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STRATEGIC PETROLEUM RESERVE

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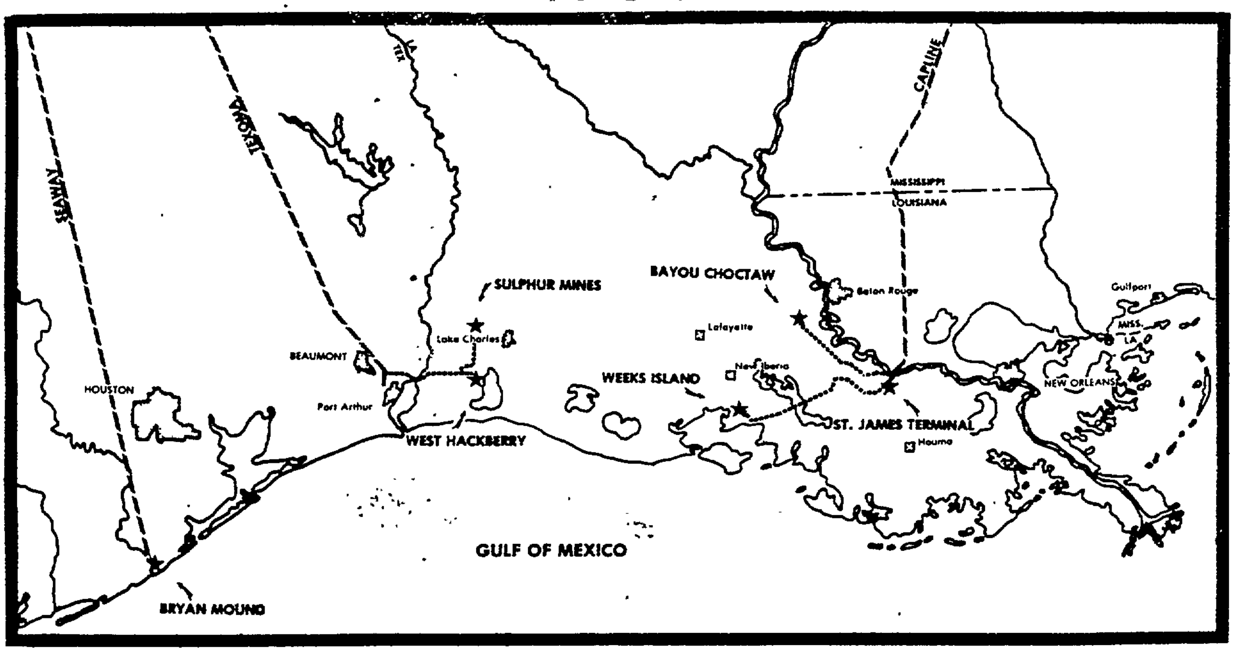

POSSI

Kaneb

Petroleum Operations and Support Services, Inc.
850 South Clearview Parkway
New Orleans, Louisiana 70123

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1. INTRODUCTION

The creation of the Strategic Petroleum Reserve (SPR) was mandated by Congress in Title 1 Part B of the Energy Policy and Conservation Act (P.L. 94-163) and approved on 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 five Gulf Coast underground salt dome oil storage complexes (four in Louisiana and one in Texas) and a marine terminal facility at St. James, Louisiana. Four of the storage complexes make use of existing cavern storage capacity and solution-mine additional space. The fifth storage complex (Weeks Island) utilizes an existing conventionally mined underground salt mine.

The sites are centered around three major inland pipeline systems which transport U.S. and foreign crude oil from the Gulf Coast to refineries in the Midwest. The inland pipeline terminals used by the SPR are Seaway Pipeline Terminal (Freeport, Texas), the Texoma Pipeline Terminal (Nederland, Texas), and the Capline Pipeline Terminal (St. James, Louisiana).

1.1 ST. JAMES TERMINAL

The St. James Terminal is located on the west bank of the Mississippi River approximately halfway between New Orleans and Baton Rouge, Louisiana. It lies approximately 1.9 miles north of the town of St. James on Louisiana Highway 18. The terminal consists of six aboveground storage tanks, two tanker docks on the Mississippi River, and associated piping and pumping equipment.

Tankships transfer oil to the terminal from the two docks (Dock 1 and Dock 2) located on the west bank of the river. A fire water dock is located next to upstream Dock 1. The docks are connected to the terminal by way of pipelines which pass over Louisiana Highway 18 and then underground to the terminal. The site is bordered on the north by the Capline terminal and on the south by the LOOP Offshore Capline (LOCAP) terminal, which connects to the Louisiana Offshore Oil Port (LOOP) salt cavern storage facility in southern Louisiana.

The terminal itself is essentially enclosed by facilities or structures which block all land flow away from the site (the Texas and Pacific Railroad to the west, the above-mentioned terminal facilities to the north and south, and the Mississippi River levee on the east between Highway 18 and the river).

The area adjacent to the Mississippi River at St. James is considered a fresh water wetland. Much of the land area surrounding the facility is used for pasture and sugar cane cultivation. This land is covered by a mixture of introduced cool and warm season grasses and legumes. Frogs, snakes, turtles, rabbits, raccoons, armadillos, muskrats, opossums, nutria, squirrels, egrets, ibis, and herons can be found on the site and in the surrounding areas.

1.2 BRYAN MOUND

The Bryan Mound SPR facility is located in Brazoria County, about 65 miles due south of Houston, Texas on the east bank of the Brazos River Diversion Channel near its juncture with the Gulf of Mexico, and three miles southwest of Freeport, Texas.

The site is 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 between the Intracoastal Waterway and the Diversion Channel. The Bryan Mound site is situated atop a salt dome, which creates a surface expression in the terrain by rising about 15 feet above the surrounding wetlands. The levees protecting the town of Freeport to the northeast form a second triangular pattern within the triangle formed by the rivers. A levee parallels the Brazos River to the west of the site. A second levee north of and parallel to the Intracoastal Waterway essentially divides the site, intersecting the Brazos River levee and proceeding northeast.

The major nearby water bodies are Blue Lake, north of the site, and Mud Lake to the south. These water bodies generally define the mounded aspect of the dome upon which Bryan Mound is located. Blue Lake is within the

3.4-square-mile protective triangle formed by the dike system. Although Blue Lake is essentially isolated by the dikes (the excess rain water is 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 and have no unique natural or scenic features. In all low-lying areas brackish marshland dominates the site with the exception of the northern area of the site where the coastal prairie ecosystem extends along the levees paralleling the Brazos River Diversion Channel. The coastal prairie is covered with medium to very tall grasses which form a moderate to very dense cover for wildlife. These grasses are usually found in the site area where soil moisture extends to a great depth. Those areas periodically inundated by seawater are dominated by gulf cordgrass.

A diverse range of habitats is created by the 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. On the site and in surrounding areas of Bryan Mound, the common egret, snowy egret, migratory waterfowl, great blue heron, least tern (a protected species), kildeer, nutria, raccoon, skunk, rattlesnake, turtle and frog can be found.

In Mud Lake, larval shrimp and fish (seasonal) and adult crabs, trout, flounder, and redfish can be found at various seasons of the year. Black drum, mullet, gar, and blue crabs are found in Blue Lake.

1.3 WEEKS ISLAND

The Weeks Island salt mine is a conventional underground mine in the Weeks Island salt dome. This geological feature borders Vermillion Bay, which opens to the Gulf of Mexico. Weeks Island is located in Iberia Parish, Louisiana, about 14 miles south of New Iberia, Louisiana. Large underground areas have been excavated, resulting in two levels of rooms and pillars with total storage capacity of 75 million barrels.

The surface expression over the salt dome which forms the island includes the highest elevation in southern Louisiana (in excess of 100 feet). The area surrounding the island is a combination of wetlands, bayous, manmade canals, and bays contiguous with the Gulf of Mexico. The SPR site is located on the southwest slope of the island above the mine previously mentioned.

The vegetation on Weeks Island is quite varied. The island is characterized by lowland hardwood species which exist here because of the higher elevation afforded by the island and the presence of very fertile loam as a soil base. The dominant trees are oak, magnolia, and hickory, which extend down to the surrounding marsh. Pecan trees are also present. The coastal wetlands found at the Weeks Island site include the manmade Intracoastal Waterway and saline and brackish marshes and bayous. Gulls, terns, herons, and egrets are commonly found in and around the marshes. Mink, nutria, otter, raccoon, and alligator are the most common inhabitants of the intermediate marshes. Others found in the environs of Weeks Island are opossums, bats, squirrels, swamp rabbits, bobcats, white-tailed deer, bears, and coyotes.

The water bodies surrounding Weeks Island are a vast nursery ground for an array of commercially and recreationally important finfish and shellfish.

1.4 SULPHUR MINES

The Sulphur Mines facility is located in Calcasieu Parish, 1.5 miles west of the town of Sulphur, Louisiana. The site is divided into two areas, the quadrangular primary site and figure-eight shaped secondary area. The primary site area is bordered on the east by several large bodies of water. The secondary site area is bordered on the west and northwest by water bodies. Most of these bodies of water are interconnected and drained by one creek flowing eastward from the site to Bayou D'Inde. A floodwater canal is located 1/4 mile east of the site. Changes in elevation throughout the site are minor, with most of the site 15 to 20 feet above sea level. The site proper is normally dry. However, high waters in the spring season sometimes flood portions of it. The lowest elevations are over the center of the dome where subsidence has occurred. Much of the surrounding area is covered with a mixed pine and deciduous forest.

