi River 19.3 (12 miles) kilometers southwest of Baton Rouge in Iberville Parish, Louisiana. The site consists of a

primary operational area and a brine disposal area occupying approximately 67 and 81 hectares (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 1.5 to 3.0 meters (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 4.9 hectare (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 109 kilometers (68 miles) east of Houston, 37 kilometers (23 miles) southwest of Port Arthur, and 14 kilometers (9 miles) north of the Gulf of Mexico. Only small unincorporated communities are located near 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 construction phase, much of the transient skilled labor was brought in from Houston, Galveston, or Lake Charles.

The site is situated on approximately 111 hectares (275 acres) of land on the Big Hill salt dome with surface elevations of up to 10 meters (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.

Approximately one kilometer (2/3 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. The nearby waterways include Spindletop Ditch approximately five kilometers south of the site, which connects to the Intracoastal

Waterway located three kilometers further south and oriented in a northeast to southwest direction. 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. A few 150 year old live oak trees are present on site. 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. The McFadden National Wildlife Refuge located south of the site provides important habitat for overwintering waterfowl.

1.3 BRYAN MOUND

The Bryan Mound site is located in Brazoria County, about 104 kilometers (65 miles) due south of Houston, Texas, and five kilometers (3 miles) south 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 237 hectares (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 levees protecting the town of Freeport form a second 5.5 square kilometer (3 1/2 sq. mi.) 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 southeast. These water bodies generally define the mounded aspect of the Bryan Mound dome, which creates a surface expression in the terrain by rising approximately five meters (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 "natural" 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. Migratory waterfowl, common egret, snowy egret, 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 42.5 hectares (105 acres) and the docks occupy 19.4 hectares (48 acres). The site is located on the west bank of the Mississippi River, approximately halfway between New Orleans and Baton Rouge, Louisiana, and 3.1 kilometers (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 (the batture) is a freshwater wetland. 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 71 hectares (175 acres) is located in Calcasieu Parish, 2.4 kilometers (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 0.4 kilometers (1/4 mile) east of the site. Changes in elevation throughout the site are minor, with most of the site four to six meters (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 are present.

1.6 WEEKS ISLAND

The aboveground facility occupies approximately three hectares (7 acres) and is located in Iberia Parish, Louisiana, about 22 kilometers (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, 52 meters (171 feet) above sea level, in southern Louisiana. The area surrounding the island is a combination of marsh, bayous, manmade canals (including the Intracoastal Waterway), 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. 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 29 kilometers (18 miles) southwest of Lake Charles, Louisiana and 26 kilometers (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 229 hectares (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 nearly seven meters (21 feet, the highest point in Cameron Parish). The majority of the dome is approximately 1.5 (5 feet) meters above sea level.

Waterways near the site include Calcasieu Lake and the Calcasieu Ship Channel approximately five kilometers (3 miles) to the east, and the Intracoastal Waterway approximately six kilometers 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.

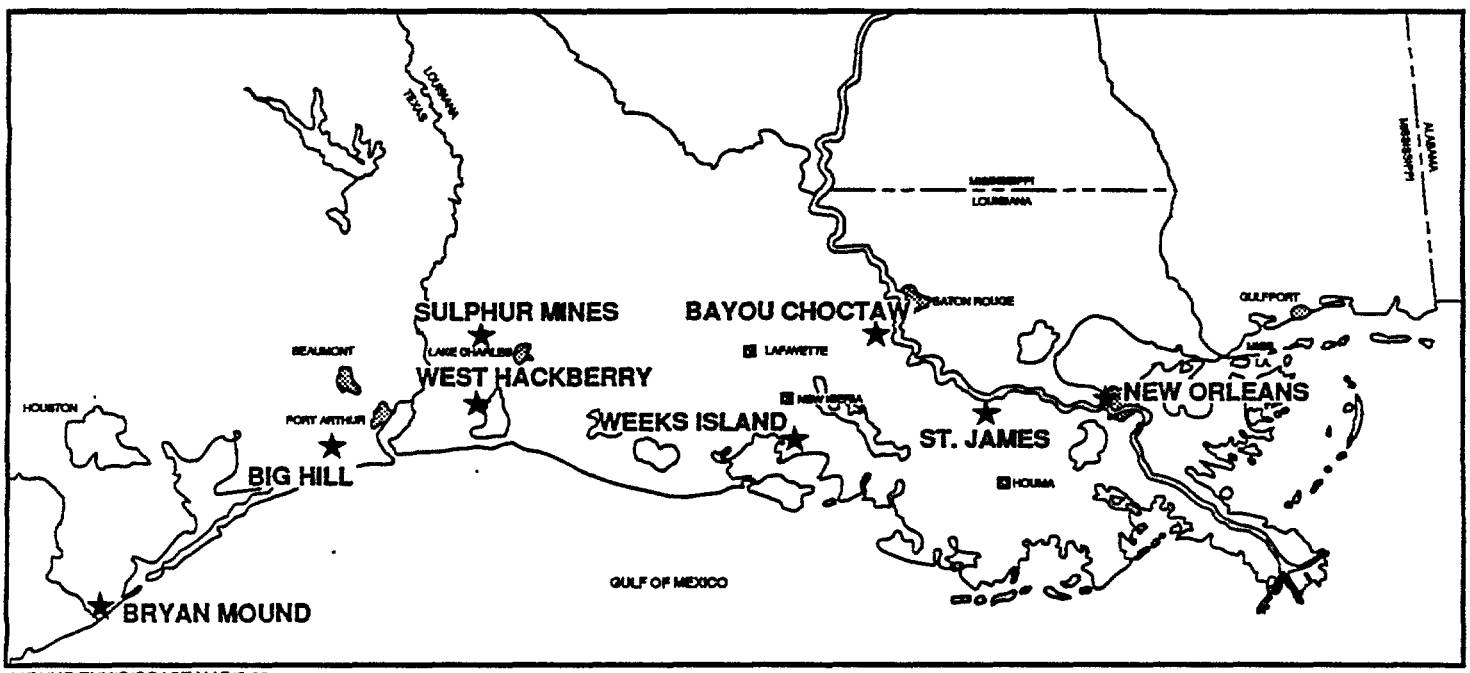

Figure 1-1. SPR Site Locations

2. PROGRAM OVERVIEW

The environmental program is implemented by the management and operating (M&O) contractor for the SPR on behalf of the United States Department of Energy (DOE). DOE, however, has the ultimate responsibility as owner and operator, in accordance with the understanding reached between the M&O 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 from SPR operations.

The results of the individual program areas such as air quality monitoring and reporting, NPDES compliance, and water quality monitoring for 1988 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, the Environmental Programs and Procedures Manual that includes a solid waste management plan, an Underground Injection Control 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 participate in annual spill response training at the Lamar University Fire and Safety Institute. Onsite training is also provided in 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 contingency plans include procedures for reporting spills to the M&O 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 M&O contractor management in New Orleans and

the onsite DOE representative. These procedures, BPS Corporate Policy and Procedures Number 220P-21 on Reporting of Spills, have been simplified and condensed to a credit card-like document for attachment to identification badges and to a laminated placard for handy desk reference. Verbal notification to the appropriate regulatory agencies follows when necessary. Final written reports from the site are 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 (Big Hill, Bryan Mound, and West Hackberry), and quarterly (Bayou Choctaw, Saint James, Sulphur Mines, and Weeks Island). 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 M&O contractor provides several other reports to or on behalf of DOE. 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 (annually and 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 Big Hill, Bryan Mound and West Hackberry (monthly); and

i. Special study reports, as required.

2.4 OIL SPILLS: RECAPITULATION

In 1988, the total amount of oil moved (received and transferred internally) was in excess of 6.3 million cubic meters (39.3 million barrels). The oil spills involving quantities in excess of 0.16 cubic meters (one barrel) that occurred during 1988 are discussed in Table 2-1. Four crude oil spills were caused by operator error and two by equipment failures. Spill containment was excellent in that no oil entered any waterway.

The total number of spills, total volume spilled, and the percent volume spilled of total volume moved are shown below for each year from 1982 through 1988.

Year	Total Spills	Volume Spilled m^3 (barrels)	Percent Spilled of Total Throughput
1982	24	847.0 (5,328)	0.00704
1983	21	380.9 (2,396)	0.00281
1984	13	134.8 (848)	0.00119
1985	7	85.4 (537)	0.00122
1986	5	1232.5 (7,753)	0.01041
1987	5	2.5 (16)	0.00002
1988	6	8.8 (55)	0.00001

The total number of spills has declined since 1982. The amount spilled during 1988 is the least amount reported in any year since 1982 based on throughput. Approximately 73% of the oil

spilled in 1988 was associated with one spill involving the overfilling of a frac tank within a diked area.

2.5 BRINE SPILLS: RECAPITULATION

The SPR disposed 76.8 million cubic meters (480.0 million barrels) of brine (saturated sodium chloride solution) during 1988. Approximately 92.0% of the brine was disposed in the Gulf of Mexico via the Big Hill (71.2%), West Hackberry (16.4%), and Bryan Mound (4.4%) brine disposal pipelines. The remainder was disposed in saline aquifers via injection wells at the Bayou Choctaw (7.0%), West Hackberry (0.1%), and Sulphur Mines (less than 0.1%) sites, and at offsite disposal wells (less than 0.1%).

The brine spills involving quantities in excess of 0.16 cubic meters (one barrel) during 1988 are discussed in Table 2-2. Six spills were caused by corrosion/erosion of piping, three by gasket/flange failures, and three by operator error.

The total number of spills, total volume spilled, and percent volume spilled of total volume disposed are shown below for each year from 1982.

Year	Total Spills	Volume Spilled m^3 (barrels)	Percent Spilled of Total Disposed
1982	43	443.8 (2,792)	0.0005
1983	44	259.4 (1,632)	0.0002
1984	17	314.0 (1,975)	0.0003
1985	16	96,494.8 (607,000)	0.1308
1986	7	275.6 (1,734)	0.0017
1987	22	96.5 (608)	0.0003
1988	12	93.8 (586)	0.0001

The substantial decrease in the amount spilled during 1987 and 1988 as compared to previous years is partially attributed to pipeline integrity testing and operator trining/awareness. No observed environmental impact was observed from any SPR brine

spills as evidenced by subsequent surveys and water quality monitoring.

2.6 WASTEWATER DISCHARGE COMPLIANCE

In 1988, a total of 10,727 analyses were performed to monitor wastewater discharge quality from the SPR in accordance with NPDES and corresponding state permits. Although 16 noncompliances were reported (tables 2-2 and 3-2 to 3-13), the SPR was in compliance with permit requirements for approximately 99.9% of the analyses performed. Eight of the noncompliances involved site sewage treatment plants, two operator errors in failing to collect samples, four problems with brineline operation, two for high pH levels in the storm-water discharges, and one related to the iron removal unit of the potable water system at Weeks Island.

Corrective actions implemented to mitigate noncompliance recurrence included developing or modifying applicable procedures, retraining and certifying personnel, and initiating special studies. One such study resulted in the SPR Sewage Treatment Plant Analysis Final Report which recommended 27 actions to improve permit compliance as well as operations and maintenance of each treatment plant. Many of these actions were completed in 1988.

2.7 SPECIAL ENVIRONMENTAL ACTIVITIES

During 1988, there were no major spills that would have prompted additional studies to assess and monitor impact. Follow-up monitoring studies were completed during the year in response to a failed cavern 111 wellhead component at West Hackberry that sprayed approximately 1,192 cubic meters (7,500 barrels) of crude oil onto the well pad, adjacent marshland, and surface waters of Black Lake in July, 1986. Monitoring results indicated a short term impact to the flora and fauna in the area

immediately surrounding the well pad. Benthic lake samples showed some longer term effects of the spill, in the form of elevated levels of oil and grease, indicating a slow degradation of the crude oil.

The Environmental Survey of the SPR conducted by DOE ES&H in Washington, D.C. was completed in early 1988. The survey included a thorough review of the SPR environmental program as well as an inspection of each site. All 29 findings were categorized as either lower level III or IV and not of an immediate threat to health or the environment. Most of the findings noted had been previously identified and duly documented through independent efforts of the SPR environmental program. Specific actions pertaining to various findings are discussed under the site specific Other Significant Environmental Activity section of Section 3. As a general accomplishment, appropriate disposal methods for AFFF were established in coordination with Louisiana and Texas officials and all Louisiana sites are categorized as small quantity generators of hazardous waste according to state law. Eleven of the 29 findings were closed by the end of 1988.

Proper methods for the disposal of aqueous film forming foam (AFFF) were resolved with the EPA and the appropriate state regulatory agencies. The material will be disposed of using commercial oilfield waste injection wells in Texas and SPR disposal wells in Louisiana.

