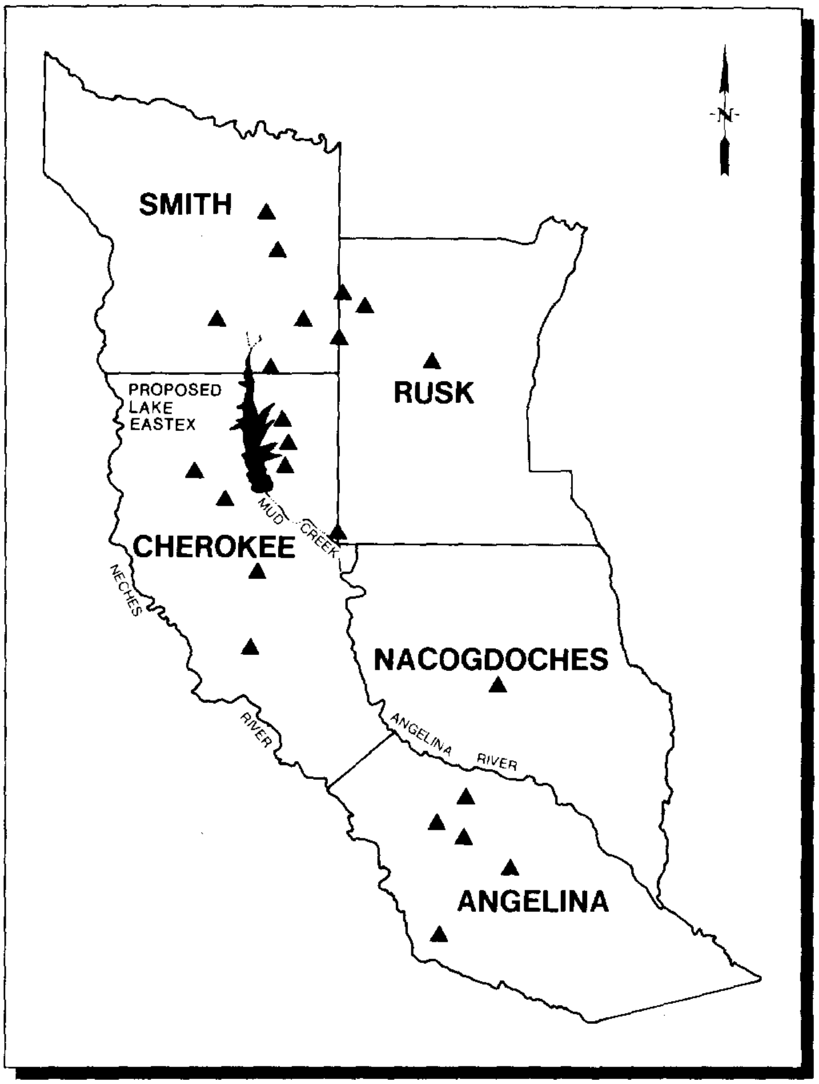
LAKE EASTEX
REGIONAL WATER SUPPLY PLANNING STUDY



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August 1991

Angelina & Neches
River Authority

Volume 2
Environmental Inventory and Issues

Lockwood, Andrews
& Newnam, Inc.

Contributing Consultants

Mariah Associates, Inc.
The Frasier Group
Legg Mason Wood Walker, Inc.
John D. Stover P.C.

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REGIONAL WATER SUPPLY
PLANNING STUDY

VOLUME 2
ENVIRONMENTAL INVENTORY AND ISSUES

Prepared for

The Angelina and Neches River Authority

by

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August 1991

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I. INTRODUCTION

I. INTRODUCTION

The Lake Eastex Regional Planning Study is a two volume report which addresses the engineering and environmental issues associated with the development of the proposed Lake Eastex. Volume 1: Engineering and Financial Analysis of the Regional Planning Study provides a detailed description of the authorization to perform the study, a summary of the history of the project, engineering information relative to the proposed project, and information relative to the financing and the cost of water. This volume (Volume 2: Environmental Inventory and Issues) provides an inventory of the environmental resources in the vicinity of the proposed project and identifies the pertinent environmental issues associated with the development of the proposed Lake Eastex. This Environmental Inventory and Issues Report builds upon previous studies conducted on the proposed reservoir including ecological evaluations conducted by the Texas Parks and Wildlife Department (TPWD, 1990) and the Frasier Group, Inc. (1990). These studies are described in detail in Section II of this volume.

Section II of this volume addresses the Baseline Environmental Setting in the vicinity of the proposed reservoir including Geological Elements, Hydrological Elements, Wetlands and Floodplains, Climate and Air Quality, Biological Elements, Historic/Archaeological Resources, Socioeconomics, Land Use, Recreation, Transportation and Noise. Section III identifies the potential environmental impacts associated with each of these disciplines and provides recommendations on how to proceed within the regulatory framework. Finally, Section IV provides a brief overview of the components of a mitigation plan and discusses previous efforts which have identified potential mitigation. Note as discussed above, this volume provides an inventory of the environmental resources in the project area and identifies the pertinent environmental issues associated with the permitting and development of the proposed Lake Eastex. This planning report is not intended to provide a comprehensive evaluation of the impacts or mitigation requirements associated with the proposed project. Detailed information on the impacts and mitigation associated with the project will be developed in support of the various federal permits.

II. BASELINE ENVIRONMENTAL SETTING

II. BASELINE ENVIRONMENTAL SETTING

A. GEOLOGICAL ELEMENTS

The baseline description of topography, geology and soils in the five county study area is presented in Volume 1, Section II.A. of this study.

B. HYDROLOGICAL ELEMENTS

1. Surface Water

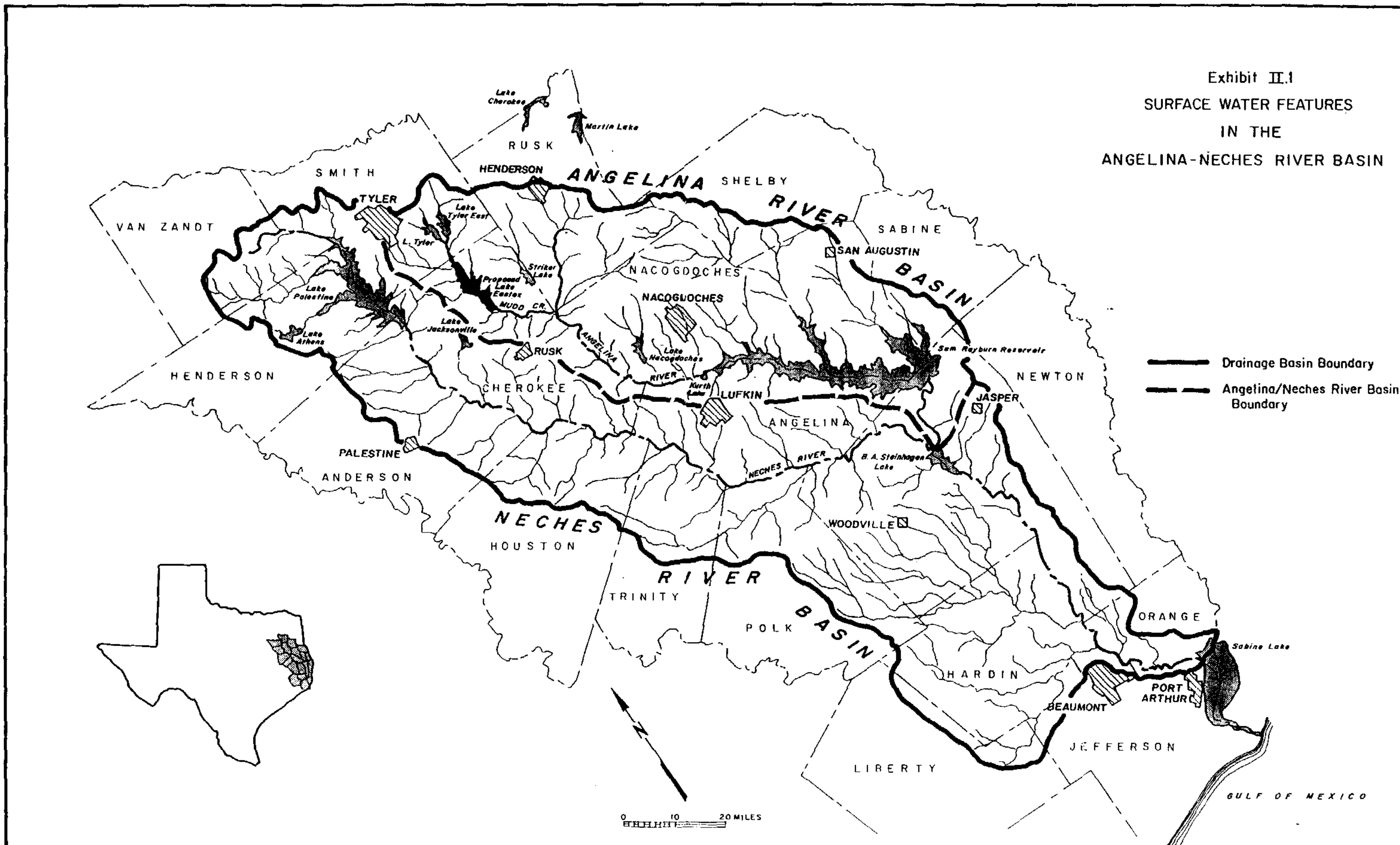
a. Hydrology

The proposed Lake Eastex reservoir project lies in the Angelina-Neches River Basin. This basin extends generally to the southeast and is bordered on the west by the Trinity River Basin, on the north and east by the Sabine River Basin, and on the south by the Neches-Trinity Coastal Basin. The Angelina River drains the northeastern one-third (3,575 square miles) of the drainage basin. The Neches River Basin which constitutes the remaining two-thirds (6,555 square miles) of the 10,130 square mile basin is drained by the Neches River, Pine Island Bayou and Village Creek. The dividing line between the Angelina and Neches River Basins runs south to southeast from the City of Tyler to the confluence of the two rivers. The Angelina River arises near Freeneytown (Rusk County) at an elevation of 290 feet and flows 205 miles to its confluence with the Neches River. The origin of the Neches River is near Canton (Van Zandt County) at an elevation of 590 feet, and flows approximately 416 miles to Sabine Lake [U.S. Army Corps of Engineers (COE), 1982]. Village Creek and Pine Island Bayou are major tributaries of the drainage basin south of the confluence of the Neches and Angelina Rivers.

Nine reservoirs greater than 750 acres exist in the drainage basin covering a total area of 166,770 surface acres. Sam Rayburn and Lake Palestine are the largest, covering 114,500 acres and 25,560 acres, respectively, with Kurth Lake being the smallest at 770 acres. Table II.1 provides the surface acreages of the nine reservoirs in the drainage basin. The Texas Water Commission (1990) has divided the drainage basin into 14 segments for water quality analysis. Surface water features in the Angelina-Neches River Basin are illustrated in Exhibit II.1

The proposed Lake Eastex will be located on Mud Creek which flows to the southeast with the upper reaches of the watershed being approximately fifteen miles southeast of Tyler, Texas in Smith County. Mud Creek intersects the Angelina River nearly six miles south of the town of Reklaw in Cherokee County. The proposed dam will be located approximately sixteen river miles upstream from the confluence with the Angelina River in Cherokee County.

The proposed Lake Eastex watershed will have a contributory drainage area at the dam site of 391 square miles located in Smith, Cherokee, and Rusk Counties. Major impoundments upstream of the proposed reservoir site include Lake Tyler and Lake Tyler East which control 107 square miles of drainage area combined.



Source: Tx. Water Commission, The State of Texas Water Quality Inventory

TABLE II.1

SURFACE ACRES OF EXISTING RESERVOIRS IN THE ANGELINA-NECHES RIVER BASIN

Reservoirs	Surface Area (acres)
Sam Rayburn Reservoir	114,500
Lake Palestine	25,560
B.A. Steinhagen Lake	13,690
Lake Tyler (and Lake Tyler East)	4,800
Striker Lake	2,400
Lake Nacogdoches	2,210
Lake Athens	1,520
Lake Jacksonville	1,320
Kurth Lake	770
Total	166,770

The Mud Creek watershed is characterized by a dendritic drainage pattern with a broad floodplain. Thirteen named tributaries contribute to the flow of Mud Creek in the project area. Eleven of these tributaries intersect Mud Creek above the proposed dam site, with two tributaries intersecting the creek immediately below the dam site (Exhibit II.2 in attached map pocket). The names of these creeks listed from confluence points with Mud Creek (North to South) are Prairie Creek, Blackhawk Creek, Bell Branch, Kickapoo Creek, West Mud Creek, Bear Creek, Lavender Branch, Birches Creek, Caney Creek, Club Lake Branch, Bridge Creek, Coon Creek, and Ragsdale Creek. Because of somewhat different channel and flow characteristics, the Mud Creek watershed in the project site vicinity can be divided into two sections. The Northern portion extends from the headwaters of the watershed to the confluence of Caney and Mud Creeks. The southern section extends south to Ragsdale Creek. The differences between these two sections are discussed below.

The origin of Mud Creek receives discharge from Lake Tyler East and consists of broad creeks with relatively fast flow. Associated tributaries in the northern section are typically long, slow moving pools with very few riffles and stagnant pools. Natural springs may also contribute to the base flow of the creek. Limited channel braiding occurs along this section of Mud Creek, just north of the West Mud Creek confluence and at the Lavender Branch confluence.

The southern sections of the Mud Creek watershed are characterized by rather extensive channel braiding. Several water systems occur in this area including sloughs, stagnant pools, oxbows, long slow moving pools, alternating patterns of riffles and large backwater pools. Flow is reduced in this region due to the complexity of the water systems.

b. Water Quality

The three different classifications of surface water pollution are point sources, where domestic or industrial wastewater is discharged from outfall sewers or drainage channels; non-point or diffuse sources, where pollutants dispensed on land by human activities are conveyed overland by rainwater or snowmelt; and background pollution derived from natural origin (decaying organic matter, sediment, and dissolved solids) is transported to tributary streams. Point sources of pollution are easily defined and the flow can be predicted from populations served by a given treatment system. Non-point sources of pollution include agricultural land drainage, nutrient-laden soil erosion, and urban storm drainage from industrial and residential communities. Pollution from natural origins is a function of site geology and topography, vegetative cover, and climatic conditions.

Point Sources of Pollution

Point Source discharges to Mud Creek and eventually the proposed reservoir are considered in this section. Current major influent sources are shown schematically in Exhibit II.3. The prime source of pollutants are the wastewater treatment plants (WWTP) which discharge into these streams. A list of these WWTP's is given in Table II.2 showing their receiving streams and their permitted limits.

TABLE II.2

LAKE EASTEX REGIONAL PLANNING STUDY
POINT SOURCE POLLUTION UPSTREAM OF PROPOSED EASTEX LAKE

Sewage Treatment	Permitted Daily Average			Discharge to:
	Flow (mgd)	BOD (mg/l)	TSS (mg/l)	
Hunter Hill	.0200	10	15	Hill Creek, Lake Tyler
Whitehouse	.68	20	20	Blackhawk Creek, Mud Creek
McKinney & Moore	.0678	20	20	Blackhawk Creek, Mud Creek
Arp	.0825	20	20	Kickapoo Creek, Mud Creek
Quail Run	.0413	20	20	Brier Branch, West Mud, Mud Creek
Cedar Valley Estates	.0300	20	20	Henshawk, West Mud, Mud Creek
Tall Timbers Estates	.0700	20	20	West Mud Creek, Mud Creek
Tyler Southside	9.000	20	20	West Mud Creek, Mud Creek
Stone Ridge	0	20	20	West Mud Creek, Mud Creek
Troup	.0700	20	20	Caney Creek, Mud Creek
	.3080			

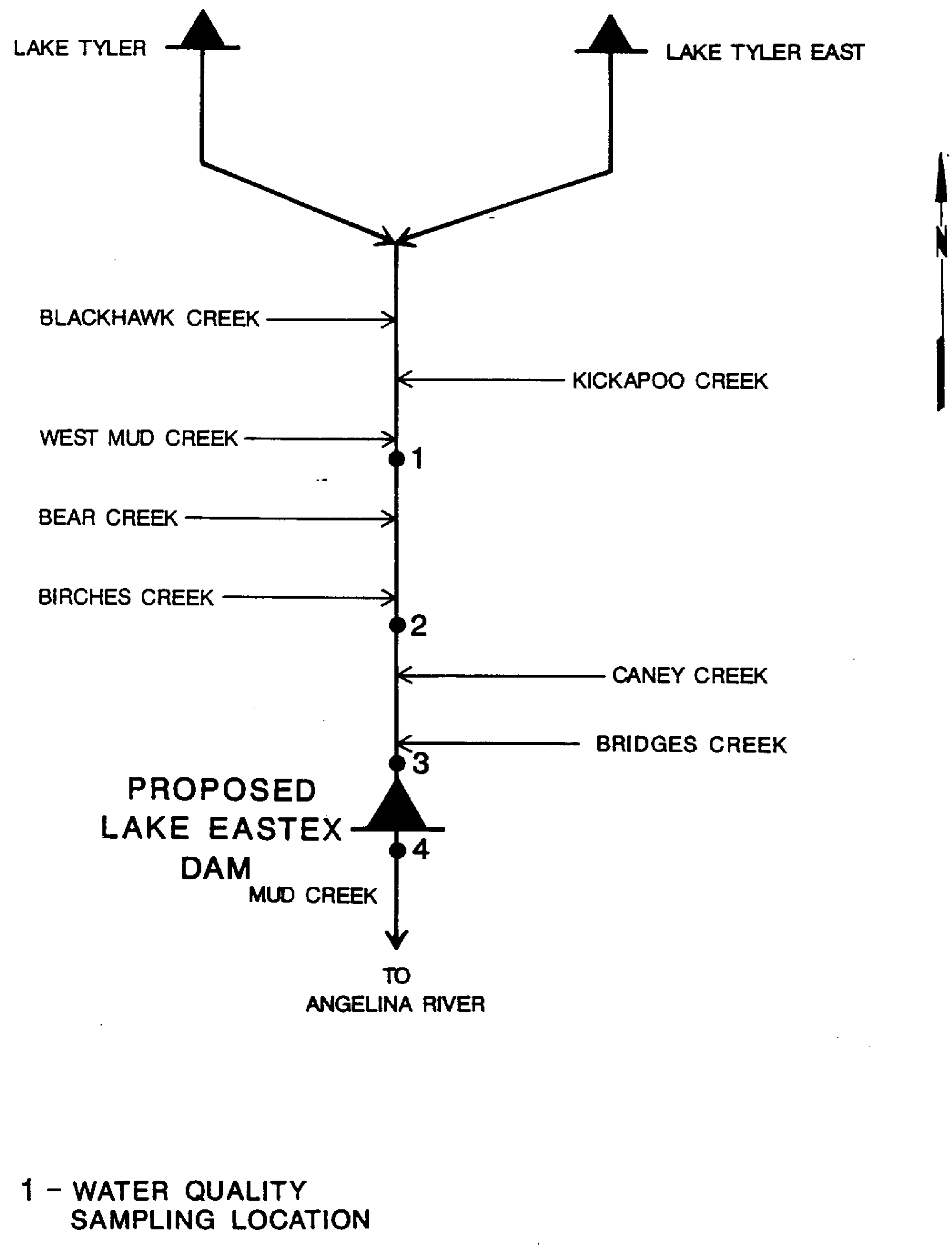


Exhibit II.3

SCHEMATIC OF INFLUENT SOURCES
LAKE EASTEX WATER QUALITY SAMPLING

Mud Creek is similar to many other East Texas streams experiencing periodic low flow conditions in certain segments. It will act as a conveyance route carrying incoming flows from adjoining tributaries to the proposed Lake Eastex. As such, its water quality is a function of fluctuations in the incoming quality and quantity of individual streams.

Lake Tyler and Lake Tyler East provide public water supply needs of the City of Tyler. Prairie Creek supplies the majority of the water to Lake Tyler but Hill and Gilley Creeks also flow into the impoundment. Lake Tyler East receives the majority of its water from Mud Creek and Caney Creek. The reservoirs are rated as high quality aquatic habitat suitable for contact recreation. The only existing point source discharge originates from Hunter Hill WWTP and flows into Lake Tyler at a rate of 0.020 million gallons per day (mgd). There is no appreciable water quality degradation from this input of 10 milligrams per liter (mg/l) BOD and 15mg/l Total Suspended Solids (TSS).

The WWTP for the City of Whitehouse discharges 0.68 mgd into the Blackhawk Creek. The permit calls for an average daily flow not to exceed 0.68 mgd with effluent limits of 20 mg/l BOD_5 and 20 mg/l TSS. The other municipal effluent discharge of 0.0675 mgd comes from McKinney and Moore WWTP.

The primary flow in West Mud Creek consists of effluents from Tyler Southside, Tall Timbers Estate, and Stone Ridge Wastewater Treatment Plants. The water quality of West Mud Creek is largely controlled and impacted by a 9.0 mgd average flow from the Tyler Southside WWTP. The wastewater treatment plants of Tall Timber Estates and Stone Ridge are each allowed an average discharge of 0.07 mgd. All the above three plants are permitted a daily average of 20 mg/l BOD and 20 mg/l TSS discharge in their effluents. Two indirect discharges of 0.03 mgd from Cedar Valley Estate and 0.0413 mgd from Quail Run into West Mud Creek have daily average concentrations of 20 mg/l BOD and 20 mg/l TSS.

Downstream from the confluence of West Mud Creek and Mud Creek, two additional municipal point sources of pollution exist. The City of Arp WWTP discharges 0.0825 mgd into Kickapoo Creek and 0.3080 mgd flows into Caney Creek from the City of Troup WWTP. The permitted effluent concentrations for each of these WWTP are 20 mg/l BOD and 20 mg/l TSS.

There are no industrial discharges within the contributing watershed. Poly-Cycle Industries, Inc. has a plant in Tecula. This plant recycled lead-acid batteries and had a permit to operate a hazardous waste management facility. There is no known or permitted point source discharges from their plant at the present time.

Non-Point Sources of Pollution

The land use in the watershed of the proposed Lake Eastex is predominantly agricultural and pasture land with small urban areas mainly in Smith County.

Urban Runoff - Non-point source pollutants commonly found in urban runoff are gasoline, lawn fertilizers, cleaning solvents and detergents, dust and other debris. Although urban runoff contains a large number of pollutants, the quantity of these pollutants is usually relatively small. The largest urbanized area within the contributing watershed of Lake Eastex is the Tyler area.

Forestry and Agricultural Runoff - Forest resources constitute about half of the total land area within the drainage basin. Early practices of selective timbering have changed dominant floral characteristics. More recent clear cutting and replanting of pine has created pine plantations. Previous agricultural row crop development efforts have failed because of the presence of sandy-soils. Present agricultural practices are dominated by improved pasture. Runoff from these areas contains sediment, nutrients, organics and salts. Generally, runoff from pasture areas contains increased levels of these pollutants over the natural conditions but should not be as severe as croplands.

Industrial Runoff - The only known diffuse source of industrial runoff in the drainage basin is a lead-acid battery recycling plant located in Tecula and belonging to Poly-Cycle Industries, Inc. The plant started operating as a hazardous waste management facility in 1983. Inspection in 1986 by the Texas Water Commission has revealed non-compliance of this plant with operational requirements of applicable regulatory statutes. A series of water, fish and sediment analyses was conducted by the Texas Parks and Wildlife Department and the Angelina and Neches River Authority (ANRA). The results of these investigations are available from the Office of Attorney General. There are currently two lawsuits against Poly-Cycle or its owners, one civil and one criminal. The Poly-Cycle plant is inactive at the present time and it is unlikely that it would go back into operation. Evidence from pre- and post-storm sampling shows no indication that Mud Creek has been effected by discharges from Poly-Cycle plant and no adverse impact on Lake Eastex is foreseen.

The Texas Water Commission, as well as the Environmental Protection Agency (EPA), are actively pursuing the possibility of listing this property as a Superfund site. The steps involved in this process are briefly described as follows:

a. Site Discovery and Preliminary Assessment. This step is used to determine the extent and level of contamination at the site as well as the future steps involved in the listing process for inclusion on the National Priority List. Preliminary assessment at the Poly-Cycle site has been completed and has indicated the need for a pre-remedial emergency response and the pursuit of future steps involved in the listing process for inclusion on the National Priority List. The pre-remedial emergency response, an action independent of the listing process, is designed to mitigate, on an emergency basis, the potential threats from direct contact with contaminated material, runoff of contaminated material with surface water, and inhalation of airborne contaminated particles. The pre-remedial emergency response is currently underway at the Poly-Cycle site. At this location, the emergency action consists of the removal of contaminated material onsite, removal of contaminated material which may have migrated offsite, and fencing the site to discourage unnecessary access to the property.

b. Screening Site Inspection. In addition to the pre-remedial response, current activity includes a screening site inspection. Information from this step in the process is used to determine the next actions at the site. Possible alternatives include dropping the site from further investigation, referring the site to the appropriate state agency, or conducting a site listing inspection. The report for the screening site investigation is in the final stage of completion and may be finished prior to 1992.

c. National Priority List Ranking. If the screening site investigation report recommends a listing site inspection, an inspection would be conducted in order to gather information to be used in ranking the site on the National Priority List. Inclusion on the National Priority List would mean the site would eventually be remediated by the Superfund process.

The Superfund remedial process, as in the listing process described above, involves several stages. These stages can be outlined as follows:

a. Remedial Investigation (RI) and Risk Assessment (RA). The results from the RI and RA are used to more fully characterize the site and support a Feasibility Study which follows.

b. Feasibility Study. The development and evaluation of remedial alternatives is accomplished during the Feasibility Study. One of the remedial alternatives is selected as the remedial method to be used at the site under consideration.

c. Remedial Design. The next stage is the Remedial Design (RD) stage. The plans and specifications required to implement the selected remedial method are developed during this stage.

d. Remedial Action. The construction or implementation of the remediation for the site is accomplished during the Remedial Action stage.

e. Post Remediation. Upon completion of the remedial action, efforts associated with post-remediation operation and maintenance is begun. This effort involves long term care-taker activities which generally includes ongoing monitoring and maintenance of the monitoring equipment.

Although the processes described above for the inclusion of the site on the National Priority List have been initiated, evidence from our sampling shows no indication that Mud Creek has been affected by discharges from the Poly-Cycle site. This information coupled with the emergency response action should confirm that the Poly-Cycle site will have little or no effect on the proposed reservoir development plans.

Previous Studies

The five-county study area of the proposed Lake Eastex covers Angelina, Cherokee, Nacogdoches, Rusk and Smith counties. Several previous investigations of the area have focused on a variety of parameters influencing the overall quality of regional water supply reservoirs as well as other water courses. Conventional water quality parameters such as Dissolved Oxygen and Total Suspended Solids were compared with Texas Surface Water Quality Standards to establish baseline data, monitor water quality with time and evaluate the impact of manmade activities on the resources. In the following discussions, results of the literature review, and the water sampling and analysis conducted by LAN and the ANRA have been reviewed in order to predict potential impact on the proposed Lake Eastex.

Cox (1976) used benthic organisms to assess the prevailing water quality of the Angelina River between the junction with Sam Rayburn Reservoir and its headwaters. Since different species have different tolerance levels to the perturbations in the aquatic environment, the use of diversity values of the entire community of benthic macroinvertebrates provided a more accurate assessment of present, as well as previous, stresses on the aquatic population. Data was analyzed by considering the dominance of Oligochaeta and Chironomidae as indications of poorer water quality and the dominance of Odonata and Ephemeroptera as indicators of good water quality. It was concluded that the stations downstream of WWTPs had the poorest water quality of all of the stations sampled. The station downstream from the confluence of Mud Creek with Angelina River and the station downstream from the confluence of LaNana Bayou with the Angelina River showed relatively good water quality.

In a study on the physicochemical conditions of Lakes Tyler and Tyler East, Wilson (1983) attempted to relate the differences between two reservoirs with land use within the drainage basin of each impoundment. Using a variety of trophic indices, he suggested that both Lake Tyler and Lake Tyler East can be classified as mesotrophic with nitrogen acting as a limiting factor on productivity. Surface runoff from a portion of Chapel Hill Oil Field located within the drainage basin of the eastern reservoir was cited as a possible source of elevated concentrations of sodium and chloride in Lake Tyler East.

In an intensive water quality monitoring survey done in 1984, the Texas Department of Water Resources (TDWR, currently Texas Water Commission, TWC) studied the upper Angelina River extending from the Shawnee Creek Confluence in Rusk County to the Paper Mill Creek confluence in Angelina County (TDWR, 1985). Although this information is now seven years old, and conditions may have changed, this report is the most recent information available. Historical data indicates relatively good water quality for the region (Segment 0611), but periodic violations of DO criterion observed in the lower portion of the segment have led to it being classified as water quality limited, ranking 30th among 311 designated segments in Texas with respect to need for stringent water quality controls. This study was a follow-up to a similar survey by TDWR in 1977 to evaluate the impact of changes since then.

Comparison with the data from the 1977 study shows a general improvement throughout the segment. In 1977, two DO sags occurred, one downstream from Keyes Creek, which transports effluent from the City of Jacksonville. In the 1984 study, no DO sag was observed below Keyes Creek apparently due mainly to a decreased waste load from Keyes Creek. The minimum 1977 DO concentration at a station downstream from the City of Nacogdoches discharge was critically low (0.8 mg/L, 9.8% saturation), whereas in 1984 no value below 5.9 mg/L (71 percent saturation) was observed and there was virtually no oxygen sag below the WWTP outfall. In LaNana Bayou, a dramatic improvement in water turbidity was observed in 1984 with a decrease of 91 percent BOD_5 load at the mouth of the bayou since 1977. Although the water quality remained below minimum standards, conditions in Paper Mill Creek had improved since 1977. A comparative listing of BOD loading to the upper Angelina River is provided in Table II.3. In summary, 1984 DO levels in seven of the eleven mainstream stations common to both surveys were greater which indicates a degree of improvement in overall water quality since 1977, probably due to reduced BOD loading to the Angelina river.

TABLE II.3

RESULTS OF BOD_5 LOADINGS TO THE UPPER ANGELINA RIVER IN AUGUST 1977 AND SEPTEMBER 1984 STUDIES CONDUCTED BY TEXAS DEPARTMENT OF WATER RESOURCES

Source	BOD_5 Loading (kg/day)		
	August 1977	September 1984	% Reduction
St. Regis Paper Mill (Champion International Corp.)	933.5	792.3	18.0
City of Nacogdoches	827.4	82.4	90.0
Mud Creek	28.6	26.4	7.7
LaNana Bayou	102.2	9.2	91.0
Paper Mill Creek	1,409.3	484.4	65.6
Total Loading from 3 Tributaries	1,540.1	520.0	66.2

West Mud Creek was surveyed by the Texas Water Commission (Weber, 1988) to provide an updated database needed for water quality management actions. The results indicated a depression of DO levels for at least 15.1 km (9.4 miles) downstream from the Tyler Southside WWTP. Reduced nitrogen was suggested as the primary cause of this condition. Concentrations of ammonia in the effluent were at levels shown to be toxic to fresh water aquatic life in other studies. Because of high fecal coliform count from unknown sources, the stream was deemed unsafe for contact recreation uses.

