CHAPTER 2

EXISTING CONDITIONS/ STUDY AREA DESCRIPTION

Chapter 2

Watershed Description

This chapter describes the existing conditions within the Cypress Valley watershed and outlines its major features. Pertinent categories addressed include climatology, physiography, geology, morphology, water resources, environmental setting, cultural resources, social and economic setting, real estate, hydrology/hydraulics, water quality, and recreation.

WATERSHED DESCRIPTION

The Cypress Valley Watershed is located in northeast Texas and northwest Louisiana. The headwaters of Big Cypress Bayou, which is the major drainage in the watershed, originate in the southwest portion of Hopkins County, Texas. From there, the watershed extends throughout all or portions of Franklin, Wood, Titus, Camp, Upshur, Gregg, Morris, Cass, Marion, and Harrison Counties, Texas. For the purposes of this investigation, the downstream boundary of the watershed is located at Caddo Lake dam, in Caddo Parish, Louisiana. The entire investigation area encompasses approximately 6,000 square miles (Figure 2-1).

DETAILED INVESTIGATION AREA

The area of investigation was confined to the portion of the watershed adjacent to the Big Cypress Bayou. This detailed area of investigation includes portions of two counties in East Texas surrounding the Big Cypress Bayou from Lake O' the Pines, through the city of Jefferson, to Caddo Lake and one Louisiana parish (Figure 2-2). The city of Jefferson is shown on Figure 2-3. The area is rich in natural and cultural resources, including Caddo Lake, which has been designated as a wetland of International significance under the Ramsar Convention, and the Historic Port of Jefferson (The location of the historic port is shown in Photograph 2-1). Historic routes through the bayou played an instrumental role in the settlement of this area of Texas.

City of Jefferson

Jefferson is located near the center of the watershed. The major highway passing through town is U.S. 59. Jefferson is served by the Kansas City & Southern and Missouri Pacific Railroads. Jefferson currently has a population of approximately 3,000 which represents about 30% of Marion County's 9,984 inhabitants. Unemployment rates are higher than the statewide average, and a significant portion of the county's population (30%) lives below the poverty line. Evaluation of Marion County's demographic profile reveals a higher-than-average population cohort of age 45 or older, suggesting a stable, mature population composed of retirees and the elderly. The lower-than-average age cohort of 25-44 suggests that residents are leaving the county to seek employment. Economic activity within the county focuses on forest products and tourism.

The largest sectors of employment within Marion County are service and trade, providing 750 of Marion County's 1950 jobs. Given the relatively low weekly wages of Marion County residents and the relatively high unemployment rates in Marion County, it seems reasonable to conclude that the expenditures supporting the large number of service and retail

jobs come from non-residents, i.e. tourists. Indeed, tourist expenditures in Marion County amounted to almost $53,000,000 in 1993.

Port of Jefferson

Despite the importance of tourism in the Jefferson/Marion County economy, and despite the extensive role played by Jefferson's navigation heritage in generating the tourism market, the port itself makes no contribution to the tourists' experience. The site of the old wharf is overgrown and generally inaccessible. The location of the turning basin is now a public boat ramp. Little remains of the brick warehouses which lined Dallas and Austin streets. The only indication of the site's historic significance is a Texas Historic Marker located at the top of the boat ramp.

PHYSICAL SETTING

Location

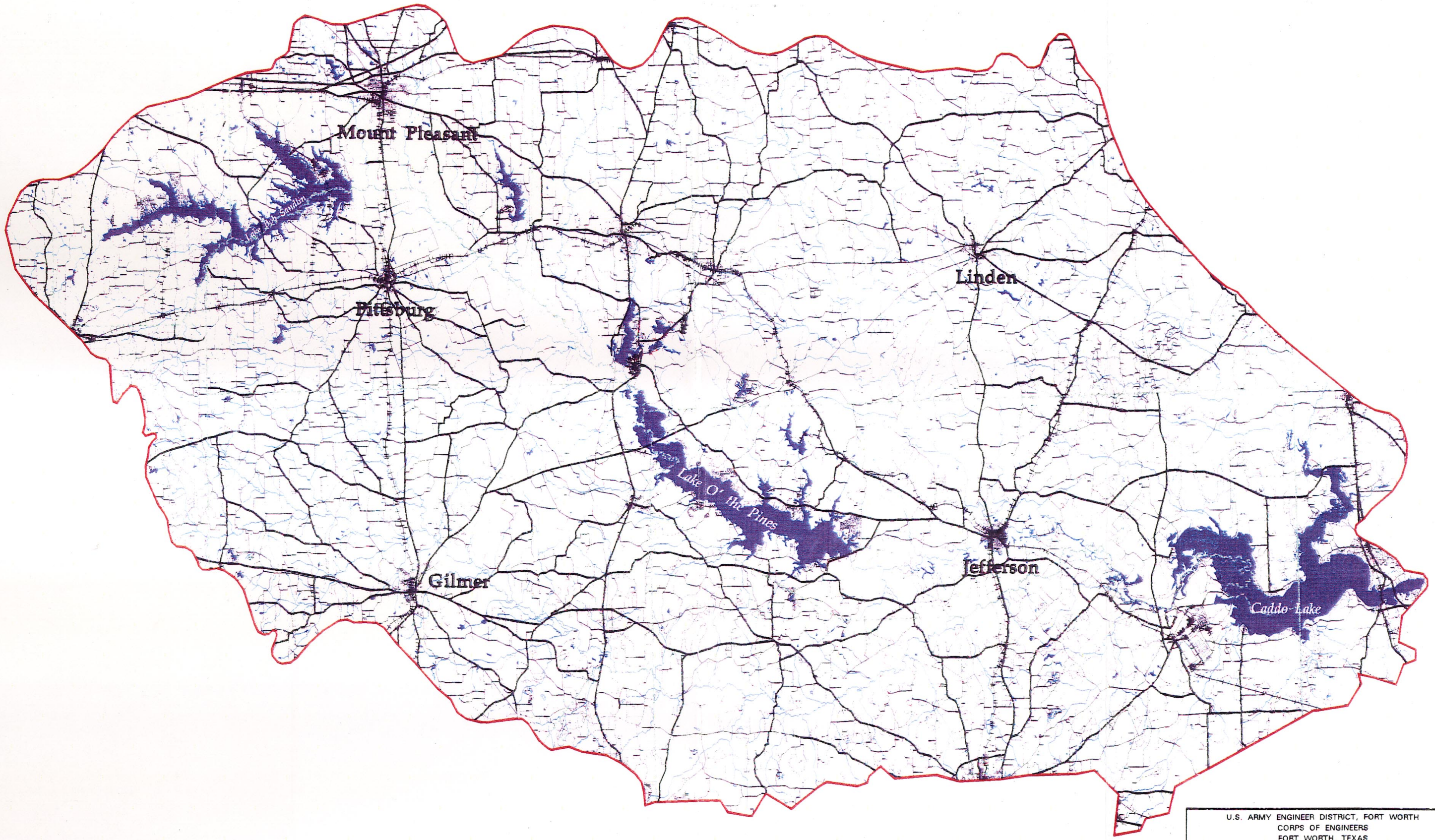
The headwaters of Big Cypress Bayou, which is the major drainage in the watershed, originate in the southwest portion of Hopkins County, Texas. From there, the watershed extends throughout all or portions of Franklin, Wood, Titus, Camp, Upshur, Gregg, Morris, Cass, Marion, and Harrison Counties, Texas. For the purposes of this investigation, the downstream boundary of the watershed is located at Caddo Lake dam, in Caddo Parish, Louisiana.

Physiography and Topography

Most of the Cypress Valley Watershed is within the Pineywoods vegetational region of Texas. The far western portion of the watershed transitions into the Post Oak Savannah vegetational region. For the most part, the watershed is characterized by gently rolling to hilly terrain dissected by flat floodplains and terraces. The average elevation of the areas is 200 to 500 feet msl. The major drainages within the watershed include Big Cypress Bayou, Little Cypress Bayou, Black Cypress Bayou, James Bayou, and Frazier Creek. The vegetation of this region is dominated by pine and mixed pine-hardwood forests, with cultivated or pasture land, and bottomland hardwood forest and Cypress swamp located along the tributaries and backwater areas. The vegetation in the Post Oak Savannah region of the watershed is characterized by deciduous forest and prairie.

Geology

The Cypress Valley Watershed is underlain by southeasterly dipping sand, clay, glauconite, and lignite of the Wilcox and Claiborne Groups of Tertiary age. Most of Texas iron ore production is found in formations within the basin. The soils of the upland areas within the watershed contain soils of the Bowie-Cuthbert-Kirvin, Darco, and Cuthbert-Redsprings associations. The Bowie-Cuthbert-Kirvin association consists of gently sloping to steep, well drained and moderately well drained, loamy and gravelly soils. Generally, these soils are characterized by a brown, fine sandy loam surface layer with a subsoil that is yellowish brown