All SPR water wells in Louisiana were registered with the Louisiana Department of Transportation and Development. In addition, the agency exempted cathodic protection wells and subsidence monument wells from the registration requirements. Water wells in Texas do not require registration. Cathodic protection wells drilled in 1988 at the Bryan Mound site were registered with the Railroad Commission of Texas.

Design modifications required to correct potable water system deficiencies were developed and implemented where necessary. Implementation of corrective actions, involving major plumbing system revisions at some sites, commenced in 1987 with completion scheduled for 1989.

Eight monitoring wells were installed around the West Hackberry site in 1988. An underground brine plume was delineated and a pumping operation to recover the contaminated groundwater was initiated. Contaminant levels have dropped by about 50% and continue to trend downwards. Repair of two sumps thought to be a likely source of contamination will proceed in early 1989.

The Environmental Advisory Committee program was developed and the committee selected. The committee's purpose is to supplement existing BPS environmental and safety efforts by providing impartial assessments and advice to the operating management, pubic, and media relative to SPR management, programs, and policies. The first meeting will be held in early 1989.

Project Directive 116, Storage and Maintenance of Drummed Materials at SPR facilities, was initiated in 1988 with participation of several BPS directorates. An overall plan was developed to improve methods for the purchase, control, storage, and disposal of drums and drummed materials. The plan is scheduled to be fully implemented by 1990.

An environmental assessment for decommissioning Sulphur Mines and expanding the Big Hill and Bayou Choctaw sites was drafted in accordance with National Environmental Policy Act guidelines. The resulting impacts from these activities were evaluated and determined to be insignificant. The final report is scheduled for completion in July 1989.

Computer programs were developed for streamlining efforts associated with reporting discharge monitoring data and fugitive

emissions data to the EPA and applicable state agencies. The programs have substantially improved efficiency as well as accuracy.

BPS supported the 250 MMB expansion study identifying environmental concerns to aid in the selection of prospective sites.

There are no chronic unpermitted discharges at Strategic Petroleum Reserve (SPR) sites. Elevated salinity levels detected in the groundwater at two sites may have resulted from the activities of previous owners or originate from undetermined SPR facilities. Studies are underway at both sites to determine the brine sources and identify any appropriate mitigation steps.

Table 2-1. 1988 Oil Spills

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
02/28/88	WH	0.48 m^3 (3 barrels)	Meter prover loop overpressured during enhancement work of cavern 112. Relieved pressure to stop leak. Washed and vacuumed area.
03/11/88	BM	0.64 m^3 (4 barrels)	Missing plug on portable tank allowed oil to flow onto well pad. Plugged hole to stop leak. Washed and vacuumed area.
06/09/88	WH	6.40 m^3 (40 barrels)	Overfilled frac tank on well pad 6. Terminated fill operation. Washed and vacuumed area.
08/15/88	BH	0.16 m^3 (1 barrel)	Faulty level indicating tube on frac tank allowed tank to overflow onto well pad 110 while the tank was being filled. Fill operation terminated. Washed and vacuumed area.
09/12/88	BC	0.32 m^3 (2 barrels)	Pressure relief valve inadvertently opened allowing BCT-2 (slop tank) to overflow. All oil contained within diked area. Washed and vacuumed area.
12/24/88	WH	0.80 m^3 (5 barrels)	Leakage resulted due to loose fitting on wellhead hydrill unit at cavern 102. Fitting repaired. Washed and vacuumed area.

Table 2-2 (Sheet 1 of 2). 1988 Brine Spills

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
01/09/88	WH	16.00 m^3 (100 barrels)	Corrosion/erosion of buried 36-inch pipeline at low pressure pump discharge header caused pipe to rupture. Brine confined to drainage area near cavern 11. Approximately 90% recovered. Washed and vacuumed area.
03/17/88	BH	8.00 m^3 (50 barrels)	Gasket failure on 30-inch header. Brine confined to culverts near header. Terminated flow to stop spillage. Washed and vacuumed area.
03/24/88	BH	0.48 m^3 (3 barrels)	Overflowed frac tank on well pad 110. Fill operation terminated. Washed and vacuumed area.
04/14/88	WH	4.80 m^3 (30 barrels)	Residual brine in piping leaked out during valve 20B118 removal. Isolated leak and terminated leaching operation. Washed and vacuumed area.
04/20/88	WH	0.48 m^3 (3 barrels)	Corrosion/erosion of low pressure brine return pipeline north of cavern 115. Pipeline repaired and contamination removed. Washed and vacuumed area.
05/16/88	WH	2.40 m^3 (15 barrels)	Packing sleeve failure on low pressure pump WHP-104. All brine contained within pump pad. Washed and vacuumed area.
06/01/88	BM	48.00 m^3 (300 barrels)	Brineline header gasket failure west of well pad 110. Brine contained to well pad 110. Washed and vacuumed area.
06/13/88	WH	1.60 m^3 (10 barrels)	Corrosion/erosion of brine return pipeline downstream of valve 20F14. Excavated and banded pipe to seal and repair fracture. Washed and vacuumed area.

Table 2-2 (Sheet 2 of 2). 1988 Brine Spills

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
06/24/88	WH	0.16 m^3 (1 barrel)	Corrosion/erosion of brine return pipeline near wellhead 117B. Brine spray confined to well pad. Washed and vacuumed area.
07/05/88	WH	2.40 m^3 (15 barrels)	Corrosion/erosion of the pipeline manifold near valve on wellhead 117B. All brine confined to well pad. Washed and vacuumed area.
08/03/88	WH	8.80 m^3 (55 barrels)	Corrosion/erosion of the 24-inch brine return pipeline near oil/brine separator No. 1. Leaching shut down and pipeline repaired. Washed and vacuumed area.
09/19/88	BC	0.64 m^3 (4 barrels)	Brine flowed from pipeline when valve H-120-BL was being replaced. Brine confined to swale below valve. Washed and vacuumed area.

3. ENVIRONMENTAL PROGRAM

3.1 INTRODUCTION

A primary goal of DOE and the M&O contractor is to ensure that all SPR activities are conducted in accordance with sound environmental practices and the environmental integrity of the SPR sites, and their respective surroundings, is maintained.

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 to provide the information necessary for the control and mitigation of unwarranted environmental impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

3.1.1 Air Quality

During 1988, 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. Emissions associated with the SPR were estimated generally lower during 1988 as compared to 1982 through 1987 due to the reduction in fill activity. Actual throughput was monitored at Bryan Mound only and is discussed in the Bryan Mound section of this report. Dust emissions from most site roads have been mitigated through paving or application of dust control agents.

3.1.2 Surface Water Quality Monitoring

During 1988, the surface waters of the Bayou Choctaw, Bryan Mound, Sulphur Mines, and West Hackberry SPR sites were sampled and monitored for general water quality. This monitoring is separate from, and in addition to, the water discharge permit monitoring program and is not required by any federal or state regulatory agency. Surface water quality monitoring was not conducted at St. James Terminal or Weeks Island because of the low potential to impact surface waters on these two sites. Surface water quality monitoring at Big Hill will be initiated in 1989.

3.1.3 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 regularly conducted point source discharges from all sites during 1988. 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.

3.1.4 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.

3.1.5 Hydrology and Ground Water Monitoring

Ground water monitoring is performed at Big Hill, Bryan Mound, and West Hackberry. Salinity, pH, and other 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 some of the existing monitoring wells which presents problems when interpreting data. The ground water characteristics of each site are discussed within each site section.

3.1.6 Radioactivity

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

A total of 132 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 fluid density changes (oil versus brine) in pipelines. Each gauge unit contains between 100 and 400 millicuries (mCi) of cesium 137. Gauge wipe tests are performed every three years as recommended by the manufacturer. No radiation leakage has been detected to date. The DOE 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.

3.2 BAYOU CHOCTAW

The Bayou Choctaw site will be used to store 10.4 million cubic meters (66 million barrels) of crude oil. Currently, there are five solution-mined caverns with one additional cavern 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 58 kilometer (36 mile), 91-centimeter (36-inch) crude oil pipeline connecting the site to the St. James Terminal.

3.2.1 Air Quality

During 1988, Bayou Choctaw operated in accordance with air quality regulatory requirements. Total emissions from the facility were calculated using mehtod AP-42 to be less than 9 metric tons(10 tons)/year (a "nonsignificant facility" as noted in the air quality regulations for Louisiana). Nonsignificant facilities are exempt from vapor monitoring requirements. There were no configurational changes which would have resulted in additional air emissions during 1988. 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 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 (pH)

The hydrogen ion activity, or pH, was essentially neutrual (7.0) in most cases. The pH ranged from 6.4 to 7.3. Median pH level was 6.9.

The pH ranged from 7.1 to 8.8, 7.0 to 8.2, 6.6 to 8.4, 6.8 to 8.6, 6.5 to 8.9, and 6.4 to 7.9 during 1982, 1983, 1984, 1985, 1986, and 1987 respectively. The 1982 through 1988 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 0.3, 3.0, 3.0, and 0.4 parts per thousand (ppt) respectively. Salinity at station A remained below 0.5 ppt throughout 1988. At station B, salinity ranged from 0.2 ppt in February to 5.0 ppt in July. Salinities at stations C and D ranged from 0.3 to 8.5 ppt and 0.1 to 1.0 ppt respectively. 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 discharges.

Station C, located on the East-West Canal to the southeast of the brine pond, has shown a slightly elevated level of salinity. This is partially attributed to residue from brining activities conducted by prior tenants of Bayou Choctaw. Station D salinities are strongly influenced by Bull Bay and the Intracoastal Waterway. Salinities at stations B, C, and D were highest during 1985 when salinities reach 9.0, 5.0, and 4.0 ppt respectively, which corresponded to a long period of dry weather reducing flushing activity.

3.2.2.3 Total Suspended Solids

Average annual TSS levels at stations A, B, C, and D were 27.2, 18.4, 31.8, and 31.3 milligrams per liter (mg/l) respectively. The highest TSS level (125.5 mg/l) was observed during March at

control station A, which monitors the inlet water to Cavern Lake. Peak TSS levels were observed in August, May, and September at monitoring stations B, C, and D respectively, indicating no particular relationship between concentration, location, or time. No outfall at the site exceeded the permit limitation for TSS during 1988. Thus, the elevated levels observed were probably not due to SPR discharges. TSS levels for 1988 were consistent with those observed during previous years.

3.2.2.4 Temperature

Temperatures ranged from 11°C at station A during January to 28°C at station D during June and July. Temperatures for all stations averaged 20°C. Temperatures above 20°C were consistently observed at all stations from May through October. The temperature range varied by 17°C in 1988 as compared to the 20, 19, 20, 13, 19, and 15°C ranges observed during 1982 through 1987 respectively. Ambient temperatures during 1988 appeared 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 1.3 mg/l at station A during November to 14.0 mg/l at station B during March. Levels were below 5 mg/l at stations A, B, C, and D during 9, 2, 6, and 6 months respectively. The DO levels at station C, the area draining the sewage treatment plant, ranged from 3.2 to 12.8 mg/l. Mean DO levels at stations A, B, C, and D were 3.6, 8.5, 7.0, and 5.3 mg/l respectively. Lower DO levels were noted at stations A and D which are located away from all SPR outfalls. This observation would suggest that SPR runoff and discharges do not

significantly reduce the DO of receiving waters. The low levels observed at various times of the year are attributed to low flow and minimal flushing typically observed at those times.

3.2.2.6 Biochemical Oxygen Demand

The five-day BOD_5 ranged from 1 to 16.1 mg/l. Mean BOD_5 levels at stations A, B, C, and D were 3.6, 3.1, 7.5 and 4.2 mg/l respectively. Ranges observed during previous years were similar to the 1988 data. Such data are typical for backwater areas. 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 originating 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 1988 with the exception of April and May. Causes for the elevated levels are unknown since there were no noncompliances or detectable levels of oil and grease in surface waters during this period. With the exception of elevated levels, these data are generally consistent with data collected since 1982. The data favorably reflect continued good site 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 have a relatively neutral pH.

b. The observed salinities were generally low. Those slightly elevated salinities observed were not attributed to SPR activity.

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

d. Low DO levels 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 since 1982 indicate 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

Most 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 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	$\geq$6.0 - 9.0
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	pH	$\geq$6.0 - 9.0

A total of 393 analyses (27.5% for sewage and 72.5% for stormwater discharges) were conducted on permitted outfalls to monitor NPDES and state permit compliance during 1988. The four noncompliances (Table 3-2) in 1988 involved high BOD_5 levels in the site sewage treatment plants (STP) and were associated with mechanical problems. A project directive has been issued to improve STP operation. All other required analyses conducted on the site discharges were within permit limitations resulting in a 99% compliance level for 1988.

3.2.4 Active Permits

Table 3-3 lists the active permits at Bayou Choctaw. Individual work permits are received from the Louisiana Underground Injection Control Division for each well workover performed. State inspectors regularly visit the site to observe SPR operations.

