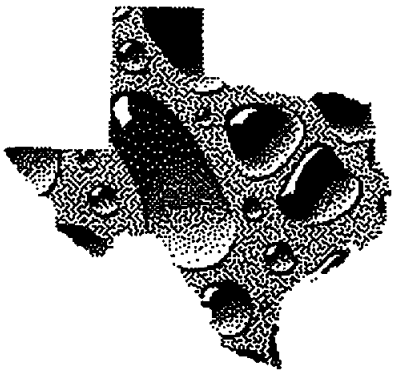


TRANS-TEXAS WATER PROGRAM

SOUTHEAST AREA

Memorandum Report

Environmental Analysis for the Neches Salt Water Barrier Beaumont, Texas

April 1998

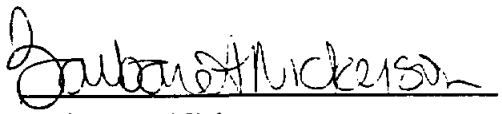
Sabine River Authority of Texas
Lower Neches Valley Authority
San Jacinto River Authority
City of Houston
Brazos River Authority
Texas Water Development Board

This document is a product of the Trans-Texas Water Program: Southeast Area. The program's mission is to propose the best economically and environmentally beneficial methods to meet water needs in Texas for the long term. The program's four planning areas are the Southeast Area, which includes the Houston-Galveston metropolitan area, the South-Central Area (including Corpus Christi), the North-Central Area (including Austin) and the West-Central Area (including San Antonio).

The Southeast Area of the Trans-Texas Water Program draws perspectives from many organizations and citizens. The Policy Management Committee and its Southeast Area subcommittee guide the program; the Southeast Area Technical Advisory Committee serves as program advisor. Local sponsors are the Sabine River Authority of Texas, the Lower Neches Valley Authority, the San Jacinto River Authority, the City of Houston and the Brazos River Authority.

The Texas Water Development Board is the lead Texas agency for the Trans-Texas Water Program. The Board, along with the Texas Natural Resource Conservation Commission, the Texas Parks & Wildlife Department and the Texas General Land Office, set goals and policies for the program pertaining to water resources management and are members of the Policy Management Committee.

Brown & Root and Freese & Nichols are consulting engineers for the Trans-Texas Water Program: Southeast Area. Blackburn & Carter and Ekistics provide technical support. This document was prepared under the supervision of:



Barbara A. Nickerson
Freese and Nichols, Inc.

Contents

Figures

Tables

Executive Summary

The Neches River salt water barrier project at Beaumont has been proposed as a means of protecting the fresh water supplies of the Lower Neches Valley Authority (LNVA) and the City of Beaumont. Both the LNVA and the City have water supply intakes located below sea level, and they are threatened during times of low flow when a salt water wedge from the Gulf of Mexico migrates upstream. The LNVA monitors the movement of the salt water wedge and coordinates upstream releases by the United States Army Corps of Engineers (COE) from Lake B.A. Steinhagen with water supply needs. These releases and natural inflows below the lake are used to prevent salt water from reaching water intake structures of the LNVA and the City of Beaumont. Recent estimates by the LNVA indicate that a flow of approximately 2,500 cubic feet per second on the Neches at the mouth of Pine Island Bayou is necessary to hold the salt water wedge downstream. During a critical drought period, water released from Lake B.A. Steinhagen for the purpose of keeping the salt water wedge downstream would represent a substantial loss of usable yield from the Lake Sam Rayburn-B.A. Steinhagen system.

At present, the LNVA is permitted by the COE to construct temporary salt water barrier structures on the Neches River and Pine Island Bayou under certain drought conditions. The temporary barriers are considered environmentally undesirable by local interest groups and regulatory agencies. As a result, the Section 10 permit to construct the temporary barriers was issued contingent upon continued efforts to develop a permanent solution to the salt water intrusion problem (such as a permanent barrier structure).

Six sites were originally considered as potential locations for construction of a permanent salt water barrier at Beaumont, Texas. Environmental and economic considerations for each were presented in the Phase I report (COE, 1981). Subsequent reevaluation of economic factors presented by the COE (1997) describe Site 6 as the National Economic Development (NED) designated site and Selected Plan. This site is fully supported and endorsed by the LNVA. This report evaluates the existing environmental conditions and potential impact of construction, operation and maintenance associated with the structure.

The site currently under consideration is located at river mile 29.7, just downstream from the confluence of the Neches River and Pine Island Bayou. Components of the project will include an overflow dam located in the Neches River, a sector gate navigation by-pass channel west of the river, a tainter gate barrier structure located in a diversion channel west of the navigation channel, an access levee road, and a service area west of the diversion channel.

Under the proposed plan, the main water intake structures of the LNVA and the City of Beaumont would be protected from salt water intrusion. The proposed site location, however, leaves the City of Beaumont's gravity water intake at Lawson's crossing vulnerable to periodic saltwater intrusion, as it is now. The city would be unable to operate the intake when

the salt water wedge reached that point on the Neches River.

A permanent barrier at Site 6 would eliminate several of the problems attributed to the temporary barriers and would provide benefits to the natural and human environment. A permanent barrier would (a) restore year-round fresh water conditions to the Neches River and Pine Island Bayou; (b) enhance the overall aquatic habitat and recreational value of the river by improving upstream water quality; (c) not interfere with the natural conditions of or boat access to the Big Thicket National Preserve (BTNP), as do the temporary barriers; and (d) provide for private and commercial navigation of the river. The permanent barrier could also eliminate the need to release water from Lake B.A. Steinhagen during times of low flow to counteract the upstream movement of salt water, potentially making additional yield available.

The site will occupy approximately 60 acres situated just south of the Big Thicket National Preserve, including high quality cypress-tupelo swamp and bottomland hardwoods, as well as wetlands dominated by other forest vegetation, emergent aquatic vegetation, and scrub shrubs. In addition to the 60 acres required for construction of the barrier and associated structures, another 8.5 acres of cypress-tupelo swamp will be acquired and preserved as undisturbed wetland habitat.

Wetlands are regulated as "waters of the U.S." by the COE. Bald cypress-water tupelo swamp is also classified as Category II habitat (quantitatively declining) by the U.S. Fish and Wildlife Service and as a "watchlisted natural community" by the Texas Organization for Endangered Species. Mitigation requirements for impacts to wetlands, in particular to Category II habitat, would likely be significant. However, an in-depth Habitat Evaluation Procedure would be necessary to determine mitigation needs. Due to the high habitat value of bald cypress-water tupelo swampland, a large mitigation area with on-site management could be required to balance the loss of these wetland habitats. Impacts to bald cypress-water tupelo swampland or other wetlands should be minimized to the extent possible.

The project has the potential to impact endangered and threatened species or their habitats. The paddlefish (Polyodon spathula) is listed as an endangered species in Texas. Two additional species listed as threatened by Texas Parks and Wildlife Department (TPWD), the white-faced ibis (Plegadis chihi) and the alligator snapping turtle (Macroclemys temmincki), also have the potential to occur at the project site. The TPWD should be consulted regarding the potential impacts to these species in the construction and operation of the permanent barrier structure.

The permanent barrier project would not impact instream flows relative to the effects of the temporary barriers at times when the temporary barriers would have been installed. Under non-drought conditions, when the temporary barriers would not have been installed, the permanent barrier would make current releases from storage in the upstream reservoir system unnecessary. This would make additional water available for local needs.

A cultural resources survey has not been completed for the proposed site area. A literature review and detailed surveys of the riverbanks and channel would be required if Site 6 is selected.

Other permitting and regulatory issues which must be addressed include hazardous, toxic and radioactive waste (HTRW) investigations. The COE has indicated that a reconnaissance-level HTRW assessment of the barrier site will be required before the project can be implemented. Testing of dredged material for potential contaminants may be necessary prior to disposal or reuse. A "Marl, Sand and Gravel Permit" from the TPWD would also be needed for the proposed outfall structure to cover excavation work conducted within the bed and banks of the Neches River.

The COE may also consult with FEMA regarding floodplain development and with the Texas Coastal Coordination Council regarding the Texas Coastal Management Plan.

1.0 Introduction

Prior to about 1900, there was not a salinity problem in the Neches River. Salt water intrusion was prevented by fresh water flows and natural bars at the mouth of the river and at Sabine Pass, between Sabine Lake and the Gulf of Mexico. However, in the late 1800s and early 1900s, larger channels were excavated in several places between Sabine Pass and Beaumont. This provided a pathway for salt water to migrate upstream during periods of low flow. Because salt water is heavier than fresh water, it tends to move into the portion of the channel that is below sea level and to force its way upstream if fresh water flows are not sufficient to counteract it.

Both the Lower Neches Valley Authority (LNVA) and the City of Beaumont have fresh water intakes that are below sea level (Figure 1.1). The LNVA supplies fresh water to a five-county area encompassing two water districts; numerous industries, including oil refineries and petrochemical companies; and approximately 100,000 acres of irrigated cropland. The City of Beaumont (1990 population: 115,323) supplies its own fresh water for municipal use. If salt water flows upstream as far as the pump stations, these critical water supplies will be disrupted.

To protect against salt water intrusion in its current operation, the LNVA monitors the movement of the salt water wedge and can request that the United States Army Corps of Engineers (COE) coordinate releases from Lake B.A. Steinhagen with water supply needs and natural inflows to the Neches River from the uncontrolled downstream portions of the watershed. Under normal conditions, there is enough flow in the river to prevent the salt water from reaching the diversion facilities. However, when flows in the river fall below about 2,500 cubic feet per second (cfs), the salt water can migrate upstream to the mouth of Pine Island Bayou, endangering the water intakes (Freese and Nichols, Inc., 1987). Under drought conditions, the amount of water which must be released from Lake B.A. Steinhagen to counteract the salt water wedge can be significant. Any water released to control the saltwater intrusion cannot be used for water supply and therefore represents a loss of dependable yield from the Sam Rayburn-B.A. Steinhagen system.

Historically, the LNVA has constructed temporary barrier structures on both the Neches River and Pine Island Bayou to hold back the salt water when necessary. Records indicate that barriers were used almost yearly from 1947 to 1982, and again in 1989 and 1996. The temporary barriers, which consist of steel sheet piling supported by timber piles, have provided a relatively economical and effective means of protection for the area's fresh water supply facilities. The LNVA was given a continuing permit to use the temporary barriers in 1945 by the COE. However, in 1991, the COE withdrew the standing permit and indicated that the LNVA would be required to apply for a new permit under Section 10 of the Rivers and Harbors Act of 1899 before installing the barriers in the future. In 1994, following a lengthy review process, the COE granted a provisional Section 10 permit for the LNVA to install the temporary barriers if needed. The

permit included several key conditions, the overall intent of which was to minimize the use of the temporary barriers and encourage the development of a permanent solution to the salt water intrusion problem (i.e., a permanent salt water barrier) in the near future. The permit will not be valid after the completion of the federal salt water barrier at Beaumont project, which was authorized under the Water Resources Development Act of 1976. If the federal project is not constructed, the existing permit will only be valid for 5 years and any extension of time request may be denied should the applicant not pursue an alternate design.

Previous hydrologic studies have shown that Sam Rayburn and B.A. Steinhagen Reservoirs have no dependable yield under current conditions without the use of either temporary or permanent salt water barriers. If no barriers are constructed, the usable storage in the reservoirs would be exhausted during a severe drought by releases to keep salt water downstream, even if no water was used for water supply.

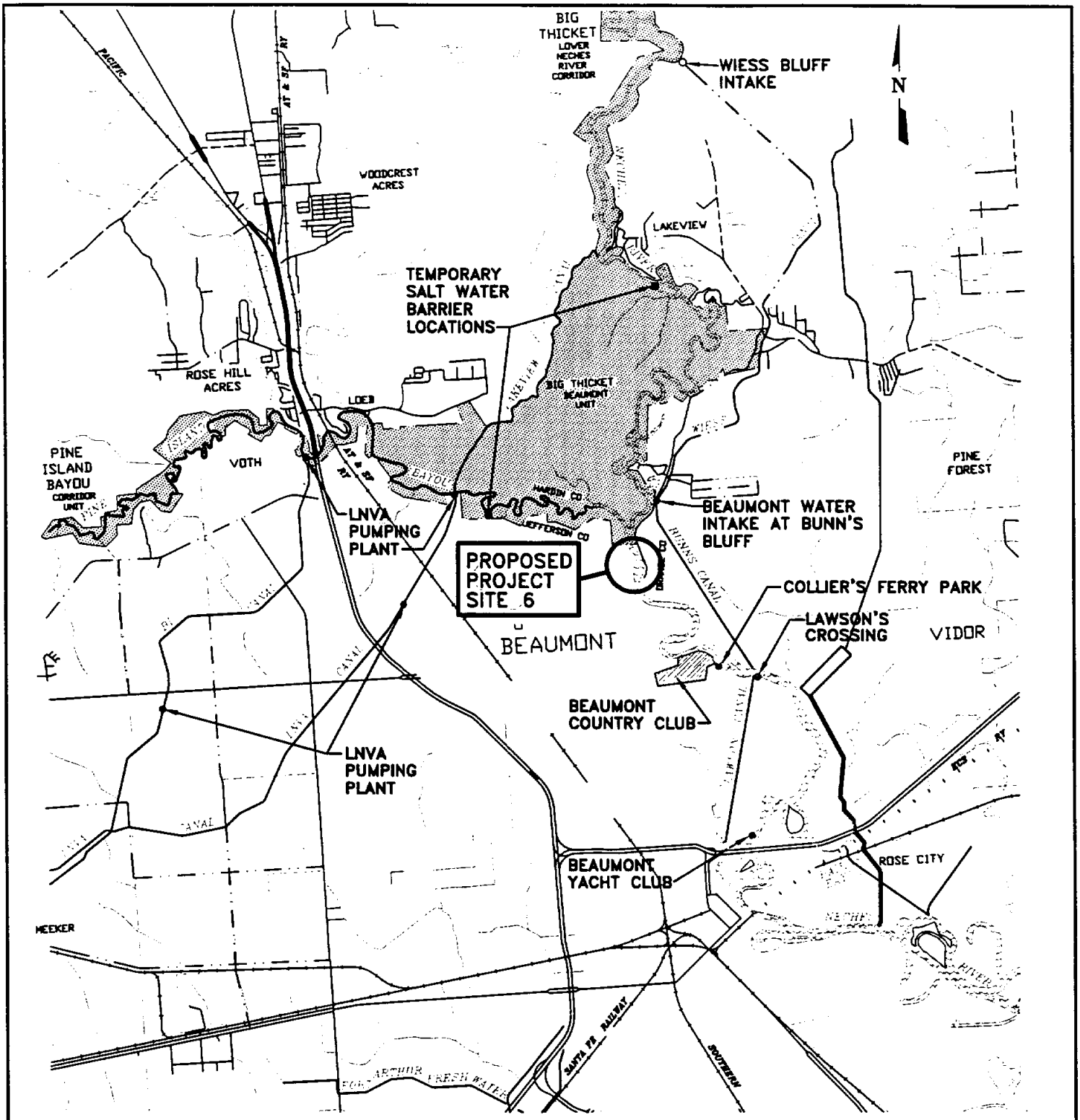
The permanent salt water barrier is to be constructed on the Neches River downstream of the main water intakes of the LNVA and the City of Beaumont. Construction of the permanent barrier will eliminate the need for temporary barriers and will protect fresh water supplies from salt water contamination. The permanent structure will allow relatively unobstructed use of the river and provide water quality benefits. The salt water barrier will not function as a dam or reservoir or create significant backwater during floods. Its function is to prevent salt water intrusion from the ship channel. The project also has the potential to maintain the dependable yield available from the Sam Rayburn-B.A. Steinhagen system.

The site currently under consideration, Site 6, is located at river mile 29.7, just downstream from the confluence of the Neches River and Pine Island Bayou (Figure 1.1). Components of the project (shown in Figure 1.2) will include an overflow dam located in the Neches River, a sector gate navigation by-pass channel west of the river, a tainter gate barrier structure located in a diversion channel west of the navigation channel, an access levee road, and a service area west of the diversion channel.

The overflow dam consists of an earthen plug with a 300-foot crown width and will tie into an existing road on the east bank and the navigation structure on the west bank. The navigation channel, located on the west bank will have two sector gates with a clear opening of 56 feet for river traffic. The diversion channel is located west of and adjacent to the navigation channel and will have five tainter gates. The cross-sectional area of the navigation and diversion channels will approximate the cross-sectional area of the Neches River at this location.