Mammals on site and in the surrounding areas are white-tailed deer, raccoons, fox squirrels, cottontail rabbits, opossums, striped skunks, armadillos, nutria, southern flying squirrels, white-footed mouse, and bobcats. (A bobcat has been sighted by Environmental personnel.) Snakes, turtles, alligators, frogs and toads can also be found. Crappie, large mouth bass, sunfish, gar, carp, bowfish, and catfish inhabit the shallow ponds on the Sulphur Mines site.

1.5 BAYOU CHOCTAW

The Bayou Choctaw facility is located on the west side of the Mississippi River 12 miles southwest of Baton Rouge, in Iberville Parish, Louisiana. The facility consists of four existing solution mined caverns. Solution mining of a fifth cavern is in progress.

The area surrounding the site is a freshwater marsh. Elevation ranges from approximately 5 to 10 feet above sea level. While there are no clear topographic expressions in the area, major surface subsidence has occurred creating substantial areas of wetlands and marshes with interconnecting waterways. The site proper is normally dry. However, flooding may occur during the spring in portions of the site. The collapse of a solution mined cavity in 1955 resulted in the formation of a 12-acre lake (Cavern Lake) on the north side of the site.

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.

Bayou Gross Tete enters from the northwest and intersects the Intracoastal Waterway south of the site with an interconnecting crossover almost due west of the site. Bayou Bordeaux enters the area from the northeast and passes through the Cavern Lake to form the north-south canal through the site. The East-West (or Wilbert) Canal extends in a generally east-west direction south of the site to intersect the Intracoastal Waterway near its intersection with Bayou Grosse Tete.

The bottomland forest and deciduous swamps are predominant at the Bayou Choctaw site. The overstory vegetation at the site includes bald cypress and water tupelo (characteristic of lowland areas), bull tongue, and spiker rushes. 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, egrets, woodpeckers, wood duck, thrushes, and woodcocks. Inhabitants of the bottomland forest and swamp include opossums, squirrels, nutria, mink, raccoons, swamp rabbits, white-tailed deer, alligators, and snakes.

1.6 WEST HACKBERRY

The West Hackberry facility is located in Cameron Parish 12 miles southwest of Lake Charles, Louisiana and 16 miles north of the Gulf of Mexico.

The site is situated on 290 acres of land on top of the West Hackberry salt dome. The dome itself is covered by a distinct mounded overburden on its western portion with elevations up to 21 feet (the highest point in Cameron Parish). The rest of the dome, an area of 890 acres, is elevated about five feet.

The bordering waterways include Lake Calcasieu and the Calcasieu Ship Channel approximately three miles to the east, and the Intracoastal Waterway crossing from east to west approximately four miles north of the site. Water bodies in the area of the site are connected to the Intracoastal Waterway by the north-south-running Alkali Ditch. Black Lake, a brackish water lake, borders the "island" formed by the upwelling of the dome on the northern and western sides and partially on the southern side. Numerous canals and natural waterways, including Black Lake Bayou, connect Black Lake to the Alkali Ditch on the eastern side of the site. Black Lake Bayou wanders in a generally easterly direction from Black Lake, eventually connecting with the Calcasieu Ship Channel northeast of the town of Hackberry. A site canal that runs northeast to southwest connects Alkali Ditch directly with the eastern side of the site.

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, and they play a large role in directing 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 at all but rather a large region of small islands. Marshes closest to the coast generally have 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, bay myrtle, live oak, and various species of marsh grass and upland crop grasses. Red foxes, alligators, snakes, egrets, herons, roseate spoonbills, raccoons, nutria, opossums, rabbits, deer, migratory waterfowl, and red-tail hawk can be found on and in the area surrounding the West Hackberry facility. Aquatic inhabitants of Black Lake include crabs, drum, croaker, spot, sheep-head, shrimp, mullet, gar, redfish, oysters, and catfish.

2. SUMMARY

The Petroleum Operations and Support Services, Inc. (POSSI) Environmental Plan is designed to support the SPR's mission through the implementation of programs aimed at avoiding or minimizing adverse environmental effects on the SPR sites, surrounding lands, and water bodies.

The monitoring and inspection program was developed using the Department of Energy SPR Programmatic Environmental Action Report and related Site Environmental Action Reports. The program, in addition to monitoring permitted National Pollutant Discharge Elimination System (NPDES) outfalls and making other required federal and state inspections, includes monthly sampling and analysis of surface water quality of onsite and adjacent water bodies. This makes possible early detection of surface water quality degradation that may occur as a result of the SPR operations.

2.1 AIR QUALITY

The operation of all SPR sites was carried out in accordance with appropriate state air quality permits. The semiannual Design and Construction reports required by the Louisiana Air Control Board in the Certificates of Approval for Air Emissions were submitted for each applicable site in accordance with specific permit requirements. The quarterly reporting requirements of the Texas Air Control Board permit for Bryan Mound were prepared and submitted on schedule throughout 1982. Development of an internally conducted fugitive emissions monitoring program was initiated at Bryan Mound during 1982. This program is expected to be fully implemented during 1983.

The Department of Energy (DOE) initiated an onshore baseline characterization of the SPR sites beginning October 1, 1982. This study focuses on air quality and meterological monitoring at all six SPR sites. Monitoring will continue through September 30, 1983. Specific parameters monitored include:

Total suspended particulates (TSP)
Ozone (O_3)
Nonmethane hydrocarbons

Wind direction
Standard deviation of wind direction (sigma theta)
Wind speed
Temperature
Barometric pressure
Short wave solar radiation
Rainfall

In addition to atmospheric monitoring, this baseline study will include a speciation of the flora at the West Hackberry site. This phase of the baseline study will begin during 1983. The final report is scheduled to be delivered to DOE by February 29, 1984.

2.2 OTHER PROGRAMS

Ancillary programs developed to support the SPR Environmental Plan include Spill Reporting Procedures and site-specific Oil Spill Contingency Plans and Spill Prevention Control and Countermeasures Plans. Compliance with Federal, state, and local laws, regulations, and permits has been accomplished by implementation of the programs cited above.

2.3 TRAINING

Site Environmental and Emergency Response Team personnel have received training in support of the Environmental Plan and Associated programs. Personnel from all sites have been trained in oil spill cleanup and control by the U.S. Coast Guard Gulf Strike Team. Site management personnel were briefed on the implementation of the Environmental Plan, Spill Reporting Procedures, the site-specific Oil Spill Contingency Plans, the site-specific Spill Prevention Control and Countermeasures Plans.

Training in the Environmental Plan and associated programs was accomplished at a meeting of the New Orleans staff and site Environmental personnel. Selected Emergency Response Team personnel from all sites have attended the Texas A&M Oil Spill School. In these programs, site personnel learned about the SPR Environmental Program and trained to respond rapidly and effectively in the containment and cleanup of oil spills.

2.4 NPDES COMPLIANCE

In calendar year 1982, the total amount of oil received in the SPR project was in excess of 75.7 million barrels. In that period of time, a total of 24 oil spills of 1 barrel or more occurred. Those spills totaled 5,328 barrels or .007 percent of the oil received. One oil spill of 4 to 5 barrels reached a navigable waterway and required a report to the National Response Center. The remaining oil was contained within system containment devices and recovered for authorized disposal.

In calendar year 1982, approximately 2,288 NPDES permitted and other monitored discharges were made at the SPR facilities. Of these, approximately 710 were associated with the brine disposal to the Gulf of Mexico. There were 55 occurrences of permit noncompliance reported. Therefore, the SPR was in compliance with the NPDES permit requirements for 97.6 percent of the discharges conducted during this report period.

3. WATER QUALITY

3.1 INTRODUCTION

The prevention and mitigation of damage to the environment resulting from SPR construction, operation, and maintenance activities are of paramount concern to POSSI and DOE. An effective water quality monitoring program provides early information describing the presence and extent of any such environmental impacts. The site water quality monitoring programs were developed to provide an effective management tool allowing control and mitigation of unwarranted aquatic impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

During 1982, the surface waters of the Bayou Choctaw, Bryan Mound, Sulphur Mines, and West Hackberry SPR sites were sampled and monitored for general water quality. These site water quality programs were developed and implemented at each of the sites by site environmental and laboratory personnel. Given the unique ecological characteristics and diverse history of these SPR sites, there is some variability in the quantity and nature of parametric measurements conducted in fulfillment of each site water quality program.

A discussion of the water quality at each of the SPR sites follows. These discussions proceed in a parametric fashion describing water quality trends and anomalies and discussing causal relationships, including operation of site outfalls. To facilitate effective evaluation of the site water quality data, the following SPR site water quality criteria were established and used:

pH	6.5 - 8.5 standard units
Salinity	Significant variation from ambient
Temperature	32°C maximum
Total Suspended Solids*	10 mg/1 or 30 mg/1
Total Dissolved Solids	500 mg/1
Dissolved Oxygen	5 mg/1
Biochemical Oxygen Demand*	10 mg/1 or 30 mg/1
Total Organic Carbon**	29 mg/1 or 40 mg/1

*10 mg/1 for the Bayou Choctaw site is based on Louisiana average discharge limitations into the classified stressed environment.

**29 mg/1 for the Bayou Choctaw site is based on the described biochemical oxygen demand (BOD) to total organic carbon (TOC) relationship at a BOD of 10 mg/1.

These criteria are based on Federal, Louisiana, and Texas water quality criteria, discharge permit limitations, environmental literature, and the professional judgment of POSSI's Environmental Control Group.