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 18 meters below the surface and extends to a depth of 150 to 182 meters (500-600 feet). The upper 18 meters (60 feet) of sediments consist of Atchafalaya clay. The interface of freshwater and saline water occurs at a depth of 122 to 150 meters (400-500 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.

There are no functioning monitoring wells at the Bayou Choctaw facility.

3.2.6 Other Significant Environmental Activity

Phase II CERCLA testing was completed during 1987. Samples from previously abandoned caverns 1, 2, 3, 8A, and 13 and boreholes 1 and 2 were analyzed and determined to be nonhazardous. Cavern 10, which had been found to contain caustic brine with a high lead level in a wellhead sample, was sampled at five depths. The caustic was determined to be confined to the interior of the casing pipe and hazardous levels (greater than or equal to 5.0 mgh) of lead were not found. These caverns and holes are scheduled for plugging and abandonment in 1990.

Considerable effort was provided for developing new filtration techniques for removing anhydrite particles from brine prior to deep well injection. The techniques developed appear successful in reducing the frequency for well workovers or the need for drilling additional injection wells. Two additional filter systems were added to increase efficiency and capacity.

3.3 BIG HILL

The Big Hill site is planned for the storage of 25.4 million cubic meters (160 million barrels) of crude oil in 14 caverns. Appurtenant facilities include a raw water intake structure on the Intracoastal Waterway with a 107-centimeter (48-inch) pipeline extending to the site, a 107-centimeter (48-inch) brine disposal pipeline extending eight kilometer (five miles) offshore in the Gulf of Mexico, and a 91-centimeter (36-inch) pipeline for transporting crude oil between the site and the Sunoco Terminal in Nederland, Texas.

Drilling and construction commenced in 1983 at the site. Actual leaching (solution mining) of the oil storage caverns began in October 1987 and continued throughout 1988.

3.3.1 Air Quality

The Big Hill facility operated in accordance with applicable air quality regulatory requirements and all conditions of the air quality permit. This included sprinkling plant roads with water and dust abatement chemicals to control fugitive dust emissions. Annual hydrocarbon emission monitoring as required by the permit will commence when actual crude oil storage (planned for 10/90) is initiated.

3.3.2 Surface Water Quality Monitoring

Beginning in 1989, 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 result from SPR operations. Parameters such as pH, salinity, 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

Water discharges at Big Hill are regulated and enforced through the EPA NPDES permit program and the similar TWC discharge permit program. A NPDES renewal application was submitted during 1988 as required every five years. No significant changes were requested in the application. The discharges at the facility involve brine to the Gulf of Mexico, hydroclone blowdown into the Intracoastal Waterway, effluent from the sewage treatment plant, and stormwater from well pads and pump pads. Figure 3-2 shows the existing outfalls and the proposed water quality monitoring locations.

There were no discharges during 1988 from the hydroclone blowdown system. Parameters for the three active discharges are described below.

Location/Discharge	Parameter	Compliance Range
brine to Gulf	flow	0.27 million m^3/day velocity $\geq$ 6.1 m/sec)
	oil and grease	$<$ 15 mg/l
	TDS	(report only)
	TSS	$<$ 40 mg/l (TWC only)
	pH	6.0-9.0
	DO	Detectable (when using O_2 scavenger)
stormwater	oil and grease	$<$ 15 mg/l
	TOC	$<$ 75 mg/l (EPA only)
	pH	6.0-9.0
sewage treatment plant (TWC only)	flow	$<$ 37.8 m^3/day
	BOD_5	$<$ 45 mg/l and $<$ 0.38 kg/day
	TSS	$<$ 45 mg/l and $<$ 0.38 kg/day only)
	chlorine	$>$ 1.0 mg/l
	pH	6.0-9.0
hydroclone blowdown (not used)	flow	report
	TSS	report
	pH	6.0-9.0

A total of 2376 analyses were performed to monitor NPDES and state discharge permit compliance during 1988. Brine discharges to the Gulf accounted for 46.3% of these analyses. Analyses of stormwater and sewage treatment plant discharges accounted for 39.8% and 13.9% respectively. There were 7 noncompliances during 1988 (Table 3-4) resulting in a 99.7% site compliance performance level.

The Big Hill site has a second TWC permit for appropriating state waters for the leaching, site utility, and fire protection systems. The permit requires a yearly report of water quantities used. In 1988, the site appropriated 53.1 million cubic

meters (43,034 acre-feet) of water from the Intracoastal Waterway. This represents 18% of the total volume permitted.

3.3.4 Active Permits

Table 3-5 lists the active permits at Big Hill.

3.3.5 Ground Water

The three major subsurface hydrological units in the Big Hill area are the Chicot and Evangeline aquifers and the Burkville aquiclude. The major source of fresh water is the Chicot Aquifer which is compressed 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 -30 meters 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.

Six monitoring wells were installed around the brine disposal pond system and were sampled for the first time in December 1987. The first full year of sampling and analysis provided the following data for monitor wells MW1 through MW6 respectively: Mean salinity (ppt) of 1.0, 1.0, 0.3, 0.4, 0.5, and 0.7; Median pH of 7.3, 6.0, 5.7, 6.9, 7.0, and 7.4; mean TOC (m_g/l) of 8.9, 7.0, 8.9, 7.4, 8.7, and 6.6. The upgradient wells (MSW 1, 2, and 3) and downgradient wells (MW 4, 5, and 6) show similar levels for each parameter. This baseline data indicates no apparent leakage at the brine pond.

3.3.6 Other Significant Environmental Activity

Phase II CERCLA testing was completed in 1987. Twenty-eight caverns were sampled for hazardous substances. As a result of these analyses, an Administrative Order was issued by the EPA and an Emergency Order by TWC requiring flushing of five wells prior to leaching and monthly inorganic analysis of the brine

being discharged to the Gulf through start of leach of all caverns. Two of the wells were flushed in 1987 and three were flushed in 1988. Analysis showed the flushed brine to be nonhazardous, and it was disposed in oilfield waste (Class II) injection wells. Remaining fluids were found to meet the chronic marine salt water quality criteria on discharge for all 61 measured constituents.

A coordinated effort to resolve the use of brackish water during site fire drills and acceptance tests was initiated in 1987. Design modifications of the firewater system were evaluated in 1988 and will include substituting fresh for brackish water while maintaining adequate water for emergencies.

3.4 BRYAN MOUND

A total storage capacity of 35.9 million cubic meters (226 million barrels) of crude oil in 20 solution-mined caverns is planned for Bryan Mound. Appurtenant facilities include a 91-centimeter (36-inch) brine disposal pipeline extending 20.1 kilometers (12.5 miles) into the Gulf of Mexico; a raw water intake structure adjacent to the site on the Brazos River Diversion Channel, two 76-centimeter (30-inch) crude oil pipelines connecting the site to the Jones Creek Tank Farm 4.8 kilometers (3 miles) northwest of the site, the Phillips docks 6.4 kilometers (four miles) northeast of the site, and the 102-centimeter (40-inch) crude oil pipeline from the site to Arco Refinery in Texas City.

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 1988. The ongoing fugitive emissions monitoring program as required by the Texas Air Control Board (TACB) includes monitoring for fugitive volatile organic

compound (VOC) emissions from valves and seals on an annual basis using a VOC detector. The program includes monthly calculations of emissions based on crude oil throughput for each storage tank. No leaks of hydrocarbon vapors from valves or pump seals were detected during 1988. Hydrocarbon emissions from surge tanks were calculated at 1.5 metric (1.6 tons) tons during 1988, or 27.3% of the permitted limit (5.5 metric tons (6.1 tons) per year). A TACB inspection conducted during 1988 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 1988. Blue Lake was sampled once monthly at each station. Mud Lake was sampled once monthly except during August and September when low tides restricted access to the lake.

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, calcium, and magnesium. The parameters are discussed below and compared to 1982 through 1987 monitoring data.

3.4.2.1 Hydrogen Ion Activity

The hydrogen ion activity, or pH, was moderately basic, ranging from 7.2 in November to 9.7 in August in Blue Lake and 7.2 in April to 8.5 in February in Mud Lake. Median pH levels in Blue Lake and Mud Lake were 8.1 and 7.6 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, typically have somewhat elevated pH levels and high mineral contents. The pH is believed to 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 the years 1982 through 1987 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, 7.9 to 9.8, 7.7 to 9.9, and 7.2 to 9.7 respectively, in general agreement with the 1988 data. There were no known pH inducing impacts to Mud Lake during 1988 or previous years as indicated by these comparisons. 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 40 mg/l in July to 160 mg/l as $CaCO_3$ in April, while the alkalinity in Mud Lake ranged from 70 mg/l in June to 125 mg/l as $CaCO_3$ in July. Mean alkalinity levels were 104.1 and 135.8 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 10.5 and 26.2 ppt in Blue Lake and Mud Lake respectively. The salinity in Blue Lake ranged from 3.0 ppt in May to 13.7 ppt in December. Salinities were highest (13.2 to 13.7 ppt) during December. Salinities were generally higher in 1983, 1986, and 1988 than during 1982, 1984, 1985, and 1987. Salinity fluctuations are attributed to meteorologically induced conditions rather than site operations, since salinities observed at control sample points were consist with those found along the site shoreline.

The salinity in Mud Lake ranged from 19 ppt in March to 39 ppt in June. Mud Lake salinities were generally higher from 1982 through 1985 and in 1987 than during 1986. The larger 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. Low rainfall and low water levels in Mud Lake contributed to the above normal salinities.

3.4.2.4 Temperature

The temperature in Blue Lake ranged from 14°C in January to 30°C in September. The temperature in Mud Lake ranged from 6°C in December to 33°C in July. No measurements were taken in Mud Lake during January, March, September, and November due to low water levels. Mean temperature readings during 1988 were 23.0 and 25.9°C in Blue Lake and Mud Lake respectively. Temperature variation within each lake between sampling locations was generally limited to 2°C suggesting no measurable site induced thermal effects.

Comparable temperatures were observed during previous years. Blue Lake ranged from lows of 9°C in January 1983 and 1984, and 17°C in December 1982 and 1986, and to highs of 33°C in August

1982, and 32°C in July 1983 and September 1984. Mud Lake ranged from lows of 13°C in December 1986, 16°C in December 1982, 15°C in February 1983, 22°C in April 1984, and 9°C in December 1985 to highs of 32°C in July 1983 and 1986, 31°C in June 1982, 29°C in July 1984, and 30°C in June and July 1985.

3.4.2.5 Dissolved Oxygen

Mean DO concentrations were 8.0 and 8.1 mg/l in Blue Lake and Mud Lake respectively. The DO concentration in Blue Lake ranged from 5.2 mg/l in July to 13.4 mg/l in November. The DO in Mud Lake ranged from 3.6 mg/l in July (no sampling during January, March, September, November, and December) to 19 mg/l in January. The DO levels in 1988 were consistent with that observed since 1982. The DO ranges observed are considered beneficial to the aquatic organisms inhabiting these lakes. Fluctuations in DO levels were attributed to the inverse relationship between temperature and DO as well as seasonal fluctuations in primary organic productivity, and meteorological factors such as wind driven mixing.

3.4.2.6 Total Organic Carbon

The TOC concentration in Blue Lake remained low, averaging 10.2 mg/l and ranging from 7.6 to 24.7 mg/l during 1988. The elevated concentrations attributed to natural phytoplankton blooms from 1982 through 1984 were not observed in subsequent years.

The TOC concentration in Mud Lake remained low, averaging 4.8 mg/l and ranging from 2.8 mg/l in April to 10.9 mg/l in October. The low TOC levels observed in both lakes are consistent with healthy conditions and a stable oxygen demand.

3.4.2.7 Chemical Oxygen Demand

The COD in Blue Lake averaged 39.1 mg/l and ranged from 5.9 mg/l in May to 144 mg/l in March. The levels observed during 1988

were consistent with 1987 (9.3 to 159.1 mg/l) and 1986 (9.9 to 159.1 mg/l), but lower during 1982 through 1984, paralleling TOC observations.

The COD in Mud Lake averaged 66.5 mg/l and ranged from 16.4 mg/l in July to 152 mg/l in March. Levels were generally similar to those observed in previous years (1982 through 1986) and during 1987 (16.7 to 257.8 mg/l). Variation in COD between the lakes is attributed to the tidal and physical differences.

3.4.2.8 Additional Water Quality Monitoring

Visual surveys of adjacent water bodies were performed periodically to monitor those climatic events and environmental perturbations that may affect the SPR either directly or by association. Survey findings for 1988 were negative.