Existing Water Quality

A recent water quality evaluation was conducted by Lockwood, Andrews & Newnam, Inc. and the Angelina & Neches River Authority to investigate the suitability of the water from the proposed Lake Eastex for various end uses. Two sampling programs were designed and the samples were analyzed for a variety of water quality parameters. Sampling event number one, conducted on February 26, 1990, took place after a storm to quantify the impact of non-point sources of pollution. The second sampling event, conducted on June 25, 1990, was performed during low flow, dry weather conditions to capture the impact of point discharges upstream of the proposed reservoir.

The sampling locations are shown in Exhibit II.3. The rationale for the selection of sampling stations were as follows:

a. Station number one will check the influence of West Mud Creek, Kickapoo Creek, Blackhawk Creek and the discharge from Lake Tyler and Lake Tyler East. This is also the location of sample collection during the 1977 study.

b. Station number two will check the influence of Bear Creek and Birches Creek. FM 2064 at Mud Creek is the location of a sampling station during the 1977 study.

c. Station number three will check the influence of Caney Creek and Bridge Creek, and is the location of a previous sample collection station.

d. Station number four is south of the proposed reservoir and will give a reasonable indication of the overall quality of water to be discharged from the reservoir. There is also data for the station from a previous study.

e. Station number five (not shown on Exhibit II.3) is located at the Angelina River and US 59 intersection. This station location allows for a check on the probable water quality should the Angelina River be used as a conveyance mechanism to the participants in the lower portion of the study area.

The analytical parameters selected for measurement were indicators of toxicity (heavy metals and pesticides), eutrophication (phosphorus and nitrogen), treatability (DO, pH, turbidity, TSS and TDS), and assimilation capacity of the receiving streams (BOD, TOC). The results of normal and wet-weather flow sampling events are provided in Table II.4. Measured parameters show no elevated concentrations of physicochemical and biological indicators beyond recommended criteria for surface water quality. BOD levels are within acceptable limits and dissolved oxygen concentrations show no sign of adverse impact on the streams.

Table II.4

LAKE EASTEX WATER QUALITY DATA FOR NORMAL AND WET-WEATHER FLOW STORM SAMPLING EVENTS

				Wet-Weather Flow Sampling February 26, 1990					Normal Flow Sampling June 25, 1990				
Parameter	Units	Texas* Drinking Water Standards	Recommended Maximum for Raw Water Supply**	Mud Creek FM 347 Site 1	Mud Creek FM 2064 Site 2	Mud Creek U.S. 79 Site 3	Mud Creek SH 204 Site 4	Angelina River U.S. 59 Site 5	Mud Creek FM 347 Site 1	Mud Creek FM 2064 Site 2	Mud Creek U.S. 79 Site 3	Mud Creek SH 204 Site 4	Angelina River U.S. 59 Site 5
Flow	CFS	-	-	221	382	514	599	1750	23.0	25.2	30.4	68.5	550
Color	CU	15	-	45.0	70.0	70.0	60.0	60.0	30.0	35.0	45.0	100	90.0
Turbidity	NTU	1	-	15.0	20.0	20.0	21.0	17.0	26.0	30.0	36.0	78.0	65.0
pH		≥7.0	6.5 - 8.5	6.87	6.09	7.12	6.9	6.62	7.18	7.25	7.50	7.43	6.89
Temperature	°F	-	-	59.5	59.7	64.9	57.9	55.0	83.8	81.5	88.2	87.4	79.9
BOD_5	mg/l			2.5	1.4	1.3	<1.7	<1.7	1.3	1.4	1.7	2.5	1.7
TDC	mg/l			4.9	5.0	5.6	7.2	6.0	5.0	5.0	5.7	5.3	5.4
Dissolved Oxygen	mg/l			7.9	8.8	8.3	7.6	8.6	8.41	8.75	9.29	8.30	6.55
Fecal Coliform	N/100ml			72	117	40	107	460	90	43	114	89	142
Chloride	mg/l	300	250	16.0	21.0	17.0	15.0	22.0	23.0	23.0	23.0	19.0	15.0
TDS	mg/l	1000	1000	156	156	212	127	73.3	140	139	147	169	119
Iron	µg/l	300	300	920	1100	1400	1700	1700	1700	2400	2600	4000	4900
Manganese	µg/l	50	50	51.0	58.0	40.0	46.0	40.0	130	130	140	370	300
Zinc	µg/l	5000	5000	14.0	15.0	16.0	11.0	12.0	10.0	6.9	32.0	17.0	<6.0
Sulfate	mg/l	300	250	25.0	28.0	34.0	38.0	35.0	25.0	25.0	30.0	31.0	23.0
Alkalinity, $CaCO_3$	mg/l			14.0	6.0	12.0	12.0	14.0	33.0	33.0	32.0	42.0	32.0
Hardness	mg/l			27.0	31.0	30.0	37.0	35.0	49.0	48.0	51.0	46.0	40.0
Arsenic	µg/l	50	50	<3.0	<3.0	<3.0	<3.0	<3.0	<6.0	<6.0	<6.0	<6.0	<6.0
Barium	µg/l	1000	1000	41.0	45.0	39.0	47.0	50.0	57.0	65.0	60.0	82.0	63.0
Cadmium	µg/l	10	10	<5.0	<5.0	<5.0	<5.0	<5.0	<4.0	<4.0	<4.0	<4.0	<4.0
Chromium, Hex	µg/l	50	50	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	µg/l	50	50	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	3.4	<3.0

C. WETLANDS AND FLOODPLAINS

1. Wetlands

a. Overview

Federal mandates have been recently issued which call for project review and mitigation (when necessary) when wetlands are impacted. Until fairly recently, several agencies produced their own guidelines and enforced them independently. The traditional lead agency for wetland-related regulation is the U.S. Army Corps of Engineers (COE). Beginning with the Rivers and Harbors Act of 1899 (33 USC 403) the COE has developed policy which operated essentially under a directive of navigational servitude. Under this navigational focus, the main concerns were with obstructions of waterways and disposal of refuse within navigable waters of the U.S. In the late 1960's, wetlands policy began to derive justification and direction from an environmental basis, as well as a navigational basis. Lawsuits filed in the late 1960's led to the drafting and passage of the Federal Water Pollution Control Act (33 USC 403) of 1972. This act included provisions for the permitting of dredge and fill activities in navigable waters (Section 404, which now corresponds to Section 1344 of the Clean Water Act). Under this permitting process, the Secretary of the Army, through the Chief of Engineers, issues permits for the discharge of dredged or fill materials into waters of the U.S., including wetlands. The COE also issues permits under Section 10 of the Rivers and Harbors Act (33 USC 403), for filling, dredging and construction in certain wetlands.

When the Section 404 permitting process is initiated, several other federal agencies automatically become involved. First of all, the Environmental Protection Agency (EPA) maintains program oversight (over the COE) and makes final determinations as to the extent of Clean Water Act jurisdiction. Secondly, the Fish and Wildlife Coordination Act (48 Stat. 401 as amended 16 USC 661 et seq.) mandates review of 404 Permits by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (Wetland Training Institute, 1989).

Prior to 1989, each agency responsible for wetland permitting review and oversight [COE, EPA, USFWS and Soil Conservation Service (SCS)] established their own wetland delineation manuals and procedures. In early 1989, after a series of meetings, the COE, EPA, USFWS and SCS formally adopted an interagency manual recommended for identifying and delineating wetlands in the U.S. This is known as the Unified Federal Method for wetland delineation. This method establishes mandatory technical criteria for vegetation, soils, and hydrology which must be met in order to delineate an area as a jurisdictional wetland. This method hinges upon the definition which describes wetlands as areas which under normal circumstances have hydrophytic vegetation, hydric soils, and wetland hydrology (Wetlands Training Institute, 1989). Immediately prior to publication of this report, directives were issued by the Chief of the Regulatory Branch of the COE Operations, Construction and Readiness Division (based on the Energy and Water Development Appropriations Act of 1992) to suspend use of the 1989 manual and revert to procedures in place in 1987. This was due to concerns relative to the application of the procedures outlined in the 1989 manual.

TABLE II.4 (Continued)

				Wet-Weather Flow Sampling February 26, 1990					Normal Flow Sampling June 25, 1990				
Parameter	Units	Texas* Drinking Water Standards	Recommended Maximum for Raw Water Supply**	Mud Creek FM 347 Site 1	Mud Creek FM 2064 Site 2	Mud Creek U.S. 79 Site 3	Mud Creek SH 204 Site 4	Angelina River U.S. 59 Site 5	Mud Creek FM 347 Site 1	Mud Creek FM 2064 Site 2	Mud Creek U.S. 79 Site 3	Mud Creek SH 204 Site 4	Angelina River U.S. 59 Site 5
Mercury	µg/l	2.0	2.0	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Selenium	µg/l	10	10	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Silver	µg/l	50	50	<5.0	<5.0	<5.0	<5.0	<5.0	<7.0	<7.0	<7.0	<7.0	<7.0
Ammonia, N	mg/l			<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.09	0.15	0.12	0.08
Orthophosphate, P	mg/l			0.12	0.10	0.08	0.07	0.05	0.30	0.24	0.15	0.21	0.12
Phosphorous	µg/l			0.15	0.12	0.21	0.09	0.08	0.40	0.24	0.22	0.31	0.19
2,4 - D	µg/l	100	100			<3.12		<3.1					
2,4,5 - TP	µg/l	10	100			<0.62		<0.62					
Diazinon	µg/l					<0.61		<0.65					
Malathion	µg/l					<0.49		<0.52					
Parathion	µg/l					<0.30		<0.33					
Chlordane	µg/l					<9.84		<10.44					
Lindane	µg/l	4.0	56			<1.23		<1.31					
Methoxychlor	µg/l	100	35			<5.33		<5.66					
Toxaphene	µg/l	5.0	5.0			<19.7		<20.9					

* Texas Department of Health Water Standards (1989).
** Recommended Maximum Concentrations from Tables 3-7, 3-8, 3-9 and 3-10 of CEO Engineering Manual EM 1110-2-503 (25 January 1984).

The results for iron and manganese show levels above standards and recommended maximums. This is due to the fact that limits established in Standards and Criteria are based on dissolved concentration of these constituents. Addition of concentrated HNO_3 called for in the water quality sampling plan reduced the pH to less than 2.0. Under these reducing conditions colloidal and organic iron complexes as well as iron present in silts and clays in suspension will be dissolved. As such, the results shown are for total iron and manganese and are within acceptable limits of 1-10 ms/l total iron and 1-2 mg/l total manganese (Benefield, Larry D. et al.). Furthermore, total dissolved solids levels, which measure dissolved iron and manganese in addition to carbonates, chlorides, sulfates, phosphates, and several other substances are below the recommended levels for the sum of only iron and manganese.

Pesticide results show no signs of contamination from land application of these constituents. The level for all pesticides measured are below applicable regulations. With respect to Toxaphene, a limit of 5 mg/l is shown for both Texas Drinking Water Standards and Recommended maximums for raw water supplies. The results from two sampling stations for which pesticides were analyzed indicate a detectable limit of instrumentation to be around 20 mg/l. This could potentially imply a concentration anywhere between 0 and 20 mg/l. However, since different organic pesticides are usually applied in a watershed of this size and because the levels observed for other pesticides of similar characteristics are acceptable, there should be no concern over a high detection limit for toxaphene and there is no indication of contamination present. Had there been elevated concentrations of other pesticides, further investigation would have been needed.

2. Groundwater

There are three significant water bearing geological formations in the proposed reservoir's watershed, the Carrizo Sand, Wilcox, and Queen City aquifers. All three aquifers directly underlay the proposed reservoir site. A portion of the proposed reservoir, from U.S. Highway 79 south to the dam site, directly overlies the outcrop area of the Queen City aquifer. The water contained in the Queen City aquifer is considered to be fresh in the outcrop area, although a few shallow dug wells have been found to contain highly mineralized water. Normally, wells pumping water from the Queen City aquifer have a concentration of dissolved solids of less than 200 parts per million (ppm) and a hardness ranging between 20 and 100 ppm.

Carrizo Sand contains fresh water with dissolved solids concentrations of 300 to 700 ppm and a hardness of 20 to 40 ppm everywhere except in its outcrop area being typical. However, south of the watershed, in Angelina County the Carrizo Sand is found to contain water of not less than 1,000 ppm. Wells in and near the outcrop area have shown variable hardness, with some wells having over 200 ppm. The outcrop area of the Carrizo is east of the proposed reservoir watershed.

In the watershed of the proposed reservoir, the Wilcox formation contains fresh to brackish and salty water. The total dissolved solids concentration increases with the depth of the formation. Similar to the Carrizo Sand, hardness in the Wilcox wells are highly variable with concentrations ranging from 20 to over 300 ppm.

C. WETLANDS AND FLOODPLAINS

1. Wetlands

a. Overview

Federal mandates have been recently issued which call for project review and mitigation (when necessary) when wetlands are impacted. Until fairly recently, several agencies produced their own guidelines and enforced them independently. The traditional lead agency for wetland-related regulation is the U.S. Army Corps of Engineers (COE). Beginning with the Rivers and Harbors Act of 1899 (33 USC 403) the COE has developed policy which operated essentially under a directive of navigational servitude. Under this navigational focus, the main concerns were with obstructions of waterways and disposal of refuse within navigable waters of the U.S. In the late 1960's, wetlands policy began to derive justification and direction from an environmental basis, as well as a navigational basis. Lawsuits filed in the late 1960's led to the drafting and passage of the Federal Water Pollution Control Act (33 USC 403) of 1972. This act included provisions for the permitting of dredge and fill activities in navigable waters (Section 404, which now corresponds to Section 1344 of the Clean Water Act). Under this permitting process, the Secretary of the Army, through the Chief of Engineers, issues permits for the discharge of dredged or fill materials into waters of the U.S., including wetlands. The COE also issues permits under Section 10 of the Rivers and Harbors Act (33 USC 403), for filling, dredging and construction in certain wetlands.

When the Section 404 permitting process is initiated, several other federal agencies automatically become involved. First of all, the Environmental Protection Agency (EPA) maintains program oversight (over the COE) and makes final determinations as to the extent of Clean Water Act jurisdiction. Secondly, the Fish and Wildlife Coordination Act (48 Stat. 401 as amended 16 USC 661 et seq.) mandates review of 404 Permits by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (Wetland Training Institute, 1989).

Prior to 1989, each agency responsible for wetland permitting review and oversight [COE, EPA, USFWS and Soil Conservation Service (SCS)] established their own wetland delineation manuals and procedures. In early 1989, after a series of meetings, the COE, EPA, USFWS and SCS formally adopted an interagency manual recommended for identifying and delineating wetlands in the U.S. This is known as the Unified Federal Method for wetland delineation. This method establishes mandatory technical criteria for vegetation, soils, and hydrology which must be met in order to delineate an area as a jurisdictional wetland. This method hinges upon the definition which describes wetlands as areas which under normal circumstances have hydrophytic vegetation, hydric soils, and wetland hydrology (Wetlands Training Institute, 1989). Immediately prior to publication of this report, directives were issued by the Chief of the Regulatory Branch of the COE Operations, Construction and Readiness Division (based on the Energy and Water Development Appropriations Act of 1992) to suspend use of the 1989 manual and revert to procedures in place in 1987. This was due to concerns relative to the application of the procedures outlined in the 1989 manual.

No field delineations of wetlands have taken place in support of this study. The Unified Federal Method, mentioned above, provides specific data regarding individual boundaries for each wetland system. Although a field delineation did not take place, rough area calculations based on the USFWS's National Wetlands Inventory (NWI) (1980) are available. An analysis of the NWI map units reveal that between 35 and 50 percent of the normal flood pool of the proposed Lake Eastex may be currently occupied by wetlands of varying classification. A discussion of the wetland classifications designated by the NWI is presented below.

b. Classifications

The following wetland classification discussion focuses upon the area of proposed inundation only. For the purposes of this general planning study, wetlands will be classified and discussed based on the USFWS System as proposed by Cowardin et al. (1979). Approximate wetland boundaries and locations are illustrated in Exhibit II.4 (in attached map pocket). The sources for the mapping are the Troup West, Troup East, Tecula, Griffin, Jacksonville East and New Summerfield sheets of the National Wetlands Inventory (1980).

In general, the Cowardin (1979) system differentiates between wetland resources upon the basis of ecological systems, subsystems and classes. Systems are broad groupings of wetland habitats which share similar hydrology, geomorphology, chemistry, and biological characteristics. The major systems include Marine, Estuarine, Riverine, Lacustrine, and Palustrine. Within the proposed maximum flood pool of Lake Eastex, only Palustrine and Riverine systems occur. Table II.5 illustrates the potential subsystems and classes of the Palustrine and Riverine systems.

For this report, the different mapping units found on the NWI sheets have been analyzed and tabulated. This method only provides general information as to the types and extent of wetland ecosystems in the study area. A very basic hierarchial approach will be followed. The goal of this approach is to characterize the general ecological trend within wetland systems in the study area. The following description will be divided by the two ecological systems which occur - riverine and palustrine. Only the dominant mapping units will be described in text, however; all units are listed and described in tabular form (Table II.6).

TABLE II.5
POTENTIAL SUBSYSTEMS AND CLASSES OF PALUSTRINE AND RIVERINE WETLAND SYSTEMS

System	Subsystem	Class
Palustrine	None	Rock Bottom Unconsolidated Bottom Aquatic Bed* Unconsolidated Shore Moss-Lichen Wetland Emergent Wetland* Scrub-Shrub Wetland* Forested Wetland* Open Water*
Riverine	Lower Perennial	Rock Bottom Unconsolidated Bottom Aquatic Bed Rocky Shore Unconsolidated Shore Emergent Wetland Open Water*
	Upper Perennial	Rock Bottom Unconsolidated Bottom Aquatic Bed Rocky Shore Unconsolidated Shore
	Intermittent	Streambed*

*Occurs within Proposed Maximum Pool of Lake Eastex.
Source: Cowardin et al. (1980).

TABLE II.6
WETLAND MAPPING UNITS FOUND WITHIN THE
PROPOSED MAXIMUM FLOOD POOL OF EASTEX RESERVOIR.

MAPPING UNIT	ECOLOGICAL SYSTEM	ECOLOGICAL SUBSYSTEM	CLASS	SUBCLASS	WATER REGIME	SPECIAL MODIFIER
R2OWH	Riverine	Lower Perennial	Open Water	Unknown Bottom	Permanent	
R4SBC	Riverine	Intermittent	Streambed		Seasonal	
R20WHX	Riverine	Lower Perennial	Open Water	Unknown Bottom	Permanent	Excavated
R4SBCX	Riverine	Intermittent	Streambed		Seasonal	Excavated
PF01A	Palustrine	None	Forested	Broad-leaved Deciduous	Temporary	
PF01C	Palustrine	None	Forested	Broad-leaved Deciduous	Seasonal	
PF06F	Palustrine	None	Forested	Deciduous	Semipermanent	
$\mathrm{P}\frac{\mathrm{FO}}{\mathrm{SS}}\mathrm{1A}$	Palustrine	None	$\frac{\text{Forested}}{\text{Scrub/Shrub}}$	Broad-leaved Deciduous	Temporary	
PF06C	Palustrine	None	Forested	Deciduous	Seasonal	
$\mathrm{P}\frac{\mathrm{FO}}{\mathrm{SS}}\mathrm{1C}$	Palustrine	None	$\frac{\text{Forested}}{\text{Scrub/Shrub}}$	Broad-leaved Deciduous	Seasonal	
$\mathrm{P}\frac{\mathrm{FO}}{\mathrm{SS}}\mathrm{6F}$	Palustrine	None	$\frac{\text{Forested}}{\text{Scrub/Shrub}}$	Deciduous	Semipermanent	
$\mathrm{P}\frac{\mathrm{FO1}}{\mathrm{EM5}}\mathrm{A}$	Palustrine	None	$\frac{\text{Forested}}{\text{Emergent}}$	Broad-leaved Deciduous/ Narrow-leaved Persistent	Temporary	
$\mathrm{P}\frac{\mathrm{FO1}}{\mathrm{AB7}}\mathrm{F}$	Palustrine	None	$\frac{\text{Forested}}{\text{Aquatic Bed}}$	Broad-leaved Deciduous/ Unknown Surface	Semipermanent	
PFO2Fh	Palustrine	None	Forested	Needle-leaved Deciduous	Semipermanent	Diked Impounded
$\mathrm{P}\frac{\mathrm{FO5}}{\mathrm{OW}}\mathrm{H}$	Palustrine	None	$\frac{\text{Forested}}{\text{Open Water}}$	$\frac{\text{Dead}}{\text{Unknown Bottom}}$	Permanent	
PF05Hh	Palustrine	None	Forested	Dead	Permanent	Diked Impounded
$\mathrm{P}\frac{\mathrm{SS1}}{\mathrm{EM5}}\mathrm{A}$	Palustrine	None	$\frac{\text{Scrub/Shrub}}{\text{Emergent}}$	Broad Leaved Deciduous Narrow Leaved Deciduous		
PPS1A	Palustrine	None	Scrub/Shrub	Broad Leaved Deciduous		
PSS1C	Palustrine	None	Scrub/Shrub	Broad Leaved Deciduous		
$\mathrm{P}\frac{\mathrm{SS1}}{\mathrm{EM5}}\mathrm{C}$	Palustrine	None	$\frac{\text{Scrub/Shrub}}{\text{Emergent}}$	Broad Leaved Deciduous Narrow Leaved Deciduous		

TABLE II.6 (continued).

MAPPING UNIT	ECOLOGICAL SYSTEM	ECOLOGICAL SUBSYSTEM	CLASS	SUBCLASS	WATER REGIME	SPECIAL MODIFIED
$P\frac{SS1}{OW}H$	Palustrine	None	Scrub/Shrub Open Water	Broad-leaved Deciduous	Permanent	
$P\frac{SS1}{EM5}F$	Palustrine	None	Scrub/Shrub Emergent	Broad-leaved Deciduous Narrow-leaved Deciduous	Semipermanent	
$P\frac{SS1F}{OW}$	Palustrine	None	Scrub/Shrub Open Water	Broad-leaved Deciduous/ Unknown Bottom	Semipermanent	
PSS1F	Palustrine	None	Scrub/Shrub	Broad-leaved Deciduous	Semipermanent	
PEM5A	Palustrine	None	Emergent	Narrow-leaved Persistent	Semipermanent	
PEM5C	Palustrine	None	Emergent	Narrow-leaved Persistent	Semipermanent	
PEM5F	Palustrine	None	Emergent	Narrow-leaved Persistent	Semipermanent	
$P\frac{EM5F}{OW}$	Palustrine	None	Emergent Open Water	Narrow-leaved Persistent/ Unknown Bottom	Semipermanent	
$P\frac{EM5F}{AB7}$	Palustrine	None	Emergent Aquatic Bed	Narrow Leaved Persistent/ Unknown Surface	Semipermanent	
PAB7F	Palustrine	None	Aquatic Bed	Unknown Surface	Semipermanent	
$P\frac{AB7}{OW}Hx$	Palustrine	None	Aquatic Bed Open Water	Unknown Surface	Permanent	Excavated
$P\frac{AB7}{OW}H$	Palustrine	None	Aquatic Bed Open Water	Unknown Surface	Permanent	
$P\frac{ABF}{OW}$	Palustrine	None	Aquatic Bed Open Water	Unknown Bottom	Semipermanent	
PAB7Hh	Palustrine	None	Aquatic Bed	Unknown Surface	Permanent	Diked/ Impounded
POWH	Palustrine	None	Open Water	Unknown Bottom	Permanent	
POWHh	Palustrine	None	Open Water	Unknown Bottom	Permanent	Diked/ Impounded
POWHx	Palustrine	None	Open Water	Unknown Bottom	Permanent	Excavated
POWF	Palustrine	None	Open Water	Unknown Bottom	Semipermanent	

Source: National Wetlands Inventory, 1980.

Riverine Ecological System

Within the study area, the most important riverine wetland feature is the main channel and tributaries of Mud Creek. The majority of these mapping units are lower perennial open water channels which are of a permanent nature. Sections of the main channel are sometimes braided and often contain upland islands and palustrine wetlands within them. These mapping units are differentiated from the riverine system as may be observed on Exhibit II.4. Although graphically differentiated, the palustrine wetlands are greatly influenced by the riverine system due to frequent flooding events. These lower perennial subsystems tend to be low gradient streams with slow water velocities and mud substrates. Given frequent oxygen deficits, floral and faunal communities typical of still waters predominate.

Some riverine subsystems within the study area are intermittent. These channels flow off and on throughout the year leaving isolated pools or no surface water at all when not flowing. Some excavated portions of both lower perennial and intermittent riverine systems occur in the study area. Table II.6 provides a breakdown of all riverine mapping units occurring within the proposed maximum pool of Lake Eastex.

Palustrine Ecological System

Within ecological systems, subsystems may be defined; however, the palustrine system has no subsystems and is further subdivided only by class. Classes are delineated by substrate material and flooding regime or by vegetative life form. The palustrine wetlands in the proposed pool are composed of the following five classes: forested, scrub-shrub, emergent, aquatic bed, and open water. The most commonly mapped of these classes include the forested, open-water and emergent units. Brief descriptions of all classes occurring within the proposed Eastex maximum flood pool follow.

Forested Class - Forested wetlands can consist of all water regimes (except subtidal) but, by definition, are dominated by woody vegetation of six meters in height or greater. These wetlands typically contain a tree overstory, an understory of young trees or shrubs and a herbaceous level. The vast majority of forested wetlands in the Lake Eastex study area are of the broad-leaved deciduous subclass. A few units mapped as deciduous and dead occur as well as a single instance of the needle leaved deciduous subclass. Water regimes within the palustrine forested wetlands mapped vary from temporarily to permanently flooded. Only two forested wetlands mapped within the study area are diked/impounded.

Scrub-Shrub Class - Wetland areas dominated by woody vegetation shorter than six meters in height fall within the scrub-shrub class. The vegetation may be true shrubs, young trees or stunted trees/shrubs. The vast majority of scrub-shrub wetlands found within the study area may be characterized as broad-leaved deciduous with only a few occurrences of the narrow leaved deciduous subclass. These scrub-shrub communities may be successional, moving toward forested, or stable. Given the prevalent commercial timber practices in the area, such wetlands may often represent regenerating logged areas composed mainly of saplings. Water regimes in the scrub-shrub wetlands within the area vary from temporary to permanent.

Emergent Class - Palustrine wetlands of the emergent class tend to be dominated by erect, rooted, herbaceous hydrophytes excluding mosses and lichens. These wetlands typically support such perennial vegetation throughout the growing season in most years. All palustrine wetlands of the emergent class mapped in the study area are of the narrow leaved persistent subclass. The vast majority have temporary or seasonal water regimes, but a few are semipermanent.

Aquatic Bed Class - Relatively few wetlands of the aquatic bed class occur within the study area. This class is dominated by plants growing on or below the surface of the water throughout the growing season in most years. Subclasses occurring within the study area include unknown surface and unknown bottom. Water regimes are semipermanent and permanent with only a few modified by excavation or diking/impounding.

Open Water Class - Several mapping units within the study area fall within the class and subclass of open water and unknown bottom, respectively. These units mainly have permanent water regimes and several are diked/impounded or excavated.

2. Floodplains

Floodplains in the immediate vicinity of the proposed Lake Eastex are delineated in Exhibit II.4 (in attached map pocket). These floodplain delineations refer to the 100 year floodplain as identified by the Federal Emergency Management Agency's (FEMA 1981) Flood Insurance Rate Map. Note, the 100 year floodplain corresponds closely with the proposed normal operating pool of the proposed reservoir.

D. CLIMATE AND AIR QUALITY

1. Climate

Climatological information for the five-county study area is presented in Volume 1, Section II.B. of this study.

2. Air Quality

In compliance with the requirements of the Federal Clean Air Act of 1970 and the Clean Air Amendments of 1977, the U.S. Environmental Protection Agency (EPA) promulgated and adopted the National Ambient Air Quality Standards (NAAQS). Table II.7 lists the NAAQS for several pollutants.

The Texas Air Control Board (TACB) and other air pollution control agencies operate ambient air quality monitoring stations across the state. No air quality monitoring, however, is currently being done in the vicinity of the proposed Lake Eastex. The monitoring data closest to the site would not be representative of the Lake Eastex location.

The TACB stated that Cherokee, Rusk, and Smith Counties meet or exceed the NAAQS for Sulfur Dioxide, Carbon Monoxide, Nitrogen Dioxide, and Total Suspended Particulate. Comparisons against Ozone standards were unclassifiable.

Table II.7
NATIONAL AMBIENT AIR QUALITY STANDARDS

Primary Standards:	
Carbon Monoxide (CO)	(a) 9 ppm (10 milligrams/m^3) maximum 8 hr. concentration not to be exceeded more than once per year. (b) 35 ppm (40 milligrams/m^3) maximum 1 hr. concentration not to be exceeded more than once per year.
Oxides of Nitrogen (NO_2)	0.05 ppm (100 micrograms/m^3) annual arithmetic mean.
Ozone (0_3)	0.12 ppm (235 micrograms/m^3) expected daily exceedances averaging less than one per year over a three year period.
Suspended Particulate Matter	75 micrograms/m^3 - annual geometric mean 260 micrograms/m^3 - maximum 24 hour concentration.
Sulfur Dioxide	0.03 ppm (80 micrograms/m^3) - annual average 0.14 ppm (365 micrograms/m^3) - maximum 24 hour concentration.
Lead	1.5 micrograms/m^3 - average over a calendar quarter.

Notes:

1. The only difference between primary and secondary standards in the above list of highway related pollutants are those for suspended particulate matter and sulfur dioxide. The secondary standard for suspended particulate matter is an annual geometric mean of 60 ug/m^3. The secondary standard for sulfur dioxide is a 3-hour maximum of 0.5 ppm.
2. Federal Standards, other than those based on annual averages of annual geometric means, are not to be exceeded more than once per year.
3. National Primary Standards: The levels of air quality necessary to protect the public health with adequate margins of safety.
4. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

E. BIOLOGICAL ELEMENTS

This section provides a description of the baseline ecology of the study area. This analysis includes a discussion of the vegetative (Section II.E.1), wildlife (Section II.E.2), and aquatic resources (Section II.E.3) of the study area. The ecology of the project area is directly related to the geological and climatological information presented in Volume 1 of this report. Each of the disciplines (vegetative, wildlife, and aquatic resources) presented in this section are addressed both separately and in concert (as necessary) to provide an overview of the ecosystems in the study area. Each of the disciplines are addressed in the same general format which includes the following.

a. Regional Overview
b. Description of Community/Habitat Types
c. Discussion of Important Species and Habitats
d. Discussion of Unique or Sensitive Communities/Habitats.
e. Summary of Previous Studies Conducted in the Study Area.