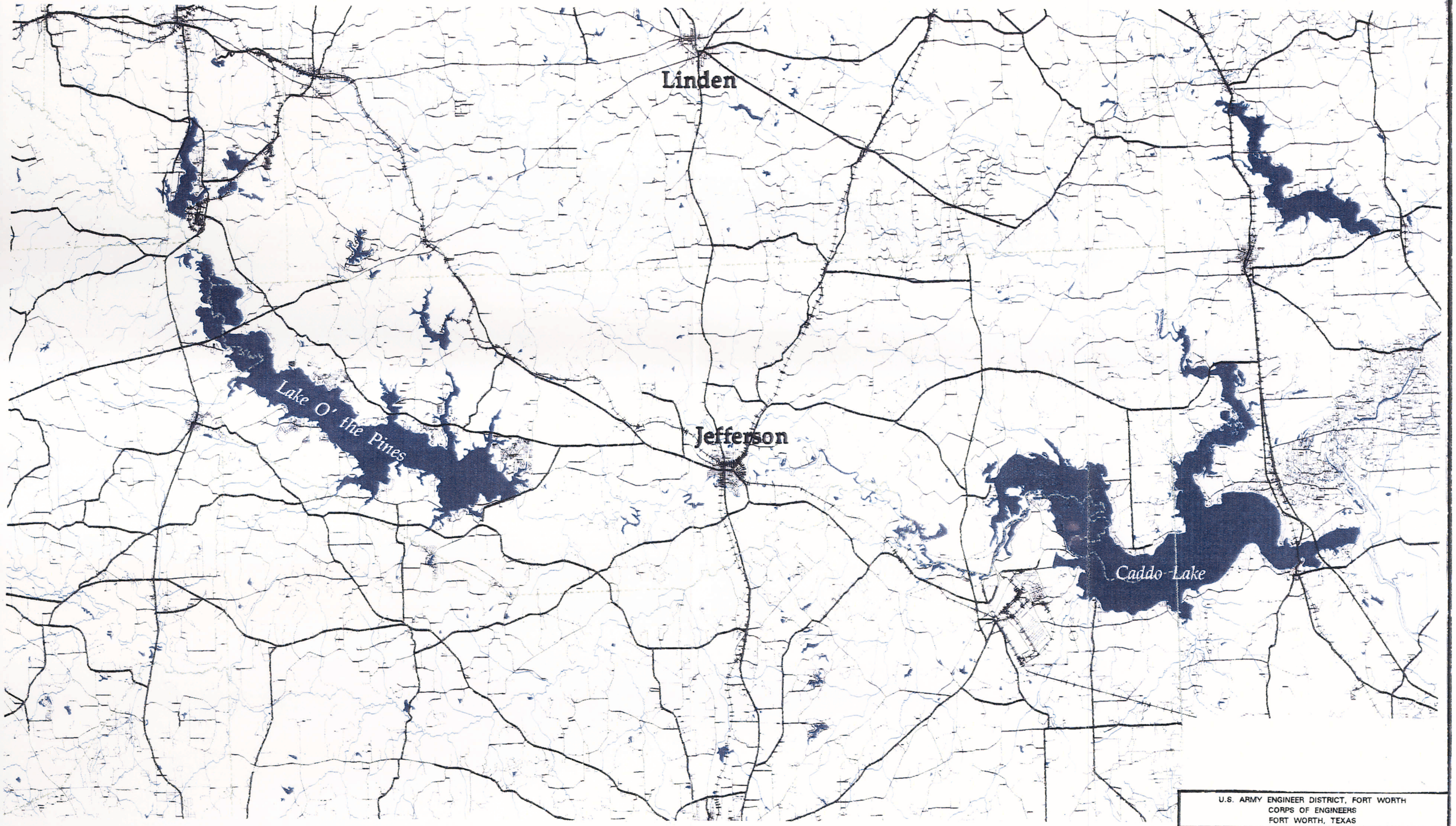


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS

WATERSHED STUDY AREA

FIGURE 2-1

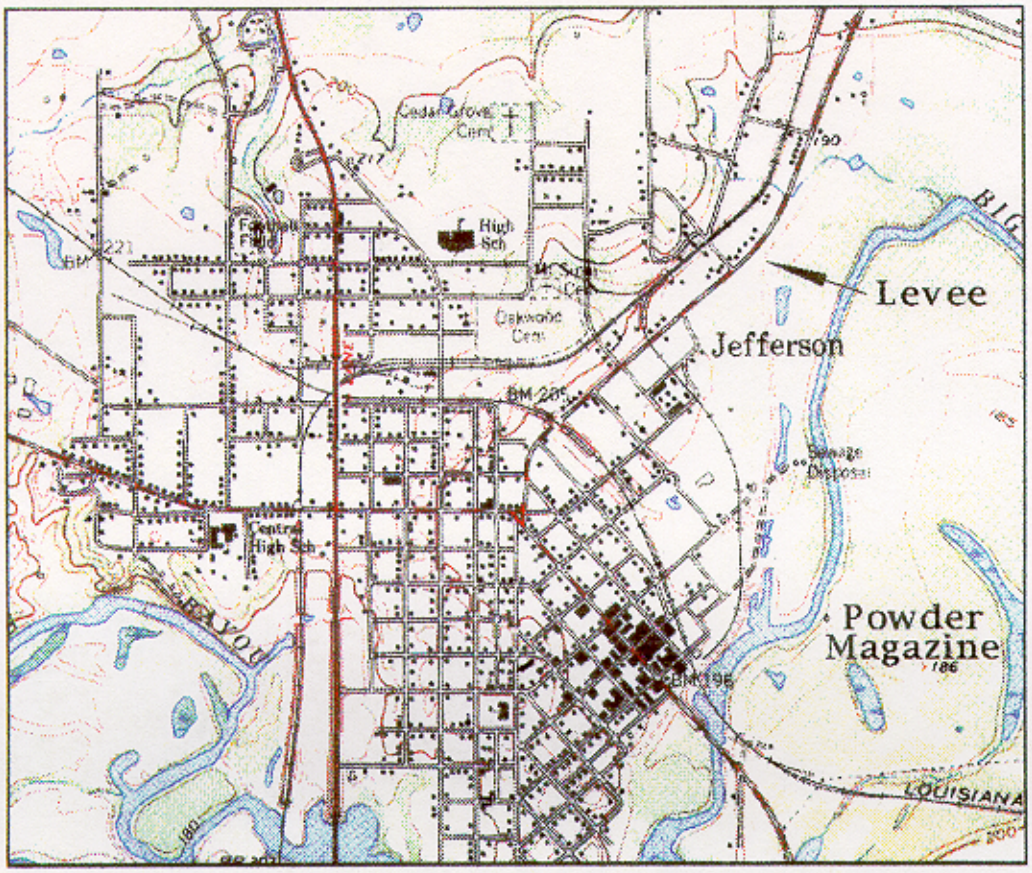


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS

BIG CYPRESS BAYOU

FIGURE 2 - 2



JEFFERSON, TEXAS

NORTH

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

CYPRESS VALLEY WATERSHED
TEXAS
CITY OF JEFFERSON
PROJECT AREA

FIGURE 2-3

Photograph 2-1:
Historic Location of the Port of Jefferson

Photograph 2-2: Abandoned RR Bridge (Jefferson) at historic port location

Photograph 2-3: City of Jefferson Raw Water Intake Structure

Photograph 2-4:
Lake o' the Pines dam and outlet works

to red mottled clays and clay loams. The Darco association is comprised of gently sloping to moderately steep, well drained sandy soils.Typically, Darco soils have a surface layer of brown to light yellowish brown fine sand with a subsoil of yellowish red sandy clay loam with strong brown mottles. The Cuthbert-Redsprings association consists of strongly sloping to steep, well drained, gravelly soils. These soils are brownish gravelly loams to gravelly fine sandy loams underlain by reddish clays.

The stream terraces within the watershed consist of soils of the Mollville-Latch association. These are nearly level, poorly drained and moderately well drained, loamy and sandy soils. Typically, the surface layer is grayish brown very fine sandy loam with a subsoil of sandy clay loam.

The floodplain soils are of the Mantachie-Iuka association. These are nearly level, somewhat poorly drained and moderately well drained, loamy soils. Generally, the surface is brown loam to fine sandy loam with clay loam to fine sandy loam subsoils.

The sediments of the investigation area are of Quaternary and Tertiary age and represent periods of both fluvial and marine deposition. The environments of deposition for the formations outcropping in the detailed investigation area range from shallow marine through deltaic and coastal to terrestrial. The Quaternary and Tertiary units forming the outcrop pattern for the investigation area include from youngest to oldest, alluvial, Sparta (sand), Weches, Queen City (sand), Reklaw and Carrizo (sand) Formations and the Wilcox Group. The youngest Tertiary outcrop material is found in the northwest and the oldest Tertiary outcrop material is found in the southeast sections of the project boundaries. This reversal in trend, from younger to older units gulfward, is due to the late Cretaceous volcanically originated Sabine uplift. The most important structural features in this area are the East Texas Syncline, Sabine Uplift, and the Rodessa Fault. The East Texas Syncline is a broad structural downwarping which trends generally northeast-southwest and whose axis lies just north of the project area. The Sabine Uplift is a structural high whose northwest flank borders the lower portion of the investigation reach. Both these features have affected the dip and thickness of the local strata. Consequently, the geologic units, except the Quaternary deposits, generally dip and thicken northwest toward the axis of the East Texas Basin. The Rodessa Fault which trends northeasterly through Jefferson has caused vertical displacement ranging from 0-200 feet in the Tertiary formations in this portion of the project area.

The alluvium in the Big Cypress consists of a fining upward sequence of gravel, sand, silt, and clay. The alluvium in the valley of Big Cypress Bayou ranges from 20 to 50 feet in thickness while along Twelvemile Bayou in the Red River Valley it thickens from 50 to 70 feet. The basal sand and gravel in the alluvium form the alluvial aquifer in the investigation area. Ground water from the alluvial aquifer is not heavily utilized for domestic or agricultural uses in the project area.

CLIMATOLOGY

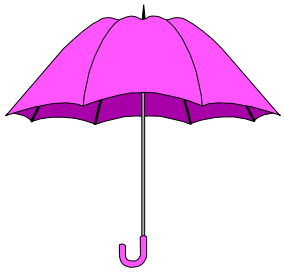
The factor that determines the climate of the investigation area is its variable exposure to differing air mass properties. The prevailing summer influence of moist tropical air from the Gulf of Mexico produces convective thunderstorms with occasional westerly and southerly winds bringing hotter and drier weather to the area. During the winter, portions of the investigation area can be subjected alternately to tropical and polar air masses, the latter being capable of large and sudden drops in temperature. Although rainfall is abundant, short periods of dry weather are frequent over small areas.

Temperature

The average annual air temperature ranges from 64 degrees to 67 degrees F. Normal monthly temperatures range from 84 degrees F. in August to 44 degrees F. in January.

Precipitation

Precipitation is predominantly of the shower type except for occasional periods of continuous general rains during the late fall, winter, and early spring. The average number of days with measurable precipitation is 60 per year. Annual normal is 32.9 inches for northeast Texas. Average monthly normals for the basin range from 1.9 inches in January to 4.65 inches in May. Months with zero precipitation have occurred at many stations throughout the investigation area. Snowfall is a minor part of the area inflow, occurring about once every 2 to 3 years. Average snowfall varies from a maximum of 2.4 to 1.7 inches in the investigation area.