3.4.2.9 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 stable and predominantly neutral 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 generally consistent with that observed during previous years. Salinity fluctuations during and among years are 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 indicate stable continued primary production.

d. Mud Lake experiences more pronounced 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. An NPDES renewal application was submitted during 1988 as required every five years. No significant changes were requested in the application. The three categories of discharges are brine to the Gulf of Mexico; stormwater from the tank farm, well pads, and pump pads; and package sewage treatment plant effluent.

Parameters for the three discharges are described below.

Location/Discharge	Parameter	Compliance Range
brine to Gulf (EPA only)	flow	0.17 million m^3/day (nozzle exit velocity $\geq$ 6.1 m/sec)
	oil and grease	$\leq$15 mg/l
	TDS	(report only)
	TSS	(report only)
	pH	6.0 - 9.0
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	TOC	$\leq$75 mg/l (EPA only)
	pH	6.0 - 9.0
	COD	$\leq$200 mg/l (TWC only)
sewage treatment plant	flow	$\leq$22.7 m^3/day (TWC only)
	BOD_5	$\leq$45 mg/l and $\leq$0.68 kg/day
	TSS	$\leq$45 mg/l $\leq$0.68 kg/day
	chlorine	$\geq$ 1.0 mg/l
	pH	6.0 - 9.0

A total of 4,177 analyses were performed on permitted outfalls for the purpose of monitoring NPDES and state discharge permit compliance during 1988. The brine discharges to the Gulf of Mexico accounted for 8.7% of these analyses. Other analyses (45.7%) were performed on stormwater and pump pad discharges and (45.6%) sewage treatment plant discharges. There were two noncompliances during 1988 (Table 3-6) 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 1988, the site appropriated .096 million cubic meters of water from the Brazos River Diversion Channel. A total of 145.89 million cubic meters of water has been appropriated to date for site activities which represents 32.2% of the total volume permitted.

3.4.4 Active Permits

Table 3-7 lists the active permits for the Bryan Mound site.

3.4.5 Ground Water

The Chicot and Evangeline Aquifers are fresh and slightly saline in the Bryan Mound area. Fresh water for Brazoria County is obtained from the upper portions of the Chicot Aquifer.

Over the salt dome fresh water is thought to occur in the upper 24 meters with slightly saline water from -24 to approximately -69 meters. However, the wells drilled on site for rig water are all brackish.

The sampling of two existing monitoring wells began in April of 1988. Installation and sampling of two new monitoring wells began in December of 1988.

3.4.6 Other Significant Environmental Activity

Phase II CERCLA testing was completed in 1987. Analytical results of samples collected from the tarry area near cavern 101 indicated nonhazardous trace levels of heavy metals typical of weathered oil. These low levels found are not an environmental or public safety threat. Cleanup and disposal of the tarry material as an oil field waste was completed by late 1988.

Dye tests performed in 1987 on well pad 113 were effective in locating dike leaks which impacted stormwater retention capabilities of the pad as required by the NPDES and TWC water discharge permits. The high density polyethylene liner installed at well pad 113 will be maintained and replaced in 1990 when the well pad will be permanently repaired.

3.5 ST. JAMES TERMINAL

The St. James Terminal has six aboveground storage tanks (total capacity 0.3 million cubic meters or two million barrels) and two tanker docks. The terminal has separate pipelines connected to 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 1988. Hydrocarbon emissions were well below the levels projected in the Emission Inventory Questionnaire (866 metric tons/year for loading operations and 541 metric tons/year for unloading operations). Seals on all six external floating roofs were visually inspected during 1987 and found to require repair to ensure continued compliance with state air quality regulations. Seal repair work commenced in 1987 and is scheduled for completion in 1989. 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 a state-conducted water quality monitoring program limit the value of a site-directed water quality monitoring program in the Mississippi River. There are no other surface waters located near the site.

3.5.3 Water Discharge Permit Monitoring

Outfall 001 is stormwater from the site retention pond. Outfalls 002 and 003 are for the two site package sewage treatment plants. All individual discharges are through a common pipe to the Mississippi River.

Parameters for the outfalls are described below.

Location/Discharge	Parameter	Compliance Range
retention pond	flow	(report only)
	oil and grease	≤15 mg/l
	pH	≥6.0 - 9.0
	TOC	≤50 mg/l
sewage treatment plants	flow	(report only)
	BOD_5	≤45 mg/l
	TSS	≤45 mg/l
	pH	≥6.0 - 9.0

A total of 219 analyses (11% for stormwater and 89% for sewage discharges) were performed on permitted outfalls to monitor NPDES and state discharge permit compliance during 1988. There were no noncompliances in 1988.

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

Site personnel received training on the proper techniques for inspecting seals and measuring seal gaps on the six crude oil storage tanks. A computerized system was also developed for calculating the total seal gap area present on each tank. The data has proven to be effective for ensuring continued compliance with applicable air quality requirements.

A design review of the potable water system was performed in 1988 to determine compliance with applicable health codes.

Pipeline thickness test were performed on the pipelines between the Bayou Choctaw site and the St. James terminal to ensure pipeline integrity. Several minor corrective actions were completed by late 1988.

3.6 SULPHUR MINES

Sulphur Mines stores 4.1 million cubic meters (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 a 40-centimeter (16-inch), 25.6 kilometer (16 mile) crude oil pipeline which connects to the West Hackberry 107-centimeter (42-inch) line at the Gulf Intracoastal Waterway. Brine disposal is via injection into four brine disposal wells located approximately two miles (3.2 kilometers) southwest of the site.

3.6.1 Air Quality

Sulphur Mines operated in accordance with all air quality permit and regulatory requirements during 1988. No configurational or operational changes affecting emission rates occurred at Sulphur Mines. Hydrocarbon emissions, based on crude oil throughput, were well below levels in the Emissions Inventory Questionnaire (0.2 metric tons (440 pounds)/year for standby (static) mode of operation). No air quality monitoring using actual monitoring equipment was required or conducted during 1988. 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 1988 due to access problems associated with construction activities by an adjacent land owner. 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 7.6 ranging from a low of 6.2 at station A in January to a high of 9.8 at station G in November. The median pH has increased slightly each year as compared to 1982 (6.0), 1983 (6.1), 1984 (6.4), 1985 (7.2), 1986 (7.3) and 1987 (7.4). The minimum and maximum pH occurred during June and March respectively during 1982, 1983, 1984, and 1986. In 1985, low and high values occurred in August and February and in December and April during 1987.

In 1988, the pH was slightly more acidic at station A with a median pH of 6.8. Stations B, D, E, F, and G were neutral to a slightly elevated pH with an overall respective median pH of 7.4.

3.6.2.2 Salinity

The salinity of the surface waters at Sulphur Mines averaged 1.1 ppt and ranged from 0 to 3.2 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 1.7). This level is also consistent with that observed in previous years.

3.6.2.3 Total Suspended Solids

Monthly TSS levels averaged 10.2 mg/l and ranged from nondetectable (<0.5mg/l) to 67 mg/l during 1988. TSS levels were generally lower than previous years. All site point source discharges were within permit limitations for TSS throughout 1988. 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 sample temperatures of the Sulphur Mines surface waters were generally conducive to supporting aquatic life throughout 1988. Maximum station temperatures as high as 30°C were observed during September, while the minimum temperatures (as low as 14°C) were observed during 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 1988, except during December 1988 when levels were 9.2 mg/l at station E. The cause for the observed level not attributed to SPR activity but to observe activities in adjacent areas. These data reflect favorably on the site spill prevention, control, and response efforts during 1988. These results are consistent with that collected during previous years.

3.6.2.6 Dissolved Oxygen

Dissolved oxygen monitoring was performed only at station A throughout 1988. This station is located in a relatively stagnant drainage ditch that receives effluent from the site package sewage treatment plant. The DO levels averaged 5.4 mg/l and ranged from 0.8 mg/l during April to 9.3 mg/l during November. The sewage plant operated in compliance throughout 1988. Thus, low DO levels are related to natural organic loading 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. In general, observations indicate a subtle shift in pH of the area surface waters from slightly acidic to slightly basic. Overall, pH continues to be relatively neutral.

b. Changes in water temperature observed during years since 1982 are attributed to seasonal meteorological variation since the SPR has no thermal discharges.

c. The DO levels observed since 1985 have been relatively consistent, with only a sight deviation in 1986, and are 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 sewage treatment plant.

Parameters for stormwater and wastewater discharges are described below.

Location/Discharge	Parameter	Compliance Range
stormwater	flow	(report only)
	oil and grease	<15 mg/l
	pH	6.0 - 9.0
sewage treatment plant	flow	<5.6 m3/day
	BOD_5	<45 mg/l
	TSS	<45 mg/l
	pH	6.0 - 9.0

A total of 507 analyses were conducted on permitted outfalls to monitor NPDES compliance during 1988. Approximately 38.5% of

the analyses performed were for monitoring stormwater runoff and 61.5% for sewage treatment plant effluent analyses. There were no noncompliances during 1988 resulting in a compliance performance level of 100%.

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. 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 at monthly intervals. Weekly sampling was performed when leaks in the pond liner were suspected. The pH was relatively constant (range 5.5 to 7.0). Salinity levels averaged 129.0 ppt and ranged between 1.2 and 214.0 ppt. The high salinities were caused by leaks in the pond liner, which were repaired during 1988.

The brine pond is filled with predominantly fresh water. The underdrain system, along with temporary repairs to the pond lining, prevents contamination of the soil beneath the brine

pond. The Sulphur Mines site is due to be decommissioned in November, 1992.

3.7 WEEKS ISLAND

The Weeks Island site consists of a large mechanically excavated (room and pillar type) salt mine with 11.6 million cubic meters (73 million barrels) of crude oil storage capacity. In addition to normal site facilities, there is a 108 (6.7 miles) kilometer long 91 centimeter (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 1988. No significant configurational or operational changes affecting emission rates occurred at the facility. Hydrocarbon emissions, based on throughput, were well below levels shown in the Emissions Inventory Questionnaire (i.e., 0.2, 0.6, and 0.8 metric tons (440, 1320 and 1760 pounds) per year for filling, withdrawal and recirculation operations respectively). Air quality monitoring using actual monitoring equipment was neither required nor conducted during 1988.

3.7.2 Surface Water Quality Monitoring

The Weeks Island site is located on the Weeks Island salt dome approximately 30 meters (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, 002, and 003 (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 separate outfalls (01B and 002) for each package sewage treatment plant. Outfall 01A consists of stormwater runoff collected in an onsite retention pond.

The various parameters for the monthly samples of all 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	$\geq$6.0 - 9.0
sewage treatment plant	flow	(report only)
	BOD_5	$\leq$45 mg/l
	TSS	$\leq$45 mg/l
	fecal coliforms	$\leq$400 colonies/100 ml
	pH	$\geq$6.0 - 9.0
iron removal unit	flow	(report)
	TSS	$\leq$45 mg/l

A total of 243 analyses (69% for sewage and 31% for stormwater discharges) were conducted on permitted outfalls to monitor NPDES compliance during 1988. There was one noncompliance in 1988 (Table 3-10). The site experienced a compliance performance level of 99.6%.

3.7.4 Active Permits

The active permits for Weeks Island are listed 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. 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

The investigation initiated in 1987 continued for determining the source of brine which is accumulating in the storage area of the mine. This involved dewatering the mine at the fill hole and disposing the collected brine at an approved offsite facility. Preliminary results indicate the brine source is from the crude oil stored and not from outside the mine. A project to condition the mine air and remove moisture was initiated in 1988. Preliminary results indicate the brine source is from the crude oil stored and not form outside the mine.

A modeling study was performed in 1988 to assess the dispersion rates of Halon 1301 during various weather conditions when vented from the Weeks Island mine. Venting procedures were modified as a result of the study to ensure the material is vented safely.

3.8 WEST HACKBERRY

The West Hackberry site will store 34.8 million cubic meters (219 million barrels) of crude oil in 22 solution-mined caverns. Brine is transported and disposed either by injection into eight active brine disposal wells located approximately three kilometers southeast of the site or to the Gulf of Mexico through a 91-centimeter (36-inch), 42 kilometer (26 mile) pipeline at an area 11 kilometers south of Holly Beach. A series of 55 brine diffuser nozzles are operated to promote brine dispersion. 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 107-centimeter (42-inch), 66 kilometer (42 mile) crude oil pipeline.

3.8.1 Air Quality

West Hackberry operated in accordance with all air quality permit and regulatory requirements during 1988. According to throughput and AP-42 computations, hydrocarbon emissions were well below the 50.4 metric tons (55.4 ton) permitted for filling operations. Air quality monitoring using actual monitoring equipment was neither required nor conducted during 1988. There were no construction or configurational changes which would have resulted in additional emissions during 1988. 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 1988. Specific monitoring stations are identified in Figure 3-7. Specific parameters monitored in the West Hackberry surface waters include pH, salinity, TSS, temperature, TOC, and oil and grease. TOC was monitored only at station E corresponding to the NPDES permit requirement regarding stormwater discharges. Each parameter is discussed in the following sections.