The access levee road will follow an existing road to the west bank of the river, connecting with a service area and the tainter gate barrier structure. The existing road will be raised and widened to handle construction and maintenance traffic. Culverts will be added to reestablish surface water flow and connect wetlands on either side of the road. A service area west of and adjacent to the diversion channel will contain an administration building, a storage building, and a parking lot.

This report addresses the potential environmental impacts of the permanent salt water barrier at the proposed site. Information contained in the report is based on a review of existing data relevant to the project, including previous studies conducted by the COE.



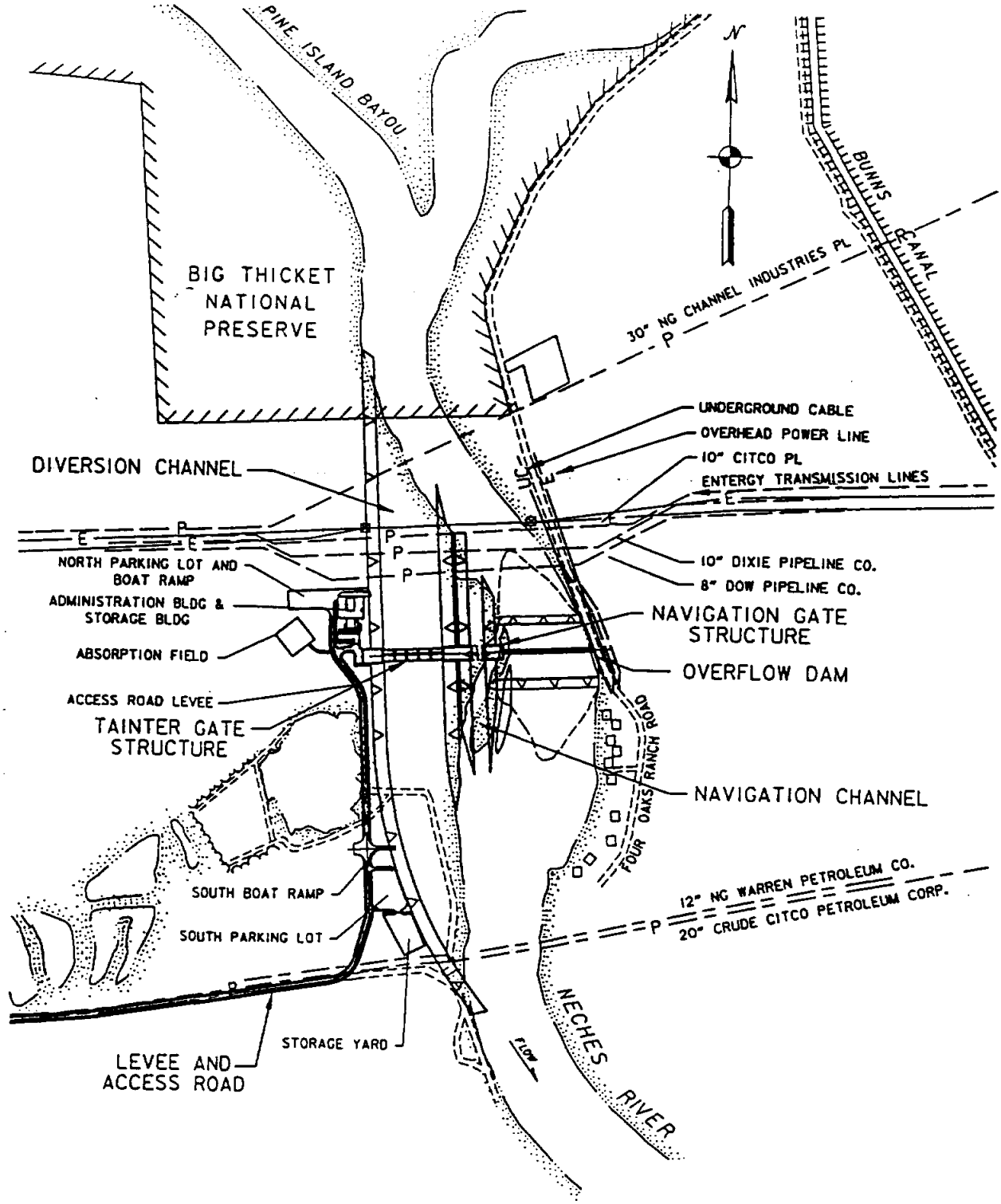
ENVIRONMENTAL ANALYSIS

PERMANENT SALT WATER BARRIER

VICINITY MAP

FREESE+NICHOLS

FIG 1.1



SITE 6 PLAN

SOURCE:
US ARMY CORPS
OF ENGINEERS 1997

ENVIRONMENTAL ANALYSIS
PERMANENT SALT WATER BARRIER

FREESE • NICHOLS

FIG 1.2

2.0 Navigation Lock Alternative

During the early Trans-Texas studies, a basically different approach to control Neches River salt water intrusion was also proposed. Its primary feature was the construction of a navigation lock (or locks), capable of handling the traffic to and from the Port of Beaumont, downstream near Sabine Lake. The lock would be either at Sabine Pass or in the Intracoastal Waterway or a short distance upstream from the mouth of the Neches River. It could control most of the entry of sea water into the Neches and would theoretically reduce the salt water threat to manageable proportions insofar as the water supply diversion pump stations are concerned. This might be a workable plan from the standpoint of the fresh water supply facilities, although it would require thorough study to confirm its feasibility. However, it has significant disadvantages.

Relatively large ships come into the Port of Beaumont, and a major structure would be required. The cost of a lock will be significantly more than the cost of the permanent salt water barrier.

If the lock is located at Sabine Pass or upstream from the mouth of the Neches River, only a single structure would be involved. If located in the Intracoastal Waterway, two locks would probably be needed: one west of the Neches River in the reach where the Beaumont ship channel and the Intracoastal Waterway coincide and one in the Intracoastal Waterway east of the Sabine River.

Construction of a lock at Sabine Pass would be basically inconsistent with the environmental goals for Sabine Lake. Stated in simplest terms, the coastal bays and estuaries should ideally be somewhat salty but not too salty, as a result of the blending of fresh water from inland rivers and salt water from the Gulf. They represent critical ecological zones that are essential to the well being of many marine species, which are in turn vital elements in commercial and recreational activities along the Texas coast. Just as withholding too much of the freshwater inflow could tend to make Sabine Lake too salty, excluding most of the sea water inflow would tend to make it not salty enough. Considering the very wide range of hydrologic conditions encountered in this case, it is highly unlikely that a suitable environmental balance could be maintained in Sabine Lake while at the same time keeping the lake fresh enough to protect the upstream pump stations from contamination.

Placing the control points in the Intracoastal Waterway, west and east of the mouths of the Neches and Sabine Rivers, would avoid the problem of blocking salt water inflows to Sabine Lake, but it would further increase the cost. The lock east of the Sabine River probably could be smaller than the lock west of the Neches River, since the larger seagoing ships would use only the latter structure. Nevertheless, the cost would be appreciably more than for a single large lock.

A single lock in the lower reaches of the Neches River appears to be the most practicable option. That would place the point of salt water control on the fresh water side of Sabine

Lake and would not conflict with estuarine environmental goals.

For each of the navigation lock options, it would be necessary to provide for passage of peak flood flows originating on the Neches River and in two of the three cases also on the Sabine River. This would involve some type of emergency spillway bypass, to discharge flows in excess of the hydraulic capacities of the locks themselves.

In view of the apparent disparity between the probable cost of a large navigation lock and that of a permanent salt water barrier upstream from Beaumont, the lock concept is not judged to be a realistic alternative.

3.0 Affected Environment

The permanent salt water barrier Site 6 lies in a bend in the Neches River north of Beaumont, within Jefferson and Orange Counties, in extreme southeast Texas. This section describes the existing environmental conditions and resources of the project area and provides a baseline for evaluating the impacts of the proposed project.

3.1 Geology and Groundwater

The lower Neches River Basin is underlain by geologic strata deposited in the Pleistocene epoch of the Quaternary period, with sedimentary formations including the Beaumont Formation, the Deweyville Formation and recent alluvial deposits. The Beaumont Formation consists of a series of clays and black sands. The formation is at least 30,000 years old and may be less than 100 feet thick. The Deweyville Formation is at least 30 feet thick and is intermediate between the Beaumont Formation and recent floodplain deposits of the Neches River. The formation consists of alluvial terrace deposits between 13,000 and 30,000 years old, which range from silty clay to very fine sand. The youngest sediments are the Holocene floodplain deposits, consisting of clay, silt, sand and organic matter less than 5,000 years old (Barnes, 1992; Wesselman and Aronow, 1971). The Holocene sediments have been deposited along abandoned segments of the Neches River channel and its floodplain.

The Evangeline and Chicot aquifers, subdivisions of the Gulf Coast aquifer, are the water-bearing units underlying the project area. The Evangeline is the older of the two aquifers, with an upper depth of approximately 500 feet in the vicinity of site 6. The Evangeline contains little or no fresh water and is not used much in the study area (Thorkildsen and Quincy, 1990). The Chicot aquifer is a sequence of sands and clay beds which overlie the Evangeline aquifer. Stratigraphic units comprising the Chicot aquifer include the Willis Sand, Bently Formation, Montgomery Formation, Beaumont Clay, the Deweyville Formation and overlying Holocene alluvium. In the vicinity of site 6, the depth to the Chicot aquifer is approximately 50 feet. Thickness of the Chicot in this area is approximately 450 feet. The aquifer is divided by clay beds into upper and lower units. The lower Chicot is the principal source of groundwater in the study area and can yield large quantities of fresh to slightly saline water (Thorkildsen and Quincy, 1990).

3.2. Soils

Dominant soils at the project site include those of the Bibb-Alluvial land association (USDA, 1965). This association occurs on the low-lying flood plains of Pine Island Bayou and the Neches River. Areas of this association are occupied by poorly drained and frequently flooded Bibb Series. The Bibb series consists of gray, acid, poorly drained, frequently flooded bottom-land soils. The surface layer is normally gray or dark grayish-brown clay loam to a depth of two to 10 inches. The subsoil is light-gray to light brownish-gray clay loam to a depth of 38 inches. Both the topsoil and the subsoil are strongly acidic, have little or no

structure (massive), and are sticky and plastic when wet, and hard when dry.

Small areas of Alluvial land and Swamp are included with Bibb clay loam in the study area. Swamp soils occur in low, flat or depressed areas that are flooded frequently. This land consists of a layer of brown to grayish-brown woody peat and muck (four to 20 inches thick) over a layer of gray sandy gravel high in organic matter (20 to 30 inches thick). Swamp soils in this area support a variety of freshwater vegetation, principally cypress trees.

3.3. Hydrologic Resources

3.3.1. Surface Hydrology

Northern and eastern Jefferson County and western Orange County are drained by the lower Neches River. The area is gently sloping, with a typical elevation of less than 20 feet above sea level. Floodplains of the lower Neches River and its tributaries are typically less than five feet above sea level and are often covered with estuarine waters. The river floodplain is characterized by formerly meandering river loops and bends which were cut off from the main channel by the natural shifting of the river. Major tributaries of the lower Neches River include Village Creek, which enters the river at mile 40 and drains an area of approximately 1,113 square miles, and Pine Island Bayou, which enters the Neches River near river mile 30 and drains an area of about 657 square miles. The Neches River flows southeasterly and empties into Sabine Lake at a point four miles west of the mouth of the Sabine River.

The Sabine Lake estuary receives flows from the Neches and Sabine rivers. The Texas Water Development Board conducted a statistical evaluation of the fresh water inflows to bays and estuaries in Texas, which included data from a 46-year period from 1941 to 1987. The study indicated that the Sabine Lake estuary has the largest average monthly fresh water inflow of the six major estuaries evaluated. The average monthly fresh water inflow was 1.09 million acre-feet with a peak monthly inflow of 8.09 million acre-feet. A trend analysis showed a statistically significant decreasing trend from 1941 to 1957, a decrease which was attributed to the drought of the 1950s. A similar drought-associated trend was identified from 1958 to 1966. However, during the period of the region's greatest development and urbanization, no significant trend was identified. A trend analysis of the entire 47-year period showed no significant trend in inflows to the estuary (Longley, 1994).

3.3.2 Control of Salt Water Intrusion

Flows on the Neches River below Pine Island Bayou are influenced by a combination of factors, including the operation of upstream reservoirs, withdrawals for municipal, industrial and agricultural use, wastewater discharges and local runoff. River flows are not always adequate to prevent salt water intrusion. Inadequate flows typically occur in July, August and September, although periods of low flow may occur during other months and for extended periods.

Historically, during periods of low flow, the LNVA has controlled the salt water wedge by construction of temporary salt water barriers. However, the present Section 10 permit covering the temporary barriers limits the times when these structures can be in place. During times when the permit does not allow them to

be installed, the COE makes extra releases as necessary from Lake B.A. Steinhagen so that there is enough flow remaining in the river after the diversions by Beaumont and the LNVA to keep the salt water wedge downstream from the mouth of Pine Island Bayou. Based on observations by the LNVA, a flow of about 2,500 cubic feet per second (cfs) is required in the Neches River to keep the wedge from entering the bayou (Freese and Nichols, 1987).

3.3.3. Instream Flows

The LNVA's current federal permit allows construction of temporary salt water barriers only when Sam Rayburn Reservoir drops into Zone 3 of its operating rule curve and stays there for more than 30 days. Once the temporary barriers are in place, they can intercept all the water in the Neches River and Pine Island Bayou as long as the flow does not exceed the amount needed for current use by the LNVA and the City of Beaumont. If the flow of the streams is slightly more than can be diverted for use, the temporary barriers can withstand a moderate amount of overflow. However, if the flow is more than about three feet over the crest of the steel sheet piling, past experience has shown that the temporary barriers probably will wash out.

In general, the amount of flow remaining in the river with the temporary barriers installed would not be significantly different if there were a permanent barrier instead. On the other hand, when there is no barrier in place, there must be a flow of about 2,500 cfs going downstream to keep the salt water wedge from encroaching on the fresh water intakes. With a permanent barrier, much of that 2,500 cfs could be retained in storage in the upstream reservoirs. Even in drought times, if a short rise in flow causes failure of one or both of the sheet piling barrier structures, the very high flows must be resumed in order to prevent salt water intrusion until the barriers can be repaired. Because the permanent barrier would not wash out, it would conserve the water that is now lost after short-term failures of the temporary structures.

All freshwater flows reaching the barrier will be passed through. No fresh water flows will be stored as a result of the installation of the permanent barrier, and no additional diversions are contemplated beyond existing water rights.

During Phase 1 of the Trans-Texas studies, tentative criteria for instream flows and pass-through flows for new reservoirs were developed by the Texas Natural Resource Conservation Commission, the Texas Parks and Wildlife Department and the Texas Water Development Board. These criteria were adopted by the TTWP. These and other similar criteria might be applied to the permanent barrier, in spite of its different purpose and function from either a typical on-stream storage reservoir or a run-of-the-river diversion installation.

In Phase I Trans-Texas studies (Brown & Root/Freese and Nichols, 1994), the increased yield due to the permanent salt water barrier with TTWP criteria for instream flows was estimated to be 156,800 acre-feet per year. More recent studies based on current Corps of Engineers rules for temporary barriers suggest that the increase in yield due to a permanent barrier could be even greater (Freese and Nichols, 1994). These studies also show that the Sam Rayburn-B.A. Steinhagen system

would have no reliable yield at all unless some salt water barriers are allowed.

3.3.4. Water Quality

The proposed salt water barrier site is located in the upper reach of the tidal portion of the Neches River. This portion of the river, which extends from the river's confluence with Sabine Lake upstream to the mouth of Pine Island Bayou, has been designated by TNRCC as Segment 0601 of the Neches River basin. Segment 0601 is classified as effluent limited, indicating that water quality standards are being maintained and that conventional wastewater treatment is sufficient to preserve existing conditions. The segment has designated water uses of contact recreation and intermediate aquatic life use. Water quality in the segment is sufficient to support these designated uses. However, fish consumption advisories were issued in 1990 and lifted in 1995 for the segment portion upstream of Interstate Highway 10, due to elevated dioxin levels in fish tissue. Segment 0601 is highly developed with numerous domestic and industrial wastewater discharges and serves as an international port. Accidental spills of oil and other contaminants from industries along the river or ships in the channel have periodically influenced the water quality in this segment of the Neches River. Although the water quality of Segment 0601 has historically been poor, significant improvements have occurred since the 1970s (Texas Natural Resource Conservation Commission, 1994).