Evaporation

Evaporation records are available for various locations near the investigation area. The Daingerfield, Texas, and Sam Rayburn Dam, Texas, gaging stations indicate evaporation rates applicable to the area. The average monthly evaporation varies from 10.1 inches in July to 2.6 inches in January for the Daingerfield station and 8.3 inches in July to 3.0 inches in January for the Sam Rayburn Dam station.

WATER RESOURCES

The Cypress Basin is one of the more developed basins in the state for its size. There are approximately 125,500 people that are dependent on this basin for their water needs. By the year 2040, the population is expected to soar to over 200,000. This anticipated growth will place higher demands on the available water yield of the basin's water resources.

EXISTING WATER SUPPLY SOURCES

There are eight major water-supply reservoirs in this 2,812 square mile (Cypress Basin) basin which can supply a total of 254,900 acre-feet per year of water. Most of this supply is used for industrial purposes and steam-electric power generation. The majority of ground-water supplies is obtained from the Carrizo-Wilcox Aquifer with lesser amounts supplied from the Queen City Aquifer.

SURFACE WATER SUPPLY

There are nine major existing reservoirs in the area of investigation. Eight of the reservoirs are located in the Cypress Bayou Basin and one reservoir is in the Twelvemile Bayou Basin. Each are discussed below. Caddo Lake is a combination non-Federal and Corps of Engineers project. Lake O' the Pines is a Corps of Engineers project. The other reservoirs are owned and operated by non-Federal interests. All the projects provide municipal and industrial water supply and/or steam electric power plant cooling water. Recreation facilities are provided at several projects. Lake O' the Pines is the only project with flood control storage.

Lake Information

Caddo Dam is located in Caddo Parish, Louisiana, about 19 miles northwest of Shreveport, at the head of Twelvemile Bayou. Caddo Lake covers areas in Louisiana and Texas. A natural lake existed prior to construction of the dam in 1914 by the Corps of Engineers. Construction of a new dam was completed by the Corps of Engineers in 1971. Prior to 1976, the dam was owned and maintained by the Caddo Lake Levee District. The Water Resources Development Act of 1976 transferred maintenance responsibility to the Corps of Engineers. The city of Marshall, which holds water rights to the flows of Big Cypress Bayou, diverts water from Big Cypress Bayou and backwaters of Caddo Lake. Oil City and Mooringsport, Louisiana, withdraw municipal water supplies from the lake. Cooling water is also withdrawn from the lake by a steam electric power plant located near Mooringsport. The city of Shreveport recently completed major elements of a pumping system which could be used to deliver water from Caddo Lake to Cross Lake (Shreveport's present supply) thence to the city for municipal use. Caddo Lake is very popular for fishing and other recreational activities. The Vicksburg District has studied the possibility of enlarging Caddo Lake to increase its yield.

Ferrell's Bridge Dam and Lake O' the Pines (Photograph 2-4) were constructed in 1957 and are operated by the Corps of Engineers for flood control, water supply, and recreation. The dam is located on Big Cypress Bayou about 8 miles west of Jefferson, Texas. The lake contains a flood control pool of 587,200 acre-feet with an area of 38,200 acres, and a water supply yield of 254,900 acre-feet with an area of 18,700 acres. The Northeast Texas Municipal Water District has contracted for the conservation storage and presently supplies municipal and manufacturing water needs to the cities of Daingerfield and Hughes Springs, industrial water needs of the Lone Star Steel Plant, and power plant cooling water.

Monticello, Ellison Creek, Welsh, and Johnson Creek Reservoirs are located on tributaries of Big Cypress Creek and all serve manufacturing and steam electric power plant cooling water needs. Monticello Lake on Blundell Creek is owned by Texas Utilities. Welsh Lake on Swauano Creek and Johnson Creek Lake are owned by Southwestern Electric Power Company. Ellison Creek Reservoir is owned by Lone Star Steel Company and supplies water for its steel mill located near Daingerfield. These lakes are maintained at constant operating levels by pumping water from existing lakes on Big Cypress Bayou. These diversions are made under a contractual agreement described later.

Lake Cypress Springs and Franklin County Dam located near the headwaters of Big Cypress Creek, is owned by Franklin County Water District. The district currently supplies raw water to the city of Mount Vernon and has commitments to serve rural areas in the Franklin County area through the South Franklin Water Supply Corporation. Water is also committed to Texas Utilities Generating Company for steam power plant cooling.

Fort Sherman Dam and Lake Bob Sandlin, located on Big Cypress Creek just downstream from Franklin County Dam, are owned by the Titus County Fresh Water Supply District No. 1. The project is located at the previously proposed Titus County Reservoir site and has also been called the Cherokee Trail Lake. The project supplies the municipal and manufacturing water needs of the city of Mount Pleasant and cooling water for a Texas Utilities Generating Company steam electric plant.

Owing to the complexities arising from the appropriation of waters of the Cypress Creek Basin and the rapid development and use of the basin supplies, extensive hydrologic studies of the basin have been performed by the local interests/water districts, etc., which have led to the development of an operating agreement between the Franklin County Water District, the Titus County Fresh Water Supply District No. 1, the Northeast Texas Municipal Water

District, the Texas Water Development Board, and Lone Star Steel Company. This agreement governs the operation of Lake O' the Pines, Monticello Lake, Ellison Creek Lake, Welsh Lake, Johnson Creek Lake, Lake Cypress Springs, and Lake Bob Sandlin. The agreement, approved by the participants in 1972, includes rules for the operation of reservoirs owned by various entities and provisions for accounting for the waters held in storage. In 1973, the Texas Water Rights Commission adopted an order approving the operating agreement. Basically, the agreement provides that Lakes Cypress Springs and Bob Sandlin can impound and store water previously appropriated to downstream entities (specifically Lake O' the Pines and Lone Star Steel Company) subject to call for releases from upstream storage to satisfy downstream requirements as needed. The agreement establishes storage accounts in the main stem reservoirs and Ellison Creek Lake such that the basin waters are appropriately divided, in accordance with existing water rights, through exchange of storage.

Cross Lake is located on Cross Bayou at the northeast edge of Shreveport. The lake is the primary source of water supply for Shreveport.

Black Bayou Lake is located on Black Bayou about 2 miles northeast of the city of Vivian, Louisiana. The lake is owned by the State of Louisiana.

GROUND WATER SUPPLY

The geologic units pertinent to the ground water in the report area range in age from Paleocene to Recent with the principal source of ground water being the geologic units of Eocene age. Units of the Wilcox Group plus the Carrizo (sand), and the Reklaw and the Queen City (sand) Formations form what is locally known as the Cypress Aquifer. This aquifer is the predominant source for water in the investigation area. Also, and in ascending order above the Queen City (sand) are the Weches (greensand) and the Sparta (sand), which occur only as outliers capping some of the ridges in the project area. These units yield only small amounts of ground water to shallow wells.

The Carrizo-Wilcox aquifer extends throughout the Cypress Bayou Basin. It consists of the Wilcox Group and the overlying Carrizo Formation of the Claiborne Group. The aquifer is made up of fine to medium grained sand and sandstone interbedded with clay and silt, and minor amounts of lignite in the Wilcox Group. Yields of large capacity wells average about 200 gpm, but some in thicker sections produce up to 900 gpm. The water generally contains less than 500 mg/l total dissolved solids and is excessive only in its iron content.

The Queen City aquifer occurs in a wide band across the central part of the basin. It consists of fine to medium grained sand, interbedded with clay, glauconite, and lignite. Total thickness ranges up to about 500 feet. Well yields are generally small. However, wells tapping the aquifer may be capable of yielding as much as 20 gpm. Water quality in the aquifer generally is acceptable for municipal, some industrial, and irrigation uses. Dissolved solid content is less than 50 mg/l and meets the standard of drinking water; however, there is an excessive content of iron.

Cypress Valley Watershed
Lake Information

Lake	Owner	Location	Surface Area (acres)	Capacity (acre-ft)	Purpose	Date of Im-poundment
Lake Cypress Springs	Franklin Co. Water District (48.4%) Texas Water Development Board (51.6%)	Franklin County Big Cypress Creek	3,400	72,800	M	1970
Monticello Reservoir	Texas Utilities Company	Titus County Blundell Creek	2,000	40,100	P	1972
Lake Bob Sandlin	Titus County Fresh Water Supply District No.1 (33.3%) Texas Water Development Board (66.7)	Camp, Franklin, Titus, and Wood Counties Big Cypress Creek	9,460	202,300	M R	1978
Ellison Creek Reservoir	Lone Star Steel Company	Morris County Ellison Creek	1,520	24,700	P I	1943
Johnson Creek Reservoir	Southwestern Electric Power Company	Marion County Johnson Creek	650	10,100	P	1961
Lake O The Pines	COE/Northeast Texas Mun. Water District	Camp, Harrison, Marion, Morris, and Upshur Counties Cypress Creek	18,680* 20,388** 38,200***	254,900* 283,682** 587,200***	M R F	1957
Caddo Lake	COE	Harrison and Marion Counties Cypress Bayou	26,800	128,600	M R	1914 1971
Welsh Reservoir	Southwestern Electric Power Company	Titus County Swauno Creek	1,360	23,590	P R	1975

M - municipal and industrial water supply
winter
P - steam-electric power
R - recreation
I - industrial water supply (no municipal use)
F - flood control

* - conservation pool

** - conservation pool summer

*** - flood control pool

FLOODPLAIN HYDROLOGY AND HYDRAULICS

As noted earlier, the natural hydrology of the watershed's floodplain has been greatly altered through the construction of various flood control and water supply reservoirs, primarily within the Big Cypress drainage. Reservoir development has resulted in reduced magnitude, frequency, and duration of peak flows downstream of the structures, and in some cases, shifted the seasonal timing of peak flows. As an example, operational discharges from Lake O' the Pines are now restricted to a maximum of approximately 3,000 cubic feet per second (cfs), whereas prior to construction of the reservoir, flood flows within Cypress Bayou had exceeded 57,000 cfs. In addition, peak flows downstream of the reservoir now occur most often in the late winter months rather than spring due to the reservoir operation schedule.