3.8.2.1 Hydrogen Ion Activity

The pH ranged from 7.0 to 8.4 for all stations. The median pH was 7.8. Less variation in pH was observed during 1988 than any year since 1983. The upper range of the monthly pH, on a station basis, exceeded 8.0 for 9.7% of the observations, which is compared to those observed in 1987 (27%), 1986 (38%), 1985 (20%), 1984 (22%), 1983 (23%), and 1982 (45%). Natural waters low in, or devoid of, carbon dioxide are medium hard to hard, with regard to mineral content, and characteristically have a

slightly high pH. 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. A mildly high pH is beneficial to aquatic life and consistent with an environmentally sound ecosystem.

3.8.2.2 Salinity

Salinity averaged 7.2 ppt and ranged from 0.3 to 19.3 ppt for stations A through F. Stations A, B, and C (Black Lake) ranged from 3.3 to 19.3 ppt with the highest levels occurring in October and January. The Black Lake data was consistent with salinity levels observed from May through November since 1982. Comparisons among stations for each month were also consistent.

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

Salinities at station D, the southeast drainage ditch, averaged 1.6 ppt and ranged from 0.3 ppt to 6.8 ppt, which is consistent with data collected since 1982. Monthly salinity values at station E, runoff from the high pressure pump pad, averaged 1.1 ppt and ranged from 0.3 to 1.8 ppt. Station E is generally less saline than Black Lake and fluctuates independently of Black Lake stations suggesting there is little to no impact to the lake from this SPR runoff.

3.8.2.3 Total Suspended Solids

TSS averaged 26.4 mg/l and ranged from nondetectable (<0.1 mg/l) to 138 mg/l. The lowest average occurred at station E (16.3 mg/l) which ranged between 1.0 and 138.0 mg/l). Similar ranges were found at stations A (averaged 25.1 mg/l), B (averaged 24.0

mg/l), and C (averaged 24.3 mg/l) in Black Lake (12.5 to 62.5 mg/l). Slightly higher levels were observed at station F (27.0 to 66.5 mg/l). Average levels at this station were 42.3 mg/l. The highest range was found at station D (1.0 to 138.0 mg/l), which had the lowest average (16.3 mg/l). Although high TSS levels were reported at station D, this station is located in the southeast drainage ditch, and has historically shown high TSS levels due to routine cleaning activities performed to keep the ditch free of weeds.

Elevated TSS levels (>50 mg/l) occurred only once at station C in Black Lake during May. This phenomenon is attributed to wind and wave driven mixing in the shallow lake. It appears that even with the one high occurrence (sediment due to low level in the deluge pond to which the HPP drains), 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) is expected for a high traffic, shallow waterway. The 1988 TSS observations were generally 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 20.6°C and ranged from 11 to 32°C. The highest temperatures were recorded during September. The temperature ranges were consistent with previous years, except 1985 when the ranges were 14.2 to 27°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 1988. These data are consistent with oil and grease data collected since 1982.

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 4.0 mg/l and ranged from 1.9 to 12.2 mg/l. These low levels indicate that effluent from the pad did not contribute to TOC loading in the lake. These low TOC levels are generally acceptable for an area dominated by industrial runoff. The small observed fluctuation in TOC is not significant.

3.8.2.7 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 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 phenomena.

c. Oil and grease levels were nondetectable in Black Lake throughout 1988.

d. TOC remained well below permit limits.

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 (Figure 3-7 (Sheet 2 of 2)) are brine disposal, sewage treatment plant effluent, and stormwater runoff from well and pump pads. The various parameters for these discharges are listed below with their maximum limits.

Location/Discharge	Parameter	Compliance Range
brine to Gulf	flow	<0.17 million m^3/day (nozzle exit velocity >7.6 m/sec.(25 ft./sec.)
	oil and grease	<15 mg/l
	TSS	(report only)
	TDS	(report only)
	pH	6.0 - 9.0
	DO	detectable (when using O_2 scavenger)
sewage treatment plant	flow	(report only)
	BOD_5	<15 mg/l
	TSS	<45 mg/l
	fecal coliform	(report only)
	pH	6.0 - 9.0
stormwater	flow	(report only)
	oil and grease	<15 mg/l
	TOC	<75 mg/l
	pH	6.0 - 9.0

A total of 2,812 analyses were conducted on permitted outfalls to monitor NPDES compliance during 1988. Discharges from the sewage treatment plant and brine disposal pipeline accounted for 2% and 48% respectively of total analyses performed. The majority of the analyses (50%) involved well and pump pad runoff.

Permit noncompliances were identified on two occasions (Table 3-12). These 1988 noncompliances, on a per analysis basis, resulted in a site compliance performance level of 99.9%.

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 flows closest to the surface in the Hackberry area, is predominantly fresh water with salinity increasing with proximity to the coast. The Evangeline Aquifer flows 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 a cone of depression has been created in some areas. The fresh/saline water interface is approximately 200 meters (700 feet) below the surface.

There are twelve monitoring wells (Figure 3-7) on the West Hackberry site. Four of these monitoring wells have been sampled monthly since 1982. The other eight were installed in 1988. Well log histories and background information on construction and installation are lacking for three of the wells installed prior to 1982.

Mean salinity levels in wells PB1, P8, P9, and P11 were 115.6, 0.7, 1.5, and 2.7 ppt respectively. Salinities ranged from 0.8 ppt at P8 during much of the year to 126.0 ppt at PB1 in July and November. Salinity levels in monitoring wells P8, P9, and P11 showed only slight fluctuations during 1988 as compared to levels noted during previous years. Salinity observations were made to the appropriate regulatory agencies. A plume was defined by the newly installed wells and a pumping program initiated which resulted in a 33% recovery of ground water quality in 1988.

The ground water pH values observed from the monitoring wells P8, P9, and P11 ranged from 6.3 to 6.9, which is consistent with previously collected data. The pH in monitoring well PB1 ranged from 5.5 to 6.1. Low pH levels for all wells were also noted in 1986 (ranged from 3.4 to 4.7).

3.8.6 Other Significant Environmental Activity

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

Environmental assessment of impact in the Black Lake area from the 1986 Cavern 111 crude oil spill continued. Analysis of water and mud from the lake indicate the overall impact from the spill was confined to a small area around the wellpad and effects were short-lived.

Brine sampling was performed on the brine disposal pipeline at the pumps and downstream at the site property line to ensure that dissolved oxygen levels remained detectable at the outfall when oxygen scavenger is used for reducing corrosion of the pipeline.

Residential water wells on property aquired adjacent to the site were plugged and abandoned in July of 1988 according to LADOTD regulations.

3.9 CONCLUSION

No adverse environmental impact resulting from SPR activities was observed during 1988. The SPR continues to maintain an excellent environmental record at all facilities.

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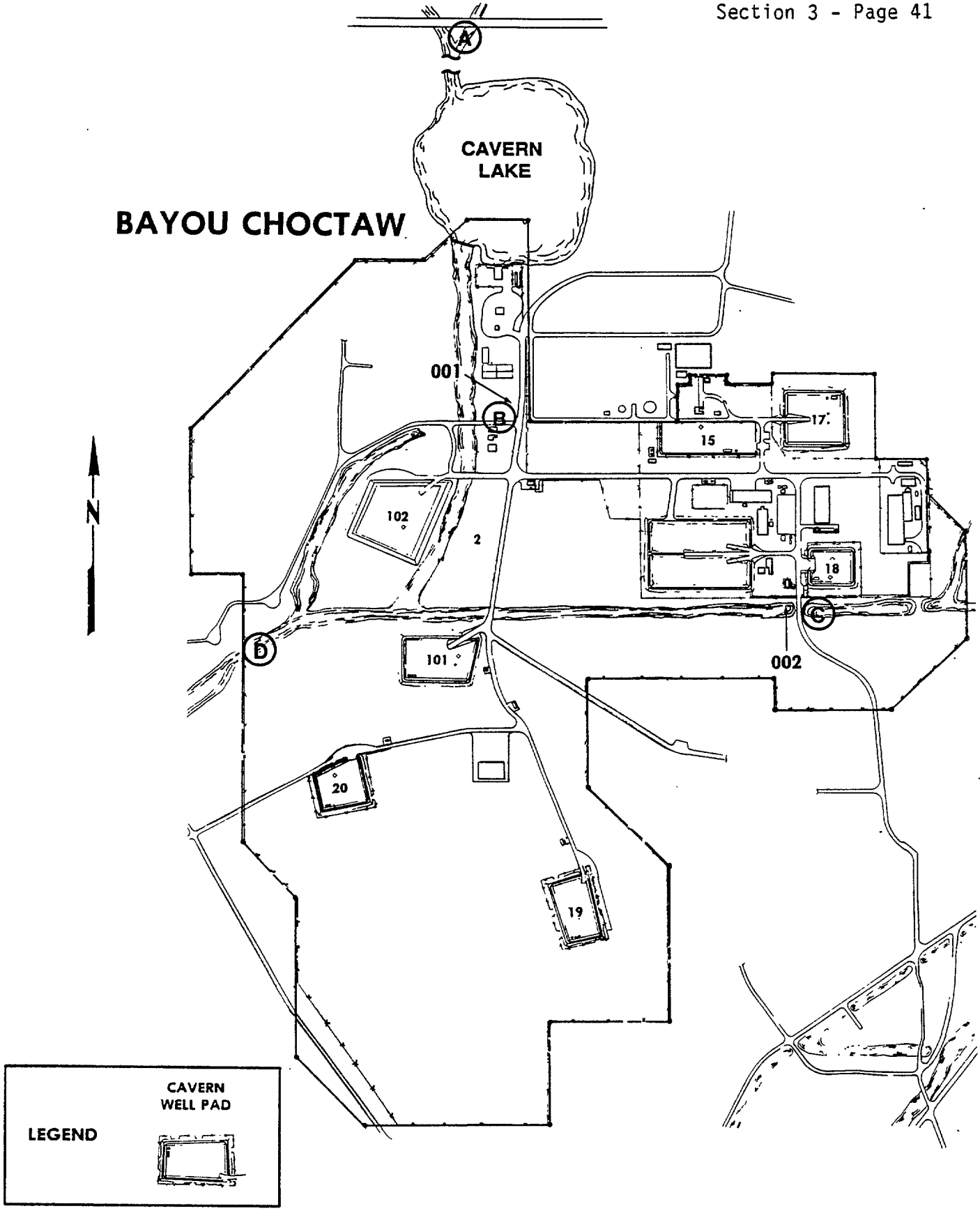