Pine Island Bayou is designated as Segment 0607 of the Neches River basin. Due to water quality violations, this 81-mile stream segment is classified as water quality limited, with designated uses of contact recreation, high aquatic life use and public water supply. Depressed dissolved oxygen levels, which may occur when stream flow becomes sluggish, preclude attainment of the high aquatic life use designation in the middle portion of the segment (Texas Natural Resource Conservation Commission, 1994).

During periods of low flow, typically from June through September, water quality in the lower Neches River and Pine Island Bayou may be affected by salt water intrusion. When the river flows fall below approximately 2,500 cfs, tidal waters can extend from the mouth of the river up past the mouth of Pine Island Bayou if not controlled.

The impact of the temporary barriers on water quality and bottom-dwelling organisms has been documented in a series of studies conducted by Dr. Richard C. Harrel of Lamar University. Dr. Harrel compared the water quality conditions and benthic communities above and below temporary salt water barriers installed in the Neches River during periods of low flow and salt water intrusion. He found that water above the temporary barriers was characterized by higher dissolved oxygen concentrations at the water and sediment surfaces, higher pH and lower turbidity, conductivity, sulfates and alkalinity than water below the barriers (Harrel, 1975; Harrel et al., 1976). Salinity measurements taken during 1967, 1970, 1971, and 1972 showed that surface water salinity concentrations were as high as 4.4 ppt. immediately below the temporary barriers located in Pine Island Bayou and the Neches River, in the BTNP. Bottom sediments above the barriers consisted of clean, odorless sand and clay, while sediments below the barriers consisted of black silt and sand with odors of hydrogen sulfide and oil. Benthic species

diversity and numbers of individuals declined dramatically below the barriers as well (Harrel, 1975; Harrel et al., 1976). These studies indicate that the barriers effectively divide the river into upper and lower water quality regions. Water quality above the barrier locations is enhanced by excluding the salt water and other contaminants, whereas water quality below the barriers is characterized by high salinities and more concentrated pollutants.

3.3.5. Wetlands

Wetlands are classified by the COE according to criteria for vegetation, soils, and hydrology. In order to be considered a wetland, a site must (a) support predominantly hydrophytic vegetation, (b) have predominantly undrained hydric soil, or (c) be saturated or covered with shallow water during a portion of the growing season each year (Wetland Training Institute, 1991). Wetlands are regulated by the COE for jurisdictional purposes under Section 404 of the Clean Water Act, using the definition found in 33 CFR 323.2(c). Wetlands serve numerous environmental functions such as water quality improvement, floodwater retention, and wildlife and fisheries habitat as well as provide aesthetic value.

Between IH-10 and the temporary salt water barrier sites on the Neches River and Pine Island Bayou, there are approximately 13,700 acres of frequently flooded lands at an elevation of less than five feet above mean sea level (msl). Much of this floodplain supports forested and emergent wetlands, including bald cypress-water tupelo swamp, bottomland hardwood forest, and fresh water marsh habitats (COE, 1981).

The proposed site will occupy approximately 60 acres situated just south of the Big Thicket National Preserve, 46 acres of which consist of high quality cypress-tupelo swamp, with another two acres in bottomland hardwoods (COE, 1997). The remaining twelve acres include wetlands dominated by other forest vegetation, emergent aquatic vegetation, and scrub shrubs. In addition to the 60 acres required for construction, another 8.5 acres of cypress-tupelo swamp will be acquired and preserved as undisturbed wetland habitat.

3.4. Biological Resources

3.4.1. Natural Communities

The proposed project site is located at the transition between the piney woods and the Gulf prairies and marshes vegetational areas of Texas (Gould, 1969). Vegetative cover is dominated by bottomland hardwood and cypress swamp communities, with salt-tolerant marshes to the south. The forests and thick understory vegetation of the region support a diverse population of small mammals, birds and reptiles. The bayous and swamps along the river provide spawning and nursery areas for aquatic organisms that are an important component of the food web for many fish and wildlife species. The river is inhabited on a permanent or periodic basis by numerous fresh water and marine species of fish, shellfish, shrimp and benthic organisms.

In addition to urban/industrial land, four vegetation cover types in the project vicinity were identified in the Phase I General Design Memorandum and Supplement to the Final Environmental Impact Statement prepared for the proposed project by the COE in 1981. These habitats included bald cypress-water tup-

elo swamp, bottomland hardwood forest, upland oak-pine forest and fresh water marsh.

Bald Cypress-Water Tupelo Swamp

Bald cypress-water tupelo swamps occur in the study area in the river bottoms and on flat, permanently or intermittently flooded lands. Portions of this swamp complex have been logged in the past, resulting in secondary stands of bald cypress-water tupelo and understory vegetation.

Bottomland Hardwood Forest

Bottomland hardwood forests dominate the riparian corridors of the project area and low ridges within the swamp. These forests are subjected to cyclic inundation and soil saturation through the growing season and act as a transition between wetland and upland vegetation communities. Both hydric and mesic species occur in the bottomland hardwood complex, with loblolly pine (Pinus taeda) abundant on more mesic sites and bald cypress common where the bottomland forests grade into adjacent swamps.

Upland Oak-Pine Forest

Upland oak-pine forests occur in the vicinity Site 6 above the Neches River floodplain. Upland forests typically are found at elevations above six feet msl and blend into bottomland hardwood forest and cypress-tupelo swamp habitats. Loblolly pine and shortleaf pine (P. echinata) dominate these upland forests, in association with oaks, hickories, gums, and understory bushes and grasses.

Fresh Water Marsh

Fresh water marsh habitat occurs in the low-lying floodplain extending south of IH-10 and adjacent to Bairds Bayou. The marsh is composed of diverse hydrophytic species, including grasses, sedges, ferns and arrowheads, and woody species. Numerous salt-tolerant species also occur in this vegetation community.

3.4.2 Threatened and Endangered Species

The USFWS, the Texas Parks and Wildlife Department's (TPWD) Texas Biological and Conservation Data System (BCD), and the Texas Organization for Endangered Species (TOES) were consulted for lists of endangered and threatened species with the potential to occur in the area of Site 6. The USFWS and TOES provide listings of threatened and endangered species at the county level, whereas the BCD provides listings of known species occurrences at specific geographic locations. The information provided by the BCD is therefore more precise. The USFWS, TOES, and the BCD identified two species possibly occurring near the project site which may be affected by operation of the permanent barrier; the alligator snapping turtle, and the paddlefish. A comprehensive listing of special species for the region and Jefferson and Orange counties is located in Appendix B.

The alligator snapping turtle (Macroclemys temmincki) lies on the bottom of lakes or rivers and lures fish with a large worm-like projection on its tongue (Conant, 1975). This large fresh water turtle occurs primarily in the southeastern U.S. It is listed as threatened by the TPWD. Suitable habitat for the alligator snapping turtle

occurs within the Neches River channel in the proposed site area.

The paddlefish (Polyodon spathula) is listed as an endangered species in Texas but does not occur on the USFWS or the TPWD listings for Jefferson or Orange counties. A planktivore, the paddlefish is one of the largest fresh water fish and is native only to North America. Its range historically extended from the Great Lakes throughout the large streams of the Mississippi Valley and adjacent Gulf slope drainages, as well as through the eastern-most portions of Texas. The fish were documented in the Neches and Angelina rivers as early as 1897 and were abundant in the natural oxbow lakes and ponds throughout the floodplain of the Neches River from 1920 to 1940. However, populations have subsequently declined, and in 1977 the fish was placed on the Texas State Endangered Species List. Its decline has been attributed to commercial and recreational harvest as well as decreased habitat availability and water quality resulting from dam construction, channelization, logging, pollution, urbanization, and industrialization (Boschung et al., 1983).

In 1989, the TPWD initiated the Paddlefish Recovery Plan in an effort to restore populations within their native Texas range. The Neches River was selected as the initial recovery area, with target recovery areas including the main stem, two major tributaries (Pine Island Bayou and Village Creek) Lake B.A. Steinhagen, the Angelina River basin at the headwaters of Lake B.A. Steinhagen, and Sam Rayburn Reservoir. Paddlefish have been stocked in the Neches River, Lake B.A. Steinhagen, Trinity River, Sabine River, Big Cypress Bayou, Angelina River, and Sulphur River since 1989. Because the lower Neches River and its tributaries are within the focus areas for the Paddlefish Recovery Plan, the status of the paddlefish population and its habitat needs are particularly relevant to the proposed project.

Life history information for the fish gathered from historic records and from hatcheries in other states indicates that, during summer, the paddlefish utilize bayous, oxbow lakes, backwaters and reservoirs with abundant zooplankton for feeding. In the winter, the fish inhabit deeper (>3 meters) still-water areas which provide refuge from river currents. When water temperatures rise from 50 to 63 degrees in the spring, sexually mature paddlefish migrate to spawning areas in deep pools at the mouths of tributaries. Spawning migrations of over 240 miles have been documented. In addition to changes in temperature and photoperiod, the actual spawning run is triggered by a sudden, 10 to 20 foot rise in water elevation. Spawning occurs in well-oxygenated water over clean gravel substrate (Pitman, 1992). Current information regarding paddlefish utilization of streams within the project area is limited. However, suitable substrate for paddlefish spawning has been located in portions of the Village Creek tributary, above the mouth of Pine Island Bayou.

The LNVA is now permitted to install temporary barriers in the Neches River near Lakeview and in Pine Island Bayou during periods of salt water intrusion. The barriers remain open to fish passage until the salt water approaches the sites. When closed, the barriers block access to upstream feeding and spawning habitats for paddlefish inhabiting any waters south of the barrier locations. Siltation resulting from the installation and removal of the temporary barriers may also result in reduced

water quality and planktonic food availability. The effects of increased salinities and pollutant levels on paddlefish populations in the downstream portions of the Neches River and Pine Island Bayou during periods of salt water intrusion are unknown (COE, 1994).

3.4.3. Fisheries

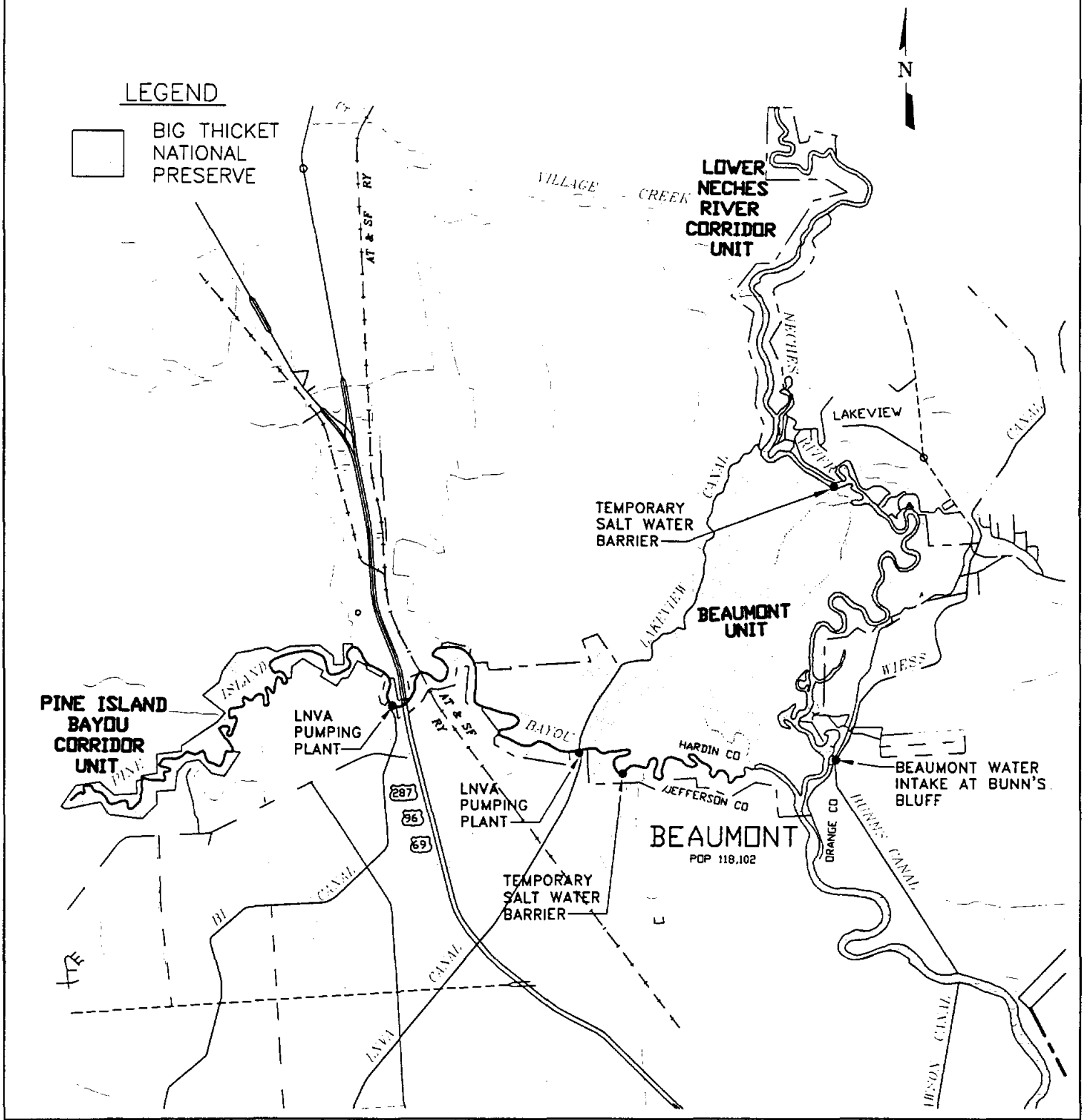
The proposed barrier site lies within the tidal reach of the Neches River. A wide range of aquatic species periodically inhabit this transition zone between fresh and salt water habitats. However, fluctuating flow rates, water quality and salinities limit the number of species that can inhabit the area year round. The fish community is dominated by those species that can tolerate transient estuarine conditions. Common estuarine species include the sheepshead minnow, sand seatrout, flounder, tidewater silverside, bay anchovy, clown goby, striped mullet, Gulf menhaden, bay whiff, and Atlantic croaker. Non-game fresh water species common to the area include the alligator, spotted and longnose gars, the smallmouth buffalo and the fresh water drum. Primary game species include the blue and channel catfish and white crappie, with frequent catches of largemouth bass, bluegills, black crappie and other species as well. Benthic species abundant in the area are the Rangia clam, river shrimp, grass shrimp, penaeid shrimp, blue crabs and fresh water mussels (COE, 1981).

Commercial fisheries' harvests in the project area were estimated in 1981 by the USFWS at 94,300 pounds annually. The catch consists primarily of pollution-tolerant catfish and nongame fish. The USFWS indicated that this catch rate was not likely to change significantly in the foreseeable future (Werner, 1981). The Rangia clam is also harvested in the area for meat and shell. The clam requires a shift in salinities in order to complete its lifecycle. These conditions now periodically occur in the tidal reaches of the Neches River. The annual harvest rate for the clam as estimated by the USFWS was 17,100 pounds (Werner, 1981).

3.4.4. Big Thicket Preserve

Managed by the National Park Service, the Big Thicket National Preserve (BTNP) is comprised of 15 separate units, of which eight are water corridor units. The BTNP was established by Congress in 1974 to conserve the great diversity of plant and animal species native to the region and to provide opportunities for high quality public recreation. About 85,000 people visit the BTNP annually (Edwards, 1995). The preserve offers interpretive nature walks, hiking, canoe trips, folklore and storytelling, and various outdoor recreation-oriented workshops. Primitive camping as well as hunting and trapping are allowed in certain areas of the park by permit.