The site discussions regarding salinity refer to the Venice system of classifying marine waters. According to this system, the surface waters throughout the SPR may be classified on the basis of salinity as polyhaline (30 to 18 ppt), mesohaline (18 to 5 ppt), oligohaline (5 to 0.5 ppt), or limnetic (less than 0.5 ppt).

Several additional parameters such as macronutrients and major ions are discussed in the text based on relative concentrations rather than absolute criteria.

3.2 BAYOU CHOCTAW WATER QUALITY

The Bayou Choctaw surface waters were monitored monthly from May through December 1982. Specific monitoring stations are identified on

Figure 3-1 by station A in Bayou Bourbeaux just north of Cavern Lake; stations B and C in Bayou Bourbeaux between Cavern Lake and the East-West (or Wilbert) Canal; stations D, E, and F in the East-West Canal; and station M at the raw water intake structure in Cavern Lake. Station M was not monitored from September through December of 1982. Parameters monitored in the Bayou Choctaw surface waters include pH, salinity, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), temperature, biochemical oxygen demand (BOD), total organic carbon (TOC), and oil and grease. Total organic carbon was monitored during June, July, and August and statistically approximated during the rest of the monitoring period. These parameters are discussed in turn and followed by summary observations.

3.2.1 Hydrogen Ion Activity (pH)

Hydrogen ion activity, or pH, was consistently on the basic side of neutrality (pH greater than 7). This is characteristic of natural waters with inorganic carbon predominately in the carbonate ion form. Generally, such waters are characterized as medium to hard in regard to dissolved mineral content. The degree of toxicity of many compounds such as hydrogen cyanide and hydrogen sulfide are affected by the degree of dissociation at low pH increasing compound toxicity to aquatic life. In this regard, a slightly basic pH such as that observed at Bayou Choctaw is beneficial to aquatic life and consistent with an environmentally sound ecosystem.

3.2.2 Salinity

Salinity, for stations A through C was recorded as zero for all sampling periods except July (2.6 ppt for each station). Non-zero salinities were recorded for stations D, E, and F from July through November, and for station M during June and July. Highest salinities were observed during July with D, E, and F averaging 5.7 ppt. Stations D and E are located on the East-West Canal where high salinities correspond to high TDS during July. However, similar dissolved solid levels were observed during May and

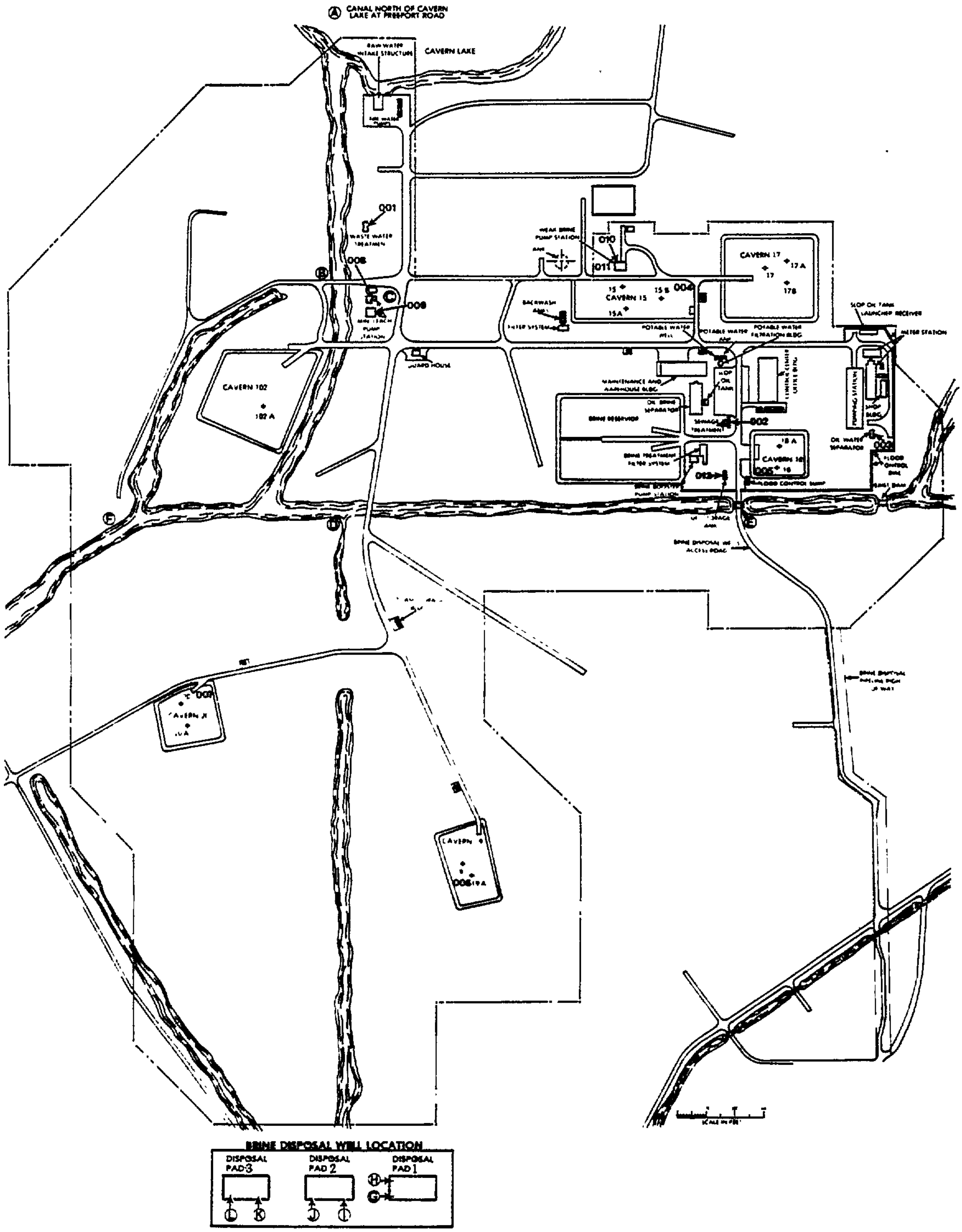

Figure 3-1 (Sheet 1 of 2). Bayou Choctaw Environmental Monitoring Stations

Discharge Monitoring Stations

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

Water Quality Stations

A	Canal North of Cavern Lake at Freeport Road
B	North-South Canal at Bridge to Cavern Pads 10, 11 and 13
C	Culvert South of Intersection of North-South Road and Weak Brine Area
D	East-West Canal at North-South Road
E	East-West Canal at Intersection of Road to Brine Disposal Wells
F	East-West Canal at Freeport Road Bridge
G	Southwest Corner Brine Disposal Well 1
H	Northwest Corner Brine Disposal Well 1
I	Southeast Corner Brine Disposal Well 2
J	Southwest Corner Brine Disposal Well 2
K	Southeast Corner Brine Disposal Well 3
L	Southwest Corner Brine Disposal Well 3

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

June with no apparent effect on salinity. TDS at D and E were generally three times the criterion levels during May, June, and July. The combination of warm summer weather, construction of a flood control levee along the East-West Canal, reconstruction of the adjacent brine ponds, and the stagnant nature of the East-West Canal are speculated to be causal factors in the salinity elevation of stations D and E. Station F is located in a minimal flow area, making it especially vulnerable to evaporation-induced salinity elevation.

3.2.3 Total Suspended Solids (TSS)

Stations D, E, and F had levels of TSS that were two to five times those of stations A, B, and C. The criterion level of 10 mg/l TSS was exceeded at stations A through F and M for 88 percent of the determinations. Given the temporal and spatial elevated suspended solids levels and the occurrence of only one noncompliance for TSS (002 during May) during the water quality monitoring period, the contribution of the site point source discharges to this high solids level can be considered minimal. Nonpoint sources such as construction may contribute to elevated TSS levels at stations D, E, and F. However, consistently elevated TSS levels at station A suggest that high TSS levels are indigenous to the stressed Bayou Choctaw aquatic environment.

3.2.4 Temperature

Temperature was observed to be within the site criterion of 32°C. It ranged from 11°C in December to 31.5°C in August. Seasonal variation was observed with temperatures from June through September approaching but not exceeding the criterion level.

3.2.5 Dissolved Oxygen (DO)

The DO concentration at each station was more than suitable for the maintenance of a healthy aquatic ecosystem, with the exception of October, when stations A, B, C, and E were observed to be depressed below the criterion of 5 mg/l dissolved oxygen. The consistently low biochemical oxygen demand from June through December indicates that organic decay was not the immediate cause of the October oxygen decline. Additionally, the decline in average temperature of 9°C from September to October suggests that the depressed DO was not temperature induced. The immediate return of DO to acceptable levels during November suggests the October DO levels to be an anomaly of unsustained environmental impact.

3.2.6 Biological Oxygen Demand (BOD)

The BOD level was observed to exceed the criterion level only during May at station E. Outfall 002, which discharges in the vicinity of E, was in noncompliance for biochemical oxygen demand during May. However, the station E biochemical oxygen demand of 14 mg/l in May dropped to 9.7 mg/l in June. Although the May biochemical oxygen demand was somewhat high, it is believed that it had a minimal impact on the biota in the vicinity of station E. This is supported by a relatively high dissolved oxygen level of 9.8 at station E during May.

3.2.7 Total Organic Carbon (TOC)

TOC was correlated as a dependent variable with the June, July, and August biochemical oxygen demand data by least squares regression analysis. A strong correlation was observed ($r = 0.85$, $n = 21$) suggesting that BOD in mg/l may be approximated, should the need arise, in a timely fashion through determination of TOC (mg/l) and use of the equation:

$$\text{BOD} = 0.39\ \text{TOC} - 1.24$$

Note that the above equation is of primary utility for waters of similar organic composition.