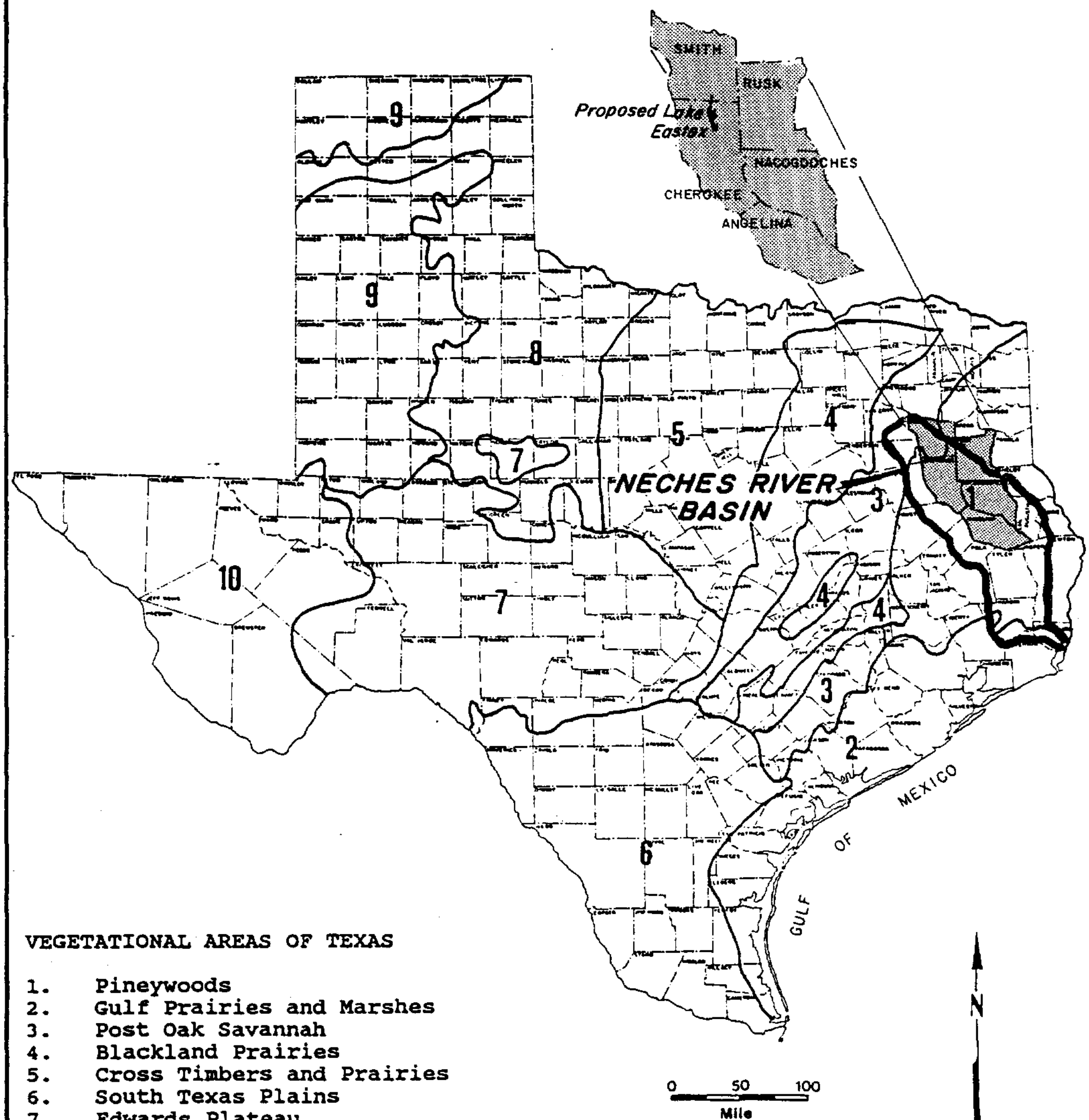
1. Vegetation

The purpose of this section is to provide a regional overview of the vegetation communities of potential occurrence in the five county study area. First, a regional overview of the major ecological communities provides a context for a more site specific discussion pertaining to the study area. Secondly, a general description of the vegetation communities occurring in the study area, including common species found in these areas, will be presented. This subsection will include a summary and comparison of previous studies conducted by the Texas Parks and Wildlife Department (TPWD) in 1984 (Frye and Curtis, 1990) and the Frasier Group, Inc. (Frasier) in 1988. Lastly, important plant species and unique or sensitive vegetation communities will be discussed, and a review of timber harvesting and agricultural practices of the study area will be provided.

a. Regional Overview

The proposed Lake Eastex project site and five county study area lie mostly within the Pineywoods, with the extreme northern portion of the drainage basin classified as Post Oak Savannah by Gould (1975). The project location in relation to the vegetational areas of Texas as described by Gould (1975) is presented in Exhibit II.5. The five county study area lies entirely within the Austroriparian biotic province as described by Blair (1950). The following discussion of the study area vegetation will begin with a regional scope and then narrow to the plant community level.

The Pineywoods is typified by pine and mixed pine/hardwood forest and extensively dissected with bottomland hardwood forests associated with rivers, streams, swamps, and reservoirs. Occasional pastureland and crop cultivation is present throughout the area. This mesophytic forest is the southwestern limit of the extensive pine hardwood forest of the southeastern United States. Many of the genera and species of this area are found northeast and



VEGETATIONAL AREAS OF TEXAS

1. Pineywoods
2. Gulf Prairies and Marshes
3. Post Oak Savannah
4. Blackland Prairies
5. Cross Timbers and Prairies
6. South Texas Plains
7. Edwards Plateau
8. Rolling Plains
9. High Plains
10. Trans-Pecos, Mountains and Basins

Source: Gould, 1975

Exhibit II.5
PROJECT LOCATION IN RELATION
TO THE
VEGETATIONAL AREAS OF TEXAS

east of Texas (Correll and Johnston, 1979). The floral composition of the regional study area is influenced by climate, soils, geology, and topography. As early as 1939, Tharp noted that man related activities, such as timbering and agriculture have also contributed to the present floral communities. These activities have had a noted impact upon vegetative communities in the area and will be discussed in detail in Section II.E.1.f.

At the turn of the century, East Texas was primarily a region of small farms and woodlands. Today the land is used mainly for forestry and ranching (Correll and Johnston, 1979). Early timbering practices were directed toward selective cutting of larger trees, thus changing the dominant forest characteristics. More recent clear cutting and replanting of pine stands has led to almost monotypic communities in areas commonly referred to as pine plantations. Past agricultural development removed many acres of forest; however, the sandy soils were not conducive to intensive agriculture and consequently many areas have again reverted to forests. Present agriculture is dominated by improved pasture. A very small percentage of the agricultural acreage is being used, or can be, for row crops. These pasturelands and old fields comprise marked ecotonal areas between forest sites.

Common upland tree species of the Pineywoods include shortleaf pine (*Pinus echinata*), loblolly pine (*Pinus taeda*), blackjack oak (*Quercus marilandica*), southern red oak (*Q. falcata*), post oak (*Q. stellata*), sweet gum (*Liquidambar styraciflua*), and hickories (*Carya tomentosa, C. ovata*, and *C. cordiformis*). Trees common to the lowlands are water oak (*Q. nigra*), overcup oak (*Q. lyrata*), willow oak (*Q. phellos*), Shumard oak (*Q. shumardii*), sugar hackberry (*Celtis laevigata*) and elms (*Ulmus* spp.) (Gould, 1975; Correll and Johnston, 1979).

Herbs and shrubs are an important component of the Pineywoods vegetation and provide forage for wildlife and domesticated animals. These plants are chiefly species of *Sporobolus, Andropogon, Paspalum, Panicum, Eragrostis, Muhlenbergia, Chasmanthium, Sorghastrum*, legumes and occasional shrubs. Other grasses as well as a large variety of forbs are represented to form an extremely complex assemblage of herbs and brush species. Prevalent invader species include smutgrass (*Sporobolus indicus*), broomsedge bluestem (*Andropogon virginicus*), red lovegrass (*Eragrostis oxylepis*), greenbriar (*Smilax* spp.), yankeeweed (*Eupatorium compositifolium*), and yaupon (*Ilex vomitoria*) (Correll and Johnston, 1979).

Native plant successional patterns in the region have been altered as a result of grasses and legumes, mostly for improved pastures. Many of these plant species have displaced some native vegetation. These invader species include Bermudagrass (*Cynodon dactylon*), vasey grass (*Paspalum urvillei*), dallisgrass (*Paspalum dilatatum*), common carpetgrass (*Axonopus affinis*), *Lespedeza* spp. and *Medicago* spp. (Correll and Johnston, 1979).

Isolated areas of evergreen shrub bogs, open seepage slopes and cypress-blackgum swamps occur throughout the area. These habitats are characterized by the presence of peat moss (*Sphagnum* spp.) in varying degrees. The shrubs associated with these habitats include *Viburnum* spp., *Rhododendron* spp., hollies (*Ilex* spp.), wax-myrtles (*Myrica* spp.), *Hypericum* spp., *Vaccinium* spp., leatherwood (*Cyrilla racemiflora*) and dogwoods (*Cornus* spp.). The herbaceous vegetation associated with these areas tend to be unique and include such uncommon species as nodding-nixie (*Apteria aphylla*), *Viola lanceolata*, *Bartonia texana*, bogmoss (*Mayaca aubletii*), grass-of-Parnassus (*Parnassia asarifolia*), pitcher plant (*Sarracenia alata*), bearded grass-pink (*Calopogon barbatus*), rose pogonia (*Pogonia ophioglossoides*), small wood orchid (*Habenaria clavellata*), and yellow fringed orchid (*H. ciliaris*) (Correll and Johnston, 1979).

b. Vegetation Community Types

Descriptions of vegetation vary depending on the analytical requirements of the data collector (i.e. timber industry or biologists). These descriptions and analyses are useful for their intended purpose, and it is often necessary to compile information from multiple sources to ascertain the composition of a vegetational area. Several sources have been used for qualitative and quantitative vegetation information. The TPWD, USFWS, and the Texas Natural Heritage Program (TNHP) provide valuable information pertaining to qualitative information on vegetation, while the USFWS and the Texas Forest Service (TFS) furnish extensive quantitative information on forest resources of the area. Discrepancies are evident in the delineation and nomenclature of vegetation types between the qualitative and quantitative sources available. Therefore the quantitative vegetation data will be discussed in the context of broad forest type categories, while the qualitative vegetation information will be reviewed as more discrete categories.

Eight general vegetation types have been identified for the five county study area by the TPWD, (McMahan et al, 1984). Exhibit II.6 provides a map of these vegetation types within the study area as delineated by TPWD. Seven of these vegetative community types will be organized under the broader headings of Grassland/Savannah, Upland Forest and Bottomland Forest, for the purpose of comparing the previous study efforts of TPWD (1990) and Frasier (1990). The Grassland/Savannah category will include the following vegetative types: Other Native and/or Introduced Grasses, Post Oak Woods, Forest and Grassland Mosaic, and Young Forest/Grassland. The Pine-Hardwoods Forest will be discussed under the heading of Upland Forest. The Bottomland Forest category includes Willow Oak - Water Oak - Blackgum Forest, Water Oak - Elm - Hackberry Forest, and Bald Cypress - Water Tupelo Swamp. The vegetation of Urban Land will not be discussed in detail. These categories are used only to provide a gross analysis of vegetative types within the study area. In addition to the TPWD's vegetation types, we will discuss hydric habitats separately. This category will include marshes, swamps, aquatic habitats, and some sections of the bottomland/riparian communities that occur within the study site. What follows is a general description of the common plant species that form these community types.

Grassland/Savannah

Grasslands and Savannahs can occur locally throughout the five county study area. Because of previous and current land use, these areas can include currently managed pasture, abandoned pasture that is regenerating with some woody species and remnant natural grasslands. What follows is a discussion of general grassland communities of potential occurrence and is by no means an exhaustive list of all possible grassland vegetation types within the five county study area.

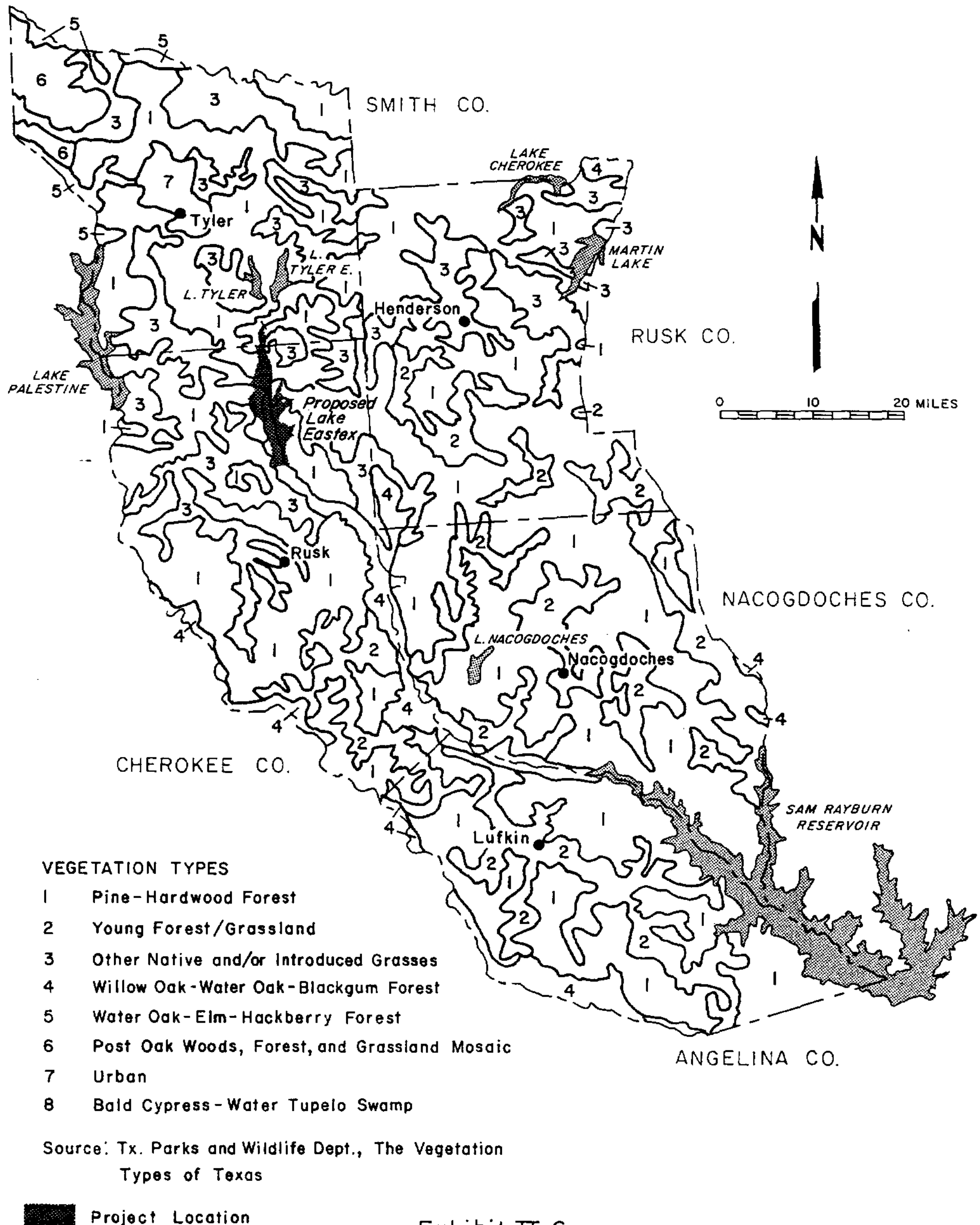


Exhibit II.6
VEGETATION TYPES
IN THE VICINITY OF THE
PROPOSED LAKE EASTEX

Young Forest/Grassland - The young forest/grassland vegetation is found on regenerative and cutover areas throughout the study area. This vegetative community type occurs primarily as a result of unmanaged regrowth in areas of abandoned logging sites or agricultural land and pasture. In either case, the absence of land management practices has resulted in the regrowth of woody species that were present prior to clearing as well as the invasion of certain plant species that tend to populate disturbed areas. The species composition of these areas can vary depending upon factors such as topography, soils, hydrologic regime and upon the type of disturbance that the site has undergone.

Typically, the young forest/grassland vegetation type consists of various combinations and age classes of pine and regrowth of pine and hardwoods. The degree and species composition of grasses in these areas depend on past land use. Common tree species of these areas include shortleaf pine, loblolly pine, slash pine (*Pinus elliottii*), longleaf pine (*P. palustris*), southern red oak, sweet gum, post oak, white oak, hackberry, elm and water oak. Typical shrubs found in these areas are holly, hawthorn (*Crataegus* spp.), wax myrtle, blackberry (*Rubus* spp.), and sumac (*Rhus* spp.). The grasses of this vegetation type include species of *Andropogon*, *Paspalum*, *Panicum*, and *Sporobolus*.

Other Native or Introduced Grasses

Hayfields, pasturelands (improved and unimproved), old fields and right-of-ways are included in a category identified as Other Native or Introduced Grasses, by Texas Parks and Wildlife Department. Managed or improved pastureland, which is the most common type of grassland in the area, is usually dominated by bahiagrass (*Paspalum notatum*), bermudagrass, and/or dallisgrass. Unimproved pastureland, old fields, and right-of-way areas consist of a variety of grasses, forbs, and woody species. Common grasses found in these habitats include johnsongrass (*Sorghum halapense*), broomsedge bluestem, lovegrass (*Eragrostis* spp.), yellow bristlegrass (*Setaria glauca*), threeawns (*Aristida* spp.), and Florida paspalum (*Paspalum floridanum* var. *glabratum*). Typical herbaceous species include woolly croton (*Croton capitatus*), bitterweed (*Helenium amarum*), Florida snakecotton (*Froelichia floridana*), buttonweed (*Diodia* sp.), yellow falsegarlic (*Nothoscordum bivalve*), asters (*Aster* sp.), thistle (*Cirsium* sp.) and flatsedge (*Cyperus* sp.). Occasional woody species include sumac, common persimmon (*Diospyros virginiana*), southern dewberry (*Rubus* sp.) and rose (*Rosa* sp.)

Post Oak Woods, Forest, and Grassland Mosaic - The Post Oak Woods, forest and grassland mosaic vegetation type occurs in the Post Oak Savannah as modified by McMahan, et al (1984). As suggested by its name, this vegetation type is an intermixture of post oak woods, forest and grasslands, the composition of which is largely dependent on topography and soils. Dominant tree species associated with these areas include post oak, eastern red cedar (*Juniperus virginiana*), blackjack oak, mesquite (*Prosopis* sp.), live oak (*Quercus virginiana*), bluejack oak (*Q. incana*), black hickory (*Carya texana*), cedar elm (*Ulmus crassifolia*) and sugar hackberry. Important shrub and herbaceous species of these vegetation types are yaupon, American beautyberry (*Callicarpa americana*), poison oak (*Toxicodendron radicans*), hawthorn, trumpet creeper (*Campsis radicans*), Alabama supplejack (*Berchemia scandens*), dewberry, coralberry (*Symphoricarpos orbiculatus*) and tickclover (*Desmodium* sp.). Common grasses in these areas include little bluestem (*Schizachyrium scoparium* var. *frequens*), silver bluestem (*Bothriochloa saccharoides* var. *torreyana*), beaked panicum (*Panicum anceps*), sand lovegrass (*Eragrostis trichodes*), sprangletop (*Leptochloa* spp.) and threeawns.

Forested Areas

Forested regions are areas where the vegetation canopy is dominated by tree species. These areas are commonly divided into Upland Forests that often occur on hills, slopes, and plateaus, and Bottomland Forests that are associated with streams, rivers and lakes. According to the USFWS the forest resources comprise approximately 57 percent of the total land area within the five-county region. Of this forested area approximately 59 percent is Upland Forest and 5 percent is true Bottomland Forest. The remaining 36 percent is Oak-Hickory forest which can occur in upland as well as riparian areas (McWilliams and Bertelson, 1986). Table II.8 provides the areal extent of these categories.

TABLE II.8

ACREAGE BY COUNTY AND LAND CLASS FOR THE FIVE-COUNTY STUDY AREA (1,000 ACRES)

County	All Land	Forest Land	% Total	Non Forest Land	% Total
Angelina	553.6	387.1	70.0	166.5	30.0
Cherokee	679.6	394.8	58.1	284.8	41.9
Nacogdoches	627.2	412.8	65.8	214.5	34.2
Rusk	600.1	294.0	49.0	306.1	51.0
Smith	607.9	256.2	42.2	351.5	57.8
			56.9		43.1
TOTAL	3,068.4	1744.9	56.9	1,323.4	43.1

Source: McWilliams and Bertelson (1986).

Upland Forest

Upland forests occur on hills and slopes of the five county study area. The topographic relief and moderately permeable soils provide rapid drainage, and the uplands are generally dry. Upland forest tree species composition varies, often due to past and current land usages such as selective cutting of hardwoods or softwoods, and timber cutting cycles. Managed pine plantations are often located in these upland areas. Timber harvesting practices are discussed in more detail in Section II.E.1.f. Because species composition can vary locally depending on past land use, what follows is a general description of the vegetation occurring in these upland areas of the proposed project site and the five county study area.

Pine/Hardwood Forest Community Type - The mixed pine/hardwood forest community typically occurs on moderately to well drained sandy loam soils on gentle slopes. This community type is generally defined as being comprised of a cover of less than 75 percent hardwood but greater than 25 percent pine or less than 75 percent pine, but greater than 25 percent hardwood. The structure of this community can vary in tree species composition depending upon soils, topography, successional status, and both historical and present disturbances. Depressional areas with relatively high soil moisture content often support more mesic tree species such as white oak (*Quercus alba*), water oak and black-gum (*Nyssa sylvatica*), while the more exposed drier areas tend to support southern red oak and pine.

The most frequently encountered overstory tree species in this community type are loblolly pine, shortleaf pine, southern red oak and sweet gum. Water oak, white oak and black-gum may be found in wetter areas. Common middle story and understory species include American beautyberry, American hornbeam (*Carpinus caroliniana*), yaupon, and hawthorn.

Bottomland Forest

Bottomland/Riparian Forests consist of vegetational areas associated with rivers and streams. The species compositions of these habitats vary due to edaphic and hydrologic factors, and to timber harvesting cutting cycles. Past timber harvesting practices have also created bottomland forests of differing maturity levels throughout the region. Timber harvesting practices are discussed in greater detail in Section II.E.1.f Bottomland forest stands, which occur where floodplains are wide along major water courses, are characterized by a dense overstory canopy and a well-developed understory and shrub layer. This vegetation association tends to narrow in the floodplains of minor streams. The wettest portions of these areas support plant species which are considered wetland indicators, and thus may be defined as wetlands under jurisdiction of the U.S. Corps of Engineers. These particular areas will be discussed separately in the Hydric Habitat Section. Below is a discussion of the three bottomland vegetation types identified in the study area by the TWPD vegetation types of Texas. As this is a general treatment of Bottomland Forest communities, other Bottomland vegetation types may occur in this area. Table II.9 provides approximate acreages for the bottomland resources of East Texas.

TABLE II.9
BOTTOMLAND RESOURCES OF EAST TEXAS, 1980.

Location	Amount (Acres)	Percent of Total
Angelina River	88,000	1.5
Neches River	257,000	4.3
Cypress Bayou	89,000	1.5
Sabine River	255,000	4.3
Sulphur River	175,000	2.9
Trinity River	305,000	5.1
Subtotal	1,169,000	19.6
Riparian Areas (east of the Navasota River)	3,062,000	51.3
Other rivers, creeks, and riparian areas	1,742,000	29.1
TOTAL	5,973,000	100%

Source: Frye & Curtis (1990).

Willow Oak - Water Oak - Blackgum Forest - Much of the bottomland forests that are found in the five county study area are considered Willow Oak - Water Oak - Black Gum Forest by TPWD (McMahan, et al, 1984). This vegetation type that is found in the Pineywoods of Texas, occurs along water courses in all but the extreme northwest corner of the five county study area. Frequently encountered overstory tree species include willow oak, water oak, blackgum, overcup oak, elm, sweetgum, white oak, and black willow. Beech (*Fagus* sp.), swamp chestnut oak (*Quercus michauxii*), cherrybark oak (*Q. falcata* var. *leucophylla*), sycamore (*Platanus occidentalis*), southern magnolia (*Magnolia grandiflora*), and bald cypress (*Taxodium distichum*) are other commonly associated tree species. In the understory of this community type, hawthorn, bush palmetto (*Sabal minor*), American elderberry (*Sambucus canadensis*), southern arrow-wood (*Viburnum dentatum* var. *dentatum*), poison oak, rhomboid copperleaf (*Acalypha rhomboidea*), and St. Andrew's cross (*Ascyrum hypericoides*) occur. Viney species occurring in this area include Alabama supplejack, trumpet creeper, crossvine (*Bignonia capriolata*), greenbriar, and blackberry.

Water Oak - Elm - Hackberry Forest - Water oak - Elm - Hackberry forests are associated with river and streams in the extreme northwestern portion of the five county study area. Along with water oak, cedar elm, American elm, and sugar hackberry, dominant tree species include willow oak, southern red oak, white oak, black willow, red ash (*Fraxinus pennsylvanica*), sycamore, cottonwood (*Populus deltoides*), pecan (*Carya illinioensis*) and osage orange (*Maclura pomifera*). In the middlestory and understory of this community type flowering dogwood

(*Cornus florida*), coral-berry, dewberry, giant ragweed (*Ambrosia trifida*), yankeeweed, and Leavenworth eryngo (*Eryngium leavenworthii*) occur. The grasses of these areas include dallisgrass, switchgrass (*Panicum virgatum*), rescuegrass (*Bromus unioloides*), eastern gammagrass (*Tripsacum dactyloides*), bermudagrass, Johnsongrass, and Virginia wildrye (*Elymus virginiana*).

Bald Cypress - Water Tupelo Swamp - In southern Angelina County along the wide bottomlands of the Neches River, lies a Bald Cypress-Water Tupelo Swamp. Tree species associated with the Bald Cypress and Water Tupelo (*Nyssa aquatica*) of the swampy flatland are water oak, water hickory (*Carya aquatica*), red maple (*Acer rubrum*) and blackgum. Middle and understory species include swamp-privet (*Forestiera acuminata*), possumhaw (*Ilex decidua*), water elm (*Planera aquatica*), black willow, common buttonbush (*Cephalanthus occidentalis*), eardrop vine (*Brunnichia ovata*), supplejack, climbing hempweed (*Mikania scandens*), and bog hemp (*Boehmeria cylindrica*). Common herbaceous species found in these areas are duckweed (*Lemna* spp.), water fern (*Azolla caroliniana*), water hyacinth (*Eichornia crassipes*), beggar-ticks (*Bidens diseoidia*), bladderwort (*Utricularia sp.*), water paspalum (*Paspalum fluitans*) and St. John's wort (*Hypericum* spp.).

Hydric Habitats

Hydric habitats within the five county study area include reservoirs, ponds, marshes, swamps, any other aquatic habitats (areas in which the dominant land cover is water), and portions of the bottomland forests. Marshy areas occur in wet depressions and around the edges of aquatic habitats. Herbaceous species associated with the marshes of the study area include smart weed (*Polygonum sp.*), bladderwort, arrowhead (*Sagittaria sp.*), cattails (*Typha sp.*), sedges (*Carex spp.*), and flatsedges (*Cyperus spp.*). Swamps are found in bottomland and are often associated with oxbow lakes and sloughs. Common plants of these areas include cattails, duckweed, watermeal (*Wolffia sp.*), and species of *Carex, Cyperus,* and *Eleocharis*. Aquatic plant species associated with rivers, streams and ponds include Alligatorweed (*Alternanthera philoxeroides*), pondweeds (*Potamogeton sp.*), duckweed, watermeal and hornward (*Ceratophyllum* sp.). Typical woody species of these hydric habitats are black willow, red ash, and common buttonbush.

c. Summary and Comparison of Previous Ecological Evaluations

During 1988, the Frasier Group, Inc. (Frasier) compiled biological data for the five county study area through field work and literature research. Frasier employed the Habitat Evaluation Procedure (HEP) to evaluate the quality of habitat in the pool area of the proposed reservoir. Additional information was obtained by Frasier regarding the standard conditions of other bottomland hardwood habitat as a comparison to the HEP (Frasier, 1991). In 1984, the TPWD executed a Wildlife Habitat Appraisal Procedure (WHAP) evaluation of the proposed Lake Eastex site. What follows is a summary and comparison of the findings of these two efforts with relation to the delineation of vegetation communities. A more detailed discussion of the results of these two efforts is presented in the Terrestrial Wildlife Section II.E.2.e.

To evaluate the quality of habitat in the pool area of the proposed reservoir, Frasier employed the HEP Method. The analysis was based upon habitat quality and quantity following the procedures developed by the USFWS. Data gathering was accomplished by a team composed of representatives from the COE, USFWS, TPWD, and the Frasier Group, Inc. The team evaluated 51 different sites within eight habitat types which included riverine, lacustrine, shrub wetland, herbaceous wetland, shrub land, improved pasture, deciduous mixed forest and deciduous forested wetland. These habitat types were sampled for the life requisites of the seven evaluation species. The Frasier Group, Inc. also obtained information on the vegetative communities of the area from 1983 color infrared aerial photographs. This information was used to compare known signatures of vegetation types in the proposed pool area of the proposed reservoir area to the HEP analysis (Frasier, pers. com., 1991).

During 1984, the TPWD performed a WHAP evaluation of the proposed reservoir area. This analysis measures important elements of each cover type that influence the ecological condition of the cover type and attending overall suitability for wildlife. Initially, this information was derived from 1974 LANDSAT imagery. At least two assessment sites were chosen for each cover type with coverage greater than 10 percent of the total reservoir area. A minimum of two investigators, including at least one representative each from the USFWS and TPWD, visited each assessment site (TPWD,1990).

In comparing the results of the HEP and WHAP evaluations, the estimates of the total acreage inundated due to reservoir construction were approximately equal for the two methods. However, noted differences in the two studies are evident in the areal extent of vegetative types. In the TPWD's WHAP analysis, grasses and Pine-Hardwood Forest losses were 2,706 and 2,999 acres, respectively. Frasier estimated an Improved Pasture category loss of 2,918 acres, and that 3,682 acres of Pine/Oak Forest would be lost. The TPWD estimated that 3,517 acres of Mixed Bottomland Hardwood Forest would be inundated by the project while Frasier calculated a loss of 2,832 acres of Oak/Pine Bottomlands and 87 acres of Oak Bottomlands. The category indicated as Other represents areas that occupy less than 10 percent of the proposed reservoir pool area. The TPWD and The Frasier Group estimated the loss of this cover type as 867 acres and 543 acres, respectively.

The differences in the acreages of vegetation types in these two studies can be attributed to a number of variables. First, two different remote sensing products were used to delineate vegetation types within the proposed reservoir pool area. In the WHAP analysis by TPWD, 1974 LANDSAT imagery was used for gross delineation of vegetation types. The Frasier Group used 1983 color infrared aerial photographs at a scale of 1:58,000. The color infrared photography provides much greater resolution than LANDSAT imagery. Secondly, a time period of eleven years separates the two image records. Some changes in the areal extent of vegetation types have occurred. For example, some of the forested areas shown on photographs dated 1983 have since been cut-over as a part of the normal harvesting cycle of the timber industry (see section II.E.1.f.). Lastly, there were differences in the ground verification techniques in the two studies. The Frasier Group evaluated 51 different sites within eight habitat types, while TPWD at a minimum, visited two assessment sites for each of the three cover types identified (Frye and

Curtis, 1990). A comparison of the areal extent of vegetation types delineated in these two studies is presented in Table II.10.