Three units of the BTNP are located near the project area (Figure 3.1). The Beaumont Unit is a 5,955-acre tract located immediately north of Beaumont at the confluence of Pine Island Bayou and the Neches River. This unit is undeveloped and is accessible primarily by boat. The 2,600-acre Lower Neches River Corridor Unit extends from north of Beaumont upstream, connecting with the Neches Bottom and Jack Gore Baygall Unit. The Pine Island Bayou Corridor Unit includes 18 miles of Pine Island Bayou from its confluence with the Neches. This 2,209-acre corridor connects the Beaumont Unit with the Lance Rosier Unit in Hardin County. Each of these units lies within the floodplain of the Neches River or Pine Island Bayou and is dominated by bald cypress-



ENVIRONMENTAL ANALYSIS

PERMANENT SALT WATER BARRIER

BIG THICKET NATIONAL PRESERVE UNITS

FREESE • NICHOLS

FIG 3.1

water tupelo and bottomland hardwood forests. These habitats are highly productive of terrestrial and aquatic species of wildlife, waterfowl and fish.

Riparian communities within the BTNP along the lower reaches of the Neches River and Pine Island Bayou currently suffer periodic stress due to salt water intrusion. Stream banks within the preserve boundaries have also been impacted by the existing practice of installing temporary salt water barriers. The temporary barriers have resulted in shoreline erosion during stream rises. The barriers also obstruct access to portions of the preserve for the general public and BTNP personnel and interfere with natural conditions of the preserve.

The proposed site for the permanent salt water barrier is located adjacent to the Beaumont Unit of the BTNP. According to information from the COE, field survey data is not yet available to determine the relative positions of the northern-most area of construction and the southern boundary of the Beaumont Unit of the BTNP. It is estimated that approximately 375 feet of the west shoreline of the Neches River in the BTNP could potentially be affected if construction in this area is deemed necessary.

3.5. Cultural Resources

A cultural resources investigation was conducted at Site 6 by Espey, Houston & Associates, Inc. (1998) on behalf of the COE. The investigation included reconnaissance level archival research; terrestrial archaeological survey with geomorphological investigations, and marine remote-sensing survey. The project area includes privately held properties on the shore, the state owned lands on the river bottoms and federally controlled properties within the boundaries of the Big Thicket National Preserve. No significant cultural resources are identified in the project boundaries and no further research is recommended.

3.6. Recreation

The lower Neches River and its floodplain are important recreational resources for the surrounding area. The river is utilized for numerous recreational activities, such as fishing, pleasure boating, sightseeing, water skiing and swimming. The river is heavily utilized for these purposes from river mile 22.5, at the IH-10 bridge, upstream to the Big Thicket National Preserve. A variety of recreational craft frequent this reach of the river, including large boats moored at boat clubs and smaller craft which are launched from trailers.

Access to the river is provided primarily by the public boat ramp maintained by the City of Beaumont at river mile 26.5 at Collier's Ferry Park. Public boat ramps are also located south of IH-10 at Riverfront Park. The Beaumont Yacht Club, located at river mile 22.5, allows public use of its launch facilities on a fee basis. The Beaumont Country Club maintains a marina at river mile 26.5. However, this facility is utilized only on a very limited basis by club members (personal communication with Hans Kohler, Beaumont Country Club, January 3, 1996).

Access by recreational watercraft from downstream to the segment of the Neches River above Lakeview and to Pine Island Bayou above Voth is currently blocked when temporary salt water barriers are installed in the river

during periods of low flow. Recreational boating originating in the Beaumont area is thus limited to the reaches below the temporary barriers during these periods. Included within these reaches are many miles of scenic streams and bayous, including portions of the Beaumont Unit and the Little Pine Island Bayou Corridor of the Big Thicket National Preserve. Likewise, access to areas downstream is limited for boats that launch at sites above the temporary barriers, when installed.

Other outdoor recreational opportunities in the study area include camping, hiking, bird watching, picnicking and hunting. Park facilities located in the vicinity of the project area include 20 rural parks, one federal park, one state park, one county park, one municipal park, 16 private parks and 81 urban parks (COE, 1981).

3.7. Navigation

Commercial navigation on the Neches River upstream of IH-10 is limited. Only one company is reported to utilize this stretch of the river for commercial purposes (personal conversation with Robert Van Hook, COE, September 9, 1995). The company dredges sand from the Neches River and transports it to a supply yard just downstream from IH-10, using 30- by 200-foot barges with loaded drafts of 5-1/2 feet. The company obtains its sand from the reach of the river extending from about 500 feet above IH-10 to 1-1/2 miles above the mouth of Village Creek. The firm makes sand shipments at a frequency of less than one trip per week (COE, 1981).

Navigation of the river is currently limited when the temporary barriers are in place. As discussed in the preceding section, public access to areas upstream of the barriers on the Neches River and Pine Island Bayou may be blocked for parts of the year. When the temporary barriers are in place, federal and state law enforcement officials are also limited in their ability to gain emergency access to portions of the river and the Big Thicket National Preserve that are reachable primarily by boat.

3.8. Aesthetics

The Neches River, its tributaries and the many sloughs and bayous of the project area constitute an important aesthetic resource of the region. The visual appeal of the Neches River corridor is strongly enhanced by the bald cypress-water tupelo swamps and bottomland hardwood forests which are characteristic of the area. The forests and swamplands are home to many species of birds and wildlife. At present, these riparian communities may be adversely impacted by fluctuations in water quality caused by salt water intrusion from the Gulf of Mexico. The salt water wedge also carries with it pollutants discharged from downstream sources, degrading the appearance, taste and odor of the water and diminishing the river's appeal.

4.0 Environmental Impacts

The permanent salt water barrier site at Beaumont was examined for potential impacts to the natural and human environment. The possible consequences of constructing the proposed barrier at Site 6 are discussed in the following sections.

4.1 Geology and Groundwater

Dewatering of any potential sand units underlying Site 6 will be necessary to construct the tainter gate and navigation gate structures. This process may result in temporary lowering of the groundwater table in the immediate vicinity, and groundwater levels will return naturally to preconstruction elevations after construction is completed. The project will not significantly impact geologic or groundwater resources.

4.2. Soils

Site 6 is located within an undeveloped portion of the floodplain which is not currently used for agricultural purposes. Construction of the barrier will permanently convert approximately 60 acres of land to project use for structures, channels and levees. A portion of the excavated and dredged material will be used to construct the overflow dam. Construction of the proposed salt water barrier will not significantly impact the soil resources of the project area.

4.3. Hydrologic Resources

4.3.1. Surface Hydrology

Major drainage patterns of the area will not be adversely impacted by constructing the permanent salt water barrier at Site 6. The existing Neches River channel will be plugged and normal flows rerouted through the diversion channel to be constructed on the west river bank. Excess material from dredging of the diversion and navigation channels will be placed in the river on both sides of the dam to create additional wetlands as partial replacement for wetlands lost during project construction. A temporary bypass channel will be required to handle flows while the canal is cut off by a cofferdam during construction. The bypass channel will be plugged once the gates are operational.

During periods when river flow is sufficient to prevent upstream migration of the salt water wedge, the navigation gates and the tainter gates on the permanent barrier will be open to allow unobstructed flow. Drainage of the river will be regulated during times of low flow by closing the gates of the barrier structure and auxiliary dam. The navigation gate will be operated as needed to reasonably accommodate navigation while preventing upstream movement of salt water. The Corps proposed that at least one tainter gate will be partially opened in the morning following each day there is no use of the navigation gate.

Earlier estimates based on installation of the temporary barriers by the LNVA and operation

of the City of Beaumont's Weiss Bluff pumping plant predicted that the permanent barrier structure will be operational for an average of 111 days per year (COE, 1981). This frequency can vary substantially from year to year, depending on river flow. Because the existing practice of installing temporary barriers during times of salt water intrusion also prevents flow on the Neches River and Pine Island Bayou, current flow patterns of the Neches River will not be substantially altered by operation of the permanent barrier.

4.3.2. Water Quality

The proposed project will prevent salt water contamination of municipal, industrial and agricultural surface water supplies provided by the LNVA and the City of Beaumont. The project will improve upstream water quality by providing a year-round fresh water environment and will also prevent the incursion of pollutants discharged into the lower river into reaches above the barrier. If the permanent barrier is constructed at Site 6 (river mile 29.7), it will afford water quality benefits to approximately seven miles of the Neches River and three miles of Pine Island Bayou, as well as associated sloughs, oxbows, blind bayous and logging canals. Although the water quality benefits discussed for the permanent structure are also provided by the temporary barriers, the selection of Site 6 will increase the area of water quality benefits farther downstream. In general, mean dissolved oxygen (DO) and pH levels will increase above the permanent barrier, while mean salinity, turbidity and carbonate alkalinity levels will decrease. When the tainter gates of the diversion channel are closed during periods of low flows and salt water intrusion, water quality below the permanent barrier is not expected to differ from existing conditions below the temporary barriers, when installed. Construction of the permanent barrier will result in reclassification of this segment of the river from "tidal" to "above tidal" by the Texas Natural Resource Conservation Commission (TNRCC).

During construction of the permanent barrier and auxiliary dam structures at Site 6, discharge and resuspension of sediment will result in increases in turbidity in the project vicinity. However, these effects will dissipate shortly after construction is completed. Construction is anticipated to take about four years.

4.3.3. Wetlands

Most of the floodplain area upstream of the proposed salt water barrier site is cypress-tupelo or bottomland hardwood wetland habitat which supports a variety of unique plant and animal species. These systems, below the temporary barriers, may experience stress during times of elevated surface water salinities along the Neches River and Pine Island Bayou. Constructing the permanent barrier will restore a year-round fresh water environment upstream, benefiting the wetlands existing along about seven miles of the Neches River and three miles of Pine Island Bayou. Because the permanent barrier will be less restrictive of fresh water flow-throughs, effects of elevated salinities on downstream wetlands would be less pronounced than current conditions provided by the temporary barriers.

Based on the estimates made by the COE, construction of the permanent salt water barrier at Site 6 will displace a total of about 60 acres, including 46 acres of the bald cypress-water tupelo swamp habitat, and two acres of riparian bottomland hardwood habitat adjacent to the

river (USFWS, 1995). Most of the acreage in the immediate project area is considered wetlands. The USFWS has indicated that the unavoidable loss of these habitats may be offset by the benefits to habitats upstream, the creation of the new marsh habitat, and the higher productivity of the remaining cypress-tupelo swamp above the barrier due to improved water quality.

4.4. Biological Resources

4.4.1. Riparian Corridors

Construction of the project at Site 6 would result in minor improvements to the health of the natural communities upstream of the permanent barrier, particularly in the reach downstream of the temporary barriers, by alleviating seasonal inundation by saltwater (Pezeshki, 1990). The water quality of approximately 10 miles of the Neches River and Pine Island Bayou would also be improved. Fish, waterfowl and wildlife that permanently or seasonally inhabit these areas upstream of the project site should receive secondary benefits from the project in the form of improved ecosystem productivity.

As discussed in section 4.3.3 above, approximately 60 acres of bottomland hardwoods, bald cypress-water tupelo, and other wetland habitats will be replaced by the main barrier and related structures. Resident and migratory birds and wildlife species occupying these areas will also be displaced to surrounding areas. Filling of the river channel to construct the overflow dam will eliminate fish habitat and will destroy the existing benthic organisms at the site. On the other hand, the resulting marsh areas will provide an additional nursery area for juvenile fish and invertebrate species, providing long-term benefits to the productivity of local fresh-water and marine fisheries. The project will impede the upstream migration of estuarine species when the barrier gates are closed during periods of low flow; however, this impact will not represent a significant change over existing conditions, as the temporary barriers currently block upstream migrations of aquatic species, when installed.

4.4.2 Threatened and Endangered Species

The proposed project is not anticipated to have significant adverse impacts to endangered or threatened species or their critical habitat, even though suitable habitat may exist in the vicinity of the proposed site for the white-faced ibis and the alligator snapping turtle. These two species are listed as threatened by the TPWD. Impacts to these and other species of wildlife will result primarily in the movement of individuals from the project area to adjacent wetlands and other habitats in the surrounding area. The TPWD should be consulted regarding the occurrence of these species at the proposed project site. Impacts to the habitat of these species should be avoided to the extent possible.

The lower Neches River and its major tributaries are target areas for the TPWD's Paddlefish Recovery Plan. The level of impact to the paddlefish will be dependent on the operation of the system. It is possible that the paddlefish's spawning migrations and movements to upstream feeding areas may be impeded if the operation requires the fish passage opening to be closed during certain periods. However, the construction of the barrier will improve the water quality upstream, which will have beneficial impacts (lower salinity) to the paddlefish. The TPWD should be consulted, upon approval of the site plan,

regarding operation of the permanent salt water barrier to minimize potential impacts to the paddlefish.

4.4.3 Fisheries

The proposed project will benefit local fresh water fisheries through enhanced water quality. The permanent barrier will maintain a fresh water environment upstream, representing improvements to 10 miles of aquatic habitat in the Neches River and Pine Island Bayou. As a result, the production of game and non-game fish species is anticipated to increase (COE, 1981). The commercial and recreational fish catch is expected to increase concomitantly, providing economic benefits to the project area. Participation in sport fishing is also anticipated to increase due to the larger number of catchable-sized game fish. However, permanent fresh water conditions will effectively eliminate reproduction and recruitment of the existing Rangia clam population in the lower Neches River above the barrier site. The loss of Rangia clam production will represent an economic loss to the local area. The permanent barrier will also inhibit upstream movement of estuarine species, but impacts to marine fisheries are expected to be minimal due to the distance from the Sabine Lake estuary.

4.4.4. Big Thicket Preserve

Currently, temporary salt water barriers are installed within the Big Thicket National Preserve on the Neches River and Pine Island Bayou when flows are insufficient to prevent intrusion of salt water from the Gulf of Mexico. Installation of the temporary barriers has, in the past, resulted in shoreline damage within the BTNP. In addition to blocking boat access to portions of the preserve, the barriers are visible above the waterline and so interfere with the visual aesthetics of the area.

Construction of the permanent saltwater barrier would alleviate repeated damage to riparian areas caused by the placement and removal of temporary barriers within the BTNP. The potential for shoreline erosion caused by these activities would be eliminated and natural riparian communities in the affected areas would be allowed to recover.

If the limited construction activities within the southern boundary of the Beaumont Unit are deemed necessary by the COE, approximately 375 feet of riparian area could be impacted. The extent and severity of impacts would be dependent on the level of disturbance due to construction.

Under typical and low flow conditions, the increase in water levels upstream created by the barrier would be less than 0.1 foot. The backwater effect during the standard project flood would be less than 0.2 foot. (Lower Neches Valley Authority, 1998).

Boat access to the BTNP would not be hampered by the permanent barrier, as traffic would be allowed to pass through the navigation channel.

4.5 Cultural Resources

No significant cultural resources occur in the project boundaries, therefore no impact to cultural resources will be realized by the project.

4.6. Recreation

Constructing the permanent salt water barrier at the proposed site will have beneficial impacts to recreational resources of the area. The project will maintain fresh water conditions in approximately 10 miles of upstream waterway and will enhance opportunities for fishing, swimming, boating, canoeing and nature study. The permanent barrier will also alleviate the existing restrictions to the BTNP experienced by recreational boaters while the temporary barriers are in place. This location for the barrier will thus compliment the ongoing activities and resources provided by the National Park Service and the City of Beaumont to improve recreational opportunities along the Neches River.

4.7 Navigation

Existing traffic on the Neches River above Beaumont consists of minor barge traffic and heavy movement of recreational craft. When in place, the temporary salt water barriers restrict recreational and commercial vessels to the reaches of the river below the barriers. The temporary barriers also restrict access by BTNP and other officials to upstream areas. The permanent barrier structure will alleviate these problems by accommodating the passage of watercraft via the navigation channel. The navigation gate will remain open after closure of the diversion channel gates, as flow conditions permit. When flow through the navigation channel becomes too low to prevent the upstream movement of salt water, the navigation gate will also be closed. This impact, however, will be relatively minor. The navigation gate will be designed to allow modification to function as a lock, should future navigation needs justify the cost.

4.8 Aesthetics

The visual character of the Neches River at Site 6 will be impacted by construction of the permanent barrier. Approximately 60 acres at the site will be replaced by structures, channels, levees and associated appurtenances. The existing river channel will be filled for construction of the overflow dam. The remaining areas of direct impact are dominated by bald cypress-water tupelo swamp and bottomland hardwood forests. These unavoidable impacts will detract from the aesthetic appeal of the immediate area.

The permanent salt water barrier will help preserve the aesthetic appeal of upstream reaches of the Neches River by maintaining a continuous fresh-water environment and eliminating the negative aesthetic impact of having temporary barriers within the BTNP. The long-term productivity and health of the riparian forests and marshes is expected to improve as a result of enhanced water quality, preserving the attractiveness of these natural resources.