The above factors have influenced the productivity of the floodplains by reducing overbank flows and altering the seasonal water needs of the vegetation. Computer simulation of the hydrological conditions which would occur in Little Cypress Bayou with construction of Little Cypress Reservoir confirmed that the reservoir would eliminate most of the overbank, flushing flows required to maintain the swamps and bottomland hardwood forests of the floodplain. Note that this project was not designed with flood control purposes in mind. Hydrologic modifications to the floodplain have also allowed increased human development due to the reduced potential for flooding. Improved access to low sites for timber harvest, pasture development, and gas and oil production have been the most common impacts.

A reduction in overbank flooding lowers water table elevations in the floodplain's backwaters and contributes to deterioration of natural terraces and berms deposited by the stream during periods of high discharge and sediment transport. In some instances, it appears that landowners have taken advantage of the reduced flood elevations to breach natural bank levees and assist in the drainage of backwater sloughs. It should be noted, however, that these same breaches offer excellent potential for improving and maintaining water levels in the backwater sloughs if structurally modified.

WATER QUALITY

Introduction

Although nutrient levels in surface waters of the Cypress Basin are often elevated, water is generally of good quality. Problems arise occasionally and may be caused by discharge of treated wastewater coupled with sluggish stream flows, low aeration rates, dense aquatic plant growth, elevated surface temperatures and other factors. Ground water quality is generally good, although shallow water-bearing sands tend to yield water with high iron levels and high acidity values. Nutrients and other constituents in discharges from agricultural, industrial and municipal unregulated point and non-point sources represent the primary threats to groundwater and surface water quality in the Cypress Valley watershed, particularly in the upper basin.

Different federal, state, and local governmental agencies have compiled data regarding water quality parameters of the Cypress Basin for various purposes since the mid-1900s. There has been a lot of variation in sampling regimes and procedures implemented by these agencies. The purpose of this portion of the report is to make a comprehensive evaluation of existing water quality data for the Cypress Basin and to identify practical means of improving water quality if necessary.

Water and Sediment Testing in the Cypress Basin

Parameters involved in water quality sampling generally include *in situ* measurements of temperature, dissolved oxygen (DO), pH, conductivity, and turbidity; physio-chemical measurements of suspended and dissolved solids, biochemical oxygen demand (BOD), and total and dissolved nitrogen and phosphorus; and enumeration of bacterial coliforms. Routine water and sediment sampling can involve testing for contaminants, such as metals, priority pollutants, pesticides, PCBs, PAHs, and explosives.

The historical data indicate that water quality in the Cypress Basin is generally good. Occasional exceedances of chloride, sulfate and heavy metal water quality criteria have been reported. DO levels have occasionally been recorded below minimum standards. Samples having parameter levels outside the recommended standards are usually taken during the summer months, when waters are stratified. However, the exceedances do not restrict the use of these waters for recreation or public water supply. Past studies indicate that sediments in some locations of the investigation area may be contaminated with heavy metals, PCBs, TNT derivatives, and PAHs.

No new testing was performed for the purpose of this report. The information outlined here is based on historical data, TNRCC data, and water and sediment investigations completed in 1992 by the USGS and the USACE Waterways Experiment Station.

Segments of the Cypress Basin

The status of the water within the Cypress Basin is reported every two years in an assessment report that is part of the Contractual requirements of the Texas Clean Rivers Program administered by the Texas Natural Resource Conservation Commission (TNRCC) in accordance with Senate Bill 818 (1992). The report is based on monitored surface and ground water quality data. It provides an overview of water quality trends, the extent to which surface water quality standards are attained, and the relative impacts of pollutants from various sources. Surface water quality data are summarized for individual stream, river, and reservoir segments. This report will review the available water quality data as it applies to these segments, based on TNRCC designation.

The TNRCC designations divide the Cypress River Basin into nine segments which consist of 181 stream miles and four major reservoirs that encompass 58,394 acres. Major tributaries to Cypress Creek are Black Bayou, James' (Jim's) Bayou and Little Cypress Creek. The nine segments are:

Segment 0401: Caddo Lake
Segment 0402: Big Cypress Creek Below Lake O' the Pines
Segment 0403: Lake O' the Pines
Segment 0404: Big Cypress Creek Below Lake Bob Sandlin
Segment 0405: Lake Cypress Springs
Segment 0406: Black Bayou
Segment 0407: James' (Jim's) Bayou
Segment 0408: Lake Bob Sandlin
Segment 0409: Little Cypress Bayou (Creek)

The segments will not be referenced by segment number in this report, only by segment name. All other waters in the Cypress Basin are not TNRCC designated segments and are considered as unclassified. Most available data has been collected from classified segments.

Twelvemile Bayou: Located below the Caddo Lake spillway, a fair amount of historical data is available for Twelvemile Bayou. The USGS has collected *in situ* data since 1943. Limited water chemistry data collection was initiated in 1965 for conservative ionic

constituents like calcium and chloride. Nutrient, metals, and pesticide data have been collected semiannually by USGS since 1979. The result of these studies indicates that water quality in Twelvemile Bayou varies considerably on a seasonal basis. The water quality is generally good when water is flowing over Caddo Lake Dam. During the summer and fall, water releases from Caddo Lake are minimal, and the water quality is significantly reduced. The dissolved mineral content increases and the conductivity can exceed 2,000 micromhos per centimeter (μmhos/cm). The source of the dissolved solids (primarily sodium chloride) is Black Bayou which drains the area northeast of Caddo Lake. In addition to seasonally high dissolved solids, Twelvemile Bayou frequently has high levels of dissolved iron and manganese and occasional high levels of dissolved copper. High mean levels of fecal streptococci and fecal coliform bacteria have been reported. Past studies have found trace amounts of TNT derivatives in the surface water and sediments of Twelvemile Bayou. Because Twelvemile Bayou is in Louisiana, this segment has no water use or water quality status designation by the State of Texas.

Caddo Lake: Caddo Lake is an impressive baldcypress swamp and was designated as a Ramsar Wetland of International Importance in October 1993. The State of Texas designates water uses of Caddo Lake as contact recreation, high quality aquatic habitat and public water supply. There are two permitted domestic outfalls and four permitted industrial outfalls (a total of 6 outfalls) in this segment. The TNRCC reports that dissolved oxygen, temperature, and pH measurements fall outside criteria in 9 percent of samples from this segment. In addition, there are serious concerns for several parameters including total metal concentrations, PCBs and dissolved lead and zinc. It is felt that, given the majority of the metals data being used in the database is from about 1982 through 1990 and was collected (prior to 1992) without consistency as to specie, the relatively small number of samples available for analyses, and that nearly all data (> 80%) in the database is from one monitoring site in the lake, it is difficult to conclude that a metals problem exists to the extent that sources of the contamination could be identified.

Big Cypress Creek Below Lake O' the Pines: The State of Texas designates water uses of this segment as contact recreation, high quality aquatic habitat, and public water supply. There are 4 permitted domestic outfalls and 3 permitted industrial outfalls (a total of 7 outfalls) in this segment. The TNRCC reports that dissolved oxygen, pH, and fecal coliforms fall outside State criteria in 23-31 percent of samples from this segment. Additionally, low aeration rates and natural organic loads create a naturally stressed condition. The most recent assessment (1996) indicate that phosphorus and a limited number of metals are possible concerns.

Lake O' the Pines: The State of Texas designates water uses of Lake O' the Pines as contact recreation, high quality aquatic habitat, and public water supply. There are 4 permitted domestic outfalls and no permitted industrial outfalls in this segment. According to current screening results, total cadmium, lead and zinc are concerns in this segment and dissolved oxygen, total and dissolved copper and dissolved zinc are possible concerns. As in the Caddo Lake segment, it is difficult to conclude that a metals problem exists to the extent that sources of the contamination could be identified given that the majority of the metals data was collected prior to 1990 without consistency to specie.

Big Cypress Creek Below Lake Bob Sandlin: The State of Texas designates water uses of this segment as contact recreation and intermediate quality aquatic habitat. There were a large number of permitted outfalls in this segment as of 1992, including 9 permitted domestic outfalls and 15 permitted industrial outfalls (a total of 24 outfalls). The report indicates that nutrients are the major concern for this segment. The most recent report (1996) acknowledges that the database in this segment is biased by water quality values that do not reflect improvements in municipal secondary treatment and more stringent industrial discharge requirements, but indicates that while ammonia nitrogen and total Kjedldahl nitrogen (TKN) show some improvement between 1994 and 1996, nitrate values were worse. This segment

will likely require more monitoring in the future because of the growing number of point sources discharging into the upper reaches of the segment.

Lake Bob Sandlin: The State of Texas designates water uses of Lake Bob Sandlin as contact recreation, high quality aquatic habitat, and public water supply. There are 3 permitted domestic outfalls and 2 permitted industrial outfalls (a total of 5 outfalls) in this segment. Dissolved oxygen (D.O.) is the major concern in this segment. Slightly more than 30 percent of the samples exceed the standard, 5.0 mg/L. The low D.O. concentrations tend to occur in the summer suggesting that the low levels are from near the bottom of the lake, which would be naturally stratified in the summer and have low D.O. levels near the bottom. It seems likely that there is also some influence from the upper source (Lake Cypress Springs) and there is likely some influence of natural conditions on the D.O. levels.

Lake Cypress Springs: The State of Texas designates water uses of Lake Cypress Springs as contact recreation, high quality aquatic habitat, and public water supply. There are no permitted outfalls in this segment. The database indicates that this segment has very good water quality, but the lastest water quality assessment report concludes that the data provide an incomplete picture of lake inflow dynamics. This is because the lake contains a nusiance growth of hydrilla which is known to take up nutrients from the water column extremely well and is possibly masking the recognition of nutrient inflows to the lake. Results of the water quality nalysis in this segment indicates a possible concern for low D.O. levels which are known to be influenced by excessive aquatic plant growth. During times when the plants are respiring (as might be the case in the early morning), dissolved oxygen would be absorbed from the water, and the D.O. concentrations in the water would be depressed. Conversely, during photosynthesis (during daylight hours when the sun in shining) excess dissolved oxygen would be released into the water and concentration values would be high. D.O. values at the sampling stations in Lake Cypress Springs range from below 0.1 mg/L to 13.0 mg/L. Such a range is consistent with a water body under the influence of excessive aquatic plant growth.