Using the previously described equation, TOC was approximated for May, September, October, November, and December. Only the TOC level of 39.4 mg/l at station E during May was found to exceed the criterion TOC level of 29 mg/l. This is in precise agreement with the discussion on BOD (paragraph 3.2.6).

3.2.8 Oil and Grease

Oil and grease were monitored at each station throughout the sampling period. In consideration of the severe ecological effects of even relatively low levels of hydrocarbons on aquatic life, a lower detectable limit of 5 mg/l was set as the site criterion. This criterion was not exceeded at any station at any time throughout the sampling period.

3.2.9 General Observations

In regard to the above discussions, the following observations are made concerning the SPR operational impact on the Bayou Choctaw environ.

a. Salinity was somewhat elevated in the vicinity of the East-West Canal and the brine pond throughout the summer. Without previous baseline data, the cause can only be speculated as some combination of brine pond construction and low hydraulic circulation. The localized nature of this salinity elevation (stations D, E, and F) limits the impact on the Bayou Choctaw environ.

b. The high ambient suspended solids level in regard to the site criteria, and the presence of only one noncompliance for solids indicates little or no TSS impact caused by the site point source discharges. The relatively higher solids level for stations D, E, and F suggests that water at these stations are dominated by Intracoastal Waterway and East-West Canal water. The relatively lower solid levels at stations A, B, and C suggests that these stations are dominated by Bayou Bourbeaux waters, which are less heavily used by industry.

c. A relatively high BOD noted in May can be attributed in part to a noncompliance that occurred during that month. However, high ambient DO levels mitigated the impact of the high BOD.

d. The continuous nondetectable levels of oil and grease suggest that site oil spills were effectively controlled to minimize their ecological impact.

e. The south side of the Bayou Choctaw site is dominated by a stagnant heavily stressed water type of possible Intracoastal Waterway origin. The west side of the Bayou Choctaw site is dominated by a less stressed cleaner water originating from Bayou Bourbeaux.

3.3 BRYAN MOUND WATER QUALITY

The Bryan Mound surface waters were monitored from May through December of 1982. Blue Lake was monitored each month during that period while Mud Lake, due to tidal and wind induced flushing, could not be monitored during the months of May, July, and August. Specific monitoring stations are identified on Figure 3-2. Monitoring stations are identified by letters A through G in Blue Lake and H through J in Mud Lake. Specific parameters monitored monthly in the Bryan Mound surface waters include pH, salinity, temperature, dissolved oxygen, total organic carbon, and chemical oxygen demand. Monitoring of nitrite, nitrate, phosphate, trivalent iron, calcium, magnesium, and alkalinity was initiated in October and continued through November and December. These parameters are discussed in turn and followed by summary observations.

3.3.1 Hydrogen Ion Activity (pH)

The hydrogen ion activity, or pH, was somewhat basic, ranging from a low of 7.7 to a high of 10.1. The water sampled from stations A through G in Blue Lake (median pH 9.2) were generally more basic than water sampled from stations H through J in Mud Lake (median pH 8.2). Monthly pH exceeded the site criterion of 8.5 at all stations in Blue Lake with the exceptions of station B (pH 7.7) in August and stations A through G (pH 8.1 to 8.4) in December. Stations H through J in Mud Lake met the pH criteria throughout the sampling period. The pH was found to be greater than 8.0 throughout the sampling period in both lakes for all stations with one

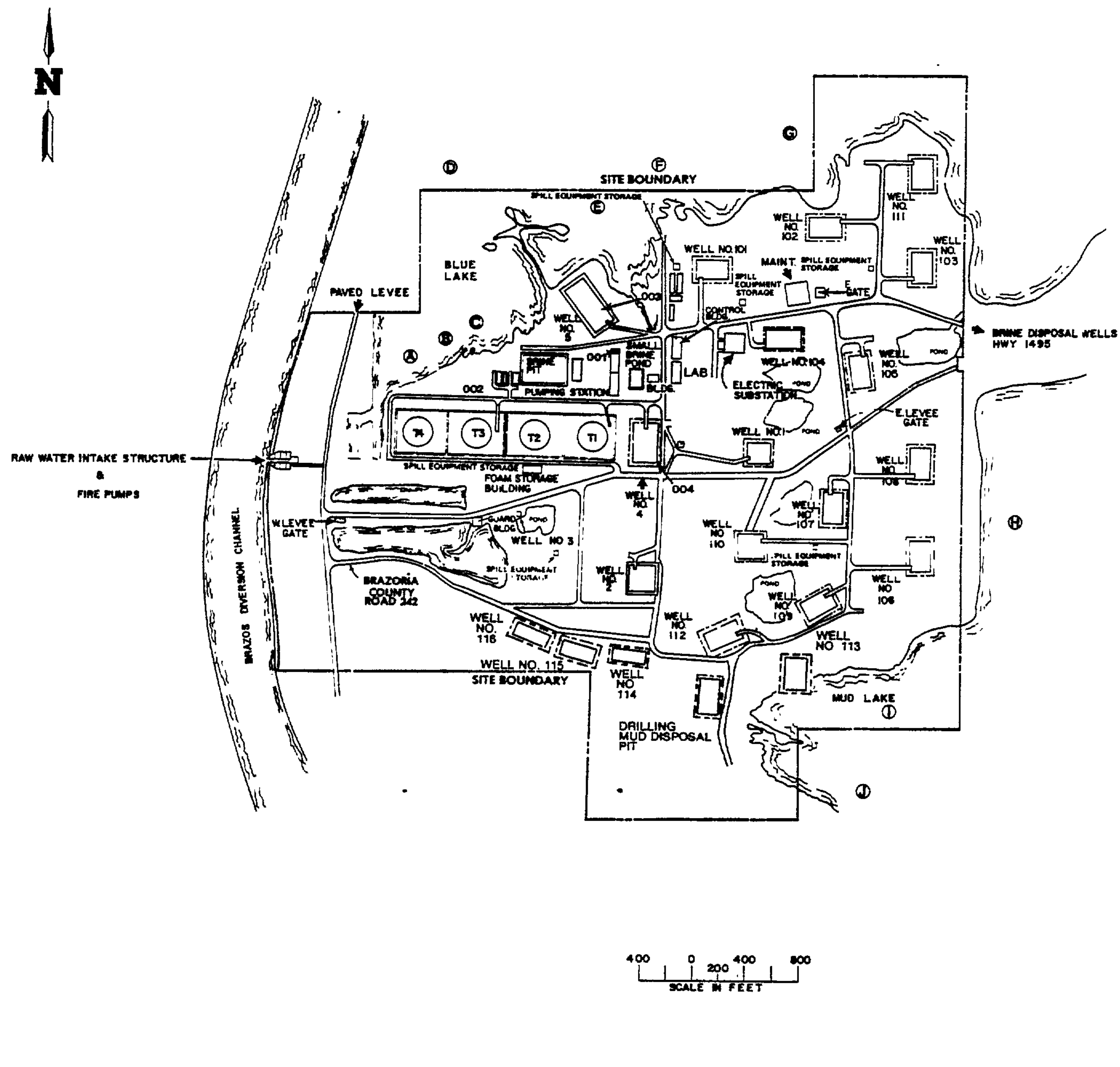

Figure 3-2 (Sheet 1 of 2). Bryan Mound Environmental Monitoring Stations

Discharge Monitoring Stations	
001	Discharge from Brine Surge Pit
002	Stormwater Runoff from Surge Tank Area (Corresponds to TX Water Comm. Permit No. 02271 Discharge 001)
003	Stormwater Runoff from Well Pad 5
004	Stormwater Runoff from Well Pad 4
005	Stormwater Runoff from Well Pad 1
006	Stormwater Runoff from Well Pad 2
101	Stormwater Runoff from Well Pad 101
102	Stormwater Runoff from Well Pad 102
103	Stormwater Runoff from Well Pad 103
104	Stormwater Runoff from Well Pad 104
105	Stormwater Runoff from Well Pad 105
106	Stormwater Runoff from Well Pad 106
107	Stormwater Runoff from Well Pad 107
108	Stormwater Runoff from Well Pad 108
109	Stormwater Runoff from Well Pad 109
110	Stormwater Runoff from Well Pad 110
111	Stormwater Runoff from Well Pad 111
112	Stormwater Runoff from Well Pad 112

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

exception (station B in August). This is characteristic of natural waters devoid of carbon dioxide and indicative of waters that are hard with regard to mineral content. Monthly consistency between the sampling stations and the control point suggests minimal site-induced impact on pH from point and nonpoint sources.

The observed alkalinity ranging from 66 mg/l as $CaCO_3$ to 197 mg/l as $CaCO_3$ is sufficient to buffer the site waters against rapid pH fluctuations.

3.3.2 Salinity

Salinity in Blue Lake ranged from 2.0 ppt in July to 11.4 in November. According to the Venice system of marine water classification, Blue Lake was oligohaline (5 to 0.5 ppt) in June and July, becoming mesohaline (18 to 5 ppt) during the rest of the sampling period. Mud Lake was found to be oligohaline during June, mesohaline during September and November and predominantly polyhaline (30 to 18 ppt) during October and December. This wide variation in Mud Lake, attributed to tidal flux and wind-induced flushing, will limit the species diversification in this ecosystem. Highly motile organisms and organisms tolerant of salinity variation would be expected to dominate the population of such an ecosystem. The more stable salinity in Blue Lake is more conducive to a stable, well-diversified ecosystem.