TABLE II.10

COMPARISON OF ESTIMATES OF LOST ACREAGE BY COVER TYPE WITHIN THE NORMAL OPERATING POOL OF THE PROPOSED EASTEX RESERVOIR

Frasier Group	
Improved Pasture	Acreage Lost
Improved Pasture	2,918
Pine/Oak Forest	3,682
Oak/Pine Bottomlands Oak Bottomlands	2,832 87
Other (Built-up)	543
Total	10,062

Source: Frasier, 1990.

TPWD	
Cover Type	Acreage Lost
Grasses	2,706
Pine-Hardwood Forest	3,517
Mixed Bottomland Hardwood Forest	3,517
Other	867
Total	10,089

Source: Frye and Curtis, 1990

d. Important Plant Species

Important plant species can be defined as those which (a) are recreationally or commercially valuable, (b) are threatened or endangered, (c) affect the fitness of some important species within criteria (a) or (b), or (d) are crucial to the structure and function of the ecological system or are biological indicators.

Commercially Important Plant Species

Commercially important species in the five county study area include pines (shortleaf and loblolly), hardwoods (oaks, red ash, elms, hickories, pecans and others), and forage species (chiefly bermudagrass and bahiagrass). Due to their value as harvestable timber, pines represent the most significant commercial plant species in the project study area. According to the TFS (1991), estimates of the value of saw timber in the project region averages $164.14/1,000 board feet for mature pines and $60.83/1,000 board feet for hardwoods. Current prices for pine and hardwood pulpwood average $60.83/cord and $9.67/cord respectively. Table II.11 provides a list of commercially important tree species and Table II.12 provides volumes harvested in 1986.

TABLE II.11
COMMERCIALLY IMPORTANT TREE SPECIES OF EAST TEXAS, 1986.

Species	Volume of Sawtimber All Grades	% of Total by Species
Yellow Pines	36,279.2	71.8
Loblolly		
Long Leaf		
Short Leaf		
Cypress	376.3	0.8
Red Cedar	65.0	0.1
Total Softwoods	36,720.5	72.7
Select White-Red Oaks	1,938.8	3.8
Other White-Red Oaks	6,402.5	12.7
Hickory	573.5	1.1
Hard Maple	6.5	<0.1
Sweetgum	2,354.0	4.7
Tupelo and Blackgum	716.0	1.4
Ash-Walnut-Black Cherry	374.8	0.7
Other Hardwoods	1,406.3	2.8
Total Hardwoods	13,772.7	27.3
Total All Species	50,493.2	100%

Volume in million of board feet
Source: McWilliams and Bertelson (1986a, 1986b)

TABLE II.12
AVERAGE ANNUAL REMOVALS OF GROWING STOCK WITHIN THE FIVE-COUNTY STUDY AREA, 1986.

County	Growing Stock (All Species)		Sawtimber (All Species)		Total Growing Stock Sawtimber	
	Millon Cubic Board-feet	% of Total Study Area	Million Board-feet	% of Total County	Million Board-feet	% of Total County
Angelina	19.2	23.6	91.0	82.6	110.2	27.6
Cherokee	18.1	22.2	71.3	79.8	89.4	22.4
Nacogdoches	15.9	19.5	57.8	78.4	73.7	18.4
Rusk	17.5	21.5	62.4	78.1	79.9	20.0
Smith	10.8	13.2	35.8	76.8	46.6	11.6
Total Study Area	81.5	100%	318.3	100%	399.8	100%

Source: McWilliams and Bertelson, (1986a, 1986b).

Threatened and Endangered Plant Species

Currently, twenty-one plant species are listed by the USFWS as Endangered or Threatened in Texas. Additionally, two plant species of the Trans-Pecos region of Texas have been proposed for listing as endangered (USFWS, 1990). None of these threatened or endangered plant species are known to occur in the vicinity of the proposed project area.

Texas is home to approximately 147 plant species that are currently under consideration by the USFWS as candidates for future proposal (TNHP 1991). These candidate species are to be considered in environmental impact analysis, although currently they have no official status and are not protected by law. Numerous Texas plant species were once under consideration as candidates, but are no longer under review for listing. A re-evaluation of these species for candidate listing could occur if further research or changes in land use indicate a significant decline of the species.

Twelve Category "2" candidate (C2) plant species are known to occur in the five county study area. Historical records indicate that an additional two C2 species potentially occur in the area. The C2 status indicates that not enough data has been compiled to support a proposed listing as threatened or endangered, and that further biological research is needed to determine the status of the species. While potentially suitable habitat of these candidate species may occur within the reservoir site, only field surveys during the specific season when the species are identifiable would determine if populations of any of the species are actually present. Table II.13 provides a list of State and Federally ranked plant species known to occur in the five county study area. None of these plant species have a designated rank by the State of Texas. Issues and information pertaining to federally protected species will be treated more thoroughly in Section II.E.4.

TABLE II.13
FEDERALLY LISTED PLANT SPECIES OF POTENTIAL OCCURRENCE IN THE FIVE COUNTY STUDY AREA

Family *Scientific Name* Common Name	Status		
	Federal	TNHP	TOES
Cyperaceae *Cyperus grayioides* Mohlenbrock's umbrella sedge	C2	G3-S3	
Xyridaceae *Xyris drummondii* Drummond's yellow-eyed grass	C2	G3-S2	
Xyris scabrifolia Rough-leafed yellow-eyed grass	C2	G2/G3-S2	

TABLE II.13 (continued)

Family *Scientific Name* Common Name	Status		
	Federal	TNHP	TOES
Lilliaceae *Trillium pusillum var. texanum* Texas trillium	C2	G2/G3Q-S2/S3	V
Orchidaceae *Cypripedium kentuckiense* Southern lady's slipper	C2	G3-S1	IV
Fagaceae *Quercus boyntonii* Boynton's oak	C2	GHQ-SH	
Nyctaginaceae *Mirabilis collina* Sandhill four o'clock	C2	G1/G2-S1/S2	
Portulacaceae *Talinum rugospermum* Rough-seed flame flower	C2	G3/G4-S1	IV
Brassicaceae *Leavenworthia texana* Texas goldenglade cress	C2	G1-S1	V
Rosaceae *Crataegus warnneri* Warner hawthorn	C2	G2Q-S2	
Gentianaceae *Bartonia texana* Texas screwstem	3C		V
Asteraceae			
Aster puniceus ssp. *elliotii* var. *scabricaulis* Rough-stemmed aster	C1	G4/T2-S1	
Coreopsis intermedia Goldenwave tickseed	C2	G2/G3-S2/S3 G2/G3-S2/S3	
Liatris tenuis Slender gayfeather	C2	G2/G3-S2	
Prenanthes barbata Rattlesnake root	C2	G2-S2	
Rudbeckia scabrifolia Bog coneflower	C2		

Source: Texas Natural Heritage Program - Special Plant List, 1991.

TABLE II.13 (continued)

Federal Status

C1	Candidate, Category 1. USFWS has substantial information on biological vulnerability and threats to support proposing to list as endangered or threatened. Data is being gathered on habitat needs and/or critical habitat designations.
C2	Candidate, Category 2. Information is possibly appropriate, but substantial data on biological vulnerability and threats are not known to support the immediate preparation of rules. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2.
3C	Former Candidate, rejected because more common, widespread, or adequately protected

Texas Natural Heritage Program Status[3]

Global Rank

G1	Critically imperiled globally, extremely rare, 5 or fewer occurrences. [Critically endangered throughout range.]
G2	Imperiled globally, very rare, 6 to 20 occurrences. [Endangered throughout range.]
G3	Very rare and local throughout range or found locally in restricted range, 21 to 100 occurrences. [Threatened throughout range.]
G4	Apparently secure globally.
GxTx	Denotes subspecific taxa.
GxQ	Indicates that the taxonomic status of the plant is a matter of conjecture.
GxGy	Indicates that the plant is borderline between ranks.
GH	Historical occurrence throughout its range.

State Rank

S1	Critically imperiled in state, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences.
S2	Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences.
S3	Rare in state, 20+ occurrences.
S4	Apparently secure in state.
S5	Demonstrably secure in state.
SA	Accidental in state.
SE	An exotic species established in state.
SH	Of historical occurrence in state. May be rediscovered.
SX	Apparently extirpated from state.

Texas Organization for Endangered Species (TOES)[4]

Plants - Federal Listed Species

Category I	The term "endangered species" means any species which is in danger of extinction throughout all or significant portion of its range other than a species of the Class Insecta determined by the Secretary of Interior to constitute a pest whose protection under the provision of the Endangered Species Act of 1973, P.L. 93-205, as amended (Dec. 1978), would present an overwhelming and overriding risk to man.
Category II	The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion its range.

TOES-State Listed Species

Category III	The term "state endangered species" means any species which is in danger of extinction or of extirpation in Texas or in addition to I and II above.
Category IV	The term "state threatened species" means any species which is likely to become a state endangered species within the foreseeable future.
Category V	The term "TOES watch list" means any species which at present has either low population or restricted range in Texas and is not declining or being restricted in its range but requires attentions to insure that the species does not become endangered or threatened (state or federal).

Other Important Plant Species

Dominant plant species qualify as important species under criterion (d), as they are, by definition, critical to the structure and function of an ecosystem. In Section II.E.1.b, important dominant species on the project site are identified.

Plant species in the project area that are important for browse and forage materials for wildlife include various oak species, sugar hackberry, sassafras (*Sassafras albidum*), pecan, hickories, yaupon, possumhaw, red ash, flowering dogwood, black willow, various grapes (*Vitis* sp.), common elderberry, greenbriar, trumpet creeper, American beautyberry, and various sedges and grasses. Oak mast is of special importance to deer.

e. Unique or Sensitive Vegetation Communities

Generally, an area may be considered ecologically sensitive or important if: 1) it supports a rare plant or animal community or a rare, threatened, or endangered species; 2) it is a highly productive habitat, or has high commercial value; 3) it is valuable due to its maturity, and the density and diversity of plants and animals it supports; or 4) it supports species considered to be wetland indicators by a regulatory agency (e.g., COE). Areas identified as sensitive and important habitats are discussed below.

Plant species of concern to State and Federal agencies were mentioned briefly in Section II.E.1.d and will be discussed in greater detail in Section II.E.4. Several species currently under consideration for listing as threatened or endangered have been recorded in the five county study area, although no federally listed threatened or endangered species are known to occur in the vicinity of the proposed reservoir site. Many of the species listed in Table II.13 typically occur in habitats associated with wet areas, especially bottomland and riparian forests.

In 1985, the USFWS published a preservation plan for the remaining bottomland hardwood areas of East Texas (USFWS, 1985). A total of 62 bottomland areas were proposed and prioritized within the eastern portion of Texas. Eleven of these sites lie within the five county study area, while one listed site occurs downstream from the proposed project. The eleven priority sites listed by the USFWS are presented in Table II.14. The bottomland area of concern is indicated as the Mud Creek site and is given Priority 1 status. The designation of Priority 1 status indicates that the area constitutes excellent quality bottomlands of high value to the key water fowl species (Wood Ducks and Mallards). What follows is a general description of the Mud Creek site and dominant characteristics and plant species of the area. Exhibit II.7 provides a map of the eleven priority bottomland Hardwood Sites in the vicinity of the proposed Lake Eastex.

TABLE II.14

PRIORITY EAST TEXAS BOTTOMLAND SITES WITHIN THE FIVE COUNTY STUDY AREA - DESIGNATED BY USFWS (1985).

Priority	Site Number	Name	County(ies)	Basin
1	SA-2	Middle Sabine Bottom	Wood/Smith	Sabine
1	A-1	Striker Creek	Rusk	Angelina
1	A-2	Mud Creek	Cherokee/Rusk	Angelina
1	A-3	Upper Angelina River Bottom	Cherokee/Nacogdoches/Angelina	Angelina
3	A-4	Alazan Bayou	Nacogdoches	Angelina
3	A-5	Forty Acres	Nacogdoches	Angelina
2	A-6	Lower Angelina River	Nacogdoches/Angelina	Angelina
4	A-7	Attoyac Bottom	Nacogdoches/San Augustine	Angelina
1	N-3	Neches River North	Anderson/Cherokee	Neches
1	N-4	Middle Neches River	Trinity/Angelina/Polk/ Cherokee/Houston	Neches
2	N-5	Neches River South	Angelina/Polk/Tyler	Neches

Source: USFWS, 1985.

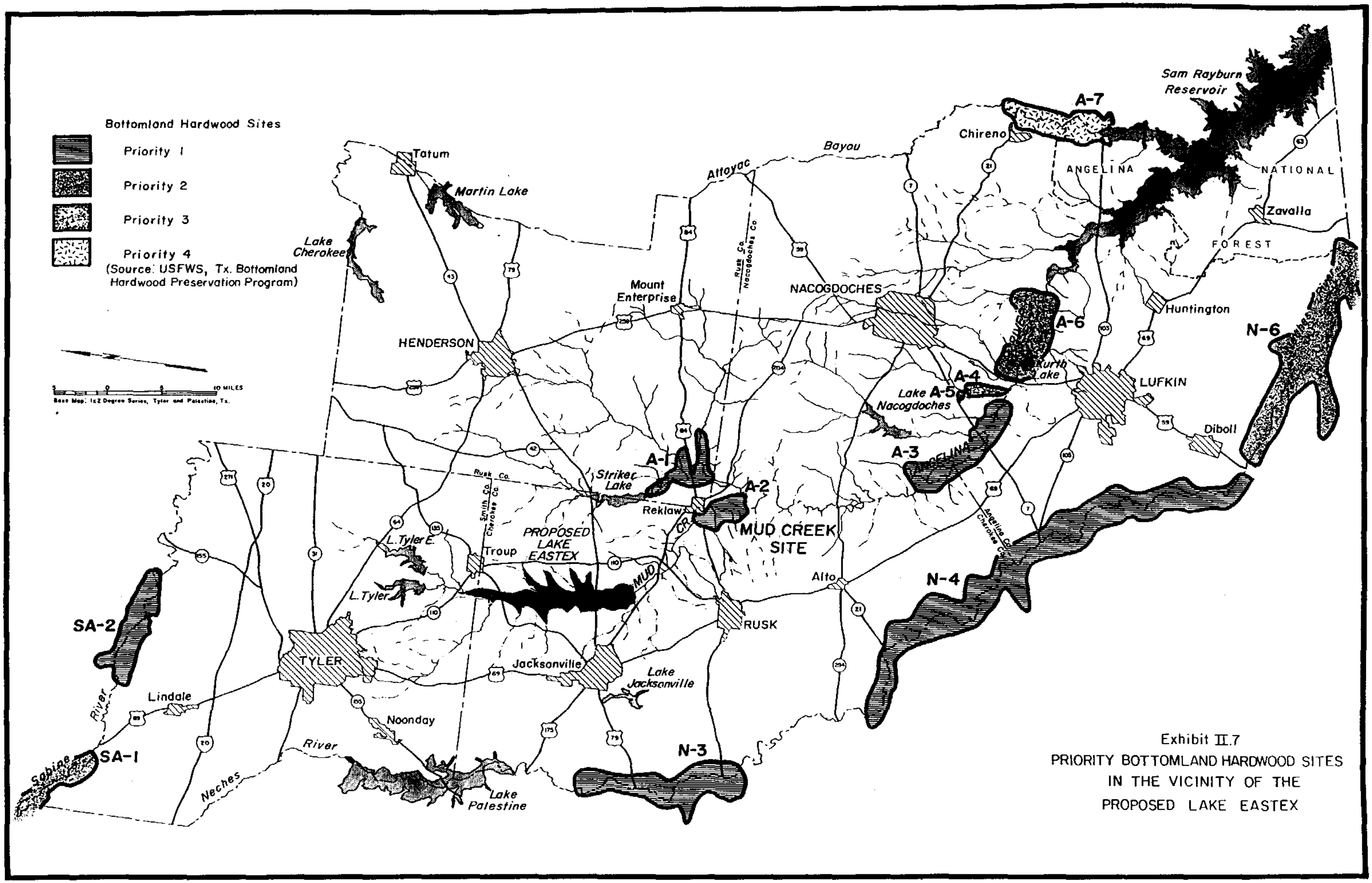


Exhibit II.7
PRIORITY BOTTOMLAND HARDWOOD SITES
IN THE VICINITY OF THE
PROPOSED LAKE EASTEX

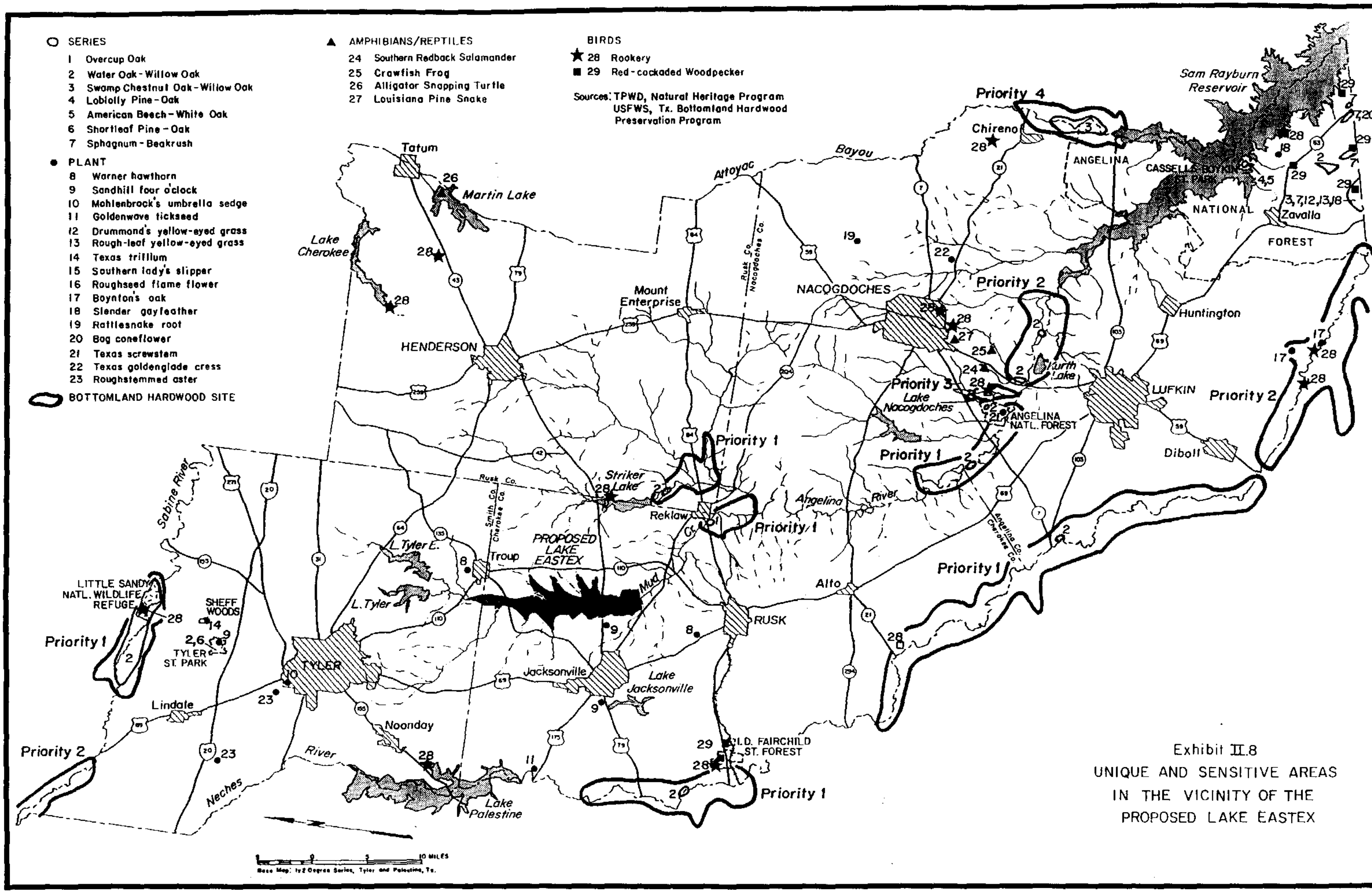


Exhibit II.8
UNIQUE AND SENSITIVE AREAS
IN THE VICINITY OF THE
PROPOSED LAKE EASTEX

The Mud Creek Priority 1 site straddles Cherokee and Rusk Counties approximately seven miles downstream from the proposed Eastex dam site. This bottomland hardwood site inhabits a total of 6,784 acres, with 78 percent of this area considered Broad and Narrow-leafed Deciduous Bottomland Forest dominated by overcup oak - willow oak and green ash - hackberry communities. Sloughs are dominated by buttonbush and water elm. This area is also marked by excellent diversity and high quality timber according to the USFWS. The waterfowl value for wintering and production are both considered high. Special Recognition Species values are indicated as high for white-tailed deer, fur-bearers, squirrels and the category of Other Migratory Birds. Habitat values for raptors and colonial waterbirds are indicated as medium to high. The hydrologic regime of this area is indicated as very favorable due to frequent flooding. The site is characterized by large tributaries, conspicuous stream braiding and a flat and fertile floodplain. The degree and type of threat is considered near-term to far-term due to continued clearing for pasture and agriculture and because it is a potential reservoir site (USFWS, 1985).

The TNHP has identified seven plant communities (Series level) ranked as sensitive, in the study area. One of these series (Overcup Oak Series) occurs within the Mud Creek Priority 1 site. Table II.15 lists the species composition, counties of occurrence and the number of occurrences of these communities. These unique and sensitive communities are presented graphically in Exhibit II.8.

Bottomland/riparian forest and associated hydric habitats in the vicinity of the proposed reservoir site should be generally considered ecologically sensitive for a number of reasons. Characteristics of these habitats which advance their ecological sensitivity and value include high species diversity and productivity, utilization by many wildlife species, predominance of species considered to be wetlands indicators and dependence on particular hydrologic regimes. Additionally, substantial areas of bottomland forest have historically been cleared due to forestry, floodplain modifications, and agricultural uses (USFWS, 1985).

f. Review of Agricultural and Timber Harvesting Practices

Since the turn of the century, the Pineywoods of Texas has been marked by deforestation by agricultural development and timbering practices. Large scale agricultural production was not feasible due to the sandy soils of the region. However, the intensity of timber production has increased dramatically since the 1930's. The following discussion focuses on the current and past timbering practices with mention of the less extensive agricultural land uses in the project area.

The importance of agricultural production in the Pineywoods has declined during the last half of this century. In the early 1900's a considerable portion of the region was cleared in an attempt to initiate substantial crop production. These efforts commonly failed due to the sandy soils that were not conducive to intensive agricultural practices. Consequently, many of these areas have again reverted to forests. Present agriculture is dominated by improved pasture. A very small percentage of the agricultural acreage is being used for row crops.

TABLE II.15
UNIQUE OR SENSITIVE PLANT COMMUNITY SERIES WITHIN THE FIVE COUNTY STUDY AREA AS IDENTIFIED BY THE TEXAS NATURAL HERITAGE PROGRAM

Vegetation Community	TNHP Status	Counties Occurring In	Number of Occurrences	Species Composition
Overcup Oak Series	G4S4	Cherokee	1	Overcup oak, red maple, water hickory, and willow oak
Water Oak-Willow Oak Series	G4S3	Angelina Cherokee Nacogdoches Rusk Smith	2 1 4 1 2	Water Oak, Willow Oak, Ash, Sweetgum, Cherrybark Oak, Overcup Oak, American Hornbeam, and Eastern Hop-hornbeam
Swamp Chestnut Oak-Willow Oak Series	G3S3	Angelina Nacogdoches	1 1	Swamp Chestnut Oak, Willow Oak, Sweetgum, Overcup Oak, Cherrybark Oak, and Dwarf Palmetto
Loblolly Pine-Oak Series	G4S4	Angelina	1	Loblolly Pine, Post Oak, White Oak, Southern Red Oak, Water Oak, Shortleaf Pine, Hickories, Flowering Dogwood, Yaupon, Wax-myrtle and American Beautyberry
American Beech-White Oak Series	G3S2	Angelina	1	American Beech, White Oak, Loblolly Pine, American Holly, and Sweetgum
Short-leaf Pine-Oak Series	G4S4	Smith	1	Shortleaf Pine, Post Oak, Blackjack Oak, Southern Red Oak, Black Oak, White Oak, with Loblolly Pine and Hickories in wetter areas.
Sphagnum-Beakrush Series	G4S2	Angelina	4	*Spagnum spp.*, Beakrush (*Rhynchospora* spp.), Yellow-eyed Grass, Pitcher Plant, Grasses and Sedges

Source: TNHP (1990)

Texas Natural Heritage Program Status

Global Rank

G1	Critically imperiled globally, extremely rare, 5 or fewer occurrences. [Critically endangered throughout range.]
G2	Imperiled globally, very rare, 6 to 20 occurrences. [Endangered throughout range.]
G3	Very rare and local throughout range or found locally in restricted range, 21 to 100 occurrences. [Threatened throughout range.]
G4	Apparently secure globally.

State Rank

S1	Critically imperiled in state, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences.
S2	Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences.
S3	Rare in state, 20+ occurrences.
S4	Apparently secure in state.
S5	Demonstrably secure in state.

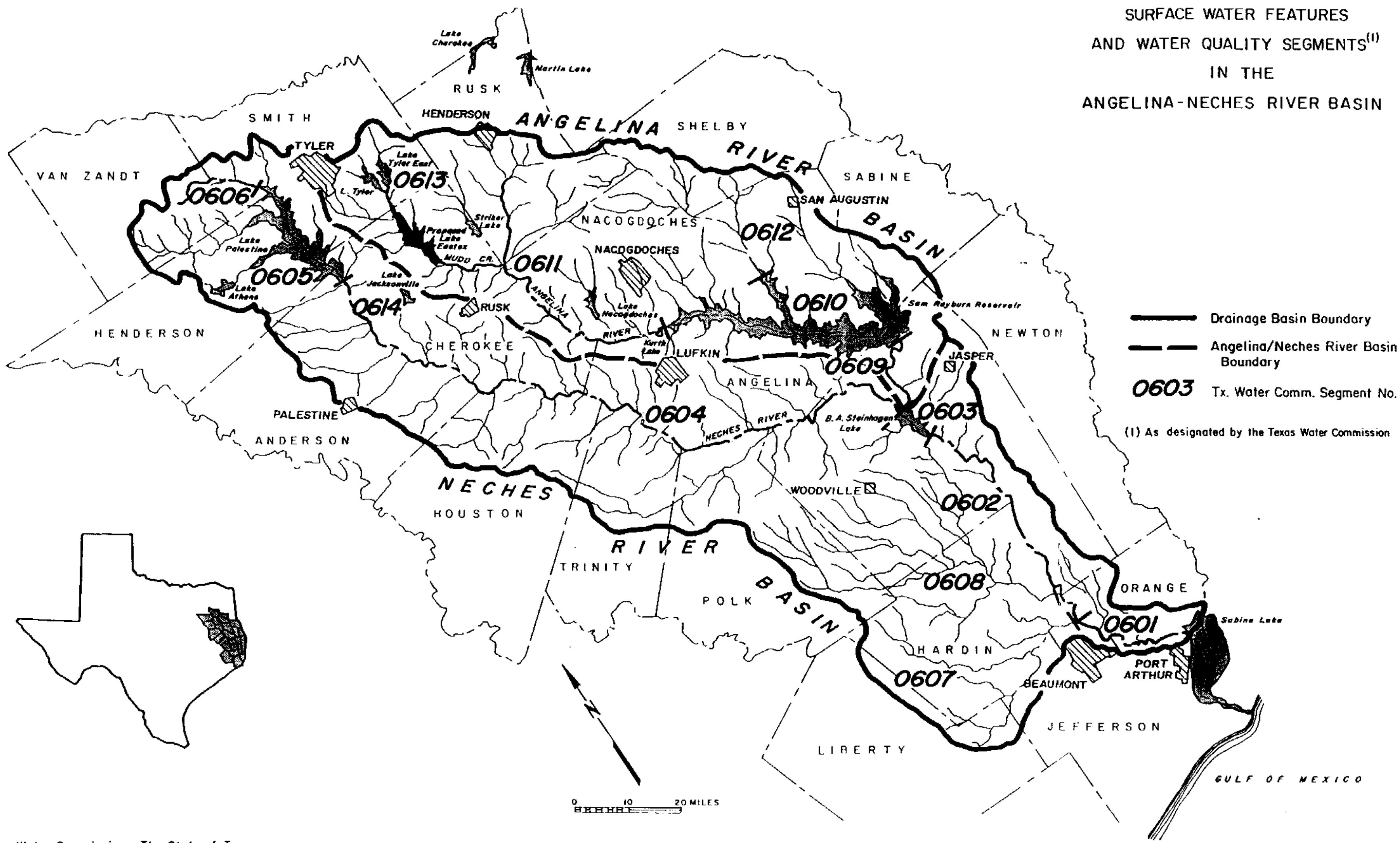
Exhibit II.10

SURFACE WATER FEATURES

AND WATER QUALITY SEGMENTS[1]

IN THE

ANGELINA-NECHES RIVER BASIN



Source: Tx. Water Commission, The State of Texas Water Quality Inventory

The forest resources comprise approximately 57 percent of the total land area within the five county region. Three dominant pine species (Loblolly, Shortleaf, and Longleaf) comprise 37.9 percent of the total forest area within the five county study area. The oak-hickory forest type accounts for 35.9 percent of the forests, while characteristic bottomland forest types of oak-gum-cypress and elm-ash-cottonwood comprise about five percent of the forested area within the region. Table II.10 provides forest resources information, by county for the study area (McWilliams and Bertleson, 1986a, 1986b). Previous and present cutting practices have left forests of differing levels of maturity throughout the region. Discussions with Mr. John Boyette of the TFS (1991) indicate that cutting cycles vary depending on the timber concern (i.e. public or private), the productivity of the area, and the product sought (i.e. sawtimber or pulpwood). According to Mr. Boyette, average cutting cycles for sawtimber and pulpwood are approximately every 40 years and 25 years, respectively (TFS, 1991).

The forest industry in the five county study area is a major source of employment and as many as 70 tree species (softwoods and hardwoods) are commercially important. Within the study area there are four large sawmills, four wood pulpmills, fifteen small sawmills, six wood preserving plants, three pine veneer mills and three commercial container veneer mills. The harvesting of forests within the area is primarily for pulp and paper with saw log, veneer logs, pilings and poles comprising the balance of the market (Clemente, 1979).

The forest industry practices discussed above have had an impact on the terrestrial habitat in the reservoir site vicinity for many years. A portion of the proposed reservoir normal pool has been cut-over since the photographs used for the mapping of vegetation types (TPWD and the Frasier Group, Inc.) were taken (see section II.E.1.c.). Future detailed evaluations of habitat quality should consider current limitations imposed by this industry.

2. Terrestrial Wildlife

The purpose of this section of the regional planning study is to characterize the wildlife communities of the five county study area and the context within which they exist. First, a regional overview of the major ecological communities provides background for more site specific discussion pertaining to the five-county study area. Next, the wildlife habitat types found in the five county study area and common residents of those habitat types will be described and listed. The next subsection focuses upon particular species of commercial, recreational or other importance. The last two subsections consist of a discussion of unique/sensitive habitat types and, finally, a summary and comparison of previous studies conducted by the TPWD (Frye and Curtis, 1990) and the Frasier Group Inc. in 1988.

a. Regional Overview

Angelina, Cherokee, Nacogdoches, Rusk and Smith are primarily forested counties of East Texas. The following paragraphs provide an ecological description of the region with emphasis on vegetation and wildlife resources.