Figure 3-1 (Sheet 1 of 2). Bayou Choctaw Environmental Monitoring Stations

Discharge Monitoring Stations

001 Discharge from Sewage Treatment Plant (Trailer Complex)

002 Discharge from Sewage Treatment Plant (Administration Building)

Stormwater Discharges

Stormwater and pump flush from pump pads

Stormwater runoff from well pads 15, 17-20, and 101

Water Quality Monitoring Stations

A Canal North of Cavern Lake at Perimeter Road bridge

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

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

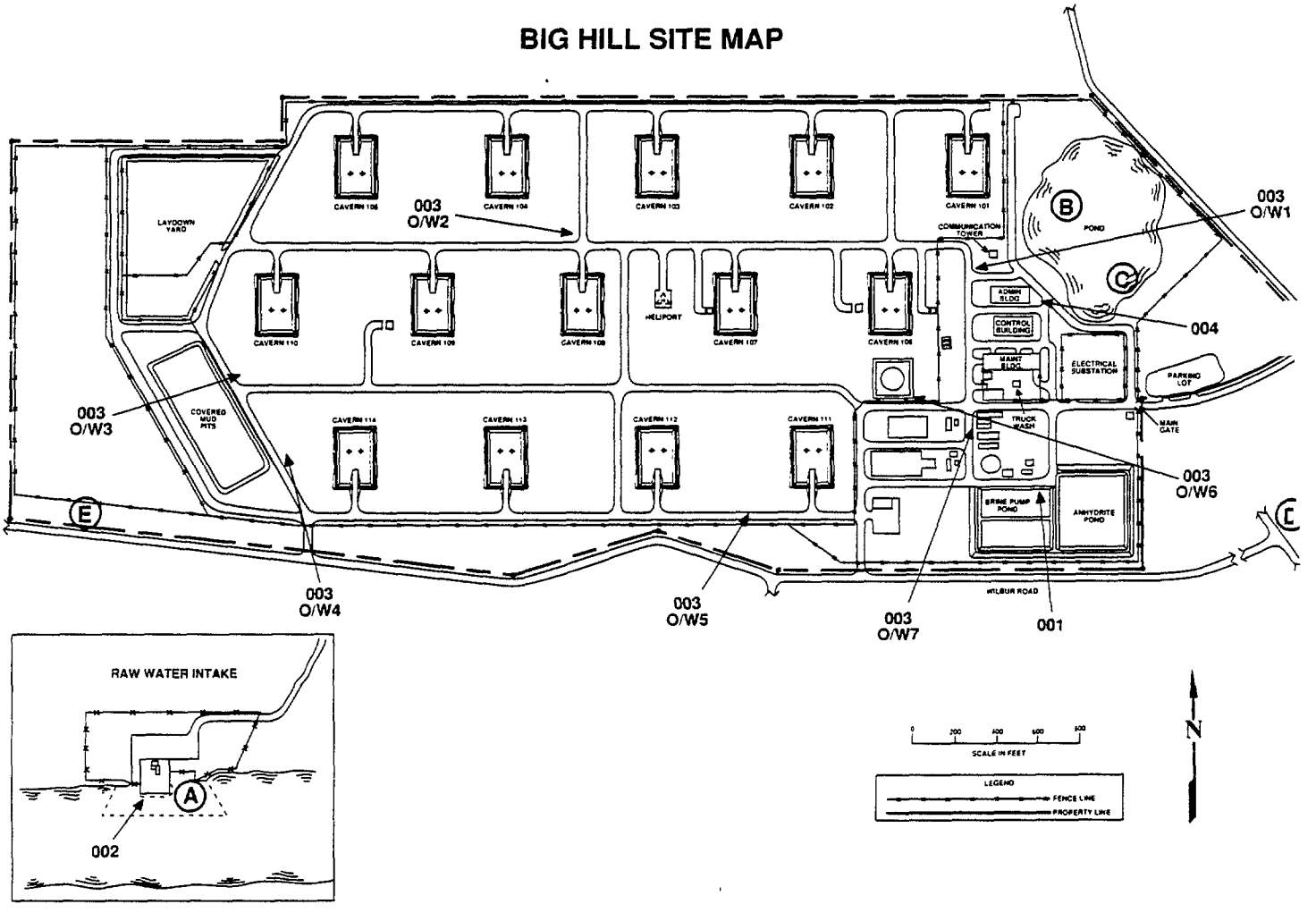

Figure 3-2 (Sheet 1 of 2). Big Hill Environmental Monitoring Stations

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 103, 104, 105
- O/W3 Stormwater from Well Pads 108, 109, 110
- O/W4 Stormwater from Well Pads 113, 114
- O/W5 Stormwater from Well Pads 111, 112
- O/W6 Stormwater from BHT-7 (crude oil surge tank) diked area
- O/W7 Stormwater from Pump and Meter Pads