5.0 Project Cost Estimates

The most recent cost information (COE, 1997) indicates that the total project investment is estimated at $60,368,000 (including interest during construction) with total average annual costs of $4,645,550. The total average annual benefits are estimated at $22,647,100, yielding a benefit/cost ratio of 4.87. These costs are based on December 1997 dollars.

A life cycle cost analysis was performed to illustrate the present worth cost of the Neches Salt Water Barrier. This analysis begins in the year 1999. The analysis is shown in Table 5.1. The analysis was based on capital cost, financing terms, and operation and maintenance costs identified in the December 1997 Corps of Engineers report on the Neches Salt Water Barrier. The Corps estimated a project first cost of $53,449,100. With interest during construction ($6,919,400), the total project investment is estimated at $60,368.000. The December 1997 capital cost of $60,368,000 was inflated one year (assuming that the financing would be acquired in 1999). The inflated capital cost of $63,084,560 was financed for 50 years at an interest rate of 7.125%. This gives a yearly debt service payment of $4,643,500. The December 1997 operation and maintenance cost of $202,000 estimated by the Corps was also inflated one year to begin at $210,080 in 1999. The inflation rate was set at 4.5%, and the discount rate was set at 4.5%.

The construction of permanent Neches Salt Water Barrier will provide additional dependable water supply by reducing required releases for salt control from Sam Rayburn and from B.A. Steinhagen. This additional yield amount was calculated to be 156,800 acre-feet per year in the Trans-Texas Water Program Phase I report for the Southeast area. This yield amount was calculated using the environmental flow criteria adopted for the Trans-Texas Water Program. These are the same criteria being considered for adoption by the state agencies at this time. The yield could vary depending on the actual instream flow criteria developed for the Salt Water barrier.

This analysis shows that the present worth cost of the Salt Water Barrier ranges from $0.095 per thousand gallons in the first year of operation to $0.017 per thousand gallons in 2048. Based on the unit costs shown in Table 5.1, the average annual per unit cost for the Neches Salt Water Barrier Strategy is approximately $35 per acre-foot.

6.0 Permitting and Regulatory Issues

The permanent salt water barrier at Beaumont is a federal project, authorized under the Water Resources Development Act of 1976. In accordance with the National Environmental Policy Act of 1969, an environmental impact statement was prepared by the Galveston District COE in 1976 to address the potential effects of the project on the natural and human environment. Minor modifications to the original project design necessitated preparation of a supplement to the Final Environmental Impact Statement (FEIS) in 1981.

The FEIS supplement concluded that "...the action proposed is based on thorough analysis and evaluation of the various practicable alternative courses of action for achieving the stated objectives; that whatever adverse effects are found to be involved they cannot be avoided by following reasonable alternative courses of action which would achieve Congressionally specified purposes; that where the proposed action has an adverse effect, this effect is either ameliorated or substantially outweighed by other considerations of National policy; that the recommended action is consistent with National policy, statutes and administrative directives; and that, on balance, the public interest should be served by implementation of the selected plan."

Since 1981, environmental regulatory requirements have changed, including implementation of a "no net loss" policy regarding wetlands. The loss of approximately 60 acres of wetlands would be associated with the main barrier structure at Site 6. In order to minimize potential mitigation, impacts to wetlands, especially bald cypress-water tupelo swamp habitats, should be minimized to the extent possible.

As stated in the Preconstruction Engineering and Design Reevaluation Report prepared by the COE in 1994, the U.S. Fish and Wildlife Service (USFWS) has indicated that bald cypress-water tupelo swamp is considered Category II habitat and will require mitigation in-kind. A Habitat Evaluation Procedure may be required to determine the mitigation necessary for the loss of these habitats. Depending on the findings of the HEP study, mitigation may take the form of habitat creation or purchase and protection of similar existing wetland habitats. Due to the high value and extensive area of wetlands to be impacted, a large mitigation area requiring on-site management could be necessary. Mitigation ratios of ten acres to one acre or higher have been required for projects with similar impacts.

The Texas Parks and Wildlife Department has initiated the Paddlefish Recovery Plan, which includes the Neches River and its tributaries. The TPWD should be consulted regarding lifecycle requirements of the paddlefish prior to project implementation. Potential impacts to other species listed as threatened or endangered should also be coordinated with the TPWD and the USFWS.

Consensus state environmental requirements for new reservoir flows would potentially be applicable to bypasses from the permanent salt

water barrier when flows are sufficient without additional releases from upstream reservoirs.

The National Historic Preservation Act of 1966 requires evaluation of impacts of federally funded or permitted projects to prehistoric or historic sites that are listed or eligible for listing in the National Register of Historic Places. A field survey and historic research work should be undertaken prior to project construction. If cultural sites are found and determined to be significant, mitigation may be required.

Regulations addressing the disposal of hazardous wastes and materials have been implemented since 1981. The previously conducted environmental studies did not include hazardous, toxic and radioactive waste investigations. An assessment of HTRW will thus be necessary for the permanent barrier site (COE, 1997). Dredged material from the river channel at Site 6 should be tested for potential contaminants from upstream discharges to determine proper disposal options. If contamination is suspected during excavation of the navigation and diversion channels, the excavated material should also be tested prior to disposal.

A "Marl, Sand and Gravel Permit" from the TPWD is required for dredging or excavation work within the waters of the state. If 1,000 or more cubic yards of sedimentary material are disturbed, an individual permit must be obtained. The TPWD has proposed rules which will allow activities affecting less than 1,000 cubic yards of material to be authorized under a general permit following notification of TPWD and the public. However, the executive director can require an individual permit if it is determined that the disturbance would adversely affect any natural resources.

Hydraulic analyses have indicated that construction of the permanent barrier will not significantly increase the Standard Project Flood or 100-year flood water surface elevations. Any backwater effects of the project will be minimal. However, because the project will be constructed in the floodplain of the Neches River, coordination with the Federal Emergency Management Agency and the local floodplain administrator will be necessary.

Coordination with the Coastal Coordination Council is required prior to issuance of a permit for an activity affecting the State of Texas' coastal zone. A permit cannot be issued unless the Council finds that the activity is consistent with the goals and policies of the Texas Coastal Management Program.

Summary of Permitting Issues

The most significant regulatory issue surrounding the permanent salt water barrier is the impact to jurisdictional waters of the U.S. Approximately 60 acres of jurisdictional wetlands could be displaced by the barrier structure at Site 6. Should it be decided to implement the project, the regulatory agencies should be consulted to determine mitigation requirements for these wetlands. A second issue of importance which will require coordination under the TTWP is the impact of the project to instream flows downstream of the barrier site and inflows to Sabine Lake. Potential impacts to the paddlefish due to operation of the barrier should be addressed, as well as possible impacts to other species listed as threatened. An assessment of the project site and pipeline right-of-way for HTRW will also be needed. Construction of the proposed outfall structure may require a sand and gravel mining permit from the TPWD. Also, existing

information regarding significant cultural resources in the project area should be updated and augmented.

Construction of the project requires coordination with and approval by the Coastal Coordination Council, to ensure that the activity is consistent with the goals and policies of the Texas Coastal Management Program.

Finally, a water right permit from the Texas Natural Resource Conservation Commission would be required. This permit would cover state approval for construction and operation of the project and would confirm the LNVA's rights to the benefits of the barrier as part of the Authority's overall system operation. In particular, it should delineate clearly the Authority's right to convey water from upstream storage in Lake B.A. Steinhagen to the fresh water pool above the salt water barrier via the bed and banks of the Neches River and to then divert the water from the barrier pool for municipal, industrial and irrigation purposes. It will be important in this regard that the new rights be consistent with the Authority's older rights that it holds under earlier permits and certified filings and the LNVA's existing certificate of adjudication.

APPENDIX A

LIST OF REFERENCES

LIST OF REFERENCES

Barnes, V.E. 1992. Geologic Atlas of Texas Beaumont Sheet. Bureau of Economic Geology, The University of Texas at Austin, Austin.

Boshung, H.T., Jr., J.D. Williams, D.W. Gotshall, D.K. Caldwell, and M.C. Caldwell. 1983. The Audubon Society field guide to North American fishes, whales and dolphins. Alfred A. Knopf, Inc. New York.

Brown and Root/Freese and Nichols, 1994. Trans-Texas Southeast Area Phase I Report. Brown and Root, Inc., Consulting Engineers, Houston, Texas, and Freese and Nichols, Inc., Consulting Engineers, Fort Worth, Texas.

Clark, W.S. and B.K. Wheeler. 1987. A field guide to the hawks of North America. Houghton Mifflin Company, Inc. Boston, Massachusetts.

Conant, R. 1975. A field guide to reptiles and amphibians of eastern and central North America. Houghton Mifflin Company, Boston, Massachusetts.

Edwards, J.R. 1995. Patchwork of paradise. Texas Parks and Wildlife Magazine, Vol. 53, No. 8, Austin, Texas.

Espey, Houston & Associates, Inc. 1998. Initial investigations archival research, remote sensing, and terrestrial survey, Neches River saltwater barrier, Beaumont, Texas, Jefferson, Orange, and Hardin Counties. Contract No. DACW64-94-D-0002. Department of the Army, Galveston District, Corps of Engineers. Galveston, Texas

Federal Register. June 6, 1995. Vol. 60, No. 110. Final rule to reclassify the bald eagle from endangered to threatened in all of the lower 48 states.

Freese and Nichols. 1987. Report on the impact of the proposed permanent salt water barrier project on water supply yield. Prepared for the Lower Neches Valley Authority. Freese and Nichols, Inc., Consulting Engineers, Fort Worth, Texas.

Freese and Nichols. 1994. Hydrologic studies of the Neches River basin. Prepared for the Lower Neches Valley Authority. Freese and Nichols, Inc., Consulting Engineers, Fort Worth, Texas.

Garrett, J.M and D.G. Barker. 1987. A field guide to reptiles and amphibians of Texas. Texas Monthly Press, Austin, Texas.

Gould, F.W. 1969. Texas plants: a checklist and ecological summary. Texas Agricultural Experiment Station, Texas A&M University, Bryan, Texas.

Harrel, R.C. 1975. Water quality and saltwater intrusion in the lower Neches River. Texas Journal of Science, Vol. XXVI, Nos. 1-2.

Harrel, R.C., J. Ashcraft, R. Howard and L. Patterson. 1976. Stress and community structure of macrobenthos in a gulf coast riverine estuary. Contributions in Marine Science, Vol. 20.

Longley, W.L., editor. 1994. Fresh-water inflows to Texas bays and estuaries: ecological relationships and methods for determination of needs. Texas Water Development Board and Texas Parks and Wildlife Department, Austin, Texas.

Lower Neches Valley Authority. 1998. Letter from A.T. Hebert, Jr., to Amy Kaarlela. Lower Neches Valley Authority, Beaumont, Texas.

U.S. Department of Agriculture, Soil Conservation Service. 1965. Soil survey for Jefferson County. U.S. Department of Agriculture, Natural Resource Conservation Service, Beaumont, Texas.

Oberholser, H.C. 1974. The bird life of Texas. Volumes 1 and 2. University of Texas Press, Austin, Texas.

Pezeshki, S.R. 1990. Comparative study of the response of *Taxodium distichum* and *Nyssa aquatica* seedlings to soil anaerobiosis and salinity. Forest Ecology and Management, Vol. 33/3, No. 1/4, pp. 531-541, June 1990.

Pitman, V.M. 1992. Special report: Texas paddlefish recovery plan. Texas Parks and Wildlife Department, Fisheries and Wildlife Division, Austin, Texas.

Scott, S.L., editor. 1987. Field guide to the birds of North America. National Geographic Society. Washington, D.C.

Texas Natural Resource Conservation Commission. 1994. The state of Texas water quality inventory, 12th Ed., Vol. 2. Texas Natural Resource Conservation Commission, Austin, Texas.

Texas Organization for Endangered Species. 1995. Endangered, threatened and watch list of vertebrates of Texas. Austin.

Texas Parks and Wildlife Department. 1997. Special Species List by County, April 1997. Texas Parks and Wildlife Department, Endangered Resources Branch, Austin, Texas.

Thexas Parks and Wildlife Department. 1998. Consultation with TPWD Endangered Resources Branch, Biological and Conservation Data System. Appril, 1998. Austin, Texas.

Thorkildsen, D. and R. Quincy. 1990. Evaluation of water resources of Orange and eastern Jefferson counties, Texas, Report 320. Texas Water Development Board, Austin, Texas.

U.S. Army Corps of Engineers. 1981. Neches River and tributaries, saltwater barrier at Beaumont, Texas, Phase I general design memorandum, main report and supplement to final environmental statement. Department of the Army, Galveston District, Corps of Engineers, Galveston, Texas.

U. S. Army Corps of Engineers. 1994. Environmental assessment and statement of findings, permit application 19611. Department of the Army, Galveston District, Corps of Engineers, Galveston, Texas.

U.S. Army Corps of Engineers. 1994. Neches River and tributaries, saltwater barrier at Beaumont, Texas. Preconstruction engineering and design re-evaluation report and appendices. Department of the Army, Galveston District, Corps of Engineers, Galveston, Texas.

U.S. Army Corps of Engineers. 1997. Neches River and tributaries, saltwater barrier at Beaumont, Texas. General re-evaluation report - draft. Department of the Army, Galveston District, Corps of Engineers, Galveston, Texas.

U.S. Fish and Wildlife Service. 1995. Draft supplemental fish and wildlife coordination act report on the Neches River saltwater barrier project. U.S. Department of the Interior, Fish and Wildlife Service, Division of Ecological Services, Houston, Texas.

U.S. Fish and Wildlife Service. 1998. Threatened and Endangered Species List; Species by County, Texas. March 1998.

Werner, F.T. 1981. Fish and wildlife coordination act report on the Neches River saltwater barrier at Beaumont, Texas. U.S. Department of the Interior, Fish and Wildlife Service, Ecological Services Office, Galveston, Texas.

Wesselman, J.B. and S. Aronow. 1971. Groundwater resources of Chambers and Jefferson counties, Texas, Report 133. Texas Water Development Board, Austin, Texas.

Wetland Training Institute, Inc. 1991. Field guide for wetland delineation: 1987 Corps of Engineers manual WTP 91-2, Poolesville, Maryland.

APPENDIX B

THREATENED AND ENDANGERED SPECIES

Threatened and Endangered Species

		Region	Jefferson County List		Orange County List		Barrier Site
Common Name	**Scientific Name**	**TOES**	**USFWS**	**TPWD**	**USFWS**	**TPWD**	**BCD**
Fishes							
Paddlefish	*Polyodon spathula*	T					
Birds							
Bachman's Sparrow	*Aimophila aestivalis*					T	
Piping Plover	*Charadrius melodus*	T	T	T		T	
Reddish Egret	*Egretta rufescens*			T			
American Peregrine Falcon	*Falco peregrinus anatum*	E		E		E	
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	T	T (SA)	T		T	
Bald Eagle	*Haliaeetus leucocephalus*	E	T		T		
Wood Stork	*Mycteria americana*	T		T		T	
Brown Pelican	*Pelecanus occidentalis*	E	E	E	E	E	
White-Faced Ibis	*Plegadis chihi*	T		T		T	
Interior Least Tern	*Sterna Antillarum athalassos*	E		E		E	
Mammals							
Red Wolf	*Canis rufus (extirpated)*	E		E		E	
Southeastern Myotis Bat	*Myotis austroriparius*	WL					
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	T		T			
Black Bear	*Ursus americanus*	T				T	
Louisiana Black Bear	*Ursus americanus luteolus*	T				T	

		Region	Jefferson County List		Orange County List		Barrier Site
Common Name	**Scientific Name**	**TOES**	**USFWS**	**TPWD**	**USFWS**	**TPWD**	**BCD**
Reptiles							
American Alligator	*Alligator mississippiensis*		T (SA)		T (SA)		
Loggerhead Sea Turtle	*Caretta caretta*	T	T	T			
Scarlet Snake	*Cemophora coccinea*			T			
Green Sea Turtle	*Chelonia mydas*	T	T	T			
Timer/Canebrake Rattlesnake	*Crotalus horridus*			T			
Leatherback Sea Turtle	*Dermochelys coriacea*	E	E	E			
Atlantic Hawksbill Sea Turtle	*Eretmochelys imbricata*	E	E	E			
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	E	E	E			
Alligator Snapping Turtle	*Macroclemys temminckii*			T		T	✓
Texas Diamondback Terrapin	*Malaclemys Terrapin littoralis*	T					
Texas Horned Lizard	*Phrynosoma cornutum*			T		T	
Paddlefish	*Polyodon spathula*						✓

E - Endangered
T - Threatened
SA - Similarity of Appearance
WL - Watch Listed

RESPONSE TO COMMENTS

Response to comments by Saul Aronow, member TAC, Beaumont, Texas:

3.5 A discussion of the cultural resources survey report by Espey, Houston, & Associates, Inc. was included in Section 3.5.