Black Bayou: The State of Texas designates water uses of this segment as contact recreation, intermediate quality aquatic habitat, and public water supply. There was only 1 permitted domestic outfall in this segment in 1992, and no permitted industrial outfalls. This segement exhibits the classic low seasonal D.O. levels which have been of concern in East Texas for many years. The D.O. concentrations follows the classic pattern in East Texas waters having sluggish flows, high temperatures and abundant plant growth. In such areas the natural ecosystem creates sufficient nutrients to foster aquatic plant growth which influences the pattern of dissolved oxygen concentrations both seasonally and diurnally, demonstrating extremely high and low D.O. concentrations.

James' (Jim's) Bayou: The State of Texas designates water uses of this segment as contact recreation, intermediate quality aquatic habitat, and public water supply. There were 3 permitted domestic outfalls in 1992 in this segment, and no permitted industrial outfalls. Dissolved oxygne is the major concern in this segment also, with slightly more than 30 percent of the samples exceeding the standard. James' Bayou exhibits the same seasonal pattern as does Black Bayou.

Little Cypress Bayou (Creek): The State of Texas designates water uses of Little Cypress Bayou as contact recreation, high quality aquatic habitat, and public water supply. There were 5 permitted domestic outfalls and 9 permitted industrial outfalls (a total of 14 outfalls) in this segment in 1992. This is the final segment with the Cypress basin. D.O. levels, nutrients and a few metals appear to be concerns or possible concerns in this segment, but since no sampling has been done in this segment since 1992, it is not clear whether the results of the analysis reflect permanent conditions or ones which have changed since the 1980s.

Aquatic Plant Growth - Caddo Lake

A site visit on May 23, 1995, revealed a flora quite similar to that observed in 1980 and 1988. Currently aquatic plants occupy up to 95% of the lake suggesting that there has been an expansion since 1988, and affirming the prediction that the entire lake was susceptible to plant colonization and growth.

Hydrilla, an exotic weed species which has characteristics that allow it to rapidly colonize open sites has become a major concern to local citizens and state and federal resource agencies. Hydrilla, which grows easily and rapidly from small stem fragments, has a high reproductive capacity, tremendous dispersal capabilities and is tolerant of low light levels. The elongated growth ability of hydrilla helps it to produce a very dense, highly branched canopy at the water surface. This mat canopy can greatly reduce the mixing rates, water exchange, light penetration and gas exchange that occur normally in a lake system, and can ultimately lead to low dissolved oxygen concentrations. Although hydrilla was not observed during 1995 site visits, a small population had been reported in Big Cypress Creek, upstream of Caddo Lake by the TPWD at that time. In late 1996, the State reported an infestation of about 500 acres in the mid-lake area. By late 1997, TPWD reported that hydrilla had spread from 500 acres to more than 5,000 acres.

In spite of the extensive coverage by submersed aquatic plants, the only chemical treatment currently being done on Caddo is for water hyacinth. Water hyacinth in Caddo Lake continues to be treated under a maintenance control program begun in 1990, with upwards to 157 acres being treated annually . Boat lanes, although vegetated, remain navigable due to the volume of boat traffic utilizing them.

WATER RIGHTS

Because the Cypress Creek Basin is an interstate basin, both Texas and Louisiana have rights to any water generated from the basin. The Red River Compact is the doctrine which governs the water rights of the Cypress Basin.

Red River Compact

The following excerpt was taken from the Red River Compact pertaining to the issue of water rights of the Cypress Basin.

ARTICLE VI, APPORTIONMENT OF WATER - REACH III
ARKANSAS, LOUISIANA, AND TEXAS

Subdivision of Reach III and allocation of water therein.

Reach III of the Red River is divided into topographic subbasins, and the water therein allocated, as follows:

Section 6.0l. Subbasin I - Interstate streams - Arkansas and Texas.

a) This subbasin includes the Texas portion of those streams crossing the Arkansas-Texas state boundary one or more times and flowing through Arkansas into Cypress Creek-Twelvemile Bayou watershed in Louisiana.

b) Texas is apportioned sixty (60) percent of the runoff of this subbasin and shall have unrestricted use thereof; Arkansas is entitled to forty (40) percent of the runoff of this subbasin.

Section 6.02. Subbasin 2 - Interstate streams - Arkansas and Louisiana.

a) This subbasin includes the Arkansas portion of those streams flowing from Subbasin 1 into Arkansas, as well as other streams in Arkansas which cross the Arkansas-Louisiana state boundary one or more times and flow into Cypress Creek-Twelvemile Bayou watershed in Louisiana.

b) Arkansas is apportioned sixty (60) percent of the runoff of this subbasin and shall have unrestricted use thereof; Louisiana is entitled to forty (40) percent of the runoff of this subbasin.

Section 6.03. Subbasin 3 - Interstate streams - Texas and Louisiana.

a) This subbasin includes the Texas portion of all tributaries crossing the Texas-Louisiana state boundary one or more times and flowing into Caddo Lake, Cypress Creek-Twelvemile Bayou or Cross Lake, as well as the Louisiana portion of such tributaries.

b) Texas and Louisiana within their respective boundaries shall each have the unrestricted use of the water of this subbasin subject to the following allocation:

(1) Texas shall have the unrestricted right to all water above Marshall, Lake O The Pines, and Black Cypress damsites; however, Texas shall not cause runoff to be depleted to a quantity less than that which would have occurred with the full operation of Franklin County, Titus County, Ellison Creek, Johnson Creek, Lake O The Pines, Marshall, and Black Cypress Reservoirs constructed, and those

other impoundments and diversions existing on the effective date of this Compact. Any depletions of runoff in excess of the depletions described above shall be charged against Texas' apportionment of the water in Caddo Reservoir.
(2) Texas and Louisiana shall each have the unrestricted right to use fifty (50) percent of the conservation storage capacity in the present Caddo Lake for the impoundment of water for state use, subject to the provision that supplies for existing uses of water from Caddo Lake, on date of Compact, are not reduced.
(3) Texas and Louisiana shall each have the unrestricted right to fifty (50) percent of the conservation storage capacity of any future enlargement of Caddo Lake, provided, the two states may negotiate for the release of each state s share of the storage space on terms mutually agreed upon by the two states after the effective date of this Compact.
(4) Inflow to Caddo Lake from its drainage area downstream from Marshall, Lake O The Pines, and Black Cypress damsites and downstream from other last downstream dams in existence on the date of the signing of the Compact document by the Compact Commissioners, will be allowed to continue flowing into Caddo Lake except that any manmade depletions to this inflow by Texas will be subtracted from the Texas share of the water in Caddo Lake.

c) In regard to the water of interstate streams which do not contribute to the inflow to Cross Lake of Caddo Lake, Texas shall have the unrestricted right to divert and use this water on the basis of a division of runoff above the state boundary of sixty (60) percent to Texas and forty (40) percent to Louisiana.
d) Texas and Louisiana will not construct improvements on the Cross Lake watershed in either state that will affect the yield of Cross Lake; provided, however, this subsection shall be subject to the provisions of Section 2.08.

Section 6.04. Subbasin 4 - Intrastate streams - Louisiana.
a) This subbasin includes that area of Louisiana in Reach III not included within any other subbasin.
b) Louisiana shall have free and unrestricted use of the water of this subbasin.

Caddo Lake Compact

In 1979, the States of Texas and Louisiana, in the interest of equitable apportionment and use of Caddo Lake water, negotiated a Compact to augment and amplify the provisions of the Red River Compact dealing with Caddo Lake. Basically, the Caddo Lake Compact dealt with controversies not adequately dealt with in the Red River Compact. Although it was disapproved by both State legislatures, the Caddo Lake Compact functions as an informal operating agreement.

The Caddo Lake Compact was not intended to amend, replace, or supersede any provisions of the Red River Compact, but was to be construed harmoniously with the Red River Compact. The purpose of the Caddo Lake Compact was to preserve and protect Caddo Lake as a valuable environmental, cultural and natural resource, and enhance water resource and recreational potentials, while allowing its utilization for water needs of adjacent portions of Louisiana and Texas. A means of accomplishing these purposes that is proposed in the Compact is to raise the spillway elevation of Caddo Lake to an elevation of 170.5 feet above mean sea level.

A summarization of some of the issues of the Caddo Lake Compact are as follows:

1) The water of Caddo Lake below 167.5 feet above mean sea level is dedicated to serve as a recreation and navigation pool. Neither the State of Texas nor Louisiana shall allow the diversion or consumptive use of the water below that level except under authorized conditions of the Compact, which are:
a) in the event of a catastrophic event, such as the destruction of a municipality or political subdivision s other water supply.
b) users who want to withdraw or divert more than 1,000 gallons per day from Caddo Lake when the lake elevation is below 167.5 feet above mean sea level must submit a water use plan and have it approved. Priority for approval is given to domestic users, municipalities or municipal use by political subdivisions and industries, in that order.

2) Whenever water is spilling over the existing spillway at 168.5 feet above mean sea level, each State may withdraw or divert water form Caddo Lake without restriction.

3) Whenever water is not spilling over the existing spillway, also referred to as the drawdown period, the total consumptive use by each State shall not exceed 8,400 acre-feet during the drawdown period; provided that neither State diverts more than 3,600 acre-feet during any one month or 4,800 acre-feet during any two consecutive months.

4) Whenever the water level of Caddo Lake is at or below 167.5 feet above mean sea level, the total consumptive use by each State shall not exceed an average of 1,000 acre-feet per month, or more than 3,000 acre-feet during any two consecutive months. However, this limitation does not apply to a municipality or political subdivision during an emergency caused by the destruction or contamination of that entity s other water source.

The Caddo Lake Compact also includes language on the official administration of the Compact by the States of Texas and Louisiana, and water operating rules in the event that the existing spillway is raised. To date, the Caddo Lake Compact for Louisiana and Texas has not been approved by the respective legislatures, nor has the elevation of the spillway been raised.