Hatch et al. (1990) refer to the majority of the study area as the Pineywoods vegetational area and describe it as an almost level to locally hilly forested plain. Anywhere from 40-56 inches of annual precipitation falls in an even distribution over the 15.8 million acres which comprise the Pineywoods. The dominant land use is timber production, followed by forest grazing, tame pasture, feed grain production, forage production and fruit and vegetable farming.

The northwestern portion of the study area as mapped by Gould (1975) falls within the Post Oak Savannah vegetational area. A large portion of Smith and a smaller portion of Cherokee County lies within the Post Oak Savannah mapping unit. Exhibit II.5 illustrates the project study area in relation to the vegetation areas of Texas.

As Gould (1975) and Hatch et al. (1990) describe vegetational areas within the state, Blair (1950) describes biotic provinces of the state with a focus on terrestrial vertebrates. The five county region lies within the Austroriparian biotic province. Exhibit II.9 illustrates the biotic provinces of Texas in relation to the five county study area. The study area marks the western boundary of the main body of this pine and hardwood forest of the eastern Gulf Coastal plain. The province to the west (The Texan), may be described as an ecotone where the forests of the southeast grade into the grasslands of western Texas and Oklahoma. The main limiting factor for forest plant and animal communities to the west of the Austroparian province is a lack of moisture. Portions of these pine-hardwood forests do extend westward where environmental conditions allow (usually along drainages). These westward extensions into the Texan Province represent potential travel corridors for dispersal of Austroriparian vertebrate species westward and for dispersal of those species indigenous to western provinces (Kansan, Balconian, and Tamaulipan) eastward.

The Austroriparian biotic province consists principally of pine, pine-oak and bottomland hardwood forests. Pine and pine-oak woodlands grow mainly on uplands and extensive networks of rivers, streams, swamps and reservoirs support bottomland hardwood forests. The combination of a mild climate and fairly restricted urbanization creates habitat for a diverse vertebrate faunal community. Several eastern forest species reach the western edges of their natural range and the prevalence of moist to wet habitats allows for the richest diversity of amphibian species of all Texas biotic provinces (Blair, 1950). The following sub-section takes a more site-specific look at habitat types found within the five county study area. Included in these discussions will be brief characterizations and listings of the respective wildlife communities of these habitat types.

b. Wildlife Habitat Types and Wildlife Communities

The following subsection consists of a series of general wildlife habitat descriptions followed by listing of wildlife species which typically utilize such habitat types. These descriptions and listings will follow the same basic format as those found in the vegetation section (II.E.1.b). The stratification of habitats and habitat utilization, for the purposes of this regional planning study, issues mainly from published documents, aerial photography and general knowledge of the area.

The description of wildlife habitat types is intrinsically linked to the soils, hydrology, climate, topography and vegetation of any given area. Since vegetative communities are shaped by the same basic physical parameters as wildlife communities, they provide a useful organizational reference. This section shall generally follow the structure set out in Section II.E.1.b - Vegetation Community Types, with the following exceptions.

The categories delineated by McMahan et al. (1984) as other native or introduced Grasses, Young Forests/Grassland, and Post Oak Woods, Forest and Grassland Mosaic will be condensed into one category referred to as Grasslands and Savannah. Given the high mobility of many species and the relatively small amount of Post Oak Savannah in the study area, this appeared to be a reasonable grouping. This Grassland and Savannah category will also encompass successional areas such as old fields and regenerating cut-over forest areas. The category delineated by McMahon (1984) as Pine-Hardwood will be referred to simply as Upland Forest. The categories delineated by McMahon (1984) as Water Oak-Elm-Hackberry Forest, Willow Oak-Water Oak, Oak-Blackgum and Bald Cypress-Water Tupelo Swamp will be grouped together and referred to as Bottomland Forest. Aquatic habitats such as riparian areas, reservoirs, ponds, marshes, etc. will be grouped into the category of Hydric Habitat. Finally, a very brief section regarding human-related wildlife habitats concludes the section; however, no real emphasis will be placed upon urban settings.

Grasslands and Savannah

As previously mentioned, native/introduced pastureland, grazing land, successional old fields/cut-over forest land and open areas within savannah comprise this category. Brief descriptions of these sub-categories follow.

Pastureland within the region varies in management level but consists typically of monotypic stands of bahia, bermuda or dallis grass.

Successional old fields and highway/railroad rights-of-way often contain grasses such as Johnsongrass, species of bluestem, lovegrasses, yellow bristlegrass, threeawns and Florida paspalum. Typical forbs include woolly croton, bitterweed, Florida snake cotton, buttonweed, yellow false garlic, asters, thistles and flatsedges. Common invading woody species in successional grasslands include sumacs, common persimmons, southern dewberry and rose.

Within regrowth areas after logging (clear-cutting), common sapling species include shortleaf, loblolly, slash, and long leaf pines, southern red oak, sweetgum, post oak, white oak, water oak, elm and hackberry. Common shrubs in these regrowth areas are hollys, hawthorns, wax myrtle, blackberry and sumac. Grasses in these areas often include species of *Andropogon, Paspalum, Panicum, Sporobolus.*

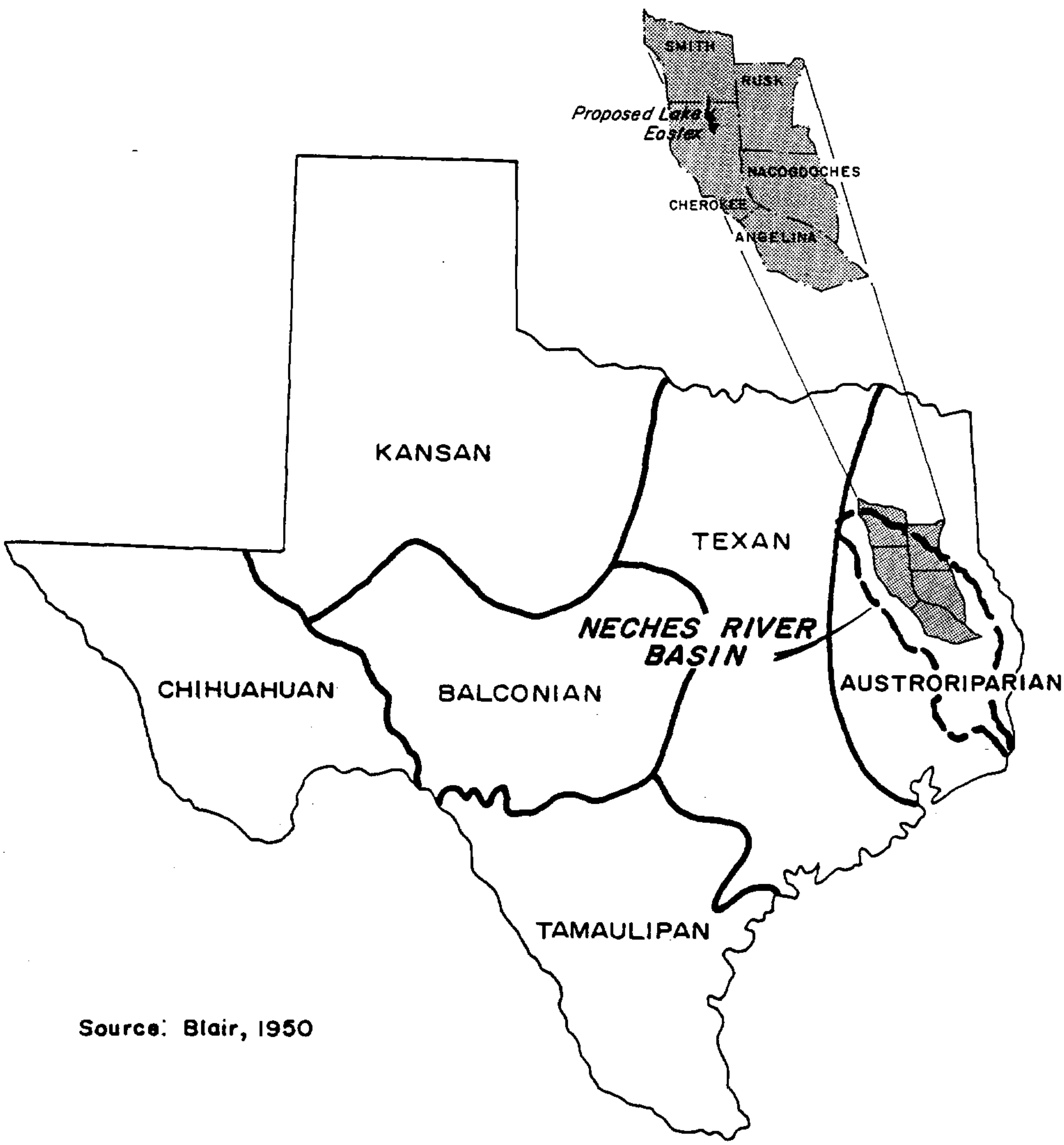


Exhibit II.9
PROJECT LOCATION IN RELATION
TO THE
BIOTIC PROVINCES OF TEXAS

In the northwestern portion of the study area, portions of Post Oak Savannah occur. This vegetational area is characterized by a mosaic of forest and grassland. Common grasses of this area include little and silver bluestems, beaked panicum, sand lovegrass, sprangletop, and threeawns. Typical shrubs and woody vines are yaupon, American beauty berry, poison oak, hawthorn, trumpet creeper, supplejack, dewberry, coral-berry and tick clover. Common trees of the Post Oak Savannah area include post oak, blackjack oak, sandjack oak, live oak, hickory, cedar elm, sugarberry, eastern red cedar and mesquite (McMahon et al. 1984).

Many species of wildlife utilize habitats which fall into this general category of grassland and savannah. Very few species solely utilize grasslands, or any one specific habitat. For this reason, the species lists for each habitat type overlap significantly. For example, many wildlife species are considered "edge" species. This means they utilize forest/forest opening, brush/agricultural land, or other similar borders. In order to accurately characterize these edge species' habitat preferences, the animals will be listed in each habitat type that they utilize. The other alternative would be to provide very abbreviated lists of species which tend to be habitat specialists. The former approach (multiple listings) is utilized in this report.

Wildlife species which utilize grassland and savannah habitats in varying degrees are identified in Table II.16. More specific habitat utilization information for each listed species may be found in Appendices A, B and C.

Upland Forest

Within the five-county area, an upland forest community composed of mainly oak and pine represents the most common wildlife habitat. A study conducted by the TPWD in 1984 indicates roughly 58 percent of the land-base supports this upland pine/hardwood community. The distribution and ratio of hardwoods to pine varies on any given landscape. The upland forest community tends to occur on well-drained sandy loams. Common upland tree species include shortleaf pine, loblolly pine, blackjack oak, southern red oak, postoak, sweetgum, and hickories (Gould, 1975 and Correll and Johnson, 1979). Wetter pockets support water oak, white oak and black tupelo. Understory species common in upland forest are American beauty berry, American hornbeam, yaupon and hawthorn.

Upland forests provide good habitat for many wildlife species; however, they are generally regarded as less productive than bottomlands of the southeastern U.S. The main reason for this lower productivity stems from lower levels of vegetative diversity which, in turn, is a result of less fertile soils and generally drier conditions. Another significant factor attributing to lower wildlife habitat values on uplands relates to land use practices in the region. Upland forests tend to be more readily logged than the wet lowlands and are often re-forested in monotypic pine stands. Upland forests serve as an important wildlife resource, in and of itself, as well as a buffer zone for species restricted to the bottomlands.

Wildlife species which utilize upland forests in varying degrees are identified in Table II.17. More specific habitat requirement information for each listed species may be found in Appendices A, B and C.

TABLE II.16

WILDLIFE SPECIES OF POTENTIAL OCCURRENCE IN GRASSLAND AND SAVANNAH HABITATS IN THE VICINITY OF THE PROPOSED LAKE EASTEX

Amphibians			
Strecker's Chorus Frog	Upland Chorus Frog	Pickerel Frog	Hurter's Spadefoot
Reptiles			
Three-toed Box Turtle	Texas Horned Lizard	Dusty Hognose Snake	Flathead Snake
Ornate Box Turtle	Texas Plains Glossy Snake	Eastern Hognose Snake	Eastern Garter Snake
Texas Spotted Whiptail	Northern Scarlet Snake	Prairie Kingsnake	Central Line Snake
Six-lined Racerunner	Tan Racer	Speckled Kingsnake	Rough Earth Snake
Broadheaded Skink	Eastern Yellowbelly Racer	Louisiana Milk Snake	Western Earth Snake
Southern Prairie Skink	Mississippi Ringneck Snake	Texas Coral Snake	
Western Slender Glass Lizard	Corn Snake	Western Pigmy Rattler	
Birds			
Cattle Egret	Mourning Dove	American Crow	Philadelphia Vireo
Greater White-fronted Goose	Inca Dove	Bewick's Wren	Painted Bunting
Snow Goose	Common Ground-dove	House Wren	Dickcissel
Canada Goose	Black-billed Cuckoo	Sedge Wren	Rufous-sided Towhee
Black Vulture	Yellow-billed Cuckoo	Marsh Wren	Bachman's Sparrow
Turkey Vulture	Greater Roadrunner	Blue-gray Gnatcatcher	American Tree Sparrow
Mississippi Kite	Barn Owl	Eastern Bluebird	Chipping Sparrow
Bald Eagle	Eastern Screech Owl	American Robin	Clay-colored Sparrow
Northern Harrier	Great Horned Owl	Gray Catbird	Field Sparrow
Swainson's Hawke	Burrowing Owl	Northern Mockingbird	Vesper Sparrow
Red-tailed Hawk	Short-eared Owl	Brown Thrasher	Lark Sparrow
Rough-legged Hawk	Common Nighthawk	Water Pipit	Savannah Sparrow
Golden Eagle	Chuck-Willis Widow	Sprague's Pipit	Grasshopper Sparrow
American Kestrel	Whip-poor-will	Cedar Waxwing	Henslow's Sparrow
Peregrine Falcon	Chimney Swift	Loggerhead Shrike	LeConte's Sparrow
Ring-necked Pheasant	Ruby-throated Hummingbird	European Starling	Song Sparrow
Northern Bobwhite	Red-headed Woodpecker	Bell's Vireo	Lincoln's Sparrow
Black-bellied Plover	Yellow-bellied Sapsucker	Yellow-throated Vireo	White-throated Sparrow
Lesser Golden Plover		Warbling Vireo	White-crowned Sparrow
Kildeer	Ladder-backed Woodpecker	Blue-winged Warbler	Harris' Sparrow
Willet	Downy Woodpecker	Tennessee Warbler	Lapland Longspur
Upland Sandpiper	Northern Flicker	Orange-crowned Warbler	Smith's Longspur
Whimbrel	Western Wood Pewee	Nashville Warbler	Chestnut-collared Longspur
Hudsonian Godwit	Eastern Wood Pewee	Yellow Warbler	Bobolink
Marbled Godwit	Yellow-bellied Flycatcher	Chestnut-sided Warbler	Red-winged Blackbird
Least Sandpiper	Willow Flycatcher	Magnolia Warbler	Eastern Meadowlark
White-rumped Sandpiper	Least Flycatcher	Prairie Warbler	Western Meadowlark
Baird's Sandpiper	Eastern Phoebe	Palm Warbler	Yellow-headed Blackbird
Pectoral Sandpiper	Vermilion Flycatcher	Black & White Warbler	Brewer's Blackbird
Dunlin	Great-crested Flycatcher	American Redstart	Great-tailed Grackle
Buff-breasted Sandpiper	Western Kingbird	Mourning Warbler	Bronzed Cowbird
Short-billed Dowitcher	Eastern Kingbird	Common Yellowthroat	Brown-headed Cowbird
Common Snipe	Scissor-tailed Flycatcher	Northern Cardinal	Orchard Oriole
American Woodcock	Horned Lark	Rose-breasted Grosbeak	Northern Oriole
Wilson's Phalarope	Purple Martin	Black-headed Grosbeak	Purple Finch
Red-necked Phalrope	Cliff Swallow	Blue Grosbeak	Pine Siskin
Bonaparte's Gull	Barn Swallow	Lazuli Bunting	American Goldfinch
Rock Dove	Blue Jay	Indigo Bunting	House Sparrow
Mammals			
Short-tailed Shrew	Plains Pocket Gopher	Hispid Cotton Rat	Gray Fox
Least Shrew	Hispid Pocket Gopher	Eastern Wood Rat	Striped Skunk
Eastern Mole	Eastern Harvest Mouse	Woodland Vole	Feral Hog
Nine-banded Armadillo	Fulvous Harvest Mouse	Coyote	White-tailed Deer
Eastern Cottontail	Northern Pygmy Mouse	Red Fox	

TABLE II.17

WILDLIFE SPECIES OF POTENTIAL OCCURRENCE IN UPLAND FOREST HABITATS IN THE VICINITY OF THE PROPOSED LAKE EASTEX

Amphibians			
Marbled Salamander	Strecker's Chorus Frog	Upland Chorus Frog	Hunter's Spadefoot
Great Plains Narrowmouth Toad			
Reptiles			
Three-toed Box Turtle	Southern Prairie Skink	Corn Snake	Louisiana Pine Snake
Green Anole	Texas Prairie Skink	Texas Rat Snake	Texas Brown Snake
Texas Spotted Whiptail	Northern Fence Lizard	Eastern Hognose Snake	Florida Redbelly Snake
Six-lined Racerunner	Southern Copperhead	Prairie Kingsnake	Flathead Snake
Southern Coal Skink	Texas Plains Glossy Snake	Speckled Kingsnake	Rough Earth Snake
Five-lined Skink	Northern Scarlet Snake	Louisiana Milk Snake	Western Earth Snake
Broadheaded Skink	Tan Racer	Eastern Rough Green Snake	
Birds			
Black Vulture	Eastern Wood Pewee	Blue-gray Gnatcatcher	Black-headed Grosbeak
Turkey Vulture	Yellow-bellied Flycatcher	Gray-cheeked Thrush	Blue Grosbeak
Sharp-shinned Hawk	Willow Flycatcher	Hermit-Thrush	Lazuli Bunting
Cooper's Hawk	Least Flycatcher	Cedar Waxwing	Green-tailed Towhee
Red-shouldered Hawk	Eastern Phoebe	Solitary Vireo	Rufous-sided Towhee
Broad-winged Hawk	Vermilion Flycatcher	Yellow-throated Vireo	Bachman's Sparrow
Merlin	Great Crested Flycatcher	Red-eyed Vireo	Fox Sparrow
Peregrine Falcon	Western Kingbird	Northern Parula	White-throated Sparrow
Wild Turkey	Eastern Kingbird	Black-throated Blue Warbler	Harris' Sparrow
Eastern Screech Owl	Barn Swallow	Blackburnian Warbler	Dark-eyed Junco
Great Horned Owl	Blue Jay	Yellow-throated Warbler	Brewer's Blackbird
Long-eared Owl	American Crow	Cerulean Warbler	Orchard Oriole
Chuck-will's Widow	Carolina Chickadee	Pine Warbler	Northern Oriole
Whip-poor-will	Tufted Titmouse	Bay-breasted Warbler	Purple Finch
Red-headed Woodpecker	Red-breasted Nuthatch	Blackpoll Warbler	Pine Siskin
Yellow-bellied Sapsucker	White-breasted Nuthatch	Black & White Warbler	Evening Grosbeak
Ladder-backed Woodpecker	Brown-headed Nuthatch	American Redstart	
Downy Woodpecker	Brown Creeper	Worm-eating Warbler	
Hairy Woodpecker	Carolina Wren	Swainson's Warbler	
Red-headed Woodpecker	Bewick's Wren	Ovenbird	
Northern Flicker	House Wren	Yellow-breasted Chat	
Pileated Woodpecker	Winter Wren	Summer Tanager	
Olive-sided Flycatcher	Golden-crowned Kinglet	Rose-breasted	
Western Wood Pewee	Ruby-crowned Kinglet	Grosbeak	
Mammals			
Eastern Mole	Evening Bat	White-footed Rat	Raccoon
Southeastern Myotis	Rafinesque's Big-eared Bat	Cotton Mouse	Eastern Spotted Skunk
Silver-haired Bat	Mexican Free-tailed Bat	Golden Mouse	Striped Skunk
Eastern Pipistrelle	Nine-banded Armadillo	Eastern Wood Rat	Bobcat
Big Brown Bat	Eastern Cottontail	Woodland Vole	Feral Hog
Red Bat	Eastern Gray Squirrel	Coyote	White-tailed Deer
Seminole bat	Fox Squirrel	Red Fox	
Northern Yellow Bat	Eastern Flying Squirrel	Gray Fox	
Hoary Bat	Plains Pocket Gopher	Ringtail	

Bottomland Forest and Hydric Zones

The bottomland forest of the Pineywoods is a complex and diverse ecosystem often described as the heart of East Texas wildlife habitat types. The USFWS (1985) documents 45 species of mammals, 273 species of birds, 54 species of reptiles and amphibians, 116 species of fish and many invertebrate species as occurring throughout forested bottomland.

Interactions between hydroperiods, climate, soils, and physiography/topography create a mosaic of floral and faunal associations throughout bottomland forests of East Texas. Physical habitat features such as river channels, oxbow lakes, permanently inundated backsloughs, active floodplains, flats, backswamps, levees, terraces, and transitional upland areas support some 24 habitat or community types throughout East Texas bottomlands (USFWS, 1985).

Within our five county study area, McMahan et al. (1984) delineates three vegetative communities common to bottomland areas. These include Willow Oak - Water Oak - Blackgum Forest, Water Oak -Elm - Hackberry Forest and Bald Cypress - Water Tupelo Swamp. Discussion of major plant species within these areas may be found earlier in this report in Section II.E.1.b Vegetation Community Types. More discussion concerning bottomland forest may be found in Section II.E.2.d, Unique and Sensitive Habitat Types. Wildlife species which utilize bottomland forest in varying degrees are identified in Table II.18. Following this listing, hydric habitats will be briefly described and hydric dependent species listed.

Many hydric zones occur in the study area. As previously mentioned, these features range from river channels, oxbow lakes, sloughs, and swamps to large, open-water reservoirs and stock tanks. These features are described in more detail in Sections II.B Hydrological Elements, and II.C.1 Wetlands. Vegetation of these areas are discussed in Section II.E.1.b.

Wildlife species which utilize hydric areas are defined in Table II.19. This Table includes those with only slight moisture needs to those restricted to aquatic environments. More specific habitat requirement information for the listed species may be found in Appendices A, B and C.

TABLE II.18

WILDLIFE SPECIES OF POTENTIAL OCCURRENCE IN BOTTOMLAND FOREST HABITAT IN THE VICINITY OF THE PROPOSED LAKE EASTEX

Amphibians			
Spotted Salamander	Dwarf Salamander	Eastern Narrowmouth Toad	Southern Crawfish Frog
Marbled Salamander	Gulf Coast Waterdog	Great Plains Narrowmouth Toad	Bullfrog
Mole Salamander	Central Newt	Cope's Gray Treefrog	Bronze Frog
Smallmouth Salamander	Western Lesser Siren	Green Treefrog	Pickerel Frog
Eastern Tiger Salamander	Northern Cricket Frog	Strecker's Chorus Frog	Southern Leopard Frog
Three-toed Amphiuma	Gulf Coast Toad	Upland Chorus Frog	Hurter's Spadefoot
Southern Dusky Salamander	East Texas Toad		
Reptiles			
Three-toed Box Turtle	Western Cottonmouth	Speckled Kingsnake	Florida Redbelly Snake
Green Anole	Eastern Yellowbelly Racer	Louisiana Milk Snake	Flathead Snake
Southern Coal Skink	Timber Rattlesnake	Texas Coral Snake	Western Ribbon Snake
Five-lined Skink	Mississippi Ringneck Snake	Eastern Rough Green Snake	Eastern Garter Snake
Broadheaded Skink	Corn Snake	Graham's Crawfish Snake	Central Lined Snake
Southern Prairie Skink	Texas Rat Snake	Western Pigmy Rattler	Rough Earth Snake
Southern Copperhead	Western Mud Snake	Texas Brown Snake	Western Earth Snake
Birds			
Black-crowned Night Heron	Western Wood Pewee	Veery	Connecticut Warbler
Yellow-crowned Night Heron	Eastern Wood Pewee	Gray-cheeked Thrush	Mourning Warbler
White Ibis	Yellow-bellied Flycatcher	Hermit Thrush	Common Yellowthroat
Wood Stork	Acadian Flycatcher	Wood Thrush	Hooded Warbler
Wood Duck	Willow Flycatcher	Gray Catbird	Wilson's Warbler
Mallard	Least Flycatcher	Cedar Waxwing	Canada Warbler
Bald Eagle	Eastern Phoebe	White-eyed Vireo	Yellow-breasted Chat
Sharp-shinned Hawk	Vermilion Flycatcher	Bell's Vireo	Summer Tanager
Cooper's Hawk	Great Crested Flycatcher	Solitary Vireo	Northern Cardinal
Red-shouldered Hawk	Western Kingbird	Yellow-throated Vireo	Rose-breasted Grosbeak
Broad-winged Hawk	Eastern Kingbird	Warbling Vireo	Blue Grosbeak
Wild Turkey	Tree Swallow	Philadelphia Vireo	Rufous-sided Towhee
Spotted Sandpiper	Northern Rough-winged	Red-eyed Vireo	Fox Sparrow
American Woodcock	Swallow	Nashville Warbler	Song Sparrow
Black-tailed Cuckoo	Bank Swallow	Northern Parula	Lincoln's Sparrow
Yellow-billed Cuckoo	Cliff Swallow	Yellow Warbler	Swamp Sparrow
Eastern Screech Owl	Carolina Chickadee	Magnolia Warbler	Dark-eyed Junco
Great Horned Owl	Tufted Titmouse	Black-throated Blue Warbler	Rusty Blackbird
Barred Owl	White-breasted Nuthatch	Blackburnian Warbler	Brewer's Blackbird
Long-eared Owl	Brown Creeper	Yellow-throated Warbler	Orchard Oriole
Belted Kingfisher	Carolina Wren	Cerulean Warbler	Northern Oriole
Red-bellied Woodpecker	Bewick's Wren	Prothonotary Warbler	Purple Finch
Hairy Woodpecker	Winter Wren	Northern Waterthrush	Pine Siskin
Pileated Woodpecker	Golden-crowned Kinglet	Louisiana Waterthrush	Evening Grosbeak
Olive-sided Flycatcher	Blue-gray Gnatcatcher	Kentucky Warbler	
Mammals			
Virginia Opossum	Seminole Bat	Eastern Gray Squirrel	Woodland Vole
Short-tailed Shrew	Northern Yellow Bat	Fox Squirrel	Coyote
Least Shrew	Hoary Bat	Eastern Flying Squirrel	Gray Fox
Eastern Mole	Evening Bat	Plains Pocket Gopher	Black Bear
Southeastern Myotis	Rafinesque's Big-eared Bat	Northern Rice Rat	Ringtail
Silver-haired Bat	Mexican Free-tailed Bat	Fulvous Harvest Mouse	Raccoon
Eastern Pipistrelle	Nine-banded Armadillo	Cotton Mouse	Bobcat
Big Brown Bat	Eastern Cottontail	Golden Mouse	Feral Hog
Red Bat	Swamp Rabbit	Eastern Wood Rat	White-tailed Deer

TABLE II.19

WILDLIFE SPECIES OF POTENTIAL OCCURRENCE IN HYDRIC HABITATS IN THE VICINITY OF THE PROPOSED LAKE EASTEX

Amphibians			
Spotted Salamander	Dwarf Salamander	Eastern Narrowmouth Toad	Bullfrog
Marbled Salamander	Gulf Coast Waterdog	Great Plains Narrow Mouth Toad	Bronze Frog
Mole Salamander	Central Newt	Cope's Gray Treefrog	Pickerel Frog
Smallmouth Salamander	Western Lesser Siren	Green Treefrog	Southern Leopard Frog
Eastern Tiger Salamander	Northern Cricket Frog	Strecker's Chorus Frog	Hunter's Spadefoot
Three-toed Amphiuma	Gulf Coast Toad	Upland Chorus Frog	
Southern Dusty Salamander	East Texas Toad	Southern Crawfish Frog	
Reptiles			
Common Snapping Turtle	Mississippi Mud Turtle	Midland Smooth Softshell	Yellowbelly Water Snake
Western Chicken Turtle	Alligator Snapping Turtle	Pallid Spiny Softshell	Broad-banded Water Snake
Mississippi Map Turtle	Texas River Cooter	American Alligator	Diamondback Water Snake
Sabine Map Turtle	Razorback Musk Turtle	Western Cottonmouth	Graham's Crayfish Snake
Yellow Mud Turtle	Stinkpot	Western Mud Snake	Gulf Crayfish Snake
Birds			
Red-throated Loon	Canadian Goose	Peregrine Falcon	Common Snipe
Common Loon	Wood Duck	King Rail	Wilson's Phalarope
Red-billed Grebe	Green-winged Teal	Virginia Rail	Red-necked Phalarope
Horned Grebe	American Black Duck	Sora	Franklin's Gull
Eared Grebe	Mallard	Purple Gallinule	Bonaparte's Gull
Western Grebe	Northern Pintail	Common Moorhen	Ring-billed Gull
American White Pelican	Blue-winged Teal	American Coot	Herring Gull
Double-crested Cormorant	Cinnamon Teal	Black-billed Plover	Caspian Tern
Olivaceous Cormorant	Northern Shoveler	Lesser Golden Plover	Common Tern
Anhinga	Gadwall	Piping Plover	Forster's Tern
American Bittern	American Widgeon	American Avocet	Black Tern
Least Bittern	Canvasback	Greater Yellowlegs	Short-eared Owl
Great Blue Heron	Redhead	Lesser Yellowlegs	Belted Kingfisher
Great Egret	Ring-necked Duck	Solitary Sandpiper	Tree Swallow
Snowy Egret	Greater Scaup	Willet	Northern Rough-winged Swallow
Little blue Heron	Lesser Scaup	Spotted Sandpiper	
Tricolored Heron	Oldsquaw	Upland Sandpiper	Bank Swallow
Cattle Egret	Surf Scoter	Whimbrel	Cliff Swallow
Green-backed Heron	Common Goldeneye	Hudsonian Grodwit	Barn Swallow
Black-crowned Night Heron	Bufflehead	Marbled Godwit	Sedge Wren
White Ibis	Hooded Merganser	Semipalmated Sandpiper	Marsh Wren
Glossy Ibis	Common Merganser	Least Sandpiper	Ruby-crowned Kinglet
White-faced Ibis	Red-breasted Merganser	White-rumped Sandpiper	Swamps Sparrow
Wood Stork	Ruddy Duck	Baird's Sandpiper	Red-winged Blackbird
Tundra Swan	Osprey	Purple Sandpiper	Yellow-beaded Blackbird
Greater White-fronted Goose	Mississippi Kite	Dunlien	Rusty Blackbird
Snow Goose	Bald Eagle	Buff-breasted Sandpiper	Great-tailed Grackle
	Northern Harrier	Short-billed Dowitcher	
Mammals			
Beaver	Muskrat	Mink	
Northern Rice Rat	Nutria	River Otter	

Human-related Wildlife Habitats

Among the many influences imposed upon wildlife by man is included the provision of habitat. Human structures, communities and land uses often provide nesting, roosting, feeding, and other essential habitat types. Wildlife species particularly well-known for such commensal behavior in the five county study area are identified in Table II.20. Specific habitat utilization information for the listed species may be found in Appendices A, B and C.