3.1 Text was revised.

Response to comments by the United States Department of the Interior:

No revisions necessary.

Response to comments by the Texas Parks and Wildlife Department:

1.0 Additional text was incorporated. Details of project cost estimates are also located in Section 5.

2.0 Due to the scope of this report, the only alternative to be investigated is a navigation lock near Sabine Lake. This discussion is located in Chapter 2D.

4.3.2 Improvement of water quality is discussed and supported with references. 4.4.1 A supporting reference was added.

4.4.2 Text was modified based on updated lists. Section 4.4.2 emphasizes the need for consultation with TPWD regarding potential impacts to paddlefish, upon approval of a site plan for the saltwater barrier.

4.4.3 A supporting reference was added.

4.4.4 Additional text was incorporated.

Response to comments by the Texas Water Development Board

3.3.5 Supporting references were added. The description of Bottomland Hardwood Forest on page 3-6 falls within the section describing "Natural Communities" not "Wetlands."

3.4.2 Updated threatened and endangered species lists were obtained for verification.

Response to comments by the Lower Neches Valley Authority:

No revisions necessary.

to: Barbara Nickerson, Freese and Nichols

from: Saul Aronow, member TAC, Beaumont, Texas;
phone (409)-892-9141)

concerning: Neches Salt-Water Barrier report

1. Cultural survey has been completed and exists in a draft form; survey done by Espey-Huston; contact Tommy Hebert of LNVA (who paid for the study) or Caroline Murphey, Corps of Engineers, Galveston.

2. page 3-1--ref to "Beaumont Clay Formation" and "Beaumont Clay" improper geologic usage. Should read "Beaumont Formation."

3. page 3-1--ref to Flawn, 1968 superseded by

Barnes, V. E., editor, 1992, Geologic atlas of Texas, Beaumont sheet. Bureau of Economic Geology, The University of Texas at Austin, Austin, Texas.

4. page 3-1--depth to Chicot and Evangeline aquifers at site of proposed barrier can be approximated by looking at x-sections in several Texas Water Development Board ground-water studies prior to Thorkildsen and Quincy (1990) which are probably in your company library. Let me know if refs needed.

United States Department of the Interior

NATIONAL PARK SERVICE
Big Thicket National Preserve
3785 Milam
Beaumont, Texas 77701

IN REPLY REFER TO:
L54(BITH)
xL2415(BITH)

March 31, 1998

Ms. Barbara Nickerson
Freese & Nichols
4055 International Plaza, Suite 200
Fort Worth, TX 76109

Subject: Neches Salt Water Barrier Environmental Report Dated February 1998

Dear Ms. Nickerson:

I would like to take the opportunity to comment on the subject Environmental Report. Over the years, as pointed out in Section 1.0, the Lower Neches Valley Authority (LNVA) has historically erected temporary salt water barriers at various locations along both the Neches River and Pine Island Bayou. I believe that in every instance of this construction, these barriers were erected within the boundary of the Big Thicket National Preserve. This construction has come at a cost to the integrity of the natural resources for which the National Park Service (NPS) has a mandate to preserve and protect.

Over the years, ***the NPS has gone on record numerous times supporting the construction of a permanent salt water barrier conditioned that the permanent barrier be located downstream of the preserve, completely outside the boundary of the preserve.*** In reading the subject document, and from information I have received through numerous conversations with the U.S. Army Corps of Engineers and the LNVA, it is clearly my understanding that the proposed construction of the permanent barrier meets this condition. Therefore, although Figure 1.2, the Site 6 Plan included in the subject report, which continues to graphically represent some portion of the barrier and/or its appurtenant works located within the preserve boundary, I hereby again go on record stating that it is my understanding that the construction

of a permanent salt water barrier shall be located downstream of the preserve, completely outside the boundary of the preserve; and, if this is true, again express National Park Service support for this project.

Thank you for this opportunity to comment on this report.

Sincerely,

Richard R. Peterson,
Superintendent

cc: Frederick T. Werner
Chief, Regulatory Activities
U.S. Fish and Wildlife Service
17629 El Camino Real, Suite 211
Houston, TX 77058

Commander - Galveston Dist.
US Army, Corps of Engineers
P.O. Box 1229
Galveston TX 77553-1229

Terry Roberts (CESSWG-PL-R)
US Army, Corps of Engineers
Galveston District
P. O. Box 1229
Galveston, TX 77553-1229

March 30, 1998

Ms. Barbara Nickerson.
Freese & Nichols
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

Re: Environmental Analysis for the Neches Salt Water Barrier - Beaumont, Texas.

Dear Ms. Nickerson:

Staff of the Texas Parks and Wildlife Department have received and reviewed the above referenced report and have comments to offer (attached).

It has been a pleasure working with you and the other South East Trans- Texas participants. The amount of time, energy and patience invested in this process will have been worthwhile as we move forward in the regional planning process. We look forward to continuing our work with the Region H and I Planning Groups to identify the most cost-effective and environmentally sensitive water management strategies to ensure safe, adequate water for all Texans.

If you have any questions, please contact Woody Woodrow, Upper Coast Team Leader, at (281) 461-4071.

Sincerely,

Cindy Loeffler, P.E.
Water Resources Team Leader
Resource Protection Division

CLL:JOW

attachments

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512-389-4800
www.tpwd.state.tx.us

Environmental Analysis for the Neches Salt Water Barrier - Beaumont, Texas.

1.0 Introduction

It would be worthwhile to present information on the amount of water (and cost of that water) that must be released from B. A. Steinhagen to provide 2,500 cfs flow at Pine Island Slough to counteract the saltwater wedge during low flow periods. This information would be useful for comparing the cost of the increased flow alternative to the cost of the salt water barrier construction. Senate Bill 1 Regional water planning guidelines state that regional plans shall consider a balance of economic, social, aesthetic, and ecological viability and that freshwater inflow needs to estuaries shall be considered.

2.0 Other Alternatives

Why were the no action, or increased flows alternatives not considered in Chapter 2?

3.3.3 Instream Flows

Although the TTWP environmental criteria were applied by Freese and Nichols in a 1994 study, it appears that the more recently developed Consensus-Based Water Plan (CWP) Environmental Planning Criteria (EPC) have not been applied. The main difference between the TTWP environmental criteria and the EPC is that the EPC act to balance water shortages since environmental pass throughs are reduced as climate conditions become drier. Senate Bill 1 Regional Water Planning groups must use the EPC in cases where site-specific information (i.e. bay and estuary or instream flow studies) have not been completed. Since the barrier restricts the flow of freshwater during drought periods to the Sabine Lake Estuary, consideration should be given to passing sufficient flows to protect this economically important resource.

4.3.3 Wetlands

While there will be a decrease in salinity upstream of the barrier it is unclear at the current time if the salinities at the surface of the water are high enough to cause stress on the cypress-tupelo vegetation complex above Location 6. Without the barrier in place and during low flow periods, the water level above Location 6 will drop significantly. Most of the swamp forest should be above the water level. These low water levels are important because cypress and tupelo seeds require exposed substrate to germinate. We would be interested in any salinity data collected above Location 6 in the near surface water column during low flow periods. These data would support the contention that increased salinities occur within the wooded swamps and that these salinities are high enough to cause stress and reduce productivity. If salinities are causing stress, benefits to riparian and wetland areas should not be lost by a reduction in tree requitement caused by backwater effects. There is no discussion of the effects that increased salinities below the barrier will have on the cypress-tupelo forest present below the barrier during low flows. The impacts to these forested wetlands and riparian zones should also be considered.

4.4.2 Threatened and Endangered Species

It is unclear what impact this project will have on threatened and endangered species, especially to paddlefish. Although the barrier is expected to lower salinity upstream, it will also create increased salinities downstream. TPWD should be consulted to discuss potential impacts to paddlefish including due to stranding below the barrier.

4.4.3 Fisheries

Again emphasis is placed on increased ecosystem productivity resulting from a reduction in salinity. This statement implies that there is currently an inhibition on ecosystem productivity because of increased salinities. A similar statement implies there will be improved fisheries because of the project. Where is the data to support these claims?

4.4.4 Big Thicket Preserve

The discussion on backwater effects should be elaborated on to define how much backwater effect will be incurred, explanation of what the natural flow regime is, and how the water quality of riparian areas will be improved.

TEXAS WATER DEVELOPMENT BOARD

March 18, 1998

Mr. Tom Gooch
Freese & Nichols
4055 International Plaza, Suite 200
Fort Worth, Texas 76109

Re: Texas Water Development Board (Board staff) Comments on Trans-Texas Water Program "Environmental Analysis for the Neches Salt Water Barrier, Beaumont, Texas", February 1998

Dear Mr. Gooch:

Board staff has reviewed the above-referenced report and offer the following comments in Attachment 1.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Gordon Thorn, Director, Research and Planning Funds Management Division, at (512) 463-7979, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles

Tommy Knowles
Deputy Executive Administrator
for Planning

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD

COMMENTS ON TRANS-TEXAS WATER PROGRAM
"ENVIRONMENTAL ANALYSIS FOR THE NECHES SALT WATER BARRIER, BEAUMONT, TEXAS"

- The description of riparian wetlands on the lower Neches River occurs in section "3.3.5 Wetlands" on pages 4-6. According to the report, "much of this floodplain supports forested and emergent wetlands, including bald cypress-tupelo swamp, bottomland hardwood forest, and fresh water marsh habitats." There is no reference to document the occurrence of these wetlands types and vegetation. If wetland ecologists from Freeze & Nichols, Inc. (F&N) actually delineated the site, please provide this documentation.

- To the contrary, our predecessor agency's Report 268, entitled "Erosion and Sedimentation by Water in Texas," published by the Texas Department of Water Resources in 1982, classifies this area as "Western Gulf Coastal Flatwoods." About 87% of the area is in forest land, principally pine and pine-hardwood. There is no bottomland hardwoods in the proposed project area according to this report. The Soil Conservation Service's "Land-Resource Map" for Texas (SCS 1979), also delineates the proposed project area as Western Gulf Coastal Flatwoods, rather than the Bottomland Hardwood Forest described by F&N.

- The description of Bottomland Hardwood Forest on page 3-6 of the draft report, falls within the section describing "Wetlands." However, there is confusion between the terminology used by Texas Parks & Wildlife Department that refers to a forest type by the name of Bottomland Hardwood Forest, and the U.S. Fish & Wildlife Service's wetland type, also called a Bottomland Hardwood Forest. The description in this draft report contains a combination of both definitions, with reference to loblolly pine occurrence in mesic sites (i.e., the mid-range moisture bearing areas), and bald cypress in the hydric areas (i.e., very moist or wet areas). The only hardwoods F&N describes for the area is in the "upland oak-pine forest" system, which is above the floodplain in the mesic areas. The use of Bottomland Hardwood Forest needs to be described and defined

- The draft report provides information on the potential occurrence of endangered and threatened species, however, it does not report on any field reconnaissance that was required in the SOS for this study. According to the report, the Texas Biological and Conservation Data System maintained by the TPWD was used to identify any possible occurrences. While this is an

important step, it is not in full compliance with the SOS. In order to be comprehensive, F&N should have reviewed current listings of the TPWD, USFWS, and TOES. There were no references to any list, nor were any references provided to any lists used in this assessment. The reader therefore cannot determine if the 12 species referred to is current and comprehensive for all the state, federal, and TOES listed species. Please provide information and references based on all of these lists.

- All other aspects of the draft report dealing with aquatic and terrestrial habitat, recreation, wetlands (other than Bottomland Hardwood Forest), the Big Thicket National Preserve, mitigation, and other factors appears to be well assessed and reported herein.

LOWER NECHES VALLEY AUTHORITY
MUNICIPAL • INDUSTRIAL • AGRICULTURAL WATER

April 8, 1998

Mrs. Amy Kaarlela
Freese & Nichols
4055 International Plaza, Suite 200
Fort Worth, Texas 76109-4895

Re: Responses to Comments on Trans-Texas Report:
"Environmental Analysis for the Neches Saltwater Barrier"

Dear Amy:

The following responses are submitted in reply to related comments and questions of Cindy Loeffler, Texas Parks and Wildlife Department.

1.0 Introduction
Ms. Loeffler infers that an "increased flow alternative" is still a viable alternative to the saltwater barrier. The drought of 1995-1996 confirmed that fresh surface water stored in Sam Rayburn and B. A. Steinhagen Reservoirs is insufficient to provide supplemental releases adequate to protect freshwater intakes against saltwater intrusion during severe drought conditions. The '95-'96 drought confirmed this to be the case even when temporary saltwater barriers, now not permitted without emergency consent beyond the year 2000, are used. The increased flow alternative is no longer a optional saltwater control technique.

2.0 Other Alternatives
The "no action" or "increased flow alternatives" are rejected by facts presented above.

3.3.3 Instream Flows
The statements are made that "the barrier restricts the flow of freshwater during drought periods," and "consideration should be given to passing sufficient flows to protect this economically important resource." The barrier will pass all freshwater flows which arrive at the structure during high, normal or drought periods. Conversely, during 31 of the past 50 + years, in which the temporary saltwater barriers were installed, no significant flows were allowed to pass those structures when in place.

Office Location 7850 Eastex Freeway, Beaumont, Texas 77708-2815 • (409) 892-4011
Mailing Address P. O. Box 5117, Beaumont, Texas 77726-5117 • FAX (409) 898-2468
Internet Address • http://www.lnva.dst.tx.us

4.3.3 Wetlands

It appears that Ms. Loeffler does not understand that the barrier will not permit saltwater above Location 6. Likewise she apparently concludes that, when in place, the barrier will raise stream elevations behind its gates. The barrier is not designed to operate as a dam, but will, as stated earlier, pass all freshwater flows which arrive at the structure. Consequently, there should be no upstream/downstream differential during low or steady state flow conditions.

Very little salinity data exist between Location 6, River mile 29.5, and the sites of the temporary Neches River saltwater barrier sites, between River miles 34 and 37. Much data exists below Location 6 because the saltwedge is monitored frequently below that point to determine the need to install the temporary barriers. An example of our monitoring report sheets is enclosed for illustration. After their installation, the saltwedge moves upstream to the temporary barrier sites. A thin zone of freshwater will exist at the surface for a short distance below the temporary barriers and into nearby riparian sloughs, because there will be an almost continuous escape of freshwater through the temporary structures' sheet pile pulling holes. Other than this, however, the stream bottoms between River mile 29.5 and 37 will be exposed to saltwater. As one may see, this 7.5 mile reach of stream bottom-dwelling organisms would be protected from salinity intrusions.

Cypress-Tupelo forests below Location 6 are currently exposed to varying salinities in almost every typical Spring-Summer-Fall period. The temporary barriers undoubtedly increase the salinity below the barriers when in place. Since the permanent barrier will be less restrictive of freshwater flow-throughs, effects of salinity on those forests should be less pronounced.

4.4.2 Threatened and Endangered Species

If paddlefish are stranded below the permanent barrier, it will be only for very short, intermittent periods, because the navigation gates, closed only during extreme low flows, will be opened periodically to permit boat passage. Texas Tech University is presently nearing completion of an investigation to determine effects of the temporary barriers on paddlefish, and their report should be forthcoming soon.

4.4.3 Fisheries

LNVA does not have data to support a position on increased ecosystem productivity. We are aware, however, of studies accomplished by Dr. Richard Harrel of Lamar University, which confirm much greater benthic species diversity in the salt-free areas above the temporary barrier sites. Additionally, a study performed on the lower Neches River by the Academy of Natural Sciences in 1996 evaluated the biological and chemical condition of the stream, including surveys of algae, macroinvertebrates and fish communities below the temporary saltwater barrier sites. A copy of the general brochure on the study is enclosed, and summarizes the finding of healthy stream conditions with good species diversity during a period in which the temporary barriers were in place.