Salinities ranging from 10 to 20 ppt in the pump seal flush water were discharged from the high-pressure pump pad in the vicinity of station E from September to October. These elevations in salinity were due to the elevated salinity in the flush water source, the Brazos River diversion canal, during the same period. Comparison of the Blue Lake stations showed station E salinity data to be in close agreement with other near-shore stations and less than the control point (station D) during each of the three months. Thus, the elevated salinities discharged into Blue Lake from the high-pressure pump pad are considered to have minimal impact on the local ambient salinities.

3.3.3 Temperature

The temperature of Blue Lake ranged from 17.3°C in December to 32.8°C in August, with three stations exceeding the 32°C criterion during July and August. Some temperature variation was noted on a station basis with a general trend of increasing temperatures as station locations became more eastern. The temperature of Mud Lake ranged from 16.3°C in December to 31.0°C in June. Recorded temperatures generally decreased throughout the 1982 monitoring period.

3.3.4 Dissolved Oxygen (DO)

The DO concentration at each station was generally in excess of the site criterion of 5.0 mg/1, with the following exception in Blue Lake. During July and September, stations B and C and during August stations B, C, and D were found to have DO levels depressed below the DO criterion. This is attributed to the shallowness of the lake during this period and the resulting surface proximity of decomposing organic sediment. The August values on the order of 1 mg/1 were severely depressed and considered detrimental to most aquatic life. However, the DO levels of stations A, E, and F during August were satisfactory, allowing all but nonmotile organisms to move to a less oxygen-stressed environment. Elevated chemical oxygen demand corresponded somewhat with stations showing depressed DO. However, the relationship is not strong enough to indicate that chemical oxygen demand is more that a secondary contributing factor to the depressed DO. Temperature and TOC were found to bear no relation to the depressed DO. Thus, because of the localized nature and the lack of strong correlation with other water quality parameters, it is speculated that this depressed DO level is due to some combination of benthic processes.

3.3.5 Total Organic Carbon (TOC)

The TOC level was consistently low, exceeding the site criterion of 39 mg/1 only at station E during May. This suggests minimal contamination of Blue Lake by organic carbonaceous matter. In Blue Lake, TOC was recorded at its highest levels during May, with a station average of 36.5 mg/l dropping to a relatively consistent average of approximately 19 mg/l during June, July, and August and to 15 mg/l during September. The months of October, November, and December averaged a consistent 13 mg/l TOC. It is speculated that the May TOC level is attributable to the spring growth of phytoplankton and a possible extrusion of soluble organic compounds by aquatic vegetation during the rapid spring growth. The stable, reduced TOC level throughout the summer is indicative of a balanced population of primary producers (plants) and grazing organisms. The further reduced fall and winter TOC levels are speculated to be due to the reduced growth rates characteristic of winter months. Thus, based on TOC data, Blue Lake is perceived to be an ecologically sound aquatic ecosystem. Mud Lake TOC levels were low, exhibiting trends similar to those of Blue Lake. Greater variability in the Mud Lake data was observed and is attributed to that lake's shallow morphology and periodic tidal and wind-induced flushing.

3.3.6 Chemical Oxygen Demand (COD)

COD was observed at a relatively low level at all stations during May and June (average 39 mg/l), increasing to a station average high during August (315 mg/l) and declining gradually through November with December COD levels undetectable. COD levels determined for the high-pressure pump pad, which discharges in the vicinity of station E, were found to be consistently high during the months of October through November. This suggests a cause-effect relationship. However, because of the wide spatial distribution of stations with high COD and the lack of any observable COD gradient extending from station E, the elevated COD levels detected on the high-pressure pump pad are not thought to have a significant effect the Blue Lake COD. In Mud Lake, COD, like TOC, was found to be highly variable, reaching a maximum of over 1200 mg/l for all three stations in September. June and December COD levels averaged less than 100 mg/l while October and November levels averaged 234 mg/l. This variability is again attributed to lake morphology in combination with wind and tidal effects.

3.3.7 Macronutrients

Macronutrients were monitored at each station during October, November, and December. Nitrite was found to be present in very low quantities (less than 0.01 mg/l), which is indicative of unpolluted waters. Nitrate was found to be relatively consistent on a temporal-spatial basis, ranging from 1 to 3 mg/l. Nitrate is the most ecologically important form of nitrogen because of its role in nutrient supply for primary production (plant growth). This form of nitrogen is required for metabolic consumption by most plants.

3.3.8 Phosphate

Phosphate was found to range from 1 to 8 mg/l with station E reaching a maximum of 25 mg/l during November. This maximum is attributed to a flock of ducks feeding in the area immediately before the sampling. Phosphate is a necessary element in biological energy transfer systems. Phosphate is generally found in small quantities in natural waters and is commonly the limiting factor of plant growth. The apparent phosphate abundance in both Blue Lake and Mud Lake relative to nitrate suggests that primary production there is limited by some factor other than phosphate.

3.3.9 Cations

The major cations of ferric iron, calcium, and magnesium were monitored at each station during October, November, and December. The trivalent ferric cation is commonly found in a colloidal state under aerobic conditions. Ferric hydroxide is a form of iron readily available to phytophankton for metabolic uptake. Iron was found to be rather low in Blue Lake at less than 1 mg/l for all but 2 stations. In Mud Lake iron averaged a much higher 2.6 mg/l. Both calcium and magnesium are micronutrients essential to the proper development of plants and animals. Calcium ranged from 128 mg/l to 188 mg/l in Blue Lake and 198 mg/l to

327 mg/l in Mud Lake. Magnesium is the essential element in the chlorophyll molecule making it necessary for plant growth. Magnesium ranged from 180 to 265 mg/l in Blue Lake and 540 to 815 mg/l in Mud Lake. These high measured mineral levels correspond with the water hardness suggested by the overall high pH of these surface waters.

3.3.10 General Observations

The following observations address operational impact on the Bryan Mound aquatic environ.

a. Observed pH was somewhat high but stable in Blue Lake and slightly lower in Mud Lake. Alkalinity and hardness should limit pH fluctuations in the event of a pollution incident.

b. Blue Lake demonstrates normal estuarine salinity variations with TOC, DO, and macronutrients indicative of a healthy, stable ecosystem.

c. Mud Lake demonstrates extreme variation in salinity and COD due to lake morphology in conjunction with tidal and wind effects. This limits the development of a stable aquatic ecosystem.

d. Although COD in Blue Lake appears to correlate with the high-pressure pump pad runoff, consistent variation among all stations suggests that elevated COD's are due to natural variation in the low water quality or to benthic processes.

e. High levels of normally limiting phosphate suggest some other limiting factor. Indiscriminate nutrient loading in Blue Lake could result in rapid eutrophication and destruction of the recreational potential of this lake.

3.4 SULPHUR MINES WATER QUALITY

The Sulphur Mines surface waters were monitored from May through December 1982 on a weekly basis. To allow monthly data correlations ensuring temporal consistency, all weekly data were reduced to monthly averages (pH was reduced to monthly minimums and maximums). All subsequent discussion of water quality data is based on these monthly averages. No data were available for station A during July and October and station C during July, September, and October. Specific monitoring stations are identified on Figure 3-3 by stations A and B in site drainage, stations C in the subsidence area, stations D and E in site impoundments, and station F at the site raw water intake structure in a flood canal. Specific parameters monitored in the Sulphur Mines surface waters include pH, salinity, total dissolved solids, total suspended solids, temperature, and oil and grease. Oil and grease was not monitored at stations A and D. These parameters are discussed in turn and followed by summary observations.

3.4.1 Hydrogen Ion Activity (pH)

The pH ranged from a low of 3.53 at station A (September) to a high of 8.53 at station E (July). Generally, pH was in the range of 6 to 7, indicating slightly acidic to neutral surface waters. Low pH is characteristic of natural waters dominated by the carbon dioxide and bicarbonate forms of inorganic carbon and devoid of the anionic carbonate radical. This is due to the pH-dependent balance between the various forms of inorganic carbon driving all inorganic carbon to the bicarbonate and carbon dioxide forms. Such water may be characterized as soft with regard to mineral content. The lowest pH was found consistently at station A, which had a range of 3.5 to 7.9. The pH at station A during June, August, September, and December was found to be below the minimum criterion of 6.5 standard units. In assessing contributory factors, Outfall 004, the site biological waste treatment plant, which drains into the station A drainage ditch, was found to discharge at a pH of less than 6.5 during the months of July, August, and September. Thus only August and September water quality data corresponded to discharge data in regard to low pH, and, therefore, Outfall 004 does not appear to be a contributory rather than the primary cause of depressed pH at station A.