004 Discharge from Sewage Treatment Plants (TWC only)

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

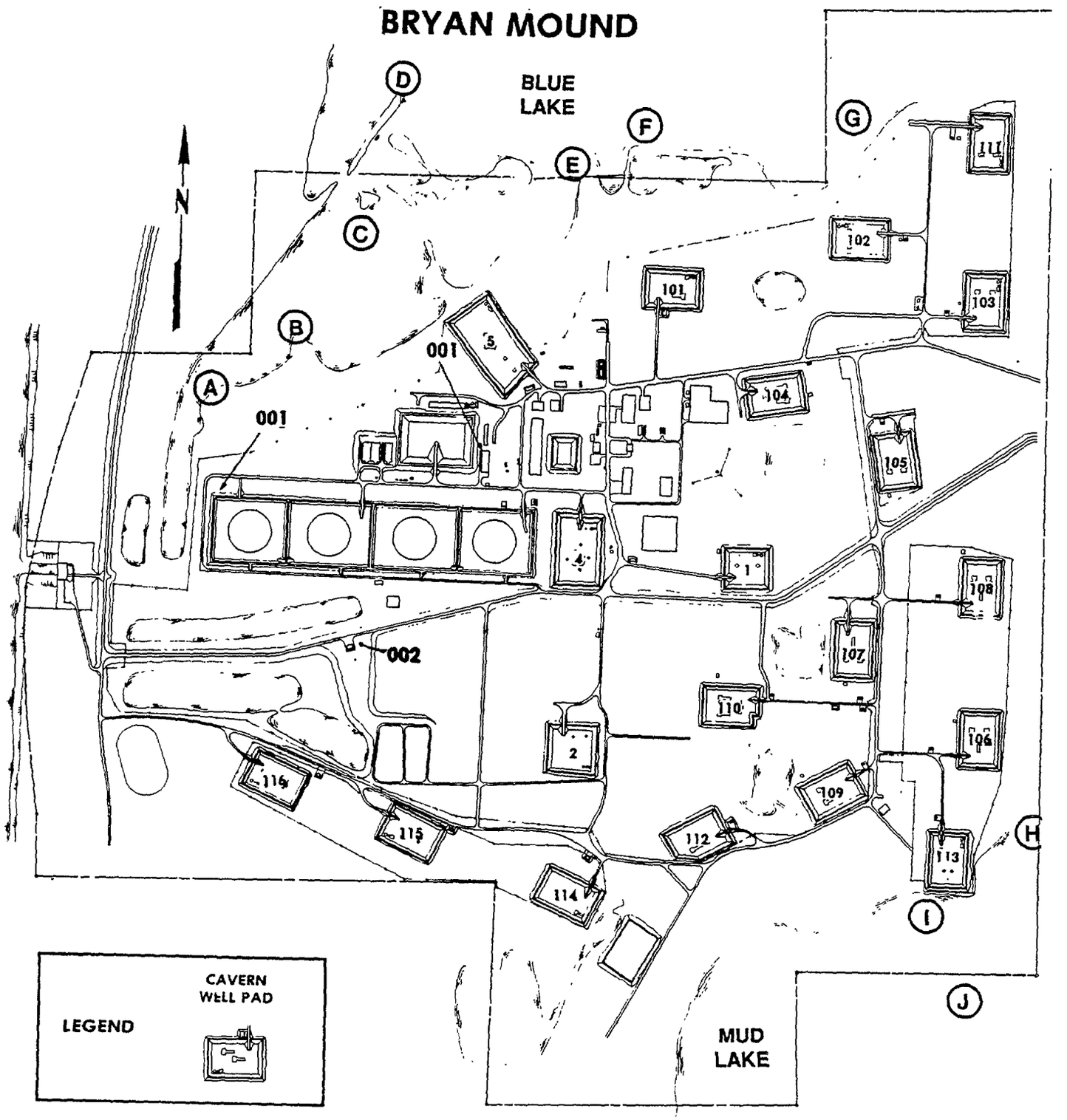

Figure 3-3 (Sheet 1 of 2). Bryan Mound Environmental Monitoring Stations

Discharge Monitoring Stations

001 Brine Disposal

002 Discharge from the Sewage Treatment Plant

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

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

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

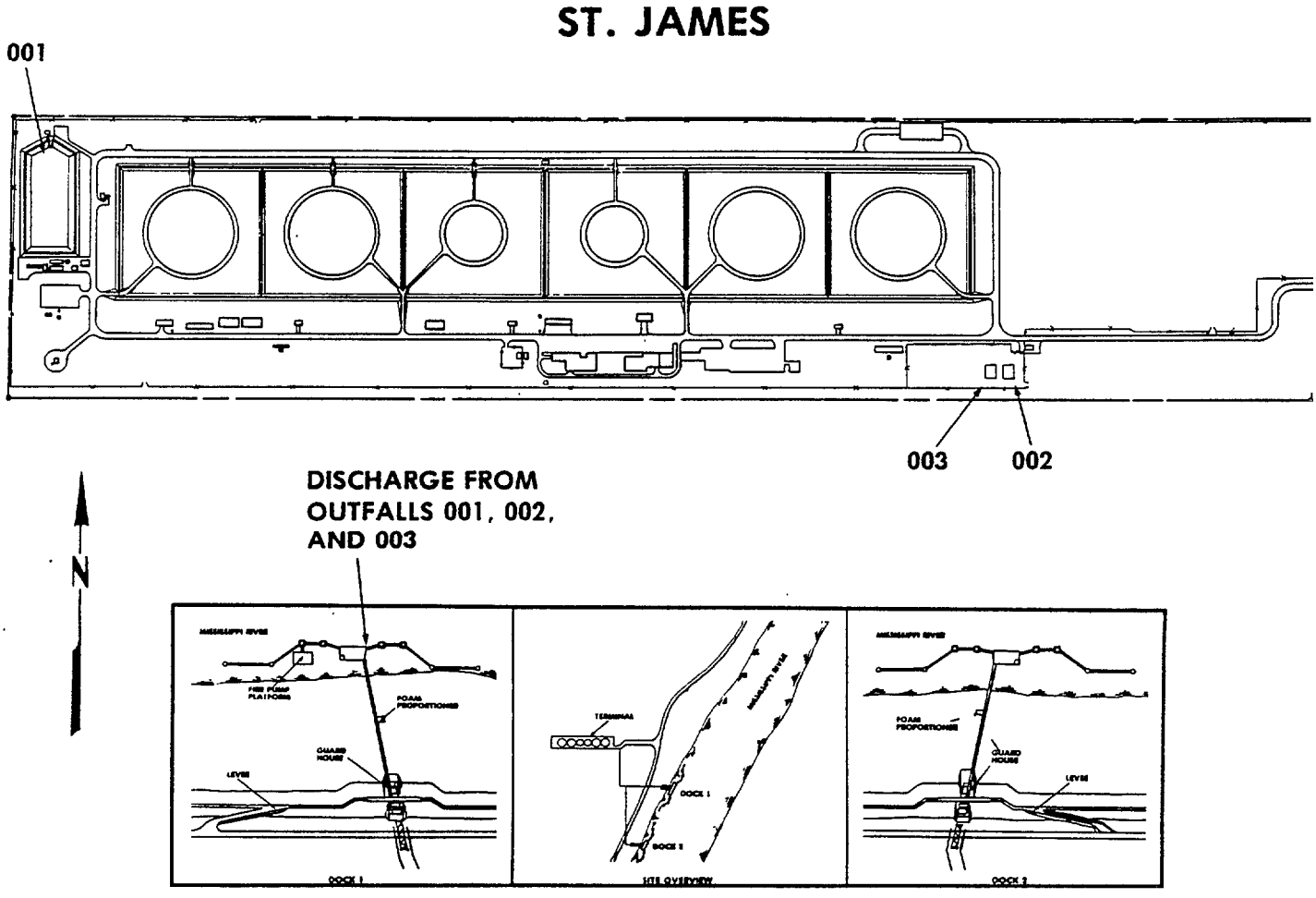

Figure 3-4 (Sheet 1 of 2). St. James Terminal Environmental Monitoring Stations

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

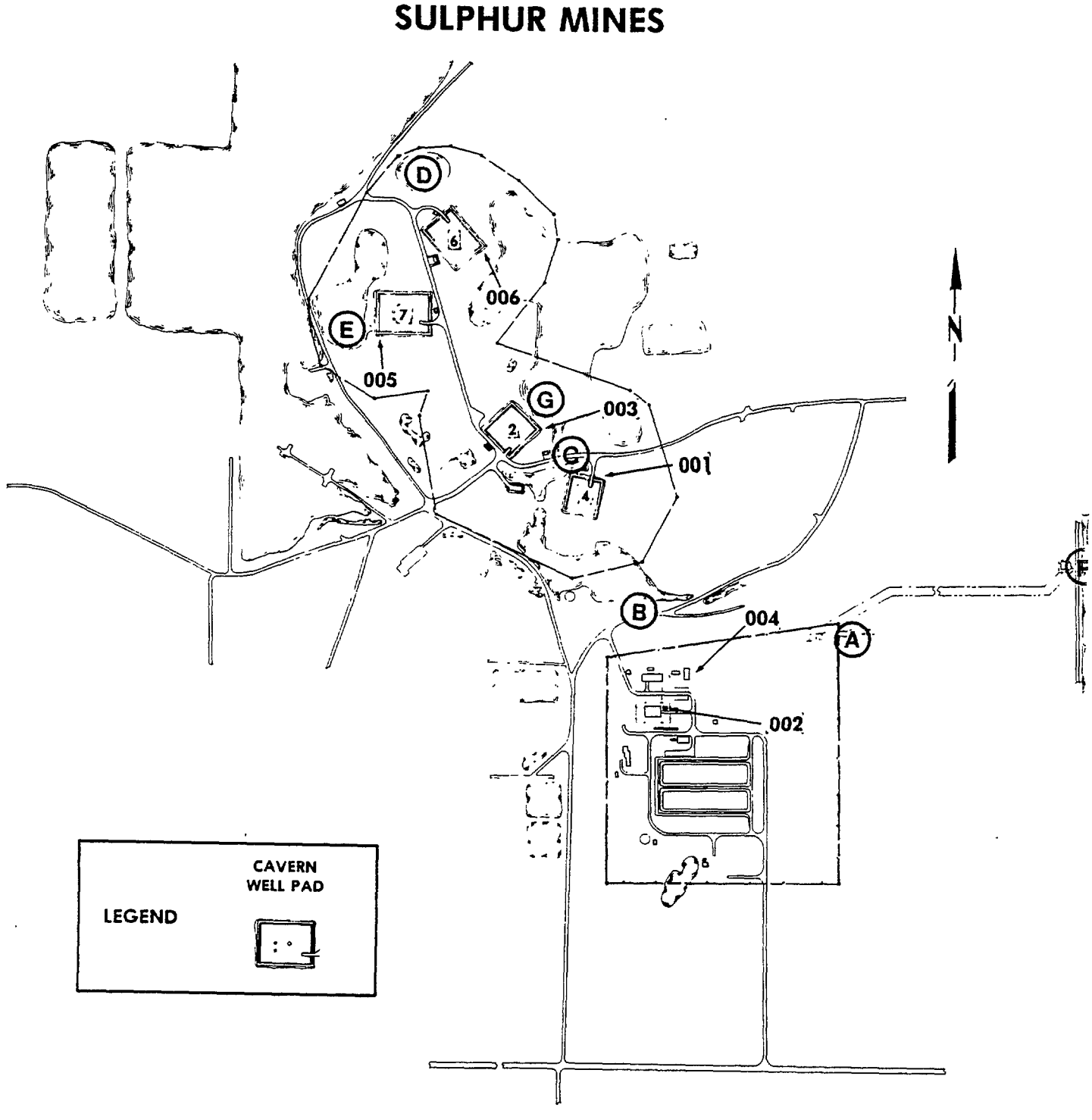

Figure 3-5 (Sheet 1 of 2). Sulphur Mines Environmental Monitoring Stations

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

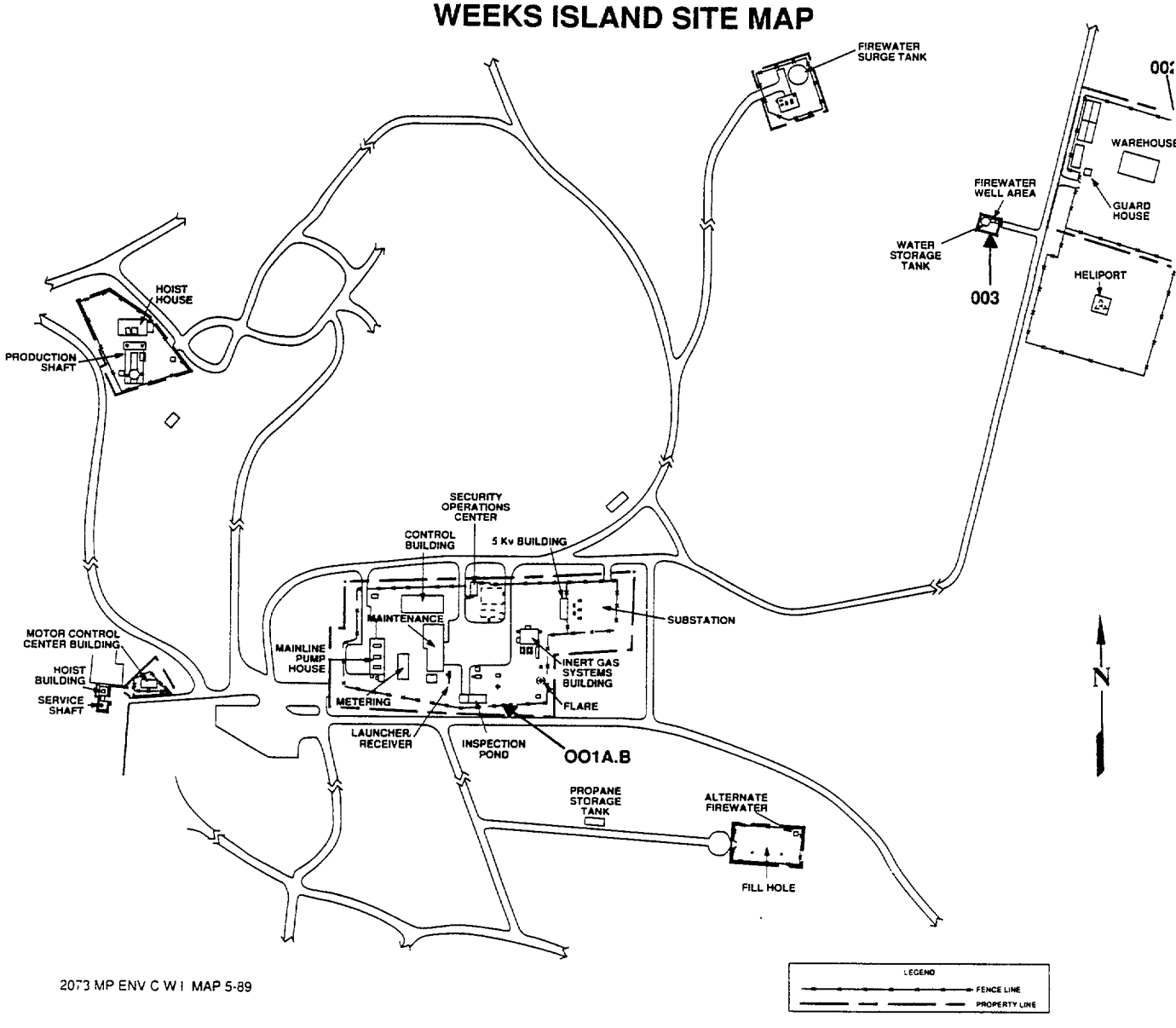

Figure 3-6 (Sheet 1 of 2). Weeks Island Environmental Monitoring Stations

Discharge Monitoring Stations

01A	Stormwater Runoff
01B	Discharge from Sewage Treatment Plant
002	Discharge from Sewage Treatment Plant
003	Discharge from portable water treatment system backwash filter.

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

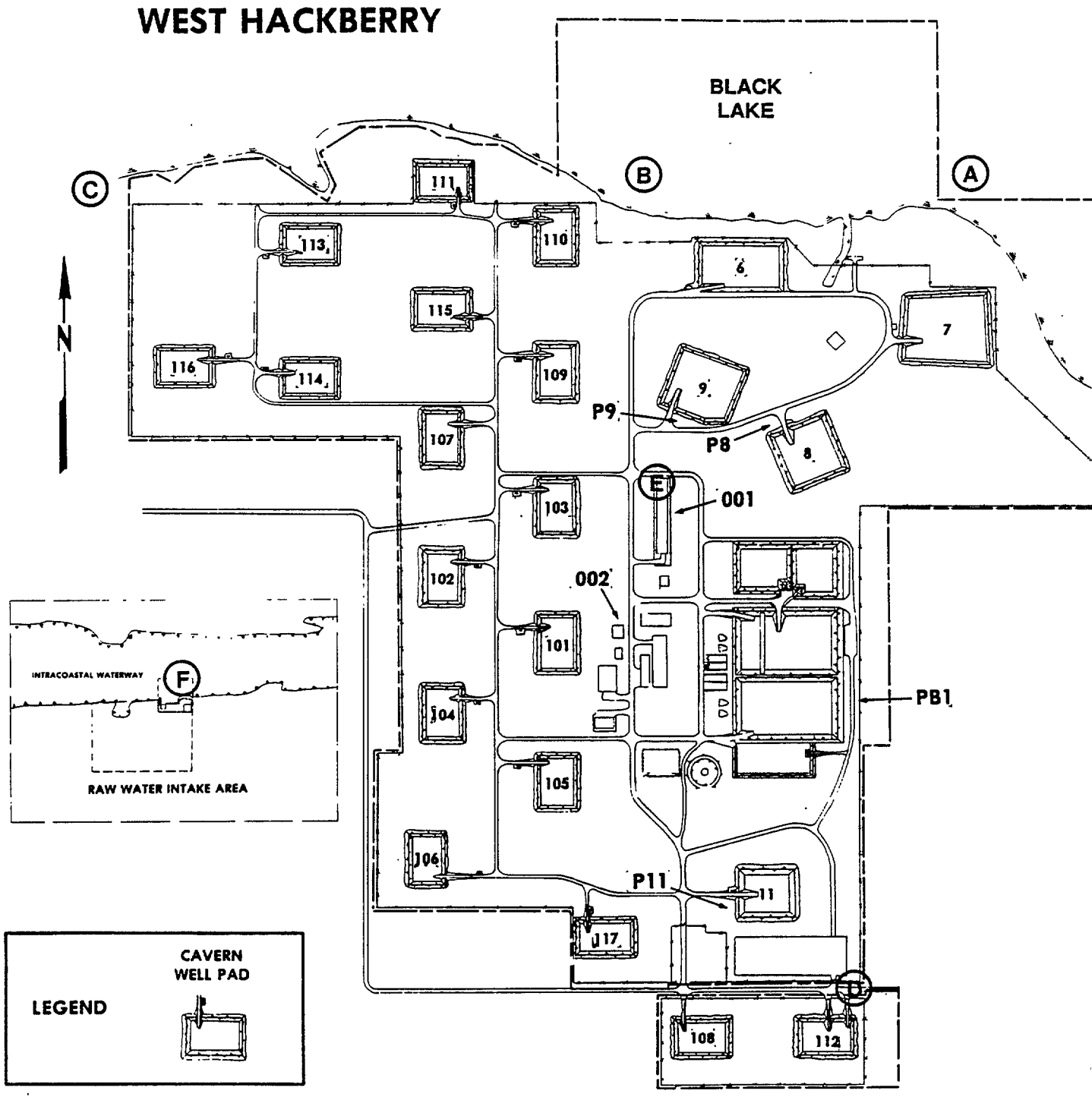

Figure 3-7 (Sheet 1 of 2). West Hackberry Environmental Monitoring Stations

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

PHYSICO-CHEMICAL PARAMETERS	SAMPLE IDENTIFICATION AND FREQUENCY BY SITE																	
	DAILY						WEEKLY			MONTHLY								QUARTERLY
	BC	BH	BM	SJ	SM	WH	BH	BM	SM	BC	BH	BM	SJ	SM	WI	WH		SJ
pH	15-20 101 HPP SWD1 SWD2 SWD3	003	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	001 002 004	A-J		A-G	01A 018 002 003	002 A-F		002 003
SALINITY		001	001			001 HPP				A-D		A-J		A-G		A-F		
SPECIFIC CONDUCTIVITY										A-D		A-J		A-G		A-F		
TEMPERATURE		001	001			001				A-D		A-J		A-G		A-F		
TOTAL DISSOLVED SOLIDS						001	001	001						A-G		A-F		
TOTAL SUSPENDED SOLIDS						001	001 002	001	004	001 002 A-D	004	002*		A-G	018 002 003	002 A-F		002 003
DISSOLVED OXYGEN						001				A-D		A-J				A-F		
BOD_5									004	001 002 A-D	004	002*			018 002	002		002 003
COD			002 TX- 001 1,2 4,5 101- 116									A-J						
OIL & GREASE	15-20 101 HPP SWD1 SWD2 SWD3	001 003	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		
TOC	003	1,2 4,5 101- 116		001		6-9 11 101- 117 HPP		001		A-D	003	A-J				E		
FECAL COLIFORM															018 002	002		
RESIDUAL CHLORINE		004	002															
FLOW	001 002 15-20 101 HPP SWD1 SWD2 SWD3	001 003	TX- 001 001 002 1,2 4,5 101- 116	001	001 002 003 005 006	HPP 001 6-9	002 004**		004	001 002	001		002 003		01A 018 002 003	002		

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

HPP: High Pressure Pump Pad
SWD: Salt Water Disposal (Injection Well)

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 (Daily Max)	57.2 & 87.4 mg/l / 45 mg/l	Overuse of disinfectant cleaners reduced biological activity of STP* on 1-8-88 and 1-14-88. Warnings reissued to clean-up crews.
002	BOD_5 (Daily Max)	63.6 mg/l / 45 mg/l	Actual cause unknown for STP upset.
002	BOD_5 (Daily Max)	73.5 & 52.9 mg/l / 45 mg/l	STP* still recovering from previous upset.
002	BOD_5 (Daily (Max)	46 mg/l / 45 mg/l	Actual cause unknown, but suspected analytical results an "outside" contract lab. BC lab incubator malfunction required use of an outside lab. Analysis performed one week later showed BOD_5 to be 11 mg/l.