4.4.4. Big Thicket Preserve
The project is anticipated to have no more than 0.2 feet of backwater effects during the project flood. During low or steady-state stream flow, or typical high water conditions, there will be no backwater effects.

Let me know if you need additional information.

Yours very truly,

Tommy

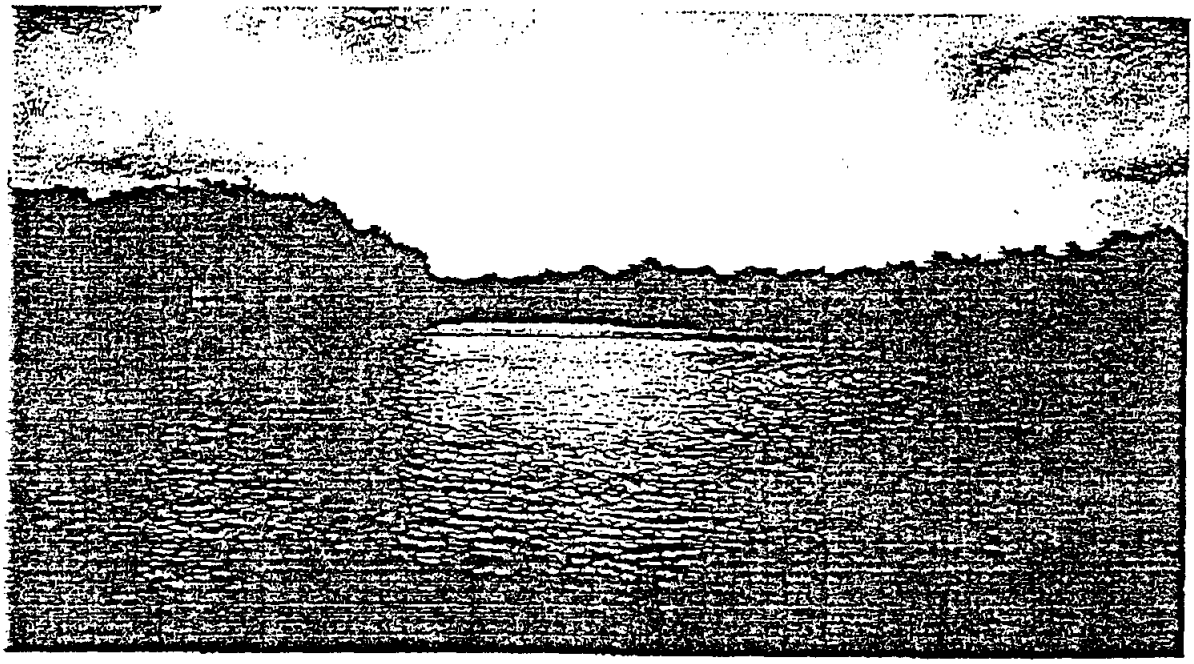
A. T. Hebert, Jr.
General Manager

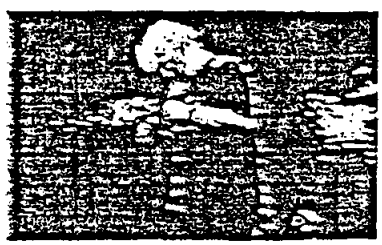
ATH/bb

enclosures

ENVIRONMENTAL MONITORING

LOWER NECHES RIVER

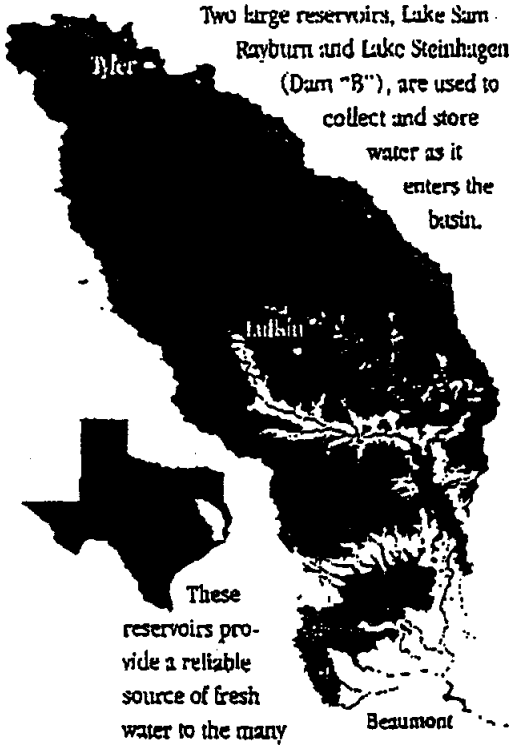




Conducted by THE ACADEMY OF NATURAL SCIENCES

Sponsored by Mobil, DuPont, and the Lower Neches Valley Authority

THE Neches River watershed is more than 200 miles long, extending from near Canton southeastward to Sabine Lake. Totaling more than 10,000 square miles, the Neches River Basin is the 7th largest coastal watershed in Texas. The Neches and its tributaries flow through many miles of picturesque pine forests including the Big Thicket National Preserve. These heavily wooded areas are the source of naturally occurring organic materials which, at times, gives the Neches River its distinctive "tea" color.



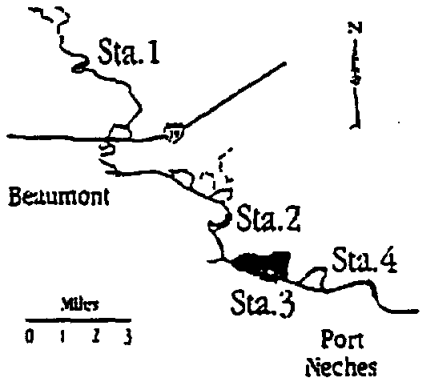
Two large reservoirs, Lake Sam Rayburn and Lake Steinhagen (Dam "B"), are used to collect and store water as it enters the basin. These reservoirs provide a reliable source of fresh water to the many communities, farms, and industries served by the Lower Neches Valley Authority (LNVA).

For over forty years independent academic and scientific institutions have conducted periodic monitoring studies of the Lower Neches River. During October 1996, the Patrick Center for Environmental Research of The Academy of Natural Sciences completed the fifth in a series of biological and water quality surveys. Previous studies were performed in 1953 (comprehensive), 1956 and 1960 (cursory), and 1973 (comprehensive). For over half a century Patrick Center scientists have been using state-of-the-art biological and chemical surveys to assess the water quality in a wide range of rivers, lakes and streams around the world.

In addition to the Academy river surveys, research scientists from Lamar University have also conducted an ongoing series of complementary biological studies of the Neches estuary. Lamar's close proximity affords a unique opportunity to monitor seasonal changes in water quality over an extended period of time.

LNVA, Mobil and DuPont jointly sponsored the most recent river survey. The study was designed to assess the general "health" of the river by taking water quality measurements, and sampling the attached algae, macroinvertebrate (crawfish, clams, aquatic insects, etc.) and fish communities. Many levels of the aquatic food web are studied because no single group can reliably indicate the condition of an ecosystem.

Four sampling zones were surveyed: three exposed to influences from various industries along the Lower Neches River (Stations 2, 3 and 4) and one reference station upriver (Station 1). The reference station was upstream of the industrial area, but was still influenced by changing tides, municipal discharges and farming activities throughout the upper watershed.



(Upper left): Originating in Van Zandt County and flowing through the piney woods of East Texas, the Neches River watershed extends over 200 miles, emptying into Sabine Lake. The bold line on the lower portion of the watershed map near Beaumont indicates the Academy's 1996 Lower Neches River study area (above).

CHEMISTRY

Many basic water quality parameters were measured during the survey. Water samples were analyzed for nutrients, certain metals and organic compounds. For selected parameters, historic TNRCC* water quality data for the Lower Neches were evaluated for long-term trends.

Dissolved oxygen (DO) concentrations were favorable, generally exceeding the water quality criteria at most sites. At Station 1, bottom DO values decreased to near zero. Variable DO concentrations are commonly found in estuarine mixing zones. Microbial activity, in conjunction with limited mixing throughout the water column, can deplete the available dissolved oxygen. Salinity generally increased with depth. A rapid increase was noted at Station 1, another indication of limited mixing at this site.

The majority of the nutrient sample analyses was below the Texas water quality screening level (SL). Dissolved nitrate concentrations and fecal coliform counts however, did exceed the SL in many cases. These parameters are commonly used as indicators of human and/or agricultural activities. Concentrations of all metals tested were below established water quality criteria. None of the selected organic compounds was detected in the surface water samples collected.

Trends were analyzed using TNRCC data ('82-'96) collected at five stations in the tidal portion of the Lower Neches River. Linear statistical analyses revealed that DO concentrations increased at most stations and fecal coliform values decreased at two of the five stations. Dissolved and total phosphorus concentrations tended to increase at two stations, while ammonia values showed no significant long-term trend.

Overall, the chemistry study of the Lower Neches River revealed improved water quality over the past 15 years for most parameters.

Cover: (Lower left and right) Academy researchers collecting macroinvertebrate and algal samples along the Neches River. (Middle) A longear sunfish, one of the many freshwater fish species recorded within the study area. (Upper) A view of the Lower Neches River.

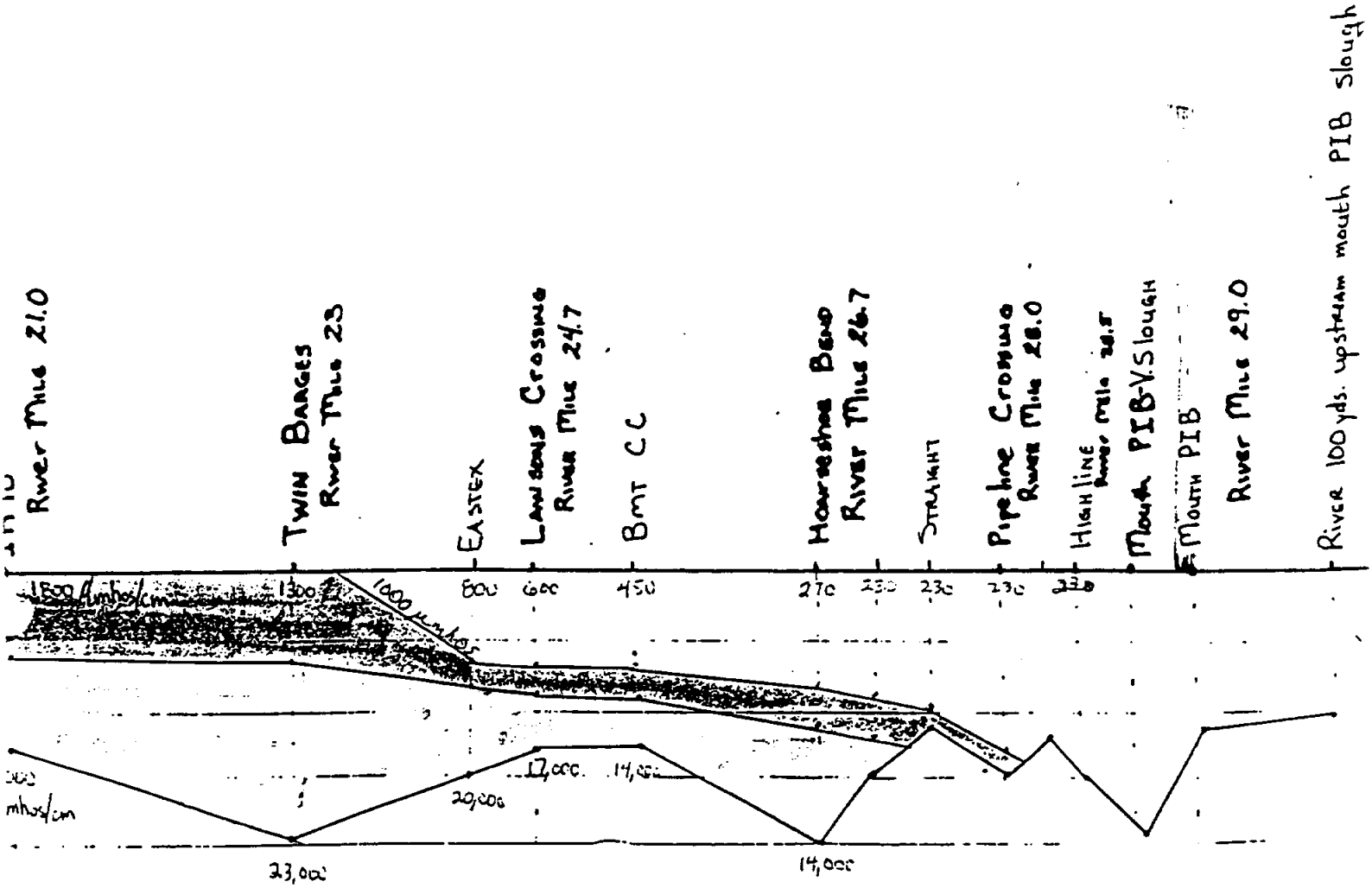
(Above): *Illustration of the State of Texas courtesy Ray Sterner, Johns Hopkins University Applied Physics Laboratory.*

* Texas Natural Resource Conservation Commission surface water quality monitoring (SWQM) data (1982-1996).

Segment 0606 - Neches River
Salt Intrusion

Date: 7/6/22

Gage: Hight Gauge 3.2'



Brackish Waters
(1000 - 10,000 µmhos)
≅ 80g/gallon

Saline Waters
(10,000 + µmhos)

Dam B release (cfs)	3240
VC	100
PIB	20
Net Inflow	3360
LNVA Diversion	900
Net Outflow	2460

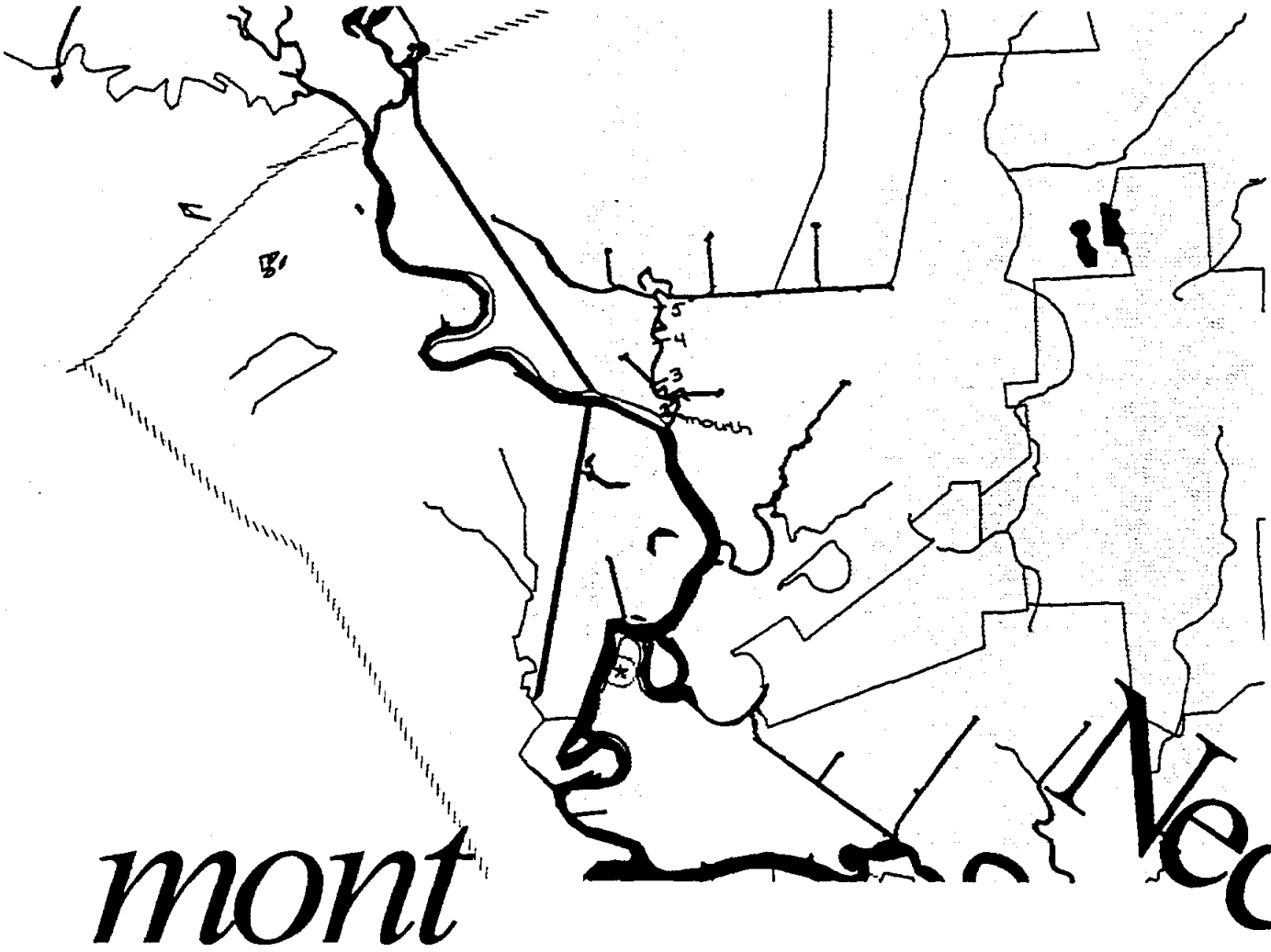
Salt made a big jump upstream since 7/5, in spite of LNVA pumping Rates dropping from 1200 cfs to 900 cfs. This latest move upstream probably caused by increasing southerly winds 15-20 mph and