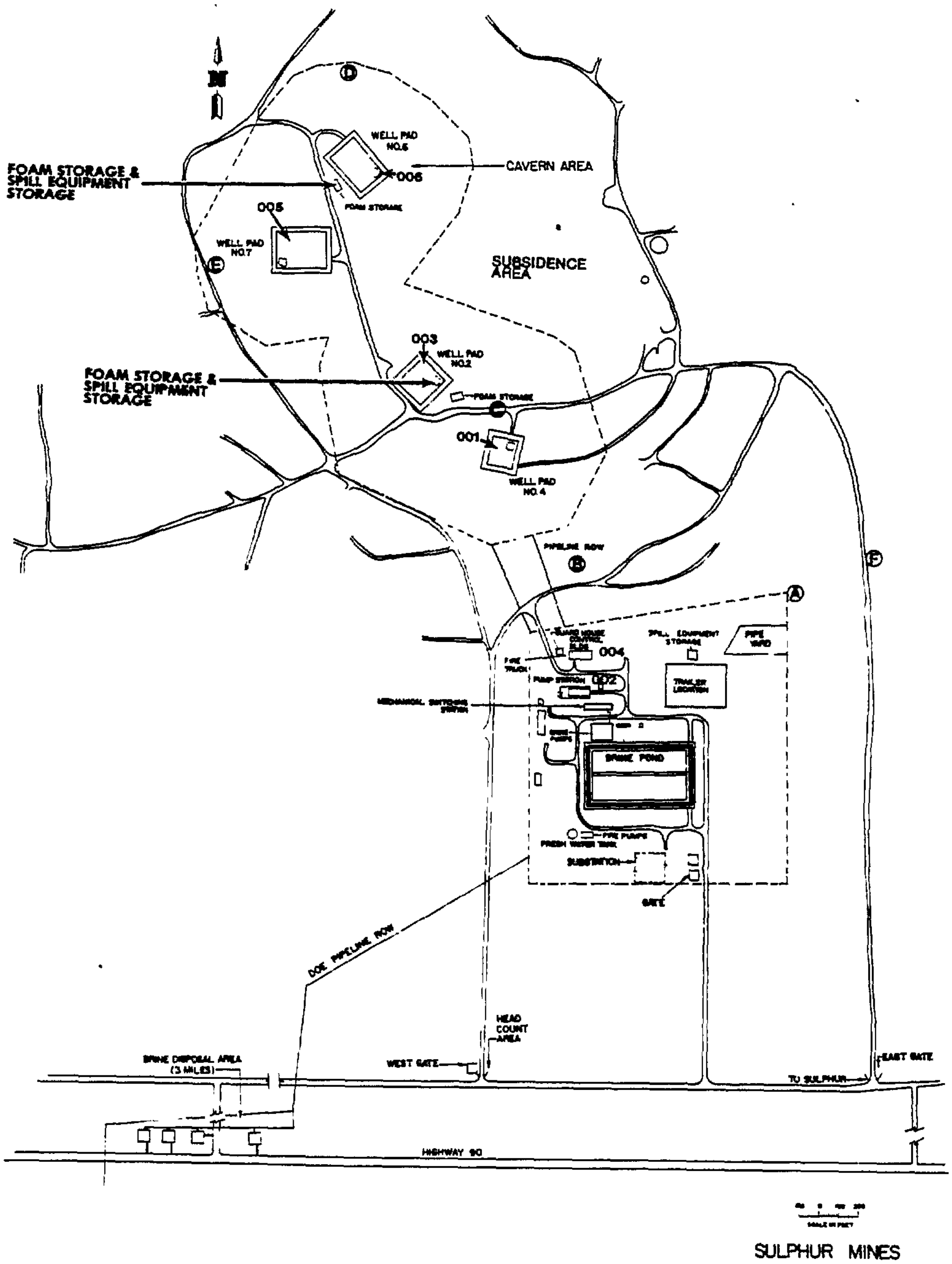

Figure 3-3 (Sheet 1 of 2). Sulphur Mines Environmental Monitoring Stations

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 Stations

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

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

The following comparison of pH and salinity by station was conducted. (Station F was not included due to the uniform 0 salinity and stable pH.)

Station	Median pH	Percent Below Criterion pH	Median Salinity	Average Salinity	Rank Order
A	6.9	67	0.8	0.8	1
B	7.2	12	2.4	2.3	3
C	7.4	0	3.2	2.8	4
D	6.9	25	1.2	1.3	2
E	7.6	0	3.8	3.2	5

The rank order by station of the increasing median pH, median and mean salinity and decreasing percent pH below the minimal criterion are identical suggesting that they are interrelated. In consideration of the above-discussed carbon dioxide dominated inorganic carbon system and the close rank correlation of pH and salinity, it appears that water hardness and probably buffering capacity at Sulphur Mines are salinity-dominated functions. Thus the wide range and fluctuations in surface water pH do not appear to be the result of point source discharges, but rather are related to geochemical processes.

3.4.2 Salinity

Under the Venice system the salinity at Sulphur Mines may be used to classify these waters generally as oligohaline (5 to 0.5 ppt). The distribution of salinity during the year was bimodal with a minor peak during June and July and a maximum peak in November reaching 5.6 ppt at station E. Station F, the intake structure, was limnetic (less than 0.5 ppt) throughout the year. The highest salinities were observed at station E (an impoundment area) and station C (the subsidence area), followed by station B (creek draining the subsidence area). Stations A and D were of relatively low salinity with a maximum of 1.8 at station D.

3.4.3 Total Dissolved Solids (TDS)

TDS levels were 2 to 15 times the fresh water criterion for all stations during each month with the exception of station F, the intake structure located on a flood control canal. TDS levels for this station were well within the site criterion of 500 mg/l. Station F is the only station with a characteristic limnetic water source and is thus in agreement with the general positive correlation of TDS to inorganic salts. Least squares regression analysis between TDS and salinity resulted in a significant correlation (r = 77, n = 39) between these variables. These data suggest that salinity contributed significantly to the TDS level in the Sulphur Mines waters.

3.4.4 Total Suspended Solids (TSS)

TSS levels exceeded the site criterion nine times (21 percent of the determinations) during the year. Six of these excessive TSS levels occurred at stations B and E. However, the distribution throughout the year appeared to be random. Station A, the drainage ditch which receives the sewage discharge from Outfall 004, had a high TSS level (140 mg/l) during September. The maximum TSS level recorded from outfall 004 during September was 6.0 mg/l, indicating this point discharge was not the causal factor of the station A TSS.

3.4.5 Temperature

Temperature was within the site criterion of 32°C throughout the year at each station. Although there was some station variation, peak temperatures were generally observed during July and August.

3.4.6 Oil and Grease

Oil and grease were observed at less than the site criterion for each station throughout the year, with the exception of station E during September. The oil and grease concentration from Well Pad 7, which discharges in the vicinity of station E, did not exceed the 5-mg/l lower detectable limit during September. Thus, the slightly elevated oil and grease level at station E is not attributed to the Cavern 7 point discharge.

3.4.7 General Observations

Based on the above discussions, the following observations are made concerning operational impact on the Sulphur Mines environment resulting from the SPR project.

a. Surface water pH at the Sulphur Mines site is generally low and variable. This variability is attributed to the natural variation in salinity of apparently soft waters rather than site point source discharges. The discharge of low pH effluent from 004 may be a contributing factor in depressed pH at station A.

b. TDS are high relative to site criteria. However, these data correlate strongly with salinity, indicating that the dissolved solids are ionic in nature.

c. Total suspended solids exceeded site criterion in one of every five determinations. However the temporal distribution was random and unrelated to site point discharges.

d. Oil and grease exceeded the site criteria in only one case. Point source discharge data in that area showed a nondetectable level of oil and grease.

3.5 WEST HACKBERRY WATER QUALITY

The West Hackberry surface waters were monitored on a weekly basis from May through December of 1982. To allow monthly data correlations ensuring temporal consistency, all weekly data were reduced to monthly averages (pH was reduced to monthly minimums and maximums). All subsequent discussions of water quality data are based on these monthly averages. Specific monitoring stations are identified on Figure 3-4 by stations A, B, and C in Black Lake, station D in the southeast drainage ditch, station E in the ditch draining the high-pressure pump pad to Black Lake, and station F in the slop oil tank dike (F was monitored only during May and June). Specific parameters monitored in the West Hackberry surface waters include pH,