SOCIAL AND ECONOMIC SETTING

POPULATION

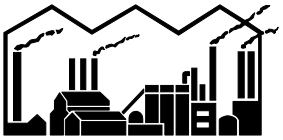
The 1990 population of the 10 Texas counties and 1 Louisiana parish located within the investigation area was 566,315, with Caddo Parish having the highest total population at 248,253. Population in the investigation area increased 39 percent (159,999 people) from 1950 to 1990.

EMPLOYMENT

Services, wholesale/retail, and manufacturing were leading employment sectors of the investigation area economy. Approximately 26.4 percent of the investigation area work force was employed in the service sector. Wholesale/retail (wholesale and retail) is the second leading economic sector with approximately 24.5 percent of the work force employed. Manufacturing was the third leading sector with approximately 23.9 percent of the work force employed. The unemployment rate in the investigation area in 1980 was 5.6 percent. In 1994 the unemployment rate was 8.0 percent. This illustrates an increase in unemployment of 2.4 percent.

PERSONAL INCOME

Personal income is considered to be the most comprehensive measure of economic activity available in this investigation since it maintains a close and generally constant relationship with the gross national product. The per capita personal income for the Cypress Bayou Basin investigation area increased 624 percent from $1,926 in 1959 to $13,951 in 1990. The average per capita income for the basin in 1990 was approximately $1,047 more than the 1990 Texas state average of approximately $12,904.



MANUFACTURING

Value added by manufacture (VAM) for the investigation area increased by 67 percent from $388.2 million in 1967 to $648.9 million in 1995 at an average annual rate of 2.8 percent. Principal industries in the investigation area include fabricated metals, food, home furnishings, and machinery (except electric).

AGRICULTURE

Value of farm products sold (VFPS) in the investigation area in 1994 totaled $524.1 million. Livestock production accounts for the majority of the value of farm production sold (64.3 percent), with crop sales accounting for 22.5 percent.

NATURAL RESOURCES

The oil and gas industry is the leading minerals industry in the Cypress Bayou Basin investigation area. The investigation area is part of what is known as the East Texas Oil Field, with oil reserves considered to be among the largest in the continental United States. Crude oil production showed a general trend of decline over the period 1970 to 1992 from 109.2 million barrels to 45.7 million barrels in Texas. While in Northern Louisiana there was an increase in production from 22.2 million barrels (1989) to 22.4 million barrels (1990). Natural gas production in the Texas portion of the investigation area remained relatively constant with a production of 185.2 million cubic feet in 1970 to a production of 178.9 million cubic feet in 1979. Natural gas production in northern Louisiana remained relatively constant with a production of 381.8 million cubic feet in 1989 to a production of 383.2 million cubic feet in 1990.

Lignite is also present in the Cypress Bayou Basin investigation area as part of lignite deposits in south and east Texas and northwest Louisiana. Lignite's value as a source of energy, under present technology and conditions, is mainly through its use in mine-mouth operations (burned at or near the lignite mine source). Currently, the use of lignite in the investigation area is limited to use as a fuel source at the Texas Utilities Electric Plant in Titus County, Texas and the Southwestern Electric Power Company' Pirkey Power Plant, located in Harrison County, Texas. Ample supplies of lignite from various deposits nearby are available to meet the needs of the expected life of the two plants.

ENVIRONMENTAL SETTING

TERRESTRIAL RESOURCES

Except for its far western portion, the Cypress Valley Watershed is within the Pineywoods vegetational region of Texas. Generally, the watershed is characterized by gently rolling to hilly terrain dissected by flat floodplains and terraces.

Pine-hardwood forests dominate the upland areas within the watershed. This forest types consists of loblolly and shortleaf pine, red oak, overcup oak, blackjack oak, post oak, hickory, maple, beech, sweetgum and sycamore. Bottomland hardwood forests, which occur along the floodplains consist of willow oak, water oak, black willow, bald cypress, blackgum, sweetgum, river birch, green ash, water hickory, winged elm, and water elm. Most of the bottomland areas are considered to be wetlands. The original upland forest has been extensively cleared for agricultural purposes, particularly in the western portion of the basin. Some of the bottomland forests have been converted to monocultured pine forest for commercial lumbering. Bald cypress swamps are present along drainages in the eastern portion of the watershed and are significant in Caddo Lake and along Big Cypress Bayou upstream of Caddo Lake.

In addition to the pine-hardwood and bottomland hardwood forests, which are primary and secondary forest types within the watershed, upland hardwood forests, pine plantations, shrub land, grassland, and cropland also occur within the watershed.

Game mammals found in the watershed include fox and grey squirrel and whitetail deer. Common small nongame mammals include armadillo, rabbits, opossum, raccoon, and several species of skunks, bats and rodents. Bobcat, coyote, and gray fox are the principal predators. Snakes, lizards, turtles, and amphibians are also abundant.

At least 216 species of birds have been recorded within the Cypress Valley Watershed. Resident game species include bobwhite quail, wood duck and turkey. Numerous species of waterfowl migrate through or winter along streams, sloughs, swamps and impoundments in the basin, which is located in the central flyway. Nongame birds include various woodpeckers, hawks, owls, warblers, thrushes, and other resident or migrating species found in wooded to partially wooded habitats. Shorebirds are common on impoundments during spring and fall migrations.

AQUATIC RESOURCES

The river systems in the Southeast United States are generally characterized as having broad floodplains, relatively flat stream gradients, and meandering patterns in the landscape.

Certain landscape features of floodplains are created over time by overbank flooding and meandering rivers that cause sediment transport, erosion, and deposition. Some of these features and their definitions are included in the characterization of Eastern North American riparian systems by:

1. Natural levees are adjacent to the channel and are composed of coarser materials that are deposited when floods flow over the channel banks. These levees are often the highest elevation on the floodplain.

2. Point bars are areas of sedimentation on the convex sides of meanders or river curves. As sediments are deposited on the point bar, the meander curve of the river tends to increase in radius and migrate downstream. Over time, the point bar will begin to support vegetation that will stabilize it as part of the floodplain.

3. Meander scrolls are depressions and ridges on the convex side of bends in the river. They are formed as the stream migrates laterally across the floodplain. Meander scrolls are also referred to as ridge and swale topography.

4. Oxbows, or oxbow lakes, are bodies of permanently standing water that result from the cutoff of meanders.

5. Sloughs are areas of dead water that form in meander scrolls.

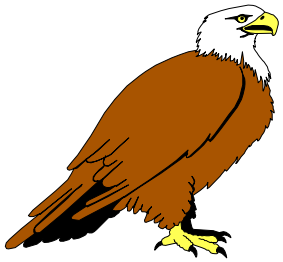
6. Terraces are ‘abandoned floodplains’ that may have been formed by the river’s alluvial deposits but are not hydrologically connected to the present river.

Aquatic habitats within the Cypress Valley Watershed are extremely diverse, ranging from large palustrine emergent and forested wetlands at Caddo Lake to intermittent tributaries in the upper portions of the watershed. Other types of aquatic habitats found in the area include perennial streams with riffles, runs, and pools; sluggish flowing bayous with numerous oxbows, sloughs, and backwaters; and man-made water impoundments and reservoirs.

These aquatic habitats support a variety of riparian and aquatic vegetation. Common woody vegetation lining streambanks and overhanging the water include bald cypress, black willow, water elm, river birch, and buttonbush. Emergent and floating aquatic vegetation is generally restricted by the steep banks of streams, but is common in shallow areas of impounded water. Aquatic vegetation is discussed in more detail in the water quality portion of this report.

The diversity and quality of the aquatic habitat within the watershed support a large and varied fishery. Several fish surveys have been conducted in the Cypress Bayou system

since the 1950's. According to a draft report on fishes of the Cypress Bayou system that compiles fishery data collected over the years, eighty-seven species of fish have been collected in the watershed. Major sport fishes that occur include largemouth and spotted bass, channel and flathead catfish, white bass, white and black crappie, and various sunfishes. Primary forage species include gizzard and threadfin shad, small sunfishes, minnows, and shiners. Spotted sucker, freshwater drum, carp, longnose and spotted gar, and black and yellow bullheads are the primary rough fish species.



THREATENED AND ENDANGERED SPECIES

The following species have been federally listed as threatened or endangered in the Cypress Valley Watershed within the state of Texas. The bald eagle (*Haliaeetus leucocephalus*) is listed as endangered and is a winter resident throughout the investigation area. Although its current range is south of the Cypress Valley Watershed, the historic range of the endangered red-cockaded woodpecker (*Picoides borealis*) extended into the Cypress Valley. Threatened species include the arctic peregrine falcon (*Falco peregrinus tundrius*) and piping plover (*Charadrius melodus*) which are migrants throughout Texas, and the Louisiana black bear (*Ursus americanus*). Also, the paddlefish (*Polyodon spathula*) is on the Texas Endangered Species List.

HAZARDOUS, TOXIC, AND RADIOLOGICAL WASTES (HTRW)

An Initial Assessment was not performed for the Cypress Valley Watershed to be included in this report. However, potential problem areas were identified within the basin and are discussed below. Additionally, details of pollutants are listed and discussed in Appendix H. If further studies are carried out the initial assessment and site investigations will be performed. These investigations will include reviews of the regulatory records, aerial photographs, and interviews.

Approximately ten municipal landfills throughout the Cypress Basin are impacted by the Subtitle D Regulations of the Resource Conservation and Recovery Act (RCRA) of 1983, as amended. RCRA regulates management and disposal of hazardous materials and wastes currently generated, treated, stored, disposed of or distributed, while Subtitle D deals with state or regional solid waste plans. Regional Councils of Government are responsible for developing plans for regionalization of landfills and achieving compliance with Subtitle D.

Five EPA designated Superfund sites are located in the Cypress Basin: Double R Plating located in Cass County, and Fabsteel, Marshall Wood Preservatives, Longhorn Army Ammunition, and Steinco, all located in Harrison County. Superfund is the common term for the program operated under the legislative authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, and the Superfund Amendments and Reauthorization Act (SARA), as amended, that funds and carries out solid waste emergency and long-term removal remedial activities at hazardous waste sites. Sites are placed either on the CERCLA list or the National Priority List (NPL). Because funds are limited, only the highest ranking sites make the EPA's NPL. The USEPA and TNRCC jointly administer CERCLA in Texas.