Figure III-2
Segment 0601 - Neches River Tidal

Conductivity (us/cm)

	mouth	1	2	3	4
Surface	1250(1.5)	1210(1.5)	950(1.5)	600(1.5)	254(1.5)
bottom	5160(11.2)	3715(12.1)	948(11.2)	612(11.2)	227(5.9)

- numbers in parentheses are the depth of measurment in feet -



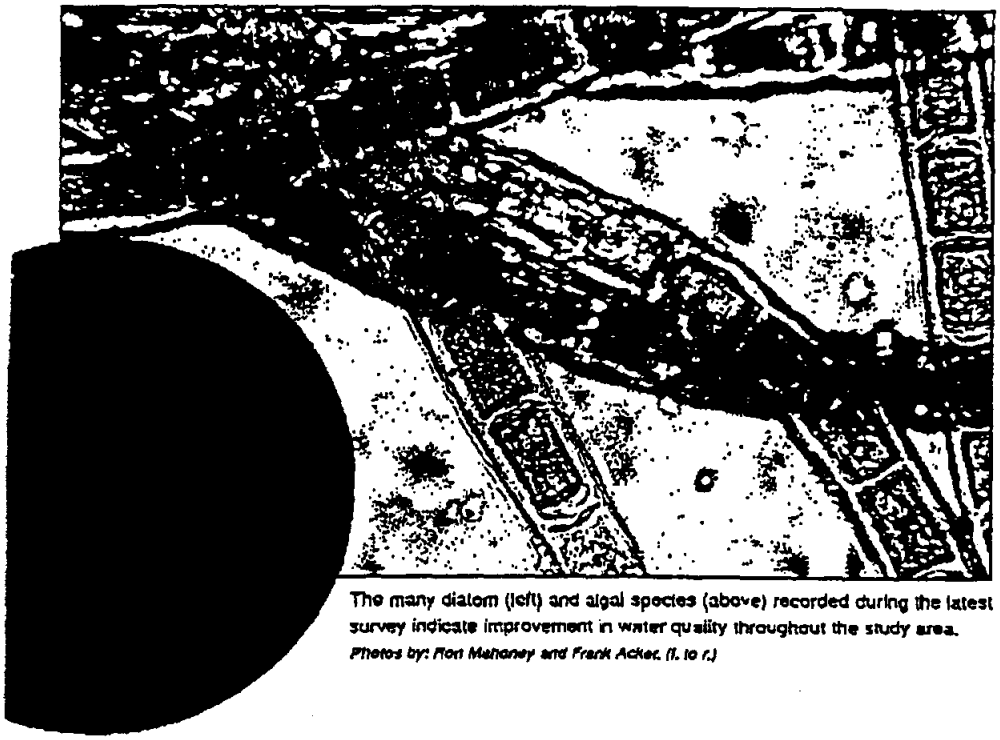
0 1.4 2.8 4.2 5.6 Miles

N

0601 stream
Lakes and Bays
Cities
Counties
LNVA Assessment Area

Monitoring locations

Segment boundary



The many diatom (left) and algal species (above) recorded during the latest survey indicate improvement in water quality throughout the study area.
Photos by: Ron Mahoney and Frank Acker. (l. to r.)

ALGAE

Algae form the base of the aquatic food chain in rivers, lakes and oceans. They use solar energy during photosynthesis to grow, providing food and oxygen for many larger organisms. Some forms of algae attach to vegetation and sediments located along the banks of rivers and streams, areas that are constantly exposed to environmental change. Their ability to colonize a wide variety of habitats makes them ideal for monitoring the health of aquatic ecosystems. An increase or decrease in the numbers of species at each site, the relative abundance of cells and community dominance (whether there's a balance of different species or the community is dominated by just a few types), are good indicators of water quality.

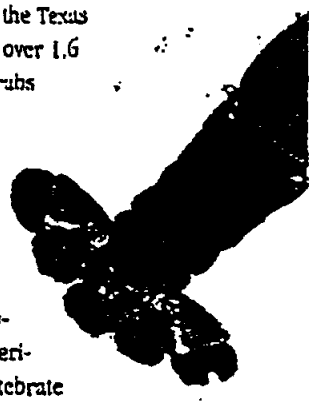
Samples of attached algae and diatoms were collected by hand from many different habitats within each station such as mud and sand shorelines, aquatic plants and hard substrates like submerged tree roots. All species were identified and counted in the laboratory and, where possible, their status as indicators of ecological conditions determined.

The numbers of different types of algae recorded were, in general, as high as in any of the previous surveys. At the upstream reference station (Station 1), blue-green algae, indicative of nutrient enrichment (primarily nitrogen and phosphorous) were present. However, the diatom population was better balanced (many species with moderate numbers) with a greater number of species than recorded in earlier years, indicating some improvement in water quality.

At the three downstream sampling stations (2-4), improved water quality was evidenced by lesser amounts of blue-green algae and a better balance in the diatom communities than seen in prior surveys. Station 4 showed the most improvement with a substantial increase in the numbers of diatoms, more balance of the diatom community, and very little blue-green algae. The 1996 algal study demonstrated a general increase in water quality compared to previous surveys at all four sampling stations.

MACROINVERTEBRATES

Macroinvertebrates (crawfish, shrimp, clams, aquatic insects, etc.) generally provide the link in the aquatic food chain between algae and animals that occupy higher feeding levels, like fish. Their limited mobility, relatively long life spans of some species and responses to a wide range of environmental conditions make them effective in monitoring long-term change. The growth and reproduction of many types are a direct reflection of changes in water quality. Some macroinvertebrates, like shrimp and blue crabs, are also vital to people who live and work along the Texas Gulf Coast. During 1996, over 1.6 million pounds of blue crabs were harvested from the Sabine-Neches system, with a dockside value in excess of one million dollars.



All available habitats were sampled to provide an accurate characterization of the macroinvertebrate community within each of the four study sites. Important considerations for the macroinvertebrates included the number and relative abundance of species, and their habitats and distributions within the estuary.

The number of different types of non-insect macroinvertebrates was higher in 1996 compared to 1973 at all stations. Thirty-one of the 38 species were recorded for the first time in Academy surveys. The Lower Neches River estuary also provides nursery grounds for the juvenile stages of at least two commercially important estuarine species: white shrimp and blue crabs.

The non-insect macroinvertebrate studies show that water quality has substantially improved at all locations since the 1953 survey.

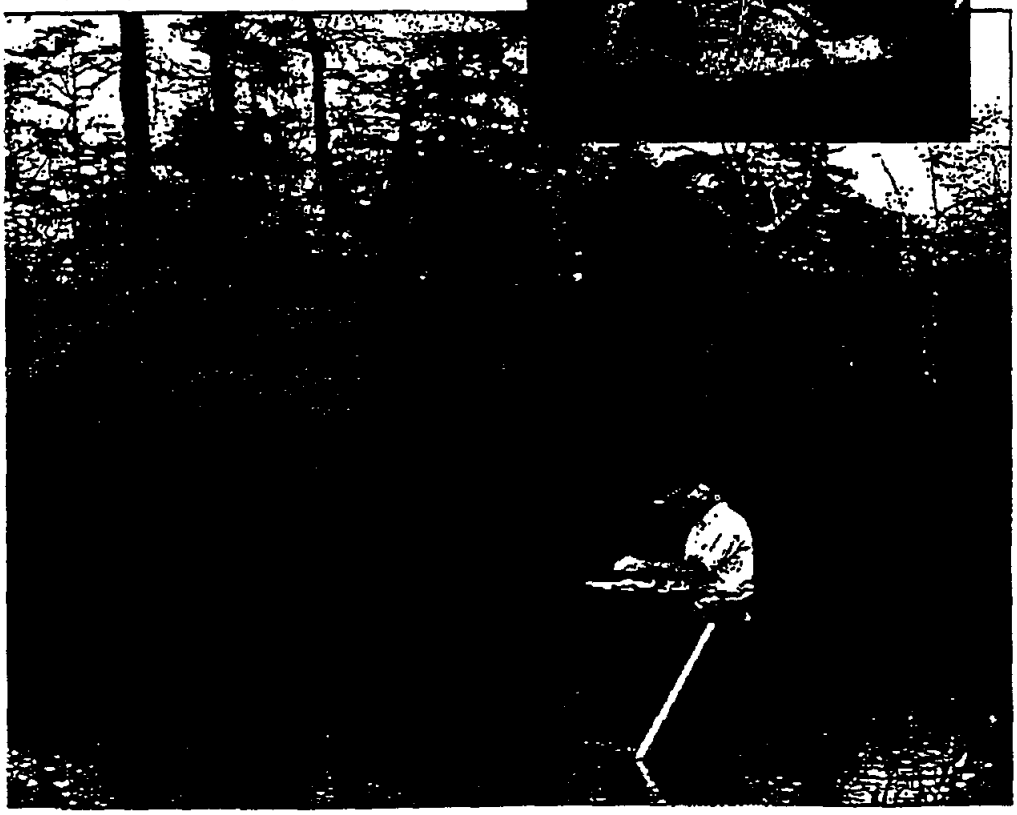
Compared to 1973, fewer numbers of insect species were found in 1996 at all stations, reflecting drought conditions

during that year. Primarily a freshwater group, the insects were more common and diverse and their distributions extended further downriver in the estuary during years of more normal rainfall patterns.

The long-term macroinvertebrate sampling (1954-1996) indicates improved water quality in the survey sections of the Lower Neches River estuary. These data are consistent with studies in the Neches River by Dr. Richard Harrel, Lamar University, which showed an improvement in water quality as measured by those macroinvertebrates that live on and within soft-bottomed substrates.

(Below): Dr. Raymond W. Bouchard sorting macroinvertebrates from Station 1. Crawfish (left) and shrimp (right) are commonly collected in the mixing zone of many southern estuaries, where fresh water flowing downriver mixes with salt water from the Gulf of Mexico.

Photos by: Dr. Raymond W. Bouchard (upper left) and Roger Thomas.



Dr. Richard C. Harrel, Lamar University, collecting macroinvertebrate samples from the Lower Neches River with a mini-Ponar dredge.

Dr. Harrel, a Fellow of the Texas Academy of Science, has been a professor of Biology at Lamar University since 1966. He has studied macroinvertebrates in Texas and Oklahoma streams and rivers for over 35 years.

Locally, Dr. Harrel has designed, completed and published several water quality studies of the Neches River. Using a wide variety of environmental indicators, he has documented the response of aquatic habitats to changing conditions throughout the Neches River estuary.

Dr. Harrel's study on changes in the macrobenthic community structure between 1971-72 and 1984-85 showed that the Neches River water quality had improved due, in part, to several local pollution abatement projects.

His latest research includes the use of the estuarine clam *Rangia cuneata* to monitor low level contaminants that are difficult to detect by standard water quality analyses. Because of their long life spans, need to filter particulates for food and inability to move great distances, clams have proven to be effective water quality monitoring organisms.

Fish species	Survey Years 1953	1956 *	1960 *	1974	1996
Longnose Gar	-	x	-	-	-
Spotted Gar	x	x	x	x	-
Alligator Gar	-	-	t	-	-
American Eel	x	-	-	-	-
Speckled Worm Eel	x	-	-	-	x
Gulf Menhaden	-	-	-	-	x
Skipjack Herring	-	-	-	-	-
Shad (2 species)	x	-	-	-	-
Smallmouth Buffalo	x	-	-	-	-
Black Buffalo	x	-	-	-	-
Bay Anchovy	-	-	x	x	x
Carp	x	-	-	-	-
Spotted Sucker	-	-	-	x	-
Catfish species	-	-	x	-	-
Blue Catfish	x	-	-	x	x
Channel Catfish	x	-	-	x	x
Flathead Catfish	x	-	-	-	-
Hardhead Catfish	-	-	-	-	x
Sheepshead Minnow	x	x	x	x	x
Western Mosquitofish	x	x	x	x	x
Sailfin Molly	-	-	x	x	x
Gulf Pipefish	-	-	-	-	x
Searobin species	-	-	-	-	x
Warmouth	x	-	x	-	-
Bluegill	x	-	x	x	x
Longear Sunfish	x	-	-	x	x
Redear Sunfish	x	-	-	-	x
Spotted Sunfish	x	-	-	-	-
Sunfish species	-	-	-	-	x
Spotted Bass	x	-	-	-	x
Largemouth Bass	x	-	-	x	-
White Crappie	x	-	-	-	-
Black Crappie	x	-	-	-	x
Flagfin Mojarra	-	-	-	-	-
Lookdown	-	-	-	-	x
Spotfin Mojarra	-	-	-	-	x
Sheepshead	-	-	-	-	x
Pinfish	-	-	-	-	x
Freshwater Drum	-	-	-	-	x
Sand Seatrout	-	-	-	-	x
Spotted Seatrout	-	-	-	-	x
Spot	-	-	-	x	x
Atlantic Croaker	-	-	x	x	x
Red Drum	-	-	-	x	x
Star Drum	-	-	-	-	x
Atlantic Spadefish	-	-	-	-	x
Striped Mullet	x	x	x	x	x
Fat Sleeper	-	-	-	-	x
Bay Whiff	-	-	-	-	-
Lined Sole	-	-	-	-	x
Hogchoker	-	-	-	-	x
Tonguefish species	-	-	-	-	x
Minnow/Shiner species	x	-	x	x	x
Topminnows, Killifish	x	x	x	x	x
Silverside species	x	x	x	x	x
Darter species	x	-	-	x	-
Goby species	x	x	x	-	x
Number of Species	38	12	24	55	51

Due to the numbers of species recorded, the table has been condensed. For example, there is more than one species in the groups Tonguefish through Goby. (indicates cursory surveys. t = tentative identification.) The background drawings represent groups of fish found in the Neches River. Predators (upper), like the Spotted Bass, feed upon smaller fish and macroinvertebrates. Filter-feeders, such as the schooling Gizzard Shad, eat small animals as they swim through the water. Longear Sunfish and Channel Catfish (lower) scour the river bottom looking for food.*

SUMMARY

Results of the 1996 Lower Neches River study clearly indicate a system-wide improvement in the diversity of the biological communities within the study area. The Neches estuary supports substantial algal, macroinvertebrate and fish populations that are generally indicative of a healthy aquatic environment.

Periodically examining the water quality and biology of the Lower Neches River ecosystem provides an invaluable guide for regional water conservation and management programs. The results of the 1996 study underscore the progress in water quality achieved since the earlier surveys.

A reliable supply of fresh water is an important key to the health and well being of all forms of life found within the Lower Neches River basin. Wise management of the watershed will ensure the availability of this valuable resource for future generations.

THE ACADEMY OF NATURAL SCIENCES

Patrick Center for Environmental Research
1900 Benjamin Franklin Parkway
Philadelphia, PA 19103-1195
(215) 299-1080
Visit our Web site at http://www.acnatsci.org

Study Director: Dr. Ruth Patrick
Written by: Roger Thomas and Dr. Raymond W. Bouchard
Edited by: Robin S. Davis
Design by: Gene Nopper

If you have any questions about the 1996 Lower Neches River studies please contact the Lower Neches Valley Authority, Beaumont, Texas (409) 892-4011 E-Mail: LNVA@pernet.net

Printed on recycled paper