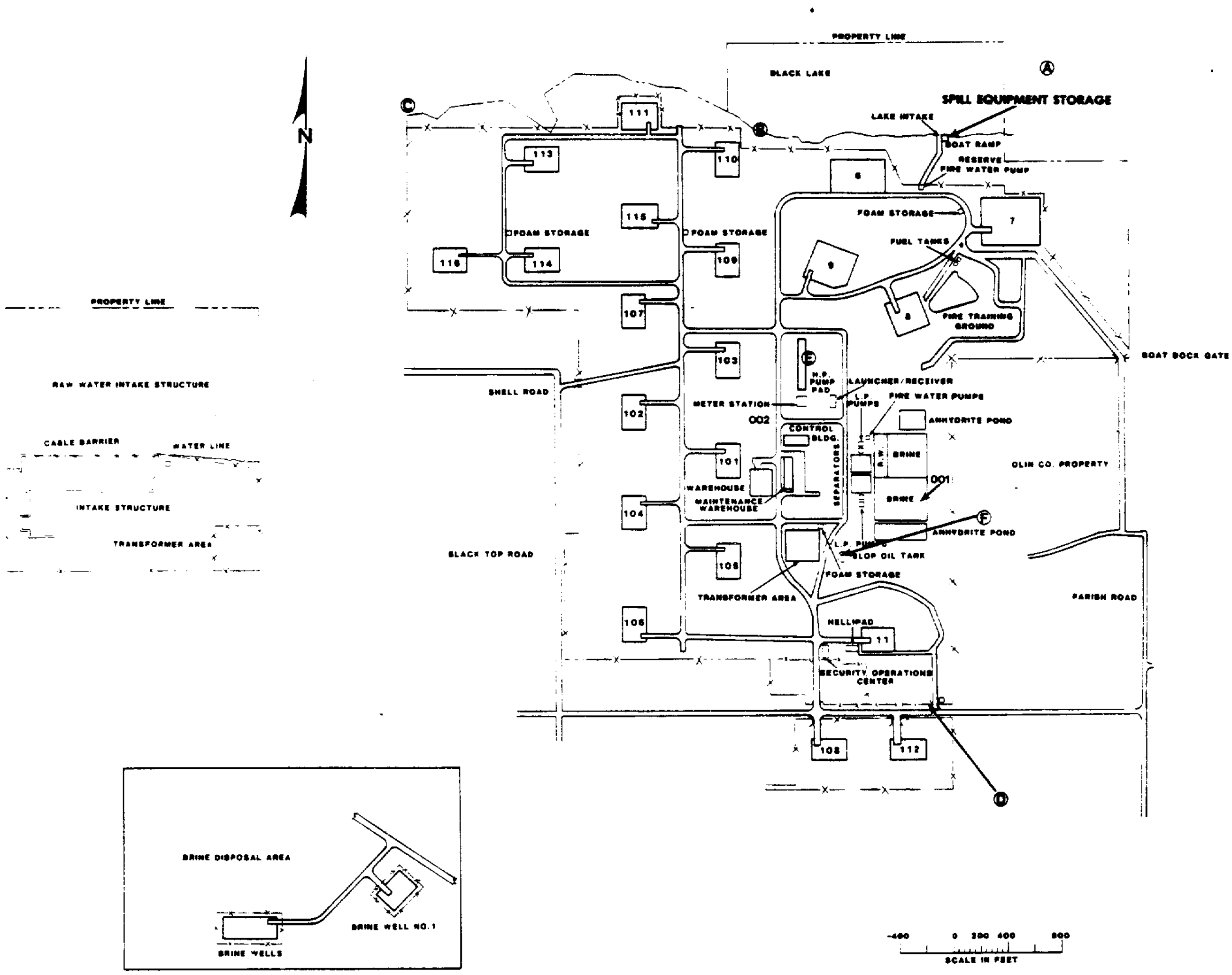

Figure 3-4 (Sheet 1 of 2). West Hackberry Environmental Monitoring Stations

Discharge Monitoring Stations

001	Brine Disposal
002	Discharge from Sewage Treatment Plant
Well Pad 6	Stormwater Runoff from Well Pad 6
Well Pad 7	Stormwater Runoff from Well Pad 7
Well Pad 8	Stormwater Runoff from Well Pad 8
Well Pad 9	Stormwater Runoff from Well Pad 9
Well Pad 11	Stormwater Runoff from Well Pad 11
Well Pad 101	Stormwater Runoff from Well Pad 101
Well Pad 102	Stormwater Runoff from Well Pad 102
Well Pad 103	Stormwater Runoff from Well Pad 103
Well Pad 104	Stormwater Runoff from Well Pad 104
Well Pad 105	Stormwater Runoff from Well Pad 105
Well Pad 106	Stormwater Runoff from Well Pad 106
Well Pad 107	Stormwater Runoff from Well Pad 107
Well Pad 108	Stormwater Runoff from Well Pad 108
Well Pad 109	Stormwater Runoff from Well Pad 109
Well Pad 110	Stormwater Runoff from Well Pad 110
Well Pad 111	Stormwater Runoff from Well Pad 111
Well Pad 112	Stormwater Runoff from Well Pad 112
Well Pad 113	Stormwater Runoff from Well Pad 113
Well Pad 114	Stormwater Runoff from Well Pad 114
Well Pad 115	Stormwater Runoff from Well Pad 115
Well Pad 116	Stormwater Runoff from Well Pad 116
HPP	Stormwater and Pump Flush from High-Pressure Pump Pad

Water Quality Monitoring Stations

A	Black Lake
B	Black Lake
C	Black Lake
D	Southeast Drainage Ditch
E	High-Pressure Pump Pad
F	Slop Oil Tank Dike

Figure 4-7 (Sheet 2 of 2). West Hackberry Environmental Monitoring Stations

salinity, temperature, total dissolved solids, total suspended solids, and oil and grease. Oil and grease were not monitored at station D. These parameters are discussed in turn, and the discussions are followed by summary observations.

3.5.1 Hydrogen Ion Activity (pH)

The pH, ranged from a neutral 7.06 to a somewhat basic 8.81. Only station F with a high of 8.81 during May exceeded the site water quality criterion. The upper range of the monthly pH on a station basis exceeded 8.0, 45 percent of the time. This is characteristic of natural waters devoid of carbon dioxide and medium hard to hard with regard to mineral content. Some compounds such as hydrogen cyanide and hydrogen sulfide increase in toxicity the to the degree of dissociation and thus demonstrate increasing compound toxicity to aquatic life with reduced pH. In this regard, a mildly basic pH is beneficial to aquatic life and consistent with an environmentally sound ecosystem.

3.5.2 Salinity

Salinity ranged from 0.7 to 64.6 ppt for stations A through F. Stations A, B, and C (Black Lake) ranged from 5.5 to 18.0 increasing steadily from May through November. Wind and tide contributed to the salinity variation in Black Lake.

This salinity range limits Black Lake to organisms tolerant of such variation or to those organisms with sufficient motility to escape unsuitable salinities. Under the Venice system of classifying marine waters, Black Lake may be classified as mesohaline (18 to 5 ppt). Monthly salinity at station D, the southeast drainage ditch, ranged from 0.7 ppt to 3.6 ppt with the exception of August, when salinity reached 13.5 ppt. This high salinity was attributed to a brine leak from the low-pressure pump pad.

Monthly salinity values for station E, the high-pressure pump pad runoff, ranged from 10.5 to 64.6. This high salinity is attributed to brine pump seal leakage on the high-pressure pump pad. Water from the high-pressure pump pad is discharged into Black Lake in the vicinity of station B. The average salinity at station B was 11.4 ppt as compared to 11.0 ppt for stations A and C. The monthly salinity at station B was exceeded only at station C during December. In September, in an effort to more closely monitor the impact of the high saline water discharge into Black Lake, monitoring station B was moved closer to the high-pressure pump pad point of discharge. The resultant data showed station B averaging 4.1 percent higher salinity than stations A and C before September and a 4.5 percent higher salinity than stations A and C during the rest of 1982.

The average salinity at station E increased from 14.8 ppt before September to 45.25 ppt during the rest of 1982. The increased salinity at station B during the last four months of 1982, whether due to increased salinity at station E or closer proximity of station B to the saline water discharge points, suggests that saline water from the high-pressure pump pad contributes to the relatively elevated salinity in Black Lake at station B.

3.5.3 Total Dissolved Solids (TDS)

The TDS level ranged from 2 to 12 times the site water criterion on a monthly and station basis. TDS was compared to salinity at each station on a monthly basis by least squares regression analysis. This produced an extremely high correlation ($r = 0.99$, $n = 37$) demonstrating that the TDS in West Hackberry surface waters are due almost exclusively to salinity.

3.5.4 Total Suspended Solids (TSS)

Total TSS exceeded the site criterion 16 times (40 percent of the determinations) during the 1982 sampling year. The flowing water stations D and F had excessive suspended solids in 56 percent of the determinations while the lake stations A, B, and C, had excessive solids in 19 percent of the determinations. Elevated levels of TSS occurred in the three lake stations seven times from August through November. Although the TSS level at station E exceeded the site criterion during six of the eight months, only two of those months (October and November), corresponded to excessive lake TSS levels. This suggests the excessive TSS levels measured at station E, the high-pressure pump pad, did not contribute significantly to the occasional high suspended solids level in the lake. The TSS level for Outfall 002, the site biological waste treatement plant, was in noncompliance during November. However, because of its relatively low flow rate and the distance from Black Lake, no TSS impact on the lake is perceived.

3.5.5 Temperature

Temperature was within the site criterion of 32°C throughout 1982 at all sampling stations. The temperature in Black Lake ranged from 18.7°C to 28.3°C. The highest temperatures for all stations were recorded during July and August while the lowest temperatures were recorded during November and December.

3.5.6 Oil and Grease

Oil and grease were observed at concentrations of less than 5 mg/l at all stations except the high-pressure pump pad station E. The chronic detection of oil and grease at station E there is attributed to the leakage of pump lubricating oil and an improperly operating oil-water separator. A weir system and the regular use of sorbent materials mitigated the impact of this oil contamination. The effectiveness of these actions is confirmed by the lack of detectable oil and grease in samples drawn from Black Lake throughout the year.

The following observations are made based on the above discussions concerning operational impact on the West Hackberry aquatic environ.

a. Runoff from the high-pressure pump pad contributed to an increase in salinity in Black Lake at station B as compared to other comparable monitoring stations.

b. Although TDS levels were excessive at all stations relative to fresh water criteria, statistical analysis demonstrated that ambient salinity was the primary cause of elevated TDS levels at West Hackberry.

c. TSS levels exceeded the site criterion in two out of every five determinations. However, based on the uniform temporal-spatial distribution of TSS throughout the site, these levels were not attributed to specific site point source discharges.

d. The effects of the high oil and grease levels discharged from the high-pressure pump pad were effectively mitigated. However, planned corrective measures are anticipated to effectively control oil and grease discharged from this area.

3.6 ST. JAMES TERMINAL

The St. James SPR Terminal is located in a low-lying agricultural area outside 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. No permanent natural bodies of water occur in the vicinity of St. James Terminal. Thus, the lack of potentially impacted surface waters precludes the need for surface water quality monitoring at the St. James SPR Terminal facility.

The St. James SPR docks are located on the west bank of the Mississippi River. These two docks are curbed, with all runoff pumped to the terminal's stormwater treatment system and retention pond. The site retention pond, which also collects stormwater runoff from diked areas in the terminal, is discharged intermittently through Outfall 001 (Figure 3-5) into the Mississippi River. At St. James the Mississippi River has a large flow volume, a high current, and a strong assimilative capacity. Thus, the intermittent nature of discharges from Outfall 001, the characteristic features of the Mississippi River at that point, and an ongoing State-conducted water quality monitoring program, precludes the need for SPR water quality monitoring in the Mississippi River.