TABLE II.20

WILDLIFE SPECIES OF POTENTIAL OCCURRENCE IN HUMAN-RELATED HABITATS IN THE VICINITY OF THE PROPOSED LAKE EASTEX

Reptiles			
Green Anole			
Mediterranean Gecko			
Birds			
Rock Dove	Ruby-throated Humming bird	Cliff Swallow	Gray Catbird
Mourning Dove	Red-headed Woodpecker	Barn Swallow	Northern Mockingbird
Inca Dove	Yellow-bellied Sapsucker	Blue Jay	Brown Thrasher
Common Ground-dove	Ladder-backed Woodpecker	American Crow	Cedar Waxwing
Barn Owl	Downy Woodpecker	Carolina Chickadee	European Starling
Eastern Screech Owl	Purple Martin	Tufted Titmouse	House Sparrow
Common Nighthawk	Northern Rough-winged Swallow	House Wren	
Chimney Swift		American Robin	
Mammals			
Virginia Opossum	Eastern Pipistrelle	Brazilian Free-tailed Bat	House Mouse
Southeastern Myotis	Big Brown Bat	Black Rat	
Silver-haired Bat	Rafinesque's Big-eared Bat	Norway Rat	

c. Important Species and Habitats

The goal of this portion of the regional planning study is to focus a bit more closely upon elements of wildlife resources which often present important policy issues. For the purposes of this report, this discussion will be limited to commercially and/or recreationally important species, threatened and endangered species and unique and sensitive habitats.

Commercially and Recreationally Important Species

In the Pineywoods of East Texas, trapping and hunting have been activities of great commercial and recreational significance. A brief synopsis of fur harvest activities and furbearer population status follows. After the fur harvest/furbearer discussion, data and trends regarding hunting in East Texas will be discussed by species.

The TPWD evaluates fur harvest for the State of Texas on an annual basis. Brownlee (1991), furbearer program leader for TPWD, estimates the Pineywoods ecological region as second only to the Edward's Plateau in terms of average annual fur harvest. On a statewide basis, fur harvests have declined dramatically. The 1989-90 fur season suffered a 52% harvest decrease from the nine-year average posted between 1979-1987 (Perkins, 1990). This drop was undoubtedly linked to a considerable reduction in fur prices in the 1988-89 and 1989-90 seasons. Numbers of trapper's licenses sold have decreased dramatically over the years as well. Between 1979 and 1980 46,245 were sold as compared to 14,157 sold in 1989-1990.

The TPWD collects incidental data on furbearer abundance between July and October through spotlight surveys, which are primarily conducted to assess White-tailed Deer populations. Measurable populations for Raccoon (8.31 animals/100 miles), Opossum (1.11/60 miles), Skunk (1.42/100 miles), Gray Fox (0.30/100 miles), Coyote (0.71/100 miles) and Bobcat (0.20/100 miles) were obtained in the Pineywoods ecological area (Sorola, 1990). In general, furbearer harvests have declined over the last decade for a number of reasons. It would be safe to assume this activity will increase if and when fur prices rise again. Hunting activities contribute significantly to the East Texas economy. Brief population and harvest summaries of the more commonly hunted species of waterfowl, upland game birds, Rabbit and White-tailed Deer in East Texas follow.

Several species of waterfowl winter in the study area. Available data from the TPWD consists of mid-winter waterfowl surveys and hunter harvest data from nearby reservoirs. Harvest data was unavailable when requested.

The surveys are conducted in January on an annual basis by airplane. The state is partitioned into five zones which are flown by TPWD and USFWS personnel. The study area under consideration lies in the northeast zone and roughly corresponds to portions of the pineywoods, post oak savannah and blackland prairie as mapped by Gould (1975). Since these zones are very large, the surveyors tend to focus upon large bodies of water where the birds are readily identifiable. Although they fly the individual zones, the overall goal is to provide population summaries on a state-wide basis. Five zones were surveyed but large portions of South and West Texas were omitted as they are generally considered to be areas harboring lower wintering waterfowl densities. The zones surveyed include the upper coast (Orange County to Aransas County), the lower coast (Nueces to Cameron Counties), the northwest (the panhandle and portions of the Rolling Plains), the north central (portions of the Cross Timbers, Edwards Plateau, Post Oak Savannah and Blackland Prairie) and the northeast survey zones (as previously described). Table II.20 summarizes these mid-winter survey results for the northeast zone. One species common to the five county study area is the Wood Duck. This species is not listed in Table II.21 because it was not observed on the large reservoirs surveyed. This is not surprising since it is a forest species which uses the larger bodies of water less frequently.

TABLE II.21

MID-WINTER WATERFOWL SURVEY RESULTS FOR THE NORTHEAST ZONE, JANUARY, 1989

Species	Number Observed	% Relative to State Total (By Species)
Mallard	4,400	2.1
Gadwall	5,700	11.5
Widgeon	2,800	13.5
Green-winged Teal	7,300	3.4
Shoveler	100	0.3
Canvasback	2,000	14.0
Scaup	700	4.0
Ring-neck	17,300	86.6
Bufflehead	100	3.0
Unidentified Ducks	400	N/A
Tallgrass Canada Goose	600	19.42
Snow/Blue Geese	200	2.9

Source: Lobpries, 1990.

Information regarding populations and harvest of upland game birds such as American Woodcock, Wild Turkey (stocking information only), Bobwhite Quail and Mourning Dove in or near the study area follows.

The American Woodcock constitutes an important game resource in the Eastern U.S. The TPWD, in cooperation with staff and students of the School of Forestry at Stephen F. Austin University, conducted a study of Woodcock density, distribution and harvest in the Pineywoods and Post Oak Savannah ecological regions (George, 1990). Twenty-five randomly selected singing ground survey routes were run in the Pineywoods. These yielded an average of 2.20 birds per route which is comparable to figures gathered in prime habitat in the north-central U.S. (2.60/route). On a statewide basis, 2,526 Woodcock hunters harvested 2,382 birds over a 3,542 hunter-day effort during the 1989-90 season. Table II.22 summarizes the survey data available from four of the five counties within the study area.

TABLE II.22

WOODCOCK SURVEY SUMMARIES FOR SELECTED COUNTIES IN THE STUDY AREA

County	Number Woodcocks Heard 1988	1989	1990
Cherokee	2	1	0
Nacogdoches	0	0	3
Rusk	2	0	1
Angelina	10	5	5

Source: George, 1990.

The Eastern Wild Turkey depends upon bottomland hardwood habitat in East Texas. Densities may reach one bird per ten acres in bottomland; as opposed to one bird per 25 acres in upland habitat (USFWS 1989). The Eastern Wild Turkey was almost exterminated from East Texas due to over-hunting and habitat loss. Re-stocking and other management efforts have brought populations back to near huntable levels again. TPWD has re-stocked turkey purchased from Midwest and Eastern States in Angelina and Rusk Counties. Between September, 1990 and March of 1991, two females were stocked in Angelina; and a total 24 males and 98 females were stocked at eight sites in Rusk County (TPWD, 1991).

A state-wide quail census was initiated by TPWD in 1976. Data, albeit sparse, was collected for the Pineywoods up until 1988 when it was discontinued due to low counts. Huntable pockets of Bobwhite Quail exist in the five county region; however, this species does not provide a major hunting resource. In only three years, out of the eleven surveyed, were median quail counts even established in the only county surveyed of our five-county study area. The surveys took place in Rusk County and established median counts of two birds per route in 1977, 1981 and 1982. All other years surveyed between 1976 and 988 posted median counts of zero (Wilson, 1990a).

The Mourning Dove is considered the most important game bird in the U.S. and Texas as far as hunter recreation. The TPWD collects data regarding density and distribution in order to made harvest recommendations. A total of 133 randomly selected 15-mile call-count surveys are conducted in late May throughout all ecological regions of the state. Call counts yield data which is expressed as birds heard per route. Between 1967 and 1990, these figures ranged from 5.2 to 21.1 and 13.4 to 31.2 birds heard per route in the Pineywood and Post Oak Savannah ecological regions, respectively. A route-regression analysis run on the long term data revealed a significant, long term decline in Mourning Dove population for the Pineywoods. Mourning

Dove hunter days per 1,000 acres ranged from three to six in Rusk, Angelina and Nacogdoches Counties to seven to twelve in Smith and Cherokee Counties (George, 1990).

Of all the mammals hunted in East Texas, squirrels rank first with over 2.5 million hunter days devoted annually. Gray Squirrels tend to inhabit bottomland hardwoods and mixed pine/hardwood areas (i.e., loblolly pine - beech - magnolia associations). Abundant hardwood fruit crops (mast) in these areas support the largest Gray Squirrel population densities. The Gray Squirrel, or "cat" squirrel, is a much more retreating species than the Fox Squirrel which prefers mature oak/hickory forest in uplands. As bottomland habitat decreases, so does the range of the Gray Squirrel. Conversely, the Fox Squirrel's range tends to increase with clearing and human-related land uses. The Fox Squirrel thrives in agricultural and urban settings where the Gray cannot (USFWS 1985). No population or harvest data were obtained for either squirrel species.

Rabbits constitute the fifth most often hunted species in Texas and the Pineywoods accounts for the largest harvest percentage among the ecological areas of the state (21%). No rabbit population data exists for the Pineywoods ecological area since it is generally collected by the TPWD during quail census efforts which have been discontinued there. The state-wide figures yield an average of 2.03 Cottontails observed per 20 mile route. No Swamp Rabbits were observed during this effort. The reason for this is the western edge of the Swamp Rabbits range in Texas corresponds with the western edge of the Pineywoods ecological region which was not sampled (Wilson, 1990b).

The White-tailed Deer is the most important game animal in terms of economic impact, in the State of Texas. Although nearly decimated in the early 1900's due to commercial and illegal hunting, the species has made a dramatic recovery (USFWS, 1985). In the past four years; however, drought conditions and increased hunting pressure has caused a 37% population decline in the Pineywoods. Long term (1980-1989) density in the Pineywoods is 27.7 acres per deer and 19.8 acres per deer in the Post Oak Savannah. Fawn production and survival for the Pineywoods and Post oak Savannah is 0.24 fawns per doe and 0.34 fawns per doe, respectively. Sex ratios of 3.84 does per buck occur in the Pineywoods and 4.15 does per buck in the Post Oak Savannah (the worst in the State). Poor physical condition and antler development in the Post Oak Savannah indicate the White-tail population currently exceeds the carrying capacity of the habitat. Table II.23 lists selected 1989 deer herd data for the five county study area (Gore and Reagan, 1990).

TABLE II.23

SELECTED DEER HERD DATA FOR THE FIVE COUNTY STUDY AREA, 1989

County	Acres of Deer Range	Est. Population	Herd Composition		
			% Bucks	% Does	% Fawns
Rusk	448,133	9,763	5.3	94.7	0
Nacogdoches	511,620	24,857	7.5	67.5	25.0
Angelina	368,440	27,912	10.0	85.0	5.0
Cherokee	598,280	21,367	12.3	78.9	8.8
Smith*	94,134	369	50	50	0

*Based on a very limited sample (1,020 acres) which took place in 1988. Data has not previously been collected in Smith County.

Source: Gore and Reagan, 1990.

Threatened and Endangered Species

Section II.E.4 deals specifically with this important issue; however, a brief summary of this information follows. Wildlife species listed by the USFWS are presented in Table II.24.

Seven wildlife species of potential occurrence within the five county study area are designated as C2 by the USFWS. This ranking means that the species may need to be designated threatened or endangered but more research regarding the species biological vulnerability, status and taxonomy must take place before the status is designated. Candidate species (C2) in the five county study area include the Alligator Snapping turtle, Texas Horned Lizard, Louisiana Pine Snake, White faced Ibis, Bachman's Sparrow, Southeastern Myotis and Rafinesque's Big-eared Bat.

Two wildlife species of potential occurrence within the five county study area are designated as threatened by the USFWS. These include the Arctic Peregrine Falcon and Piping Plover. Also the Black Bear is currently under consideration for threatened status.

TABLE II.24
FEDERALLY LISTED WILDLIFE SPECIES OF POTENTIAL OCCURENCE IN THE FIVE COUNTY STUDY AREA.

Family Common Name *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]	
<u>REPTILES</u>					
Chelydridae Alligator Snapping Turtle *Macroclemys temmincki*	C2	T	T	G3	S3
Iguanidae Texas Horned Lizard *Phrynosoma cornutum*	C2	T	T	G5	S5
Colubridae Northern Scarlet Snake *Cemophora coccinea copei*	NL	T	WL	G5T2	S5
Louisiana Pine Snake *Pituophis melanoleucus ruthveni*	C2	T	E	G5	S5
Viperidae Timber Rattlesnake *Crotalus horridus*	NL	T	T	NL	
<u>BIRDS</u>					
Threskiornithidae White-faced Ibis *Plegadis chihi*	C2	E	T	G5	S2
Ciconiidae Wood Stork *Mycteria americana*	NL	T	T	NL	
Accipitridae American Swallow-tailed Kite *Elanoides forficatus*	3C	T	T	G5	S2
Bald Eagle *Haliaeetus leucocephalus*	E	E	E	G3	S2

TABLE II.24 (continued)

Family Common Name *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]	
Falconidae Arctic Peregrine Falcon *Falco peregrinus tundrius*	T	T	T	G3T1	S1
Charadriidae Piping Plover *Charadrius melodus*	T	T	T	G2	S2
Picidae Red-cockaded Woodpecker *Picoides borealis*	E	E	E	G2	S2
Emberizidae Bachman's Sparrow *Aimophila aestivalis*	C2	T	WL	G3	S2
MAMMALS **Vespertilionidae** Southeastern Myotis *Myotis austroriparius*	C2	NL	WL	G4	S3
Rafinesque's Big-eared Bat *Plecotus rafinesquii*	C2	T	T	G4	S4
Ursidae Black Bear *Ursus americanus*	PT	E	T	G5	S3

Federal Status[1]

E	Listed Endangered
T	Listed Threatened
LELT	Listed Endangered in part of range, Threatened in a different part
PE	Proposed to be listed Endangered
PT	Proposed to be listed Threatened
PEPT	Proposed Endangered, Threatened
S	Synonyms
C1	Candidate, Category 1. USFWS has substantial information on biological vulnerability and threats to support proposing to list as endangered or threatened. Data is being gathered on habitat needs and/or critical habitat designations.

TABLE II.24 (continued)

C2	Candidate, Category 2. Information is possibly appropriate, but substantial data on biological vulnerability and threats are not known to support the immediate preparation of rules. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2.
3	Taxa no longer being considered for listing as threatened or endangered. Three subcategories indicate the reasons for removal from consideration
3A	Former Candidate, rejected because presumed extinct and/or habitats destroyed
3B	Former Candidate, rejected because not a recognized taxon; i.e. synonym or hybrid
3C	Former Candidate, rejected because more common, widespread, or adequately protected
NL	Not currently listed

State Status[2]

E	Listed as Endangered in the State of Texas
T	Listed as Threatened in the State of Texas
NL	Not Currently listed

Texas Organization for Endangered Species (TOES)[3]

Plants
Federal Listed Species

Category I	The term "endangered species" means any species which is in danger of extinction throughout all or significant portion of its range other than a species of the Class Insecta determined by the Secretary of Interior to constitute a pest whose protection under the provision of the Endangered Species Act of 1973, P.L. 93-205, as amended (Dec. 1978), would present an overwhelming and overriding risk to man.
Category II	The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion its range.

Texas Natural Heritage Program Status[4]

Global Rank

G1	Critically imperiled globally, extremely rare, 5 or fewer occurrences. [Critically endangered throughout range.]
G2	Imperiled globally, very rare, 6 to 20 occurrences. [Endangered throughout range.]
G3	Very rare and local throughout range or found locally in restricted range, 21 to 100 occurrences. [Threatened throughout range.]
G4	Apparently secure globally.
GxTx	Denotes subspecific taxa.
GxQ	Indicates that the taxonomic status of the plant is a matter of conjecture.
GxGy	Indicates that the plant is borderline between ranks.
GH	Historical occurrence throughout its range.

TABLE II.24 (continued)

State Rank

S1	Critically imperiled in state, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences.
S2	Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences.
S3	Rare in state, 20+ occurrences.
S4	Apparently secure in state.
S5	Demonstrably secure in state.
SA	Accidental in state.
SE	An exotic species established in state.
SH	Of historical occurrence in state. May be rediscovered.
SX	Apparently extirpated from state.

TOES-State Listed Species

Category III	The term "state endangered species" means any species which is in danger of extinction or of extirpation in Texas or in addition to I and II above.
Category IV	The term "state threatened species" means any species which is likely to become a state endangered species within the foreseeable future.
Category V	The term "TOES watch list" means any species which at present has either low population or restricted range in Texas and is not declining or being restricted in its range but requires attentions to insure that the species does not become endangered or threatened (state or federal).

Animals

E	In danger of extinction in all of most of the species' range in the United States, particularly in Texas
T	Depleted or impacted by man so as likely to become endangered in the near future
WL	Potentially endangered or threatened in the United States, especially in Texas, although not necessarily in its range as a whole.

Two wildlife species listed as endangered may potentially occur in the study area. These include the Bald Eagle and Red-cockaded Woodpecker. Additionally, although not placed in Table II.23, the Red Wolf (E) historically inhabited the area. This species is thought to be restricted only to upper coastal counties in Texas. The Red Wolf is not sure to exist even in these counties (Schmidly 1983).

Please see Section II.E.4 for more details on sensitive plant, fish and wildlife species in the five county study area.

d. Unique or Sensitive Habitats

Overall, the most critical wildlife habitats in the five county study area are bottomland hardwood forest and wetlands. For the most part, these occur as forested wetlands. Concentrations of mast producing trees and other wildlife food sources such as emergent aquatic vegetation are highest in these forested wetlands. These areas provide the essentials of good wildlife habitat (food, water and cover) for many wildlife species, including game. Gray Squirrels, White-tailed Deer, Mallards, Wood Ducks and Eastern Wild Turkey all depend heavily upon bottomland hardwoods and associated wetlands, (USFWS, 1985).

Wetland resources are described in Section II.C.1 and their distributions illustrated in Exhibit II.4. These figures represent preliminary documentation only since no wetland delineations have taken place in the field. Recently, the U.S. Fish and Wildlife Service released a document which outlines their basic preservation policy for bottomland hardwoods in Texas. A summarized description of areas considered by the USFWS (1985) to be important bottomland hardwood sites follows.

Within the five county region, eleven sites have been preliminarily delineated by the USFWS as bottomland hardwood sites potentially worthy of preservation. A total of 62 such sites occur throughout East Texas and have been stratified according to their inherent value. Criteria such as stability of hydrological regime; habitat diversity and quality; waterfowl utilization and production; degree and imminence of threats; and presence of federal endangered or threatened species and state species of special concern factored into the priority designations for the individual sites. These eleven sites are discussed in more detail in Section II.E.1.e.

e. Summary and Comparison of Previous Ecological Evaluations

Two separate habitat-based ecological evaluations have been conducted within the proposed pool of Lake Eastex. These evaluations include a 1984 Wildlife Habitat Appraisal Procedure (WHAP) done by TPWD and the USFWS and a Habitat Evaluation Procedure (HEP) done by personnel from the U.S. Corps of Engineers, USFWS, TPWD and the Frasier Group, Inc. in November of 1988. Descriptions of each effort are followed by a summary which compares the data from each.

The Wildlife Habitat Appraisal Procedure

The Wildlife Habitat Appraisal Procedure (WHAP) provides qualitative, holistic evaluations of wildlife habitat with minimal investments of labor (field work), and data analysis (Frye, 1991). The technique involves a three-stage approach which 1) measures key ecological condition components which contribute to wildlife utility; 2) addresses potential for protected plant and animal occurrence, and; 3) analyzes acquisition priorities and management suitability for the given tract. Each section produces scores derived from the evaluation parameters which are combined to yield a final summary for the tract at issue.

The WHAP focuses upon ecological productivity and diversity as an indication of habitat suitability for wildlife. Each vegetative cover type occurring within a WHAP study area is assigned a habitat quality (HQ) score based upon an evaluation of key components. These include: "site potential for woody and herbaceous plant production; age of existing vegetation; relative abundance of the habitat types and its value to wildlife; diversity of occurring woody species; vertical stratification of vegetation canopy cover; relative abundance or scarcity of dens and refuge sites; and availability of browse and herbaceous materials," (Frye and Curtis 1990). The habitat quality (HQ) score is directly comparable to a unit called the habitat suitability index (HSI) in the USFWS Habitat Evaluation Procedure (HEP). This HQ score ranges numerically from 0.0 to 1.0 with the higher number equating to the highest quality wildlife habitat. This HQ score, when multiplied by the number of acres of the given cover type, in a project area yields habitat units (HU). These HU values provide the means for evaluating project impacts in a standardized fashion (Frye 1991).

Without foregoing or drastically altering a project, such as a reservoir, the only form of mitigation left is compensation for wildlife habitat losses which result from project impacts. In order to fully realize the value of the habitat within proposed project boundaries, every cover type, corresponding acreage of each type and percent of the reservoir areas containing these types are evaluated in accordance with the WHAP. Once each of these cover types is evaluated, they are assigned resource category designations per USFWS (1981) guidelines. These categories represent inherent importance of the habitat to evaluation species. These are defined as "species, populations or communities representing ecological, social or economic aspects of the habitat," (Frye & Curtis 1990). Table II.25 illustrates the resource categories, designation criteria and mitigation and planning goals used by TPWD and USFWS in comparing impacts of various projects.

TABLE II.25

USFWS RESOURCE CATEGORIES AND MITIGATION PLANNING GOALS

Resource Category	Designation Criteria	Mitigation and Planning Goal
1	High value for evaluation species - unique and irreplaceable.	No loss of existing habitat[1] value.
2	High value for evaluation species and scarce or becoming scarce.	No net loss of in-kind habitat[2] value.
3	High to medium value for evaluation species and abundant.	No net loss of habitat value while minimizing loss of in-kind habitat value.
4	Medium to low value for evaluation species.	Minimize loss of habitat value.

Source: Frye and Curtis 1990

1 Existing habitat values are those at the specific site in question.

2 In-kind habitat values are those of habitat of the same type.

Another very important criteria involved with compensation of wildlife habitat losses is management. According to this method, the concept of mitigation hinges not only upon acquisition of suitable land but also upon the proper management of suitable land. Compensation requirements for habitat losses may be met by a level of management which sufficiently increases carrying capacity (based upon existing HQ values) to support existing wildlife plus additional populations roughly equivalent to those lost as a result of the project. The following formula is utilized to determine compensation acreages for project losses, (Frye and Curtis 1990).

HU's lost due to project = (acres impacted by project) (existing HQ values on impacted lands)

HQ increase = HQ of compensation land after management - existing HQ of compensation lands

HU's gained on compensation lands = (compensation acres)(HQ increase)

Since compensation is the equal replacement of HU's, then: HU's lost due to project must equal HU's gained on compensation land; and

HU's lost due to project = (compensation acres needed)(HQ increase) or
compensation needed = HU's lost due to project ÷ HQ increase.

As a part of a joint publication, the USFWS and TPWD evaluated the 44 reservoirs proposed in the Texas Water Development Board's 1984 Water Plan. The goal of the evaluation was to determine preliminary acreage compensation requirements for projected losses suffered as a result of inundation. They assumed three levels of management which correspond to potential HQ gains predicted. These are briefly explained below.

25% HQ Gain = Minimal management: i.e., marking wildlife management area boundaries; providing periodic protective surveillance; limited grazing control; and allowing habitat quality increases through natural succession.

50% HQ Gain = Moderate management: i.e., the above practices implemented; plus planting of selected seedlings and vegetation manipulation through mechanical means or burning.

100% HQ Gain = Intensive management: i.e., above mentioned practices, plus; extensive plantings of specific species; vegetative maintenance; wildlife trapping; transplanting and restocking; and public recreation use.

Table II.26 summarizes the results of the TPWD/USFWS WHAP performed in 1984.

TABLE II.26

WILDLIFE HABITAT APPRAISAL PROCEDURE (WHAP) RESULTS FOR THE PROPOSED LAKE EASTEX

Cover Type/ Resource Category	Lost Acres	HQ/ HSI	Habitat Units Lost	Management Option	Potential HQ Gain	Compensation Requirements (Acres)
Grass/Resource Category - 3	2,706	0.32	866	Minimum 25% Moderate 50% Maximum 100%	0.170 0.340 0.680	5,094 2,546 1,274
Pine-Hardwood Forest/ Resource Category - 3	2,999	0.62	1,859	Minimum 25% Moderate 50% Maximum 100%	0.095 0.190 0.380	19,568 9,784 4,892
Mixed Bottomland Hardwood Forest/ Resource Category 2	3,517	0.70	2,462	Minimum 25% Moderate 50% Maximum 100%	0.075 0.150 0.300	32,827 16,413 8,207
Other	867					
Total	10,089			Minimum 25% Moderate 50% Maximum 100%		57,489 28,744 14,373

Source: Frye and Curtis 1990.

The Habitat Evaluation Procedure

The Habitat Evaluation Procedure (HEP) differs from WHAP mainly in that it is a species specific habitat assessment approach, as opposed to a broad, ecological habitat assessment approach. The method assumes habitat quality and quantity may be assigned numerical values which may then be used when comparing alternative project or mitigation sites. Habitat Suitability Index (HSI) values are determined on individual tracts by field inventory of key habitat components known to be vital to the species chosen. Existing habitat conditions are compared to optimum habitat conditions when calculating the HSI for the species. Since optimum habitat conditions are those which yield highest concentrations of the target species, the HSI represents an index of carrying capacity for the species on the given tract. As with WHAP, the HSI, multiplied by the acreage, provides a quantity of Habitat Units (HU's) for the subject tract and the specific species chosen (USFWS, 1980). Since many of the same concepts previously described for the WHAP apply to HEP, a discussion of the actual study performed for the proposed Lake Eastex follows. All descriptions and data concerning this effort were supplied by the Frasier Group, Inc.

Coordination meetings to organize the study design for the habitat evaluation were attended by personnel from the Fort Worth District of the U.S. Army Corps of Engineers, the Environmental Protection Agency, the U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department. During the course of these meetings, seven wildlife species and eight habitat components were chosen for evaluating the reservoir's impact. Wildlife species chosen include the Barred Owl, Gray Squirrel, Red-tailed Hawk, Green (or Green-backed) Heron, Belted Kingfisher, Swamp Rabbit, and Wood Duck. Habitat components include riverine, lacustrine, herbaceous wetland, shrub wetland, forested wetland, improved pasture, shrub-land, and deciduous mixed forest. Life requisites for the seven wildlife species were evaluated at 51 sites within the eight different habitat components using HEP. Documentable field visits undertaken by members of the above mentioned inter-agency team took place November 2-4, 1988. Subsequent communication between the various agency personnel, Dr. Frasier and Mariah indicate the HEP was not completed by the inter-agency team, but by the Frasier Group, Inc. Table II.27 summarizes the data provided by the Frasier Group, Inc.

Different results were reached in the WHAP and HEP studies executed. The principle differences are found in the cover types chosen, the lost acreage figures, and the HQ/HSI values assigned to the cover types. These categorical differences cause major changes to ripple through each entire study resulting in significant differences in suggested compensation acreages.

Cover types delineated by Frye and Curtis (1990) are grasses, pine-hardwood forest, mixed bottomland forest and other. Cover types delineated by Frasier (1990) include improved pasture, pine-oak forest, oak-pine bottomland, oak bottomland and other. The most notable difference here is the separation, by Frasier (1990), of bottomland forest into the oak-pine and oak categories.

TABLE II.27

HABITAT EVALUATION PROCEDURE RESULTS FOR THE PROPOSED LAKE EASTEX

Cover Type	Lost Acreage	HQ/HSI	Habitat Unit Loss	Management Option (%)	Potential HQ Gain	Compensation Acreage
Improved Pasture	2,918	0.11	320.9	Minimum 25 Moderate 50 Maximum 100	0.28 0.45 0.89	1,146 713 361
Pine/Oak Forest	3,682	0.17	625.9	Minimum 25 Moderate 50 Maximum 100	0.21 0.42 0.83	2,981 1,490 755
Oak/Pine Bottomlands	2,832	0.39	1104.5	Minimum 25 Moderate 50 Maximum 100	0.16 0.31 0.61	6,903 3,563 1,811
Oak Bottomlands	87	0.69	60.1	Minimum 25 Moderate 50 Maximum 100	0.08 0.16 0.31	751 370 194
Other Built-up	543					
Total				Minimum 25 Moderate 50 Maximum 100		11,781 6,136 3,121

HQ = Habitat Quality
HSI = Habitat Suitability Index
Source: Frasier, 1990.

In terms of lost acreages, grasslands are fairly similar with Frye and Curtis (1990) showing 2,706 acres of grasses lost and Frasier (1990) showing 2,918 acres of improved pasture lost. However, significantly different HQ/HSI values were posted by Frye and Curtis (1990) for grasses (0.32) than that posted by Frasier (1990) for improved pasture (0.11). This seems to indicate Frasier finds all grasslands to be improved pasture and therefore, of significantly lower value as wildlife habitat.

Lost acreages for the forest types become more difficult to compare due to the different cover types chosen for each study. Frye and Curtis (1990) show 2,999 acres of pine-Hardwood forest with a HQ/HSI value of 0.62 to be lost. Frasier (1990) delineates 3,682 acres of Pine/Oak forest with a HQ/HSI value of 0.17 to be lost. There is a notable difference between the bottomland cover types chosen by Frasier (1990) and Frye and Curtis (1990). That is, Frasier distinguishes between Oak/Pine bottomland and oak bottomland, whereas Frye and Curtis refer to only one mixed bottomland hardwood forest. Frasier's Oak/pine bottomland to be lost consists of 2,832 acres with a HQ/HSI of 0.39 and the oak bottomland to be lost is 87 acres with an HQ/HSI of 0.69. Frye and Curtis (1990) document 3,517 acres of mixed bottomland hardwood forest with an HQ/HSI of 0.70 to be lost. This seems to indicate Frasier distinguishes between a mixed oak/pine (successional) bottomland forest and a mature, purely oak bottomland of relatively small acreage but extremely high habitat value. The resulting compensation acreages vary dramatically and are presented in Table II.28.

TABLE II.28

COMPARISON OF WHAP AND HEP ACREAGE COMPENSATION REQUIREMENTS FOR THE PROPOSED LAKE EASTEX (BY MANAGEMENT LEVEL)

Management Level (%)	WHAP[1] - Acres	HEP[2] - Acres
25	57,489	11,781
50	28,744	6,136
100	14,373	3,121

[1] Frye and Curtis, 1990.
[2] Frasier, 1990.

The reasons for these significant differences may possibly be attributed to the different methodologies employed and the different times when they were conducted. Frasier (1990) used HEP, color infrared aerial photography (dated 1983) commercial timber stand data and conducted his study between 1988 and 1990. Frye and Curtis (1990) used LANDSAT imagery (dated 1974) and conducted their study in 1987. Between the different photography sets, field methodologies and dates of the two studies different results might be expected.