There are numerous abandoned and existing oil wells within the Cypress Basin, each having a brine pit associated with it. A pit is needed to hold the concentrated brine which is mined along with crude oil for evaporation or removal. Each pit is a potential source of chloride contamination resulting from a spill caused by either failure of the pit containment, or more commonly, overflow due to intense rainfall. Most oil well permits are located in the southern half of the Basin.

FISH AND WILDLIFE PLANNING AID STUDIES

This document, *A Characterization of Habitats and Fish and Wildlife Management Opportunities at Cypress Bayou Basin, Texas and Louisiana*, dated February 1995, (Appendix J) summarizes information collected by Fish and Wildlife Service (FWS) on the fish and wildlife resources of the Cypress Valley watershed over the past decade during the course of various land and water resource project investigations. FWS studies have concentrated primarily on identifying and characterizing the structural components of the habitats and quantifying the value of the habitats to representative wildlife species using various habitat assessment methodologies. Emphasis has been placed on the evaluation of bottomland hardwood forests and wetlands, since these habitat types often are the most threatened by development and provide the highest resource values to fish and wildlife within the watershed.

This report also provides some preliminary recommendations on fish and wildlife management measures which should be considered during future detailed planning within the basin. These measures range from preservation of the highest quality natural resources to restoration of degraded habitats. In addition, many opportunities are available to private landowners, agencies, and conservation organizations for improvements to existing fish and wildlife habitats within the watershed, thereby contributing to the overall quality of the natural resource base while providing additional opportunities for the public to enjoy those resources.

Partners for Wildlife Program

Partners for Wildlife is a program of the FWS designed to improve and protect fish and wildlife resources on private lands and to cultivate a sense of stewardship for these resources. It involves technical and financial assistance to private landowners, local governments, educational institutions, or other non-federal entities while leaving land in private ownership. This program was instituted with the FWS's recognition that the future of the nation's fish and wildlife resources is directly dependent upon the quality, quantity, and distribution of suitable habitat on private lands. History has shown that these lands face the greatest threat of loss or degradation; however, they also provide the greatest potential for restoration and protection.

The FWS's Arlington Field office is actively working with landowners in the Cypress Bayou watershed to restore and protect valuable fish and wildlife habitats. Currently, seven Partners for Wildlife projects have either been completed or planned in Harrison County, with two projects underway for Marion County. Beginning in Fiscal Year 1995, some of these projects are being cooperatively developed with the U.S. Bureau of Reclamation as part of the comprehensive Federal water resource studies being conducted in the watershed.

Detailed information on each site and its location within the watershed is provided in the Planning Aid Report. To date, most of these projects have involved restoration of wetland hydrology on site through construction of diversion levees and water-level control structures. Additional habitat restoration features as discussed below have also been incorporated into the project where appropriate.

CULTURAL RESOURCES

The cultural resources work for the Cypress Bayou Investigation was conducted in accordance and partial fulfillment of the U.S. Army Corps of Engineers obligations under the National Historic Preservation Act of 1966, as amended (PL 89-665). Other obligations include the Archeological and Historical Preservation Act of 1974, as amended (PL 90-190), and Executive Order No. 11593, the "Protection and Enhancement of the Cultural Environment".

HISTORY

The Big Cypress Basin in North Eastern Texas is truly the land that time forgot. Much of the very early history of Texas revolves around the empirical aspirations of Spain and France. The Spanish succeeded in building a great Empire, leaving an orientation and historical perspective in Texas which looked toward Mexico and Spain. The French empire in north America which most influenced north east Texas died quietly, leaving a little known legacy.

The Caddo Indians native to the region, being agrarian, did not engage in the predatory raiding which gave fame and retribution to the plains Indians. As the United States developed east of the Mississippi the Cherokee Indians pushed out of Tennessee, Alabama and Georgia moved west. The Cherokee settled in Piney Forest of East Texas, Arkansas and Louisiana forming a powerful confederacy with the Caddo and other tribes of the region. Even the battles with General Gaine's Texans which occurred during their removal have not received much attention from historians.

The Regulator-Moderator War, basically a conflict between vigilants and law and order proponents over how to deal with the lawless element which developed in the Indian Territories and the Undefined Area prior to the Civil War, has not received the attention of similar disputes, such as the Railroad War in Missouri or the Lincoln County War in New Mexico.

The Civil War's Red River Campaign was aimed at cutting off supplies and manufactured goods from Texas, most of which originated or passed through the Big Cypress Basin. General Taylor, C.S.A. stopped General Steele, USA, in Arkansas and completed the defeat of General Banks in Louisiana. Even the Civil War was unable to pull the Big Cypress Basin into historical focus. Because no major campaign reached the Big Cypress Basin, it remains only a point of origin for supplies and some of the most famous fighting units of the Civil War and the location of confederate capital for the State of Missouri.

The Big Cypress Basin left the Civil War much better off than most other parts of the Confederacy because the area was never devastated by battle or invasion during the war. Commercial quantities of agricultural products produced in the basin included timber, cotton and molasses. In addition, a small but thriving industrial community had been started as the result of war time requirements with substantial iron and leather goods production. The head of navigation was at Jefferson within the Big Cypress Basin. Because of the relative prosperity and transportation facilities, the Big Cypress Basin became the destination for many southerners leaving more devastated regions of Mississippi, Alabama and Georgia, as well as the destination of the much less popular reconstruction government and federal troops.

As the United States moved into the Era of the Railroad Barons, Big Cypress Basin began to lose advantages gained before and during the Civil War. The major transportation base changed from steamboat and barge to railroad. Big Cypress Basin lost the limited navigation capability it had when the great log jam was removed from the Red River to provide navigation and drain land for farming in the Red River Basin. Struggling under reconstruction governments, the small and isolated industrial base in the Big Cypress Basin began to dwindle. The timber industry was undergoing phenomenal growth during this period, but it also required heavy lift transportation, either by water or rail, and the Big Cypress Basin could not provide those facilities prior to World War I. The Big Cypress Basin timber industry did not recover until the poor timber management practices of the era had made timber scarce in areas closer to the coast and truck development made it possible to sustain commercial timber operations in the basin.

During The Twentieth Century the Big Cypress Basin has seen a return of prosperity with the development of oil, timber, commercial agriculture and steel industries. Lone Star Steel, Pilgrim's Chickens, large timber and oil industries have not achieved the recognition for the area, which similar events created for other areas of the country.

Washed by empires in conflict, with Civil War to the east, the Texas Revolution and Mexican War to the Southwest and Indians Wars to the North and West, Big Cypress Basin has always remained an ignored island of peace.

A more detailed description of the history of the investigation area and state of Texas can be found in Appendix I.

CULTURAL INVESTIGATIONS

The potential is high for finding historic and prehistoric cultural resources throughout the investigation area. The earliest published works concerning the prehistory of the basin noted the presence of mounds in the Caddo Lake area. In the 1930's, major field expeditions into the region bean under the auspices of the Works Progress Administration. With the start of World War II, archeological field work in the area was halted and remained somewhat stagnant until 1951, when a survey report was prepared by the River Basin surveys of the Smithsonian Institution, on Ferrell's Bridge Reservoir (Lake O' the Pines) in Harrison, Marion, Upshur, Cass, Morris, Titus, and Camp Counties. In the 1960's and 1970's, a number of archeological salvage projects were also undertaken in the basin area.

A reconnaissance level investigation of the Cypress Bayou Basin was conducted in 1981, by the Fort Worth District. The investigation area focused in on the area between two potential lake sites and includes specifically Lake O' the Pines. Studies in and around the project area suggest occupation in the Archaic period from about 3000 B.C. to A.D. 500, followed by the Caddoan period, with sites dating from A.D. 500 to A.D. 1600. This time period is subdivided into several segments called focuses: Alto, Haley, Whelan, Titus, and possibly Kinsloe.

The investigation outlined a number of areas of high probability for prehistoric sites. In addition, local informants indicated the locations of eight prehistoric and five historic sites within the boundaries of the two investigated reservoirs. Although no sites currently listed on the National Register of Historic Places were noted within either potential lake boundary, a number of potentially eligible sites at both locations are thought to exist.

GIS DATA BASE/MAPPING

The Geographical Information System (GIS) component developed as part of this investigation consists of a digital geospatial database detailing the physical, natural, and economic characteristics of the watershed. The GIS data compiled was designed to serve a variety of objectives including: support for many of the environmental and economic studies; serving as a digital appendix of baseline data and results to facilitate resource management, education, and future GIS-based analysis in the watershed.

The GIS data compiled provided a means for basic mapping, spatial analysis, and environmental/economic modeling. Further, the GIS products supported investigation efforts in wetland restoration, vegetation mapping, assessment of aquatic diversity, non-point source pollution/water quality, urbanization trends, deforestation trends, endangered species distribution, and cultural resource locations. To support the long-term goals of the investigation, the GIS database has been copied to cd-rom and made available to the

supporters and participants of the investigation to aid in future analysis and for distribution to interested parties. Detailed information on the content and format of the GIS database is included at the end of this section.

The database consists of 25 separate map layers, or themes, including basic physical geographical data such as topography (elevation, aspect, slope); satellite imagery (landsat Thematic Mapper); hydrology (streams, lakes, & watershed delineation); soils (digital Soil Conservation Service maps); geology and economic features (roads, utilities, wells airports, railroads, state and county boundaries from TIGER Census database). These data have been compiled from public sources, in cooperation/cost sharing with other state and federal agencies including United States Geological Survey (1:24,000 scale digital elevation), United States Department of Agriculture - Natural Resource Conservation Service (digital County soils maps), Texas Parks and Wildlife Dept. (vegetation landcover/wildlife habitat mapping). Geology was digitized in-house from the hardcopy version of the Geologic Atlas of Texas by the US Army Corps of Engineers.

Other map-layers have been generated in the course of the Cypress Valley Watershed investigation including vegetation/landcover distribution, water quality assessment, tourism/recreational resources, endangered and threatened species, lake and bayou aquatic data, and documented cultural resource locations (archeological and historic sites). A description of the data sources and analysis methods involved in the production of each data-layer are outlined in this section.