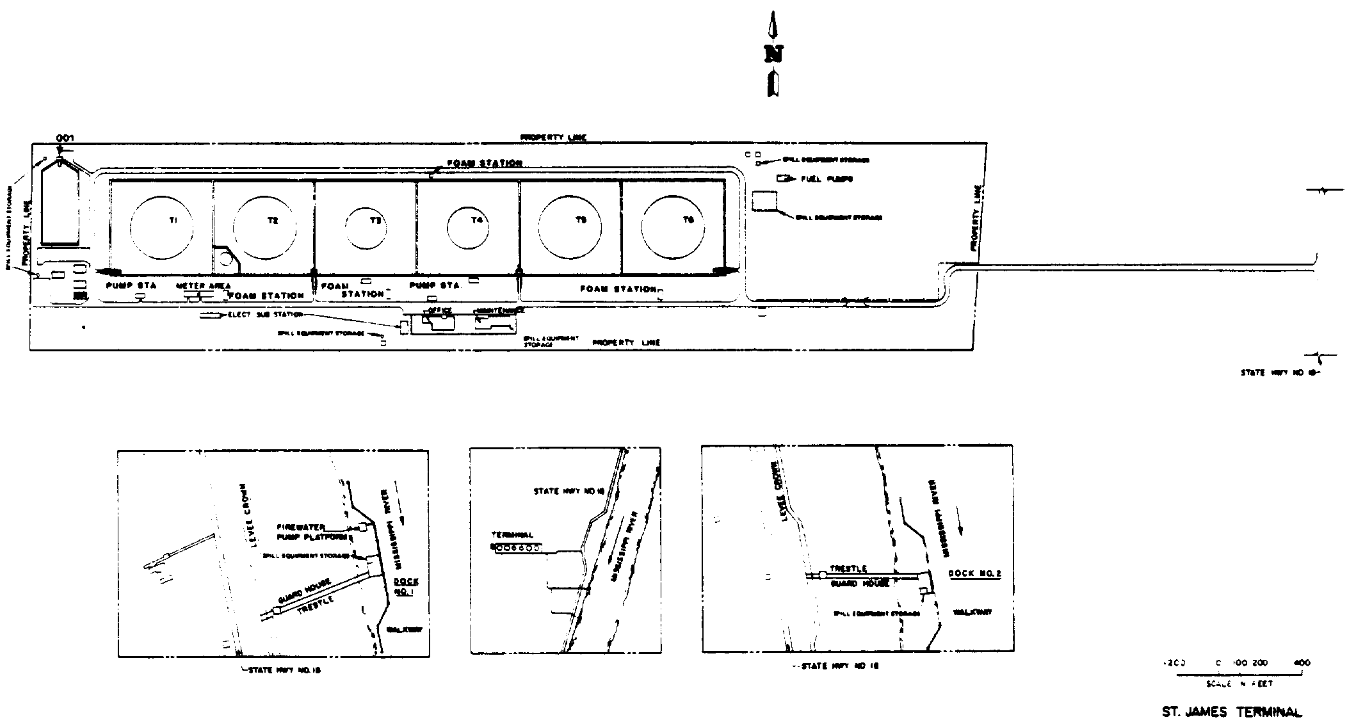

Figure 3-5 (Sheet 1 of 2). St. James Terminal Environmental Monitoring Stations

Discharge Monitoring Stations

001 Discharge from Retention Pond
Discharge from Contractor's Sewage Treatment Plant

Figure 3-5 (Sheet 2 of 2). St. James Terminal Environmental Monitoring Stations

3.7 WEEKS ISLAND

The Weeks Island SPR site is located on the Weeks Island salt dome approximately 100 feet above sea level, with a surrounding topography of rather sharp relief. The surface waters at this site are intermittent in nature draining rapidly and thoroughly after precipitation. The site outfalls (001A, 001B, and 002, shown on Figure 3-6) discharge small volumes into surface drainage a substantial distance from surface bodies of water. Thus, this lack of potentially impacted surface waters precludes the need for surface water quality monitoring at the Weeks Island SPR site.

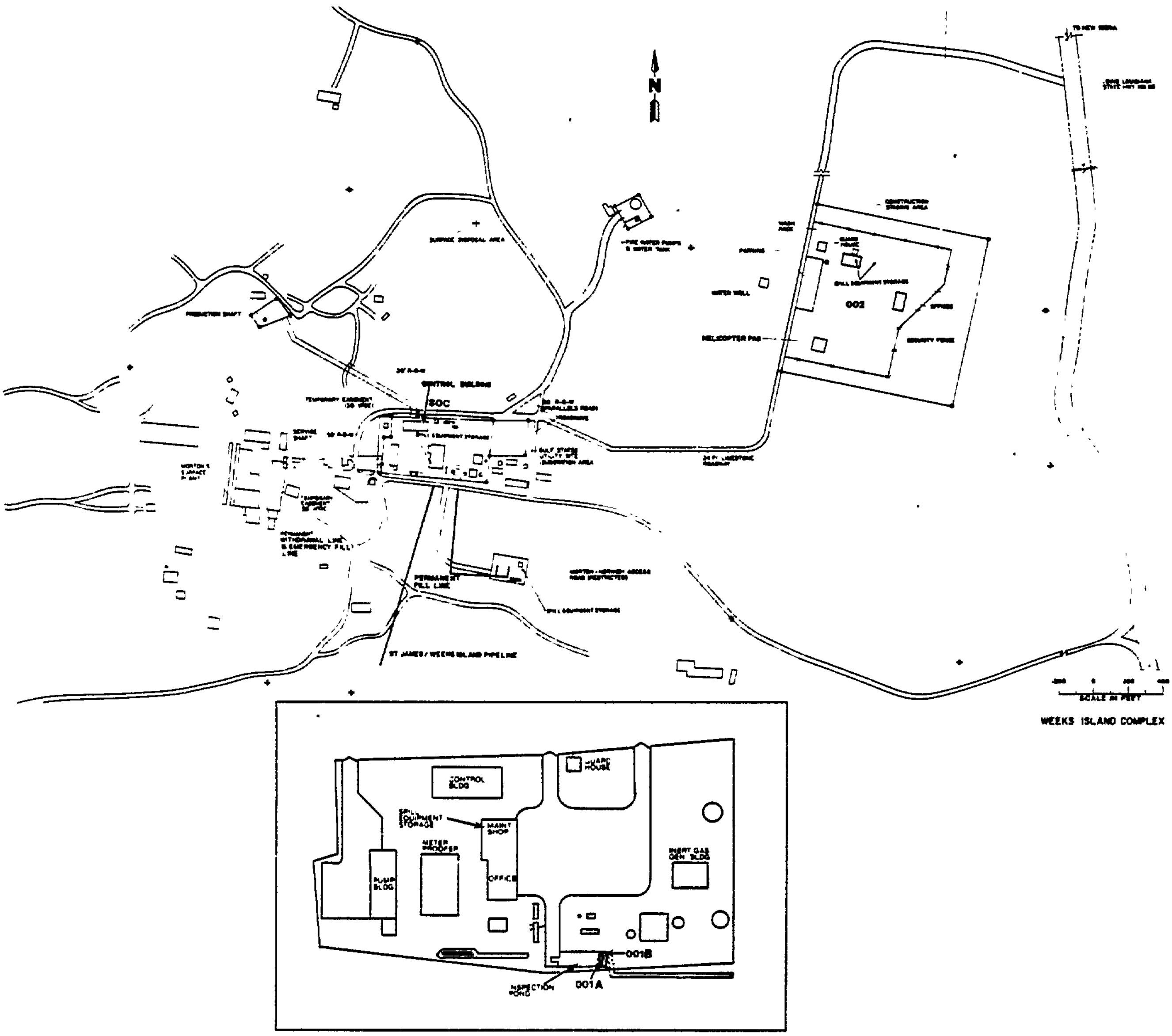

Figure 3-6 (Sheets 1 of 2). Weeks Island Environmental Monitoring Stations

Discharge Monitoring Stations

001A	Stormwater Runoff
001B	Discharge from Sewage Treatment Plant
002	Discharge from Sewage Treatment Plant (laydown yard)

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

LIST OF REFERENCES

The following documents were used in the preparation of this report:

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

Final Environmental Impact Statement, Strategic Petroleum Reserve (Texoma Group Salt Domes, November 1978), volumes 1-5, United States Department of Energy

Final Environmental Impact Statement, Strategic Petroleum Reserve (Seaway Group Salt Domes, June 1978), volumes 1-3, United States Department of Energy

Final Environmental Impact Statement, Strategic Petroleum Reserve (Capline Group Salt Domes, July 1978), volumes 1-4, United States Department of Energy

Final Environmental Impact Statement, Strategic Petroleum Reserve (Sulphur Mines Salt Dome, March 1978), United States Department of Energy

Quality Criteria for Water (U.S. Government Printing Office, July 1976), United States Environmental Protection Agency

Reid, George K., and Richard D. Wood, Ecology of Inland Waters and Estuaries, 2nd edition. (New York, D. Van Nostrand Company, 1976)

Standard Methods For the Examination of Water and Wastewater, 15th Edition, (American Public Health Association, 1980)

State of Louisiana Water Quality Criteria, 1977, Louisiana Stream Control Commission

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