3. Aquatic Fauna and Flora

The purpose of this section is to characterize the aquatic fauna and flora within the study area. A regional overview of the surface water hydrology and regional aquatic resources is presented initially. This is followed by a description of the various aquatic habitats within the Angelina-Neches Basin and a discussion of the species of potential occurrence with each of the various habitat types. Next, the important aquatic species in the study area will be discussed. Finally, a description of the unique and/or sensitive aquatic resources in the study area is presented.

a. Regional Overview

An overview of the aquatic resources in the study area is presented in this section. This overview includes a review of the surface water hydrology (and water quality) of the Angelina-Neches River Basin with specific emphasis on the aquatic resources directly related to Mud Creek.

Angelina-Neches River Basin

The proposed Lake Eastex reservoir project lies in the Angelina-Neches River Basin. This basin extends generally to the southeast and is bordered on the west by the Trinity River Basin, on the north and east by the Sabine River Basin, and on the south by the Neches-Trinity Coastal Basin. The Angelina River drains the northeastern one-third (3,575 square miles) of the drainage basin. The Neches River Basin which constitutes the remaining two-thirds (6,555 square miles) of the (10,130 square miles) basin is drained by the Neches River, Pine Island Bayou and Village Creek. The dividing line between the Angelina and Neches River Basins runs south to southeast from the City of Tyler to the confluence of the two rivers. The Angelina River arises near Freeneytown (Rusk County) at an elevation of 290 feet and flows 205 miles to its confluence with the Neches River. The origin of the Neches River is near Canton (Van Zandt County) at an elevation of 590 feet, and flows approximately 416 miles to Sabine Lake (COE 1982). Village Creek and Pine Island Bayou are major tributaries of the drainage basin south of the confluence of the Neches and Angelina Rivers.

Nine reservoirs greater than 750 acres, have been implemented in the drainage basin covering a total area of 166,770 surface acres. Sam Rayburn Reservoir and Lake Palestine are the largest, covering 114,500 acres and 25,560 acres, respectively, with Kurth Lake being the smallest at 770 acres. Table II.29 provides the surface acreages of the nine reservoirs in the drainage basin.

TABLE II.29

SURFACE ACRES OF EXISTING RESERVOIRS IN THE ANGELINA-NECHES RIVER BASIN

Reservoirs	Surface Area (acres)
Sam Rayburn Reservoir	114,500
Lake Palestine	25,560
B.A. Steinhagen Lake	13,690
Lake Tyler (East & West)	4,800
Striker Lake	2,400
Lake Nacogdoches	2,210
Lake Athens	1,520
Lake Jacksonville	1,320
Kurth Lake	770
Total	166,770

The Texas Water Commission (1990) has divided the drainage basin into 14 segments consisting of 749 stream miles and five major reservoirs covering 159,981 acres (TWC, 1990). The locations of these segments are presented graphically in Exhibit II.10. A summary of designated areas and water quality status of each of the segments is presented in Table II.30. In general, the water quality parameters are well within the criteria for the segments and the aquatic habitat is described as high quality by the TWC.

The proposed Lake Eastex will be located on Mud Creek which flows to the southeast with the upper reaches of the watershed being approximately fifteen miles southeast of Tyler, Texas in Smith County. Mud Creek intersects the Angelina River nearly six miles south of the town of Reklaw in Cherokee County. The proposed dam will be located approximately sixteen river miles upstream from the confluence with the Angelina River in Cherokee County.

The proposed Lake Eastex watershed will have a contributory drainage area at the dam site of 391 square miles located in Smith, Cherokee, and Rusk Counties. Major impoundments upstream of the proposed reservoir site include Lakes Tyler and Tyler East which control 107 square miles of drainage area combined.

In 1984 the Texas Department of Water Resources (TDWR) conducted an intensive survey of segment 0611 of the Angelina River. Approximately 36 stations were set up on the Angelina River and its tributaries starting in Tyler, Texas and ending at the Sam Rayburn Reservoir. Water quality throughout this system ranged from moderate to poor. The poorest water quality was found in two places: just south of Tyler and slightly north of Sam Rayburn Reservoir. Moderate water quality was found throughout Mud Creek and its tributaries between Tyler and Sam Rayburn Reservoir. The TDWR concluded that the poor water quality in the northern area of the basin came from the City of Tyler Southside Wastewater Treatment Plant discharge. Dissolved Oxygen (DO) conditions were extremely low at Stations C2 and C3 but recovered after several miles as seen at Stations C4 and C6. Extremely low DO conditions in this area may have been caused by sluggish water velocity, low atmospheric re-aeration, heavy shading and organic loading from wastewater treatment plants. Paper Mill Creek was also a poor water quality tributary lying just north of Sam Rayburn Reservoir. This creek had critically low oxygen concentrations due to wastewater from a paper product company (TDWR, 1984). The locations of the sample stations and data collected from Mud Creek are presented in Exhibit II.11 and Table II.31, respectively. Note, significantly more detail on the surface water hydrology and water quality of the study area is presented in Section II.B.1 of this Volume.

TABLE II.30

DESIGNATED USES AND WATER QUALITY STATUS FOR THE ANGELINA-NECHES RIVER BASIN (BY TWC WATER QUALITY SEGMENT)

Water Quality Parameter	Criteria	0601	0602	0603	0604	0605	0606	0607	0608	0609	0610	0611	0612	0613	0614
Recreation	NA	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact	Contact
Public Water Supply	NA	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Aquatic Habitat	NA	Intermed. quality	High quality	High quality	High Quality	High quality	Intermed. quality	High quality	High quality	High quality	High quality	High quality	High quality	High quality	High quality
Dissolved Oxygen (mg/l) Range Mean	5.0 (except where noted)	3.2 - 10.4 5.4[1]	4.3 - 10.4 5.4[1]	4.6 - 6.2 5.6	4.0 - 1.0 6.8	5.9 - 8.2 7.0	2.0[3] - 15.0 5.2	2.8 - 9.7 4.7	3.9 - 10.2 7.5	4.1 - 11.4 8.2	0.0 - 11.9 7.5	3.2 - 12.1 7.7	5.6 - 9.7 7.7	6.0 - 9.8 8.0	7.2 - 7.7 7.5
pH Range Mean	6.0 - 8.5	5.0 - 8.1 7.1	5.9 - 8.6 7.1	7.3 - 7.6 7.4	3.6 - 7.4 6.9	6.4 - 7.6 6.9	5.9 - 7.2 6.7	5.8 - 8.2 7.0	5.0 - 7.3 6.6	6.4 - 7.9 7.2	5.8 - 7.7 6.8	5.4 - 7.4 6.6	6.3 - 7.6 7.2	6.2 - 7.0 6.7	7.6 - 7.8[9] 7.7
Total Dissolved Solids (mg/l) Range Mean	150 (except where noted)	27 - 15880 3077[2]	36 - 136 75	51 - 80 71	47 - 121 83	61 - 88 72	84 - 263 167	33 - 400[4] 114	24 - 59[5] 40	50 - 81[6]	47 - 887[7] 207	34 - 601[8] 152	21 - 62 39	48 - 66 56	41 - 47[10] 44
Fecal Coliform (#/100 ml) Range Mean	200 (except where noted)	2 - 1470 62	8 - 840 85	3 - 25 6	26 - 290 90	1 - 5 1	10 - 1020 121	7 - 390,000 403	20 - 840 56	2 - 11 5	1 - 1317 35	48 - 2500 60	80 - 1260 176	1 - 60 3	2 - 28 7

(1) D.O. criteria for Segment 0601 is 3.0 mg/l.
(2) TWS criteria for Segment 0601 has not been established.
(3) D.O. criteria for Segment 0606 is 4.0 mg/l.
(4) TDS criteria for Segment 0607 is 300 mg/l.
(5) TDS criteria for Segment 0608 is 300 mg/l.
(6) TDS criteria for Segment 0609 is 250 mg/l.
(7) TDS criteria for Segment 0610 is 250 mg/l.
(8) TDS criteria for Segment 0611 is 200 mg/l.
(9) pH criteria for Segment 0614 is 6.5 to 9.0.
(10) TDS criteria for Segment 0614 to 750 mg/l.

Note that the number of samples for each segment and parameter vary considerably. These samples do, however, provide valuable information as to the water quality within the Angelina-Neches River Basin.

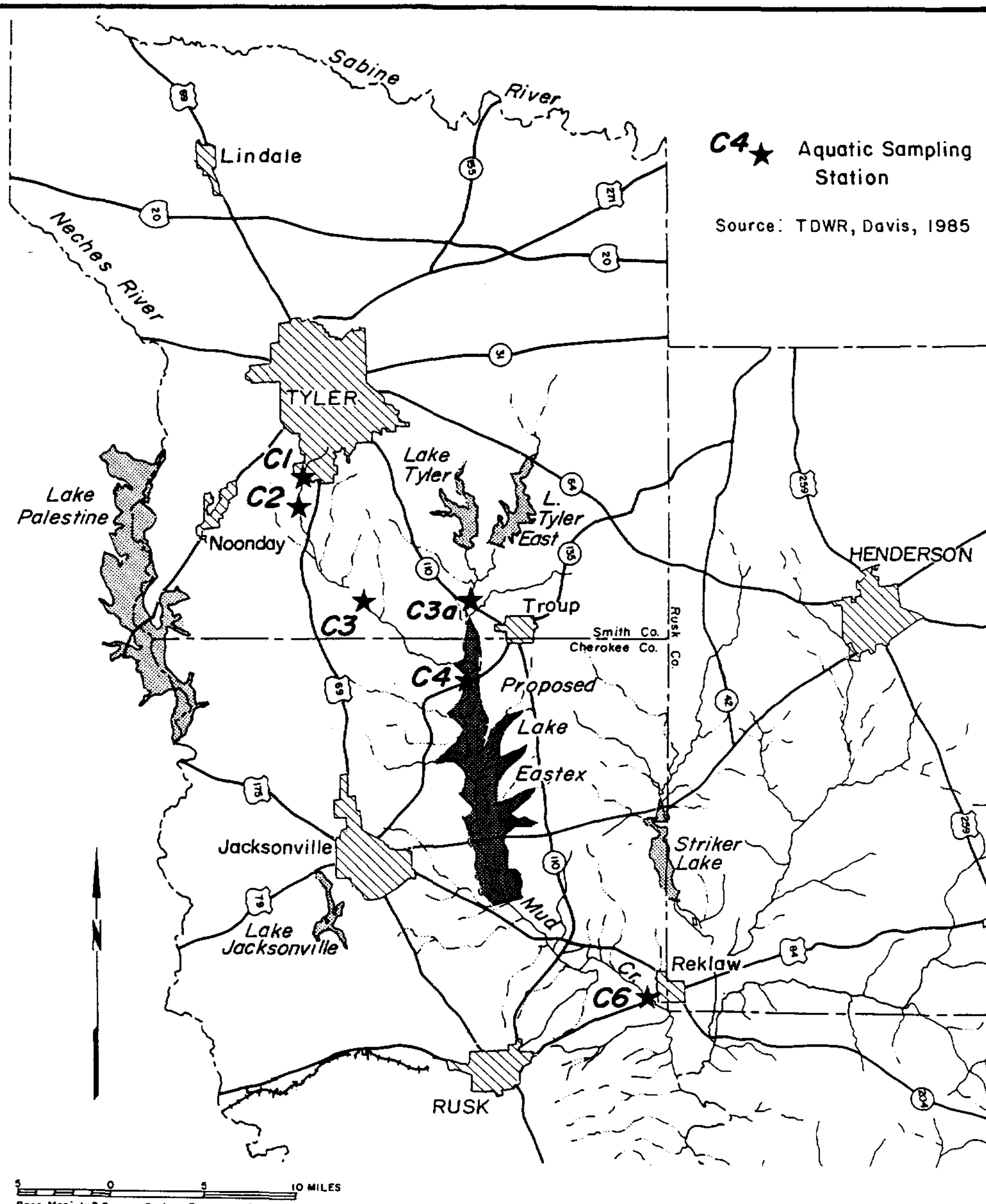


Exhibit II.11

WATER QUALITY SAMPLING STATIONS
IN THE VICINITY OF THE PROPOSED LAKE EASTEX

TABLE II.31

WATER QUALITY DATA FROM SAMPLING STATIONS ON MUD CREEK

Station	Time	Dissolved Oxygen		Temp °C	pH
		mg/l	% Sat.		
C1	0940	3.7	44.9	25.0	6.5
	1350	3.9	48.2	26.0	6.5
	1830	3.9	47.3	25.0	6.5
	0540	3.2	38.1	24.0	6.2
		3.6	44.2	24.9	6.4
C2	1025	0.0	0.0	27.0	6.5
	1420	0.2	2.5	27.0	6.5
	1900	0.1	1.3	27.0	6.5
	0630	0.1	1.2	25.0	6.5
		0.1	1.3	26.4	6.5
C3	1050	3.0	36.4	25.0	6.5
	1440	3.7	46.6	27.0	6.5
	1920	1.8	22.2	26.0	6.5
	0700	1.8	21.0	23.0	6.5
		2.3	28.4	25.0	6.5
C4	1125	5.6	67.9	25.0	5.9
	1525	6.1	75.4	26.0	6.2
	2000	6.4	79.1	26.0	6.2
	0735	5.6	66.7	24.0	6.2
		6.0	72.6	25.2	6.2
C5	1600	4.5	55.6	26.0	6.8
C6	1045	5.0	62.0	26.2	7.3
	1420	7.0	90.6	28.6	7.6
	1910	7.3	94.0	28.3	7.6
	0610	5.4	64.7	24.3	7.4
		6.2	78.4	26.7	7.5

Source: TDWR, 1985

Mud Creek Drainage

A physical description of Mud Creek downstream to the Angelina River is provided below. This description is based upon information gathered from the TDWR (1985) and analysis of topographical maps and aerial photographs of the specified areas.

Mud Creek of the Angelina-Neches Watershed System begins in central Smith County, just south of Tyler, Texas. The creek runs south by southeast for 41 miles until it reaches the Angelina River, which flows another 22 miles to the Sam Rayburn Reservoir in Angelina County. Important tributaries discharging into Mud Creek (listed from north to south) include West Mud Creek, Caney Creek, Birches Creek, Bridge Creek, Bendabout Creek, Horse Creek and Cooke Creek. Intensive survey studies on West Mud Creek contributed much of the data for the following descriptions.

Mud Creek is divided into two sections. The first section occupies an area from Tyler to U.S. Highway 79; and the second site is from Highway 79 to the Angelina River. This section consists of a broad creek area and fast flow. The banks along this section are deeply cut. Detritus and organic matter are less prominent than in other areas. Many of the tributaries along this northern section are dominated by long, slow moving pools with few riffles or stagnant pools. The faster flowing streams along this section are primarily caused by the discharge from Lake Tyler. Natural springs may also contribute to the flow in this area of the creek. Several studies performed in this area concluded that the tributaries and water systems impair the aquatic communities in this section. For instance, a study performed on West Mud Creek by the TWC (1988) concluded that throughout the Northern Mud Creek area under low flow conditions, dissolved oxygen levels were extremely depressed. Fecal coliform levels were also listed as exceeding the criterion of 200 colonies per 100 ml throughout much of the extreme northern section of Mud Creek (TWC 1988).

As Mud Creek flows south past Highway 79, the main creek separates into several types of water systems. These systems include sloughs, stagnant pools, oxbows, long slow moving pools, alternating patterns of riffles and large backwater pools. In general, this area typifies a swampy or boggy region. From Highway 79 to the Angelina River, Mud Creek becomes braided into several channels. These channels form all the water systems mentioned above and still manage to flow in a south by southeast direction. The water quality of Mud Creek is considered to be moderate by TDWR (1985), due primarily to the reduced waste loading from the tributaries. These tributaries may contribute to low pH values and DO concentrations because of acidic leaf litter and organic material coming from the slow moving pools (TDWR, 1985).

Mud Creek generally has two types of water systems which are characterized either by swift moving riverines or stagnant slow moving tributaries. Overall the water quality ranges from moderate to good.

b. Aquatic Habitats and Species

The Angelina-Neches Basin contains five types of aquatic habitats. The following habitats are listed and generally described below: Reservoirs, Rivers, Intermittent Streams, Perennial Streams, and Estuaries.

Reservoirs

As previously mentioned, nine reservoirs with a total surface acreage of 166,700 acres are located in the Angelina-Neches River Basin. Reservoirs can be defined as large bodies of water that are somewhat homogenous in water quality and can be assumed to provide common habitat for a variety of fish species. Because of the vast acreage that reservoirs occupy the number of individuals would likely be greater than that of riverine type habitats. Fish species of potential occurrence in reservoirs in the Angelina-Neches basin are identified in Table II.32.

Rivers and Streams

For the purpose of this report, rivers are classified as free flowing bodies of water which usually sustain flowing water all year long and provide habitat for a variety of species. Streams are defined as small free flowing water systems with seasonal changes in water levels. Streams include riffles, runs and long slow moving pools. These streams most likely provide habitat for the majority of different species found in this river basin. Intermittent streams are water systems that are either temporary or have the potential to dry up. This type of system provides habitat for species that can survive in stagnant or slow moving bodies of water. In Texas, these intermittent streams have a tendency to be at maximum capacity during the spring and completely dry during late summer.

Mud Creek contains many different habitats within its riverine and stream systems. These habitats include runs, riffles and pools. Runs primarily include areas where flow is more noticeable compared to stagnant bodies of water. Riffles are shallow, swift, gravelly sections of streams. Pools include long, slow moving bodies of water or stagnated sections of water. Oxbow lakes are also present within this system. These types of lakes are formed by rivers or riverines, which actually change direction, cutting off bodies of water that were formerly part of the river system, and leave a lake type system. Along Mud Creek's water system, leaf litter and debris has had an impact on this system by providing a range of habitats within these subhabitats. Dominant fish species of potential occurrence in riverine habitats are presented in Tables II.33, II.34, and II.35.

A summary of fish species of potential occurrence (and corresponding habitat types) throughout the Angelina-Neches River Basin is presented in Table II.36.

TABLE II.32

FISH SPECIES OF POTENTIAL OCCURRENCE IN RESERVOIRS IN THE ANGELINA-NECHES RIVER BASIN.

Scientific Name	Common Name
Petromyzontidae	
Ichymyzon castaneus	Chestnut Lamprey
Polydontidae	
Polydon spataula	Paddle Fish
Lepisosteidae	
Atractosteus spatula	Alligator Gar
Lepisosteus oculatus	Spotted Gar
Amiidae	
Amia calva	Bowfin
Clupeidae	
Dorosoma pretense	Threadfin Shad
D.cepedianum	Gizzard Shad
Cyprinidae	
Cyprinus carpio	Common Carp
Notemigonus crysolucas	Golden Shiner
Notropis atherinoides	Emerald Shiner
Poeciliida	
Poecilia catipinna	Sailfin Molly
Percichthyidae	
Morone chrysops	White Bass
M. Mississippiensis	Yellow Bass
M. saxalitis	Striped Bass
Centrarchidae	
Micropterus punctulatus	Spotted Bass
M. salmoides	Large Mouth Bass
Lepomis gulosus	Warmouth
L. cyanellus	Green Sunfish
L. punctatus	Spotted Sunfish
L. microlophus	Redear Sunfish
L. macrochirus	Blue Gill
L. megalotus	Longear Sunfish
Pomoxis annularis	White Crappie
P. nigromaculatus	Black Crappie
Catostomidae	
Ictibus bubalus	Smallmouth Buffalo
Carpiodes carpio	River Carpsucker
Erimyzon oblongus	Lake Chubsucker
Ictaluridae	
Ictalurus punctatus	Channel Catfish
I. furcatus	Blue Catfish
Pylodictis olivaris	Flathead Catfish

Source: (Lee, D.S., et al., 1990)

TABLE II.33

FISH SPECIES OF POTENTIAL OCCURRENCE WITHIN RIVERINE TYPE HABITATS IN THE ANGELINA-NECHES RIVER BASIN

Scientific Name	Common Name
Polydontidae	
Polydon spataula	Paddle Fish
Lepisosteidae	
Atractosteus spatula	Alligator Gar
Lepisosteus oculatus	Spotted Gar
L. osseus	Longnose Gar
Clupeidae	
Dorsoma pretense	Threadfin Shad
Characidae	
Astyanax mexicanus	Mexican Tetra
Cyprinidae	
Hybopsis storeriana	Silver Shub
Notropis atherinoides	Emerald Shiner
N. amibilis	Texas Shiner
N. texanus	Weed Shiner
N. amnis	Pallid Shiner
N. venustus	Blacktail Shiner
N. volucellus	Mimic Shiner
Pimephales vigilax	Bullhead Minnow
Campostoma anomalum	Central Stoneroller
Cyprinodontidae	
Zygonectes olivaceus	Blackspotted Topminnow
Poecililiidae	
Poecilia latipinna	Sailfin Molly
Percichthyidae	
Morone chrysops	White Bass
M. mississippiensis	Yellow Bass

Source: (Lee, D.S., et al., 1990)

TABLE II.34

FISH SPECIES OF POTENTIAL OCCURRENCE IN RIFFLES AND CHUTES IN THE ANGELINA-NECHES RIVER BASIN

Scientific Name	Common Name
Percidae	
Percina shumardi	River Darter
P. macrolepida	Bigscale Logperch
Etheostoma parvvipinne	Goldstripe Darter
E. radiosum	Orangebelly Darter
Phenacobius mirabilis	Suckermouth Minnow

Source: (Lee, D.S. et al., 1990)

TABLE II.35

FISH SPECIES OF POTENTIAL OCCURRENCE WITHIN SLUGGISH BACKWATER POOLS, AND SWAMPY AREAS IN THE ANGELINA-NECHES RIVER BASIN

Scientific Name	Common Name
Centrarchidae	
Micropterus punctulatus	Spotted Bass
Lepomis cyanellus	Green Sunfish
L. auritus	Redbreast Sunfish
Pomoxis annularis	White Crappie
P. nigromaculatus	Black Crappie
Cyprinidae	
Ciprinus carpio	Common Carp
Catostomidae	
Minytrema melanops	Spotted Sucker
Erymyzon oblongus	Creek Chubsucker
Ictaluridae	
Ictalurus punctatus	Channel Catfish
I. furcatus	Blue Catfish
I. melas	Black Bullhead
Noturus nocturnus	Freckled Madtom
Percidae	
Percina sciera	Dusky Darter
Ammocrypta vivax	Scaly Sand Darter
A. clara	W. Sand Darter
Lepisosteidae	
Lepisosteus oculatus	Spotted Gar
Amiidae	
Amia calva	Bowfin
Clupeidae	
Dorosoma cepedianum	Gizzard Shad
Ėsocidae	Redfin Pickerel
Essox americannus	Chain Pickerel
E. niger	

TABLE II.35 (continued)

Scientific Name	Common Name
Cyprinidae	
Notemigonus crysolucas	Golden Shiner
Notropis amabilis	Texas Shiner
N. fumeus	Ribbon Shiner
N. umbratilis	Redfin Shiner
N. cornutus	Common Shiner
N. texanus	Weed Shiner
N. sabinae	Sabine Shiner
N. lutrensis	Red Shiner
N. atrocaudlis	Blackspot Shiner
N. buchanani	Ghost Shiner
Hybognathus nuchalis	Mississippi Silver Minnow
Pimephales promelas	Flathead Minnow
Cyprinodontiidae	
Fundulus chrysotus	Golden Topminnow
F. blairae	Batatit
Poecilidae	
Gambusia affinis	Mosquito Fish
Poecililia latipinna	Sailfin Molly
Centrarchidae	
Lepomis symmetricus	Bantam Sunfish
L. punctatus	Spotted Sunfish
L. microlophus	Redaer Sunfish
L. macrochirus	Blue Gill
L. humilis	Orange Spotted Sunfish
L. marginatus	Dollar Sunfish
Centrarchus macropterus	Flier
Elassoma zonatun	Banded Pygmy Sunfish
Catostomidae	
Moxostima congestum	Gray Redhorse
Minystrema melanops	Spotted Sucker
Erymyzon sucetta	Lake Chubsucker
Ictaluridae	
Ictalurus natalis	Yellow Bullhead
Noturus gyrinus	Tadpole Madtom
Aphredoderidae	
Aphredoderis sayanus	Pirate Perch
Percidae	
Etheostoma chlororosumum	Bluntnose Darter
E. gracile	Slough Darter
E. fusiforme	Swamp Darter
E. spectabile	Orange-throated Darter
E. proeliare	Cypress Darter

Source: (Lee, D.S. et al., 1990).

TABLE II.36

FISH OF POTENTIAL OCCURRENCE IN THE ANGELINA-NECHES RIVER BASIN (BY HABITAT TYPE)

Scientific Name	Common Name	Habitat
Petromyzontidae		
Ichthymyzon castaneus	Chestnut Lamprey	Large river basins/large bodies of water.
Polydontidae		
Polyodon spataula	Paddle Fish	Large bodies of water/large free flowing rivers/improvements.
Lepisosteidae		
Atractosteus spatula	Alligator Gar	Free flowing rivers/reservoirs, clear water with much aquatic vegetation.
Lepisosteus oculatus	Spotted Gar	Brackish water of larger streams.
L. osseus	Longnose Gar	
Amiidae		
Amia calva	Bowfin	Sluggish/clear, vegetative low land waters
Anguillidae		
Anguilla rostrata	American Eel	Common in most aquatic systems that have access to the sea.
Clupeidae		
Dorosoma pretenense	Threadfin Shad	Lakes, ponds, estuaries and reservoirs, swift flowing rivers.
D. cepedianum	Gizzard Shad	Natural in-land lakes, ponds, pools and backwater.
Esocidae		
Esox americanus	Redfin Pickerel	Small quite heavily vegetated waters like in streams.
E. niger	Chain Pickerel	Clean,shallow vegetated shoal water, deep lakes.
Characidae		
Astyanax mexicanus	Mexican Tetra	Streams and river habitats.
Cyprinidae		
Cyprinus carpio	Common Carp	Streams, lakes.
Notemigonus crysolucas	Golden Shiner	Ponds, lakes, sluggish streams, rivers.
Opsopoeodus emiliae	Pugnose Minnow	Clear, sluggish, weedy waters.
Hybopsis storeriana	Silver Chub	Large, silty rivers.
Phenacobius mirabilis	Suckermouth Minnow	Riffles in sand bottom.
Notropis atherinoides	Emerald Shiner	Large, open rivers, lakes.
N. amabilis	Texas Shiner	Spring headwater tributaries, larger rivers.
N. fumeus	Ribbon Shiner	Creeks, ditches, agricultural area - very tolerant.
N. umbratilis	Redfin Shiner	Small, medium size streams, long slow moving pools.
N. cornutus	Common Shiner	Alternating pools, medium size streams, not riffles.
N. texanus	Weed Shiner	Open sand bottom streams in all size streams.
N. sabinae	Sabine Shiner	Smaller streams with slight to moderate current.
N. amnis	Pallid Shiner	Medium to large rivers.
N. venustus	Blacktail Shiner	Moderate to large rivers.
N. lutrensis	Red Shiner	Low gradient, backwater habitat - not in high gradient streams.
N. atrocaudalis	Blackspot Shiner	Shallow, low flowing streams.
N. volucellus	Mimic Shiner	Very large turbid rivers.
N. buchanani	Ghost Shiner	Low gradient sections of larger creeks and rivers.
Hybognathus nuchalis	Missisipy Silvery Minnow	Pools, backwaters. Low gradient streams.
Pimephales vigilax	Bullhead	Rivers, stream pools.
P. promelas	Flathead Minnow	Pools to flowing streams.
Campostoma anomalum	Central Stoneroller	Riffles, pools, rapid current.

TABLE II.36 (continued)

Scientific Name	Common Name	Habitat
Catostomidae		
Cycleptus elongatus	Blue Sucker	Fast moving river systems.
I. bubalus	Smouthmouth Buffalo	Clear waters with modest current.
Carpiodes carpio	River Carpsucker	Pools of rivers and in reservoirs.
Moxostoma congestum	Gray Redhorse	Medium to large warm streams.
Minytrema melanops	Spotted Sucker	Creeks and small rivers.
Erimyzon sucetta	Lake Chubsucker	Ponds, oxbows, sloughs and areas of little or no flow.
E. oblongus	Creek Chubsucker	Small rivers and creeks, improvements.
Ictaluridae		
Ictalurus punctatus	Channel Catfish	Medium to large rivers with strong currents, spring lakes.
I. furcatus	Blue Catfish	Swift chutes, pools with swift currents.
I. melas	Black Bullhead	Ponds, pools, streams, rivers, swampy areas.
I. natalis	Yellow Bullhead	Smaller, weedier bodies of water.
Pylodictis olivaris	Flathead Catfish	Deep holes, medium to large sized rivers.
Noturus gyrinus	Tadpole Madtom	Slow moving waters, pools.
N. nocturnus	Freckled Madtom	Turbid streams, riffles.
Aphredoderidae		
Aphredoderus sayanus	Pirate Perch	Lakes, ponds and quiet pools.
Cyprinodontidae		
Fundulus chrysotus	Golden Topminnow	Ditches and slow moving streams.
F. blairae	Batstit	Swamps, barrow ditches, sloughs and streams.
Zygonectes notatus	Blackstripe Topminnow	Cleaner, faster flowing streams.
Z. olivaceus	Blackspotted Topminnow	Fast flowing relatively clear streams.
Poeciliidae		
Gambusia affinis	Mosquito Fish	Ponds, ditches, backwater, sluggish water.
Poecilia latipinna	Sailfin Molly	Ubiquitous
Percichthyidae		
Morone chrysops	White Bass	Clear lakes, reservoirs, rivers.
M. mississippiensis	Yellow Bass	Tributary streams/lakes.
M. saxatilis	Striped Bass	Lakes/improvements.
Centrarchidae		
Micropterus punctulatus	Spotted Bass	Smaller streams and rivers.
M. salmoides	Largemouth Bass	Clear, quite waters with vegetation.
Lepomis gulosus	Warmouth	Lakes and ponds, brackish.
L. cyanellus	Green Sunfish	Many habitats.
L. symmetricus	Bantam Sunfish	Sloughs, oxbows, lakes, and swamps in vegetation.
L. punctatus	Spotted Sunfish	Quiet, moderate moving water.
L. microlophus	Redear Sunfish	Quiet, clear water with stumps and vegetation/brackish.
L. macrochirus	Blue Gill	Shallow, warm lakes, ponds, rivers.
L. humilis	Orange Spotted Sunfish	Quiet, stream/vegetated lakes.
L. auritus	Redbreast Sunfish	Rivers and large streams.
L. megalotis	Longear Sunfish	Reservoirs/small streams - upland parts of rivers.
L. marginatus	Dollar Sunfish	Swamps, sluggish streams.
Pomoxis annularis	White Crappie	Streams, lakes, pond, rivers.
P. nigromaculatus	Black Crappie	Large ponds, prefer cleaner, deeper, cooler waters.
Centrarchus macropterus	Flier	Sluggish, low-land with clear vegetated waters.
Elassoma zonatum	Banded Pygmy Sunfish	Clear, quite waters with thick vegetative growth.