GLOBAL POSITIONING SYSTEM (GAP) ANALYSIS AND THE LANDCOVER CLASSIFICATION SYSTEM

The objective of the image classification was to derive a landcover map encompassing major land-use and vegetation classes distributed within the Cypress Bayou Watershed for use in a number of natural resource assessments. First, the information for vegetation would provide an approximation of the status, type, and extent of broad plant communities in the investigation area and guide the design of plans for long range wildlife and timber management. Second, landcover would contribute to the generation of a preliminary GAP based classification for east Texas. Third, landcover would serve as a base-map in combination with other environmental data for assessment of natural resources in the Cypress Bayou Watershed such as threatened and endangered species, wetlands, aquatic data, and water quality. Finally, the landcover map would also be a vital component in further GIS-based environmental investigation on future urbanization, deforestation trends, and non-point source pollution modeling.

The classification model to be employed in the Cypress Bayou Watershed satellite imagery analysis was the GAP Analysis Vegetation Classification System for Texas (McKinney 1994). GAP is a nationwide effort sponsored by the U.S. Fish and Wildlife Service to identify and delineate natural communities important to maintaining biological diversity at regional, state, and local levels (Winckler 1992:74). The intent of GAP is to identify areas where gaps in federal and state protection exist so that proactive cooperative efforts can be taken to establish adequate natural preserve areas and partnerships with private landowners (Winckler 1992:74-81). As noted in the Conservation Strategies Appropriations Documentation for GAP, "Management for biodiversity is intended to maintain representative populations of naturally occurring species and vegetation cover types in sufficient abundance to insure their long-term viability" (Defenders of Wildlife 1992:2). In conserving biological diversity, GAP seeks to address the shortcomings of the Endangered Species Act with its reactive crisis focus on endangered individual species with a comprehensive ecosystem approach to biological conservation and habitat protection (Winckler 1992:80).

GAP analysis involves overlaying, modeling, and analyzing mapped information on land ownership/landuse, animal and plant community distributions, and natural resource preserves in order to answer questions on the status of biological diversity. GIS is a critical tool for the accomplishment of these tasks which include compilation, integration, and analysis of data from diverse sources such as multi-spectral satellite imagery, videography, vegetation, soil types, geology, topography, and landownership/landuse. To meet the demanding data and research requirements of GAP implementation, GAP programs nationwide build cooperative agreements with government agencies, universities, and private interests to collaborate on and share costs for the generation of statewide GIS databases and baseline natural resource mapping.

GAP efforts in Texas have been organized around a network of state and federal agencies and universities who have an interest or jurisdiction in natural resource management and vital geospatial data necessary for construction of the basic GAP map layers. These have included The Nature Conservancy, US Fish and Wildlife Service, US Army Corps of Engineers, National Park Service, USDA-Natural Resource Conservation Service, Texas Parks and Wildlife Department, University of North Texas, Rice University, Texas A&M University, University of Houston, and Texas Tech University (Defenders of Wildlife 1992:18). The US Army Corps of Engineers, Fort Worth District works closely with GAP officials in Texas and has pledged assistance in sharing data pertinent to GAP investigation goals whenever possible and adopting the Texas GAP Classification scheme in Corps' GIS vegetation mapping.

Vegetation mapping in Texas has been initiated for some parts of the state with completion of the mapping for the entire state planned by June 1998. The Mapping Sciences Lab at Texas A&M has been selected to compile boundary maps of public conservation areas, obtain Landsat TM Satellite imagery, process the airborne videography, and construct the vegetation map for East Texas. A minimum mapping unit of 40 hectares (ha) was chosen for the maps which will be produced at a scale of 1:100,000 (National Biological Survey 1995:1-2). As planned, the Texas GAP Project will rely on airborne videography for ground truth data and validation and will not entail actual fieldwork.

The Texas vegetation classification scheme has gone through several drafts and reviews. An initial scheme was developed by the Mapping Sciences Lab at Texas A&M University utilizing the UNESCO-format (UNESCO 1973) and also incorporating vegetation series recognized by the Texas Natural Heritage Program (TNHP 1993). The UNESCO system is an integrated ecological land classification scheme uniting several fundamental elements of the landscape including vegetation, soil, landforms, climate, and water in a hierarchical framework that defines general and various sublevels of plant community associations. The TNHP list includes 89 plant community series defined for the Nature Conservancy's Biological Conservation Database (BCD).

In June 1994, when watershed land-cover mapping was being conducted, Draft 7 of the Texas GAP Classification was undergoing additional revisions planned for 1995 implementation designed to streamline the classification and bring the scheme closer in line with the methodologies of videography and satellite imagery. The revisions sought to collapse the current 120 classes down to a workable 60 classes by eliminating some smaller plant communities and also collapsing similar plant community classes that could not be distinguished from each other without intensive field checking (David Diamond and Tony McKinney, personal communication 1994). In meetings between Ft. Worth District Corps and GAP officials from Texas A&M and Texas Natural Heritage Program, a decision was made to conduct Cypress Bayou Watershed land-cover classification within the Draft 7 scheme with the intention of adjusting the classification later to reflect new GAP land-cover classes.

The Corps was assisted in field ground truthing and adapting the GAP Draft 7 scheme to the Cypress Bayou Watershed area by the Texas Parks and Wildlife Department (TPWD) and Dr. Bill Sheffield, a biologist with considerable field experience in east Texas. Dr. Sheffield

found it necessary to make additions to the GAP scheme to include transitional plant community types for successional types and Pine Plantation (see Sheffield's section - this report). TPWD and Dr. Sheffield worked closely with US Army Corps of Engineers staff in processing the Landsat satellite imagery and classified the imagery into a land-cover map.

RECREATIONAL RESOURCES

TEXAS OUTDOOR RECREATION PLAN

The *Texas Outdoor Recreation Plan* (TORP) contains the state's five-year comprehensive planning document for assessment and policy development required under provisions of the Federal Land and Water Conservation Fund Act (Public Law 88-578). The Cypress Valley Watershed is within the TORP Planning Region 5 - Northeast Texas and Planning Region 6 - East Texas. Data for the 1990 TORP was collected between 1986 and 1989. Information from the TORP pertinent to the Cypress Valley project is included herein.

Population Trends

The population of Region 5 is projected to remain stable, with modest continuous growth of about 1 percent annually to nearly 273 thousand by 1995 over the estimated 247 thousand persons in 1986 for an increase of 10 percent. Much of the growth will occur in the incorporated areas of Sulphur Springs, Mount Pleasant, Atlanta, Texarkana, and Paris. These cities will have almost twice the growth of any other area. This growth will continue and the increased population will create a greater demand for recreation facilities and parkland.

The population of Region 6 is projected to experience rapid growth of about 2.4 percent annually to nearly 778 thousand by 1995 over the estimated 640 thousand persons in 1986 for an increase of 24 percent. The incorporated cities are expected to receive much of the increase in population, allowing the region to retain its rural character. This population growth will place a great burden on local park and recreation departments. Currently local park and recreation agencies are having trouble providing sufficient outdoor recreation facilities in the developing growth areas. Future population growth will strain cities and rural recreation facilities.

Resource Attractions

Region 5 has over twenty thousand surface acres of lakes. The lakes and streams within this wooded region provide many settings conducive to outdoor recreation. Wright Patman Lake, Pat Mayse Lake, and Lake Bob Sandlin are located such that most residents of the region have less than an hour’s drive to reach one of these fresh water and camping opportunities. The Red and Sulphur rivers within the region are floatable year round and several sections are suitable for canoeing, kayaking, and rafting. There are six other creeks, and rivers that are seasonally floatable. Public access to these waterways is meager, making them underutilized as recreation opportunities.

Region 6 has almost 171 thousand surface acres of lakes. The freshwater lakes are the dominant resource attraction in this region. Twenty-two different water bodies in the region provide a multitude of freshwater boating, fishing and swimming opportunities. Caddo Lake on the Louisiana border is the only large natural freshwater lake in Texas, and Lake Fork has produced many of the top ten large-mouth bass caught in Texas. Portions of the Angelina, Neches, Sabine, and Trinity rivers along with Big Cypress Creek are permanently floatable waterways within the region. However, public access is limited which may be due to the emphasis on lake access. Trail resources include the Caddo Forest Trail in Caddo Lake State

Park, the New Birmingham Trail developed by Southern Paper Mills, and Cargill Long Park hike and bike trail in Longview. Long distance trail opportunities are located nearby in the national forests only a few hours away.

Recreation Supply

Lake Bob Sandlin State Park was opened to the public in 1987 and quickly became a popular recreation site. Boat launching, camping, picnicking, fishing and hiking facilities at the state site greatly improve the opportunities on and access to the lake. This new site complements Daingerfield and Atlanta state parks, both of which are popular camping destinations in Region 5. The camping facilities at Lake Bob Sandlin have helped to relieve peak time camping pressure at existing sites. The overall rural character of this region makes resource-based facilities the dominant recreation opportunities currently existing. The Corps of Engineers operates numerous sites around Wright Patman and Pat Mayse Lakes providing ample access to these bodies of water. The Corps parks around these two reservoirs account for almost 75 percent of the regions parkland and almost 50 percent of the campsites.

Rural recreation facilities dominate the outdoor recreation picture in Region 6. As of 1988, there were 4,145 campsites and 236 boat ramps in the region, with over half provided by the private sector. Two state parks (Martin Creek Lake and Purtis Creek) have been developed and opened to the public in recent years. The Corps of Engineers offers a variety of quality recreation opportunities at Lake O' the Pines. County maintained boat ramps and eight concession areas are also located at the reservoir.

Popular Activities

In 1995 the most popular activities in Region 5, in terms of percentage of the population participating, will be walking for pleasure, picnicking, pool swimming, freshwater fishing, freshwater swimming, and playground use, respectively. Statewide, this compares to walking for pleasure, pool swimming, picnicking, playground use, open space activities, and bicycling.

Region 5 residents are active outdoors and enjoy a variety of recreational activities. Activities projected to exceed the statewide rate in user occasions per capita in 1995 are off-road vehicle use, horseback riding, baseball, and hunting.

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