* STP = Sewage Treatment Plant

Table 3-2. 1988 Noncompliances/Bypasses at Bayou Choctaw

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0053040	EPA	Water	11/09/87	11/08/92	(1)
WP0179	LDEQ	Water	11/09/87	11/08/92	(1)
1280-00015-000	LDEQ	Air	10/01/87	Open	
None	LDNR	Injection	1/11/83	Open	(2)
LMNOD-SP (Bayou Plaquemine)17	COE	Maint.	09/26/77	Open	(3)
LMNOD-SP (Bull Bay)3	COE	Constr. Maint.	01/30/79 1/30/79	01/29/82 Open	(4), (6)
LMNOD-SE General Permit	COE	Constr.	08/31/85	08/31/90	(5), (6)

(1) Renewal submitted (2/2/83 and 11/9/87).
(2) Letter of financial responsibility to plug and abandon injection wells.
(3) Maintain 36-inch crude oil pipeline.
(4) Dredge and maintain Bull Bay.
(5) Excavate and fill to construct and maintain well pad 17.
(6) 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

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
004	Residual Chlorine	0.5 mg/l / >1 mg/l	Low flow resulted in low residual chlorine due to dissipation.
003	pH (Max)	9.4 / 9.0	Addition of new limestone lowered pH temporarily.
004	TSS (Daily Avg.)	22 mg/l / 20 mg/l	Possible design deficiencies plus unstable start-up conditions resulted in slight elevation of TSS. Parameters being evaluated.
001	Oil & Grease		No sample collected (TWC non-compliance only).
003	pH	9.3 / 9.0	Well pad valve leaks prevented adequate pH adjustment of storm - water prior to discharge. Corrective actions being implemented.
003	pH	Improper Analysis	Weekend sample was not analyzed immediately for pH as required by EPA standard methods. Procedures modified to prevent recurrence.
001	DO	0 mg/l / detectable levels ($\leq$0.1 mg/l)	Non-dectectable DO levels due to a reduction in brine discharge without a proportionate reduction in oxygen scavenger. Procedures modified to correct the discrepancy.

Table 3-4. 1988 Noncompliances/Bypasses at Big Hill

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
TX0092827	EPA	Water	01/18/84	01/17/89	(1)
SWGCO-RP 16536	COE	Constr. Maint.	01/11/84 01/11/84	12/31/88 Open	(2)
P-7	F&WS	Constr. Operate	07/31/86 07/31/86	07/31/88 07/29/2036	(3)
C-9256	TACB	Air	05/17/83	Open	(4)
02937-02939	RCT	Operate	11/28/83	Open	(5)
0048295-0048320	RCT	Operate	05/09/83 06/23/83	Open Open	(6)
02638	TWC	Water	06/23/87	06/22/92	(7)
4045	TWC	Water	11/11/83	Open	(8)

(1) Renewal submitted 7-16-88.
(2) Completion of raw water, brine disposal, and crude oil pipeline extended. Amended to install offshore pipeline by trenching.
(3) Completion of pipeline construction extended.
(4) Under construction.
(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.

* F&WS - U.S. Fish and Wildlife Service
RCT - Railroad Commission of Texas
TACB - Texas Air Control Board
TWC - Texas Water Commission

Table 3-5. Active Permits at Big Hill

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
002	pH (Daily Max)	9.2 / 9.0	Improper sample collection method/technique.
002	pH (Daily Max)	9.3 / 9.0	Improper sample collection method/technique. Collection location and method being modified.

Table 3-6. 1988 Noncompliances/Bypasses at Bryan Mound

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
TX0074012	EPA	Water	08/01/88	07/03/93	(1)
SWGCO-RP-12347(1)	COE	Dredging	02/22/78	12/31/94	(2)
3-67-782 (Docket#)	RCT	Injection	08/21/78	Open	(3)
P001447 & 8	RCT	Constr.	07/03/85	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	07/30/79	Open	(6)
02271	TWC	Water	02/05/85	02/04/90	(7)
R-6176B	TACB	Air	07/20/79	Open	
82-8475	TDH&PT	Constr.	01/01/83	Open	(8)

(1) Renewal submitted 8/1/88.
(2) Maintenance dredging of raw water intake extended.
(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) Corresponds with SWGCO-RP-16177.

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

Table 3-7. Active Permits at Bryan Mound

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0054674	EPA	Water	07/12/85	07/11/90	
LMNOD-SP (Mississippi River) 998	COE	Constr.	03/20/78	03/19/88	(1)
WP 0929	LDEQ	Water	09/26/84	09/26/89	
983	LDEQ	Air	07/25/78	Open	(2)

(1) Permit and all amendments recorded with Registrar of Deeds in St. James Parish.
(2) Requires annual operating 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	Maint.	07/24/78	Open	(1)
LA0055786	EPA	Water	04/19/85	04/18/90	(2)
1042	LDEQ	Air	09/26/78	Open	(3)
None	LDOTD	Water	01/01/87	12/31/87	(4)
None	LDNR	Injection	01/11/83	Open	(5)
SDS-6	LDNR	Injection	07/20/78	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 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
003	TSS (Daily Max)	333 mg/l / 45 mg/l	Iron removal system design deficiency resulted in high TSS. System shutdown for modifications.

Table 3-10. 1988 Noncompliances/Bypasses at Weeks Island

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0056243	EPA	Water	10/13/87	10/12/92	(1)
LMNOD-SP (Atchafalaya Floodway) 251	COE	Maint.	06/12/78	Open	(2)
1051	LDEQ	Air	01/30/78	Open	(3)
SDS-8	LDNR	Injection	02/16/79	Open	(4)
None	LDEQ	Water	07/12/79	Open	

(1) Renewal submitted 10/15/87.
(2) Recorded permit and amendments with applicable Parish Registrars of Deeds.
(3) Requires annual operating report.
(4) 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
001	DO	0.0 mg/l / Detectable levels 0.1 mg/l	DO levels were reduced to zero when "old" (low DO) brine was discharged to the Gulf. Procedures modified to compensate for long brine storage times resulting in normal DO reduction/elimination.
001	Flow (Daily min)	1.7 & 2.3% below min. permit level	On 9-21-88 and 9-23-88 small quantities of brine were discharged to the Gulf resulting in intermittent/irregular flow. Operation/procedural changes implemented to avoid recurrence.

Table 3-12. 1988 Noncompliances/Bypasses at West Hackberry

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0053031	EPA	Water	08/22/84	08/21/89	
LMNOD-SP (LTCS)26	COE	Dredging	02/08/79	02/07/89	(1)
LMNOD-SP (Black Lk)31	COE	Dredging	10/26/82	05/25/97	(2)
LMNOD-SP (Black Lk)43	COE	Constr.	07/26/84	07/25/87	(3)
LMNOD-SP (Gulf of Mexico)2574	COE	Constr. Maint.	05/29/86 05/29/86	05/28/89 Open	(4)
None	LDNR	Injection	08/07/79	Open	(5)
971198-9	LDNR	Injection	10/06/83	Open	(6)
None	LDEQ	Water	03/30/79	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

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 eighth annual EPA Discharge Monitoring Report Quality Assurance Study during 1988. 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 the M&O contractor's 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 eighth 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 1988 for the eighth time. The Big Hill facility participated in the Quality Assurance study for the third time.

The analytical data submitted to EPA by the Big Hill laboratory was also well within acceptance limits for all but one required parameter. Oil and grease was unacceptable due to an apparent normal variation in the data distribution. The data missed the acceptance criteria by 20%. Data from six voluntary analyses (cadmium, chromium, copper, lead, nickel, and zinc) were performed by a contract laboratory and submitted for non-permit required parameters. performed by a Lead was reported as unacceptable (45% error) by the EPA and nickel was designated "check for error." These data are under review by the contract

laboratory. The Bryan Mound data was acceptable for all but the total residul chlorine analysis. This data missed the acceptance criteria by 14%. West Hackberry data fell outside of the acceptance criteria for one parameter. This excursion occurred for BOD which missed the acceptance criteria by 24%. Unconditional acceptability is defined as falling within $\pm$ 1.5 standard deviations of the statistically correct value. Those values falling within $\pm$ 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	-0.4	-0.6
TSS (mg/l)	+0.2	+0.7	-0.2
Oil and Grease (mg/l)	-2.4	-0.2	-0.1
TOC (mg/l)	+1.4	-1.0	+0.6
BOD_5 (mg/l)	-0.5	-1.5	+3.8
Residual Cl^- (mg/l)	N/A	+2.8	N/A

4.2 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. Several thousand of these quality assurance analyses were performed in addition to the 1988 discharge compliance analyses to verify the continuing high quality of SPR laboratory data.

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 1988, regulatory and DOE auditors examined the SPR laboratories' precision and accuracy data and found this data, the program, and methodology in order.

4.3 ENVIRONMENTAL AUDITS

In addition to federal and state regulatory agency audits, the M&O contractor conducts an annual environmental audit at each site. Each audit is performed 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 1988 environmental audit at each SPR site showed the overall implementation and execution of the SPR Environmental Program to be outstanding. Findings reported during 1988 by those state and federal regulatory agencies that performed compliance inspections and by the environmental baseline survey team sponsored by DOE Washington D.C. were consistent with SPR findings. Such positive findings are attributed to the high level of environmental awareness exhibited among all site personnel and the emphasis SPR management has placed on fulfilling the intent and conditions of the SPR Environmental Program.

Internal audits are conducted in accordance with a detailed audit check list which addresses the pertinent aspects of all

environmental programs and activities. Additional audits were conducted in 1988 by the EPA, COE, TACB, RCT, LDEQ, LDNR, TDH, USCG, and DOE.

REFERENCES

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater. 16 ed. Washington, D.C.: American Public Health Association, 1985.

Faust, Samuel D. and Osman M. Aly. Chemistry of Natural Waters. Ann Arbor: Ann Arbor Science Publishers, 1981.

Louisiana Office of Water Resources. "State of Louisiana Water Quality Standards." 1984.

Reid, George K. and Richart D. Wood. Ecology of Inland Waters and Estuaries. 2nd ed. New York: D. Van Nostrand Company, 1976.

Sandia National Laboratories. Strategic Petroleum Reserve (SPR) Geological Site Characterization Report Bayou Choctaw Salt Dome. SAND80-7140. December 1980; available from National Technical Information Service.

_____. Strategic Petroleum Reserve (SPR) Geological Site Characterization Report Big Hill Salt Dome. SAND81-1045. September 1981; available from National Technical Information Service.

_____. Strategic Petroleum Reserve (SPR) Geological Site Characterization Report Bryan Mound Salt Dome. SAND80-7111. October 1980; available from National Technical Information Service.

_____. Strategic Petroleum Reserve (SPR) Geological Site Characterization Report Sulphur Mines Salt Dome. SAND80-7141. December 1980; available from National Technical Information Service.

_____. Strategic Petroleum Reserve (SPR) Geological Site Characterization Report Weeks Island Salt Dome. SAND80-1323. October 1980; available from National Technical Information Service.

_____. Strategic Petroleum Reserve (SPR) Geological Site Characterization Report West Hackberry Salt Dome. SAND80-7131. October 1980; available from National Technical Information Service.

Swedish Ministry of Agriculture, Environment '82 Committee. Acidification Today and Tomorrow. A study prepared for the Stockholm Conference on Acidification of the Environment, 1982.

Texas Department of Water Resources. Texas Surface Water Quality Standards. April 1981.

U.S. Department of Energy. Final Environmental Impact Statement, Strategic Petroleum Reserve, Capline Group Salt Domes. 4 vols. July 1978; available from National Technical Information Service.

_____. Final Environmental Impact Statement, Strategic Petroleum Reserve, Seaway Group Salt Domes. 3 vols. June 1978; available from National Technical Information Service.

_____. Final Environmental Impact Statement, Strategic Petroleum Reserve, Sulphur Mines Salt Domes. March 1978; available from National Technical Information Service.

_____. Final Environmental Impact Statement, Strategic Petroleum Reserve, Texoma Group Salt Domes. 5 vols. November 1978; available from National Technical Information Service.

_____. Final Supplement to Final Environmental Impact Statement, Strategic Petroleum Reserve, Phase III Development, Texoma and Seaway Group Salt Domes. October 1981; available from National Technical Information Service.

_____. Interpretation of Contract Provisions. Correspondence from Michael McWilliams, DOE Contracting Officer to H. E. Ovens, BPS Contracts Director. Letter dated March 28, 1985.

U.S. Environmental Protection Agency. Quality Criteria for Water. July 1976; available from U.S. Government Printing Office.

_____. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA-600/4-79-019 September, 1979; Cincinnati, Ohio: Office of Research and Development.

_____. Air Pollution Engineering Manual. 2nd edition, May 1973, Method AP-42; Research Triangle Park, N.C.: Office of Air Quality Planning and Standards.

_____. Compilation of Air Pollutant Emission Factors, Supplement No. 12. April 1981; Research Triangle Park, N.C.: Office of Air Quality Planning and Standards.

_____. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Revised March, 1983; Cincinnati, Ohio: Office of Research and Development.

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