TABLE II.36 (continued)

Scientific Name	Common Name	Habitat
Percidae		
Percina sciera	Dusky Darter	Large streams and rivers over gravel.
P. shumardi	River Darter	Chutes, riffles where current is swift.
P. macrolepida	Bigscale Logperch	Gravel race ways in a moderate to swift current riffles.
Ammocrypta vivax	Scaly Sand Darter	Larger rivers with swift currents.
A. clara	W. Sand Darter	Upper river drainages.
Etheostoma chlorosumum	Bluntnose Darter	Sluggish streams of low lands, backwater pools where no currents.
E. gracile	Slough Darter	Slow/moderate flowing waters with little or no aquatic plants.
E. fusiforme	Swamp Darter	Stagnant water of ponds, swamps in detritus.
E. parvipinne	Goldstripe Darter	Gravel riffles associated with vegetation.
E. radiosum	Orange Belly Darter	Riffle areas of gravel bottom streams.
E. spectabile	Orange Throated Darter	Smaller streams, does not live in areas of continuous flow.
	Cypress Darter	
E. proeliare		Lakes, streams, bayous, swamps and backwater.
Sciaenidae		
Aplodinotus grunniens	Freshwater Drum	Large, silty lakes and rivers.
Mugilidae		
Mugil cephalus	Striped Mullet	Tropical and subtropical streams

Source: (Lee, D.S., et al., 1990; Hubbs, 1982)

c. Summary of Aquatic Studies in the Vicinity of Mud Creek

This section presents a review of studies conducted in the general area of the proposed reservoir. The information provided below may be considered to be representative of the species that may be collected in aquatic habitats similar to that of Mud Creek.

Fish

Several surveys of the fish populations of East Texas have been conducted in the past decade. At least two studies have concentrated on areas with habitats similar to that of Mud Creek. These studies include an "Intensive Survey of West Mud Creek, Neches River Basin" (TWC, 1988) and "An Assessment of Six Least Disturbed Unclassified Texas Streams" (TWC, 1989). Sampled creeks in the general vicinity of Mud Creek with similar physical characteristics include West Mud Creek, Catfish Creek and Black Cypress Creek. The locations of sampling locations of these creeks with respect to Mud Creek is presented in Exhibit II.12. Fish specimens collected from West Mud Creek, Catfish Creek, and Black Cypress Creek are presented in Tables II.37, II.38, and II.39, respectively. Due to the proximity to the proposed Lake Eastex and similarity of habitat types, these samples can be considered to be somewhat representative of the populations that can expected to be found in Mud Creek.

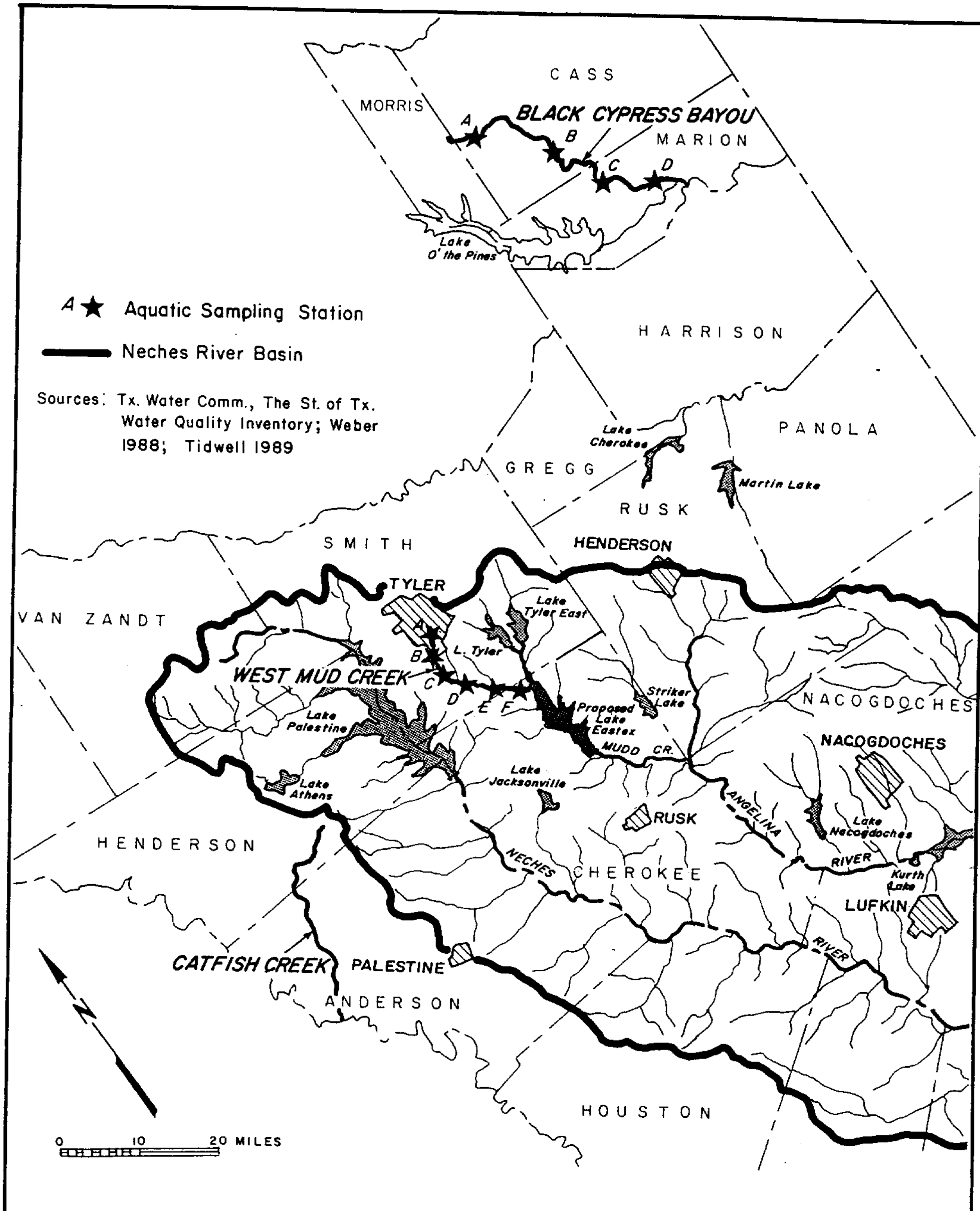


Exhibit II.12
AQUATIC SAMPLING STATIONS
IN THE VICINITY OF MUD CREEK

TABLE II.37

FISH SPECIES COLLECTED
FROM THE WEST MUD CREEK WATER SYSTEM, 8/87

Scientific Name	Common Name
Ciprinnidae	
Notropis venustus	Blacktail Shiner
N. atrocaudalis	Blackspot Shiner
N. fumeus	Ribbon Shiner
Pimephales vigilax	Bullhead Minnow
Cyprinodontidae	
Fundulus notatus	Blackstripe Top Minnow
Poeciliidae	
Gambusia affinis	Mosquito Fish
Labidesthes sicculus	Brook Silverside
Centrarchidae	
Lepomis humilis	Orange Spotted Sunfish
Promoxis nigromaculatus	White Crappie
Ammocrypta clara	W. Sand Darter
Species Diversity Ranges from .77 to 1.47	

Source: (TWC, 1988)

An analysis of the three samples previously discussed indicate similar species composition in all three sample sites. However, Catfish Creek samples contained fish such as the redfin pickerel which primarily occur in larger rivers or large bodies of water. This was probably caused by the release of water from reservoirs near Catfish Creek allowing fish that primarily live in large water systems to travel out of their preferred habitat.

Note that these samples are only intended to provide a representation of fish species found in similar environments to Mud Creek. Sampling Mud Creek with a variety of techniques (seining, electroshocking, etc.) is the only method of ensuring a comprehensive baseline data set has been developed.

TABLE II.38

FISH SPECIES COLLECTED FROM CATFISH CREEK, 8/88

Scientific Name	Common Name
Lepisosteidae	
Lepisosteus oculatus	Spotted Gar
Esocidae	
Esox americanus	Redfin Pickerel
Cyprinidae	
Notemigonus crysoleucas	Golden Shiner
Notropis atherinoides	Emerald Shiner
N. emiliae	Pugnose Shiner
N. fumeus	Ribbon Shiner
N. lutrensis	Red Shiner
N. texasnus	Weed Shiner
N. vennustus	Blacktail Shiner
Pimephales vigilax	Bullhead Minnow
Catostomidae	
Minytrema melanops	Spotted Sucker
Ictaluridae	
Ictalurus melas	Black Bullhead
I. natalis	Yellow Bullhead
I. punctatus	Channel Catfish
Noturus nocturnus	Freckled Madtom
Pylodictus olivaris	Flathead Catfish
Aphredoderidae	
Aphredoderus sayanus	Pirate Perch
Cyprinodontidae	
Fundulus notatus	Blackstripe Topminnow
F. olivaceus	Blackspotted Topminnow
Poeciliidae	
Gambusia affinis	Mosquito Fish
Centrarchidae	
Centrarchus macropterus	Flier
Lepomis cyanellus	Green Sunfish
L. gulosus	Warmouth
L. macrochirus	Bluegill
L. megalotis	Longear Sunfish
L. punctatus	Spotted Sunfish
Pomoxis nigromaculatus	White Crappie
Peridae	
Etheostoma chlorosomum	Bluntnose Darter
E. gracile	Slough Darter
Percina sciera	Dusky Darter
Species Diversity Ranged from .95 - 2.23	

Source: J.R. Davis, 1988

TABLE II.39

FISH SPECIES COLLECTED FROM BLACK CYPRESS CREEK, 11/87

Scientific Name	Common Name
Lepisosteidae *Lepisosteus oculatus*	 Spotted Gar
Amiidae *Amia calva*	 Bowfin
Clupeidae *Dorosoma cepedianum*	 Gizzard Shad
Cyprinidae *Notropis venustus*	 Blacktail Shiner
Cyprinodontidae *Fundulus notatus*	 Blackstripe Topminnow
Poeciliidae *Gambusia affinis*	 Mosquito Fish
Centrarchidae *Carpiodes carpio* *Centrarchus macropterus* *Lepomis humilis* *L. marginatus* *L. macrochirus* *Micropterus salmoides*	 Common Carp Flier Orange Spotted Sunfish Dollar Sunfish Blue Gill Largemouth Bass
Ictaluridae *Ictalurus natalis* *I. punctatus* *Noturus gyrinus*	 Yellow Bullhead Channel catfish Tadpole Madtom
Peridae *Etheostoma gracile*	 Slough Darter
Species Diversity Ranged from 1.88-2.97	

Source: J.R. Davis, 1988

Macroinvertebrates

The TWC collected macroinvertebrates on West Mud Creek and Black Cypress Creek in 1987, two streams with similar habitats to that of Mud Creek. A summary of these invertebrate collections is presented below.

Invertebrate collections within the Angelina-Neches River basin have shown a significant amount of grazer/gatherers, miners and shredders, which would indicate detrital residue naturally occurring within the basin creeks. Grazers are detrivores who usually feed on the surface. Gatherers feed in the metalimnion and gather much of the suspended food. Filterers are considered to be herbivores - detrivores living on algal cells that decompose particulate organic matter. Miners are herbivores and detrivores that decompose vascular plant tissue. Predators are considered to be piercers and swallowers and are generally considered to be carnivores. The following data (derived from samples on West Mud, and Black Cypress Creeks) represents what potentially may be found in invertebrate samples throughout the Angelina-Neches basin including Mud Creek.

Grazers (% of Community)	20-35%
Gatherers (% of Community)	30-40%
Filterer (% of Community)	3-10%
Miners (%of Community)	15-25%
Shredders (%of Community)	3-10%
Predators (% of Community)	1-15%

Source: TWC, 1989

This data shows that the saprophytic number is relatively high compared to the predator number. Therefore, it is evident that organic matter is an important food source for the benthic communities in the sampled streams.

Invertebrates collected in West Mud Creek and Black Cypress Creek are presented in Table II.40.

TABLE II.40

INVERTEBRATES COLLECTED FROM WEST MUD CREEK (8/87)
AND BLACK CYPRESS CREEK (11/87)

West Mud Creek

Scientific Name
Oligochaeta
Limnodrilus sp.
Hirudinea, unid.
Mollusca
Pisidium sp.
Sphaeriidae, unid.
Crustacea
Macrobrachium sp.
Ephemeroptera
Hexagenia sp.
Brachycerus sp.
Stenonema sp.
Odonata
Sympetrum sp.
Argia sp.
Hetaerina sp.
Nasiaaeschuna sp.
Hemiptera
Graptorixa sp.
Corixidae, unid.
Diptera
Bezzia sp.
Chaoborus sp.
Tanypus sp.
Cryptochironomus sp.
Polypedilum sp.
Dicrotendipes sp.
Micropsectra sp.
Tribelos sp.
Constempellina sp.
Chironomidae, unid.

Source: TWC, 1989

Black Cypress Creek

Scientific Name
Hirudinea
Helobdella elongata
Oligochaeta
Aulodrilus piqueti
Ilyodrilus templetoni
Limnodrilus hoffmeisteri
I. udeicemianus
Pristina americana
P. sp.
Gastropoda
Amnicola limosa
Pellecypoda
Eupera cubensis
Pisidium compressum
P. nitidum
Sphaerium transversum
Decapoda
Cambarellus sp.
Palamonetes kadiakensis
Isopoda
Lirceus
Coleoptera
Hydraena
Diptera
Chironomus riparius
Clinotanypus
Dicrotendipes neoodestus
Limnophila
Polypedilum nr. scalaenum
Probezzia sp.
Procladius sp.
Stenochironomus sp.
Tanypus sp.
Tanytarsus guerulus
Ephemeroptera
Caenis sp.
Hexagenia limbata venusta

Source: TWC, 1989

The two sample sites that were studied for benthic organisms were somewhat different in content most likely due to a difference in water conditions and water chemistry.

Note as previously discussed, this data does not represent findings in the area, but due to similarity in geographic location and ecology, invertebrates collected may be considered to be somewhat representative of populations in Mud Creek. Again site specific sampling would be required to establish the baseline data set for Mud Creek.

d. Important Aquatic Species

The following information analyzes and describes different types of important species found in the Angelina-Neches Basin.

Commercial or Recreationally Important Species

There are no known commercially important species found within the study area. The important game fish throughout the study area consists primarily of channel catfish, largemouth bass and sunfish.

Threatened and Endangered Fish Species

Currently, there are no federally listed threatened or endangered fish species in the Angelina-Neches Basin. However, five species of fish are listed with the Texas Natural Heritage Program as limited or imperiled in the Angelina-Neches basin. The fish species and ranking are as listed below on Table II.41.

A more detailed discussion of the threatened and endangered species in the study area is provided in Section II.E.4.

e. Unique or Sensitive Aquatic Communities

No sensitive or unique aquatic resources have been identified by the USFWS, TNHP, or the TPWD within the study area. However, the proposed reservoir area does contain a vast array of aquatic habitats, including swift moving riverines, braided riverines, slow moving stagnant systems, and oxbow type lakes which provide habitat for a variety of fish and invertebrate species.

The potential impacts of the proposed reservoir on aquatic communities will be discussed in Section II.E.3.

TABLE II.41

FEDERAL AND STATE LISTED FISH SPECIES OF POTENTIAL OCCURRENCE IN THE ANGELINA-NECHES RIVER BASIN

Family / Common Name / *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]	
<u>FISH</u>					
Ithymyzon					
Chestnut Lamprey *Ithymyzon*	NL	NL	NL	G5	S3
Polydontidae					
Paddlefish *Polydon spathula*	3C	E	T	G4	S1
Catostomidae					
Blue Sucker *Cycleptus elongatus*	C2	T	NL	G4	S3
Creek Chubsucker *Erimyzon oblongus*	NL	T	NL	G5	S2S3
Percidae					
Western Sand Darter *Ammocrypta clara*	NL	NL	T	G3	S2
Swamp Darter *Etheostoma fusiforme*	NL	NL	NL	G5	S1

<u>Federal Status</u>[1]

E	Listed Endangered
T	Listed Threatened
LELT	Listed Endangered in part of range, Threatened in a different part
PE	Proposed to be listed Endangered
PT	Proposed to be listed Threatened
PEPT	Proposed Endangered, Threatened
S	Synonyms
C1	Candidate, Category 1. USFWS has substantial information on biological vulnerability and threats to support proposing to list as endangered or threatened. Data is being gathered on habitat needs and/or critical habitat designations.
C2	Candidate, Category 2. Information is possibly appropriate, but substantial data on biological vulnerability and threats are not known to support the immediate preparation of rules. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2.
3	Taxa no longer being considered for listing as threatened or endangered. Three subcategories indicate the reasons for removal from consideration
3A	Former Candidate, rejected because presumed extinct and/or habitats destroyed

TABLE II.41 (continued)

3B	Former Candidate, rejected because not a recognized taxon; i.e. synonym or hybrid
3C	Former Candidate, rejected because more common, widespread, or adequately protected
NL	Not currently listed

State Status[2]

E	Listed as Endangered in the State of Texas
T	Listed as Threatened in the State of Texas
NL	Not Currently listed

Texas Natural Heritage Program Status[3]

Global Rank

G1	Critically imperiled globally, extremely rare, 5 or fewer occurrences. [Critically endangered throughout range.]
G2	Imperiled globally, very rare, 6 to 20 occurrences. [Endangered throughout range.]
G3	Very rare and local throughout range or found locally in restricted range, 21 to 100 occurrences. [Threatened throughout range.]
G4	Apparently secure globally.
GxTx	Denotes subspecific taxa.
GxQ	Indicates that the taxonomic status of the plant is a matter of conjecture.
GxGy	Indicates that the plant is borderline between ranks.
GH	Historical occurrence throughout its range.

State Rank

S1	Critically imperiled in state, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences.
S2	Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences.
S3	Rare in state, 20+ occurrences.
S4	Apparently secure in state.
S5	Demonstrably secure in state.
SA	Accidental in state.
SE	An exotic species established in state.
SH	Of historical occurrence in state. May be rediscovered.
SX	Apparently extirpated from state.

Texas Organization for Endangered Species (TOES)[4]

Plants - Federal Listed Species

Category I	The term "endangered species" means any species which is in danger of extinction throughout all or significant portion of its range other than a species of the Class Insecta determined by the Secretary of Interior to constitute a pest whose protection under the provision of the Endangered Species Act of 1973, P.L. 93-205, as amended (Dec. 1978), would present an overwhelming and overriding risk to man.
Category II	The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion its range.

TABLE II.41 (continued)

TOES-State Listed Species

Category III	The term "state endangered species" means any species which is in danger of extinction or of extirpation in Texas or in addition to I and II above.
Category IV	The term "state threatened species" means any species which is likely to become a state endangered species within the foreseeable future.
Category V	The term "TOES watch list" means any species which at present has either low population or restricted range in Texas and is not declining or being restricted in its range but requires attentions to insure that the species does not become endangered or threatened (state or federal).

Animals

E	In danger of extinction in all of most of the species' range in the United States, particularly in Texas
T	Depleted or impacted by man so as likely to become endangered in the near future
WL	Potentially endangered or threatened in the United States, especially in Texas, although not necessarily in its range as a whole.

4. Threatened and Endangered Species

The goal of this section is to provide a brief introduction to the listing and monitoring processes employed by federal, state and private entities, to provide a listing of threatened and endangered species potentially occurring in the five county study area and to give brief life history descriptions of federally listed threatened and endangered species in the study area. The listing/monitoring description will be presented by entity.

a. Listing and Monitoring Process

Federal - U.S. Fish and Wildlife Service

The USFWS has legislative authority to list and monitor the status of species whose populations are considered to be imperiled. This federal legislative authority for the protection of threatened and endangered species issues from the Endangered Species Act of 1973, and its subsequent amendments. Regulations supporting this act are codified and regularly updated in Sections 17.11 and 17.12 of Title 50 of the Code of Federal Regulations. The federal process stratifies potential candidates based upon the species biological vulnerability. The vulnerability decision is based upon many factors affecting the species within its range and is always linked to the best scientific data available to the USFWS at this time. Species listed as Endangered (E) or Threatened (T) by the USFWS are provided full protection. This protection includes a prohibition of indirect take such as destruction of critical habitat. The Endangered Species Act and accompanying regulations provide the necessary authority and incentive for the individual states to establish their own regulatory vehicle for the management and protection of threatened and endangered species.

State - Texas Parks and Wildlife Department

Endangered species legislation was passed in Texas in 1973 (amended in 1981, 1985, and 1987) (TPWD, 1991). Subsequently, 1975 and 1981 revisions to the TPWD Code established a state regulatory vehicle for the management and protection of threatened and endangered species. Chapters 67 and 68 (the 1975 revisions) of the code authorizes TPWD to formulate lists of threatened and endangered fish and wildlife species and to regulate the taking or possession of the species. A 1981 revision (and 1985 amendment) to the code provides authority for TPWD to designate plant species as threatened or endangered and to prohibit commercial collection or sale of these species without permits.

The ensuing department regulations are Sections 65.171 - 65.177, 65.181-65.184, and 69.01-69.14 of the Texas Administrative Code (for Chapters 67, 68, and 88 of the TPWD Code, respectively). These sections regulate the taking, possessing, transporting, exporting, processing, selling or offering for sale, or shipping of endangered or threatened species of fish, wildlife and plants. Neither specific criteria for the listing of plant and animal species, nor protection from indirect take (i.e., destruction of habitat or unfavorable management practices) are found in either of the above mentioned statutes or regulations (TPWD, 1991).

Functionally, the TPWD oversees endangered resources through the Resource Protection Division. The Division, is further divided into branches, with the Endangered Resources Branch consisting of the Endangered Species Program and the Natural Heritage Program. The Endangered Species Program lists, regulates and plans for recovery of threatened and endangered species. The Natural Heritage Program catalogs, monitors, and provides information on rare species and communities of concern (TPWD, 1991).

Private - Texas Organization for Endangered Species (TOES)

Lastly, a private group of biologists, conservationists and natural resource managers formed the Texas Organization for Endangered Species (TOES) in 1972 to study vanishing plants and animals in Texas and to educate the public regarding their conservation. The TOES group publishes lists which provide status reports of their own as well as federal and state listings on a periodic basis. The status of the given species and brief descriptions of preferred habitats and possible reasons for their listing appear in these reports (TOES, 1987).

b. List of Threatened and Endangered Species

The list of threatened and endangered species potentially occurring in the five county study area issues from the above mentioned federal and state regulations (lists), and supplementary information comes from the Texas Natural Heritage Program and the Texas Organization for Endangered Species. Table II.42 presents the current status of those threatened and endangered species and footnotes below the table explain the rationale for the various classifications.

c. Habitat Requirements and Texas Status of Federally Protected Species

As mentioned in the first paragraph of this section, brief life histories of federally listed threatened or endangered species will be presented. There are no plant or fish species federally listed as threatened or endangered within the five county study area. The following wildlife species are federally listed threatened or endangered species which could potentially occur within the five county study area: Bald Eagle (E), Arctic Peregrine Falcon (T), Piping Plover (T), Red-cockaded Woodpecker (E), and Black Bear (Proposed T).

TABLE II.42
THREATENED AND ENDANGERED SPECIES OF POTENTIAL OCCURENCE WITHIN THE FIVE COUNTY STUDY AREA

Family Common Name *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]
<u>PLANTS</u>				
Cyperaceae Mohlenbrock's Umbrella Sedge *Cyperus grayioides*	C2	NL	NL	G3 S3
Xyridaceae Drummond's Yellow-eyed Grass *Xyris drummondii*	C2	NL	NL	G3 S2
Rough-leaf Yellow-eyed Grass *Xyris scabrifolia*	C2	NL	NL	G2G3 S2
Liliaceae Texas Trillium *Trillium pusillum var. texanum*	C2	NL	V	G2G3Q S2S3
Orchidaceae Southern Lady's Slipper *Cypripedium kentuckiense*	C2	NL	IV	G3 S1
Fagaceae Boynton's Oak *Quercus boyntonii*	C2	NL	NL	GHQ SH
Nyctaginaceae Sandhill Four O'Clock *Mirabilis collina*	C2	NL	NL	G1G2 S1S2
Portulacaceae Rough-seed Flame Flower *Talinum rugospermum*	C2	NL	IV	G3G4 S1
Brassicaceae Texas Goldenglade Cress *Leavenworthia texana*	C2	NL	V	G1 S1
Rosaceae Warner Hawthorn *Crataegus warneri*	C2	NL	NL	G2Q S2

TABLE II.42 (continued)

Family Common Name *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]	
Gentianaceae Texas Screwstem *Bartonia texana*	3C	NL	V	G2	S2
Asteraceae Rough-stemmed Aster *Aster puniceus* ssp. *elliotii* var. *scabricaulis*	C1	NL	NL	G4T2	S2
Goldenwave Tickseed *Coreopsis intermedia*	C2	NL	NL	G2G3	S2S3
Slender Gayfeather *Liatris tenuis*	C2	NL	NL	G2G3	S2S3
Rattlesnake Root *Prenanthes barbata*	C2	NL	NL	G2G3	S2
Bog Coneflower *Rudbeckia scabrifolia*	C2	NL	NL	G2	S2
<u>FISH</u>					
Ithymyzon Chestnut Lamprey *Ithymyzon*	NL	NL	NL	G5	S3
Polydontidae Paddlefish *Polydon spathula*	3C	E	T	G4	S1
Catostomidae Blue Sucker *Cycleptus elongatus*	C2	T	NL	G4	S3
Creek Chubsucker *Erimyzon oblongus*	NL	T	NL	G5	S2S3

TABLE II.42 (continued)

Family Common Name *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]	
Percidae					
Western Sand Darter *Ammocrypta clara*	NL	NL	T	G3	S2
Swamp Darter *Etheostoma fusiforme*	NL	NL	NL	G5	S1
<u>REPTILES</u>					
Chelydridae					
Alligator Snapping Turtle *Macroclemys temmincki*	C2	T	T	G3	S3
Iguanidae					
Texas Horned Lizard *Phrynosoma cornutum*	C2	T	T	G5	S5
Colubridae					
Northern Scarlet Snake *Cemophora coccinea copei*	NL	T	WL	G5T2	S5
Louisiana Pine Snake *Pituophis melanoleucus ruthveni*	C2	T	E	G5	S5
Viperidae					
Timber Rattlesnake *Crotalus horridus*	NL	T	T	NL	
<u>BIRDS</u>					
Threskiornithidae					
White-faced Ibis *Plegadis chihi*	C2	E	T	G5	S2
Ciconiidae					
Wood Stork *Mycteria americana*	NL	T	T	NL	

TABLE II.42 (continued)

Family Common Name *Scientific Name*	Federal[1]	State[2]	TOES[3]	Texas Natural Heritage Program[4]
Accipitridae				
American Swallow-tailed Kite *Elanoides forficatus*	3C	T	T	G5 S2
Bald Eagle *Haliaeetus leucocephalus*	E	E	E	G3 S2
Falconidae				
Arctic Peregrine Falcon *Falco peregrinus tundrius*	T	T	T	G3T1 S1
Charadriidae				
Piping Plover *Charadrius melodus*	T	T	T	G2 S2
Picidae				
Red-cockaded Woodpecker *Picoides borealis*	E	E	E	G2 S2
Emberizidae				
Bachman's Sparrow *Aimophila aestivalis*	C2	T	WL	G3 S2
<u>MAMMALS</u>				
Vespertilionidae				
Southeastern Myotis *Myotis austroriparius*	C2	NL	WL	G4 S3
Rafinesque's Big-eared Bat *Plecotus rafinesquii*	C2	T	T	G4 S4
Ursidae				
Black Bear *Ursus americanus*	PT	E	T	G5 S3

<u>Federal Status[1]</u>

E	Listed Endangered
T	Listed Threatened
LELT	Listed Endangered in part of range, Threatened in a different part

TABLE II.42 (continued)

PE	Proposed to be listed Endangered
PT	Proposed to be listed Threatened
PEPT	Proposed Endangered, Threatened
S	Synonyms
C1	Candidate, Category 1. USFWS has substantial information on biological vulnerability and threats to support proposing to list as endangered or threatened. Data is being gathered on habitat needs and/or critical habitat designations.
C2	Candidate, Category 2. Information is possibly appropriate, but substantial data on biological vulnerability and threats are not known to support the immediate preparation of rules. Further biological research and field study will be necessary to ascertain the status and/or taxonomic validity of the taxa in Category 2.
3	Taxa no longer being considered for listing as threatened or endangered. Three subcategories indicate the reasons for removal from consideration
3A	Former Candidate, rejected because presumed extinct and/or habitats destroyed
3B	Former Candidate, rejected because not a recognized taxon; i.e. synonym or hybrid
3C	Former Candidate, rejected because more common, widespread, or adequately protected
NL	Not currently listed

State Status[2]

E	Listed as Endangered in the State of Texas
T	Listed as Threatened in the State of Texas
NL	Not Currently listed

Texas Organization for Endangered Species (TOES)[3]

Plants - Federal Listed Species

Category I	The term "endangered species" means any species which is in danger of extinction throughout all or significant portion of its range other than a species of the Class Insecta determined by the Secretary of Interior to constitute a pest whose protection under the provision of the Endangered Species Act of 1973, P.L. 93-205, as amended (Dec. 1978), would present an overwhelming and overriding risk to man.
Category II	The term "threatened species" means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion its range.

Texas Natural Heritage Program Status[4]
Global Rank

G1	Critically imperiled globally, extremely rare, 5 or fewer occurrences. [Critically endangered throughout range.]
G2	Imperiled globally, very rare, 6 to 20 occurrences. [Endangered throughout range.]
G3	Very rare and local throughout range or found locally in restricted range, 21 to 100 occurrences. [Threatened throughout range.]
G4	Apparently secure globally.
GxTx	Denotes subspecific taxa.
GxQ	Indicates that the taxonomic status of the plant is a matter of conjecture.
GxGy	Indicates that the plant is borderline between ranks.
GH	Historical occurrence throughout its range.

TABLE II.42 (continued)

State Rank

S1	Critically imperiled in state, extremely rare, very vulnerable to extirpation, 5 or fewer occurrences.
S2	Imperiled in state, very rare, vulnerable to extirpation, 6 to 20 occurrences.
S3	Rare in state, 20+ occurrences.
S4	Apparently secure in state.
S5	Demonstrably secure in state.
SA	Accidental in state.
SE	An exotic species established in state.
SH	Of historical occurrence in state. May be rediscovered.
SX	Apparently extirpated from state.

TOES-State Listed Species

Category III	The term "state endangered species" means any species which is in danger of extinction or of extirpation in Texas or in addition to I and II above.
Category IV	The term "state threatened species" means any species which is likely to become a state endangered species within the foreseeable future.
Category V	The term "TOES watch list" means any species which at present has either low population or restricted range in Texas and is not declining or being restricted in its range but requires attentions to insure that the species does not become endangered or threatened (state or federal).

Animals

E	In danger of extinction in all of most of the species' range in the United States, particularly in Texas
T	Depleted or impacted by man so as likely to become endangered in the near future
WL	Potentially endangered or threatened in the United States, especially in Texas, although not necessarily in its range as a whole.

Sources

50 CFR Part 17. January 6, 1989. Endangered and Threatened Wildlife and Plants; Animal Notice of Review. Dept. of Interior. Fish and Wildlife Service.

50 CFR Part 17.11 & 17.12 April 15, 1990. Endangered and Threatened Wildlife and Plants; Animal Notice of Review. Dept. of Interior. Fish and Wildlife Service.

31 T.A.C. 65.171-177. December 28, 1987. Regulation for Taking, Possessing, Transporting, Exporting, Processing, Selling, or Offering for Sale, or Shipping Endangered Species.

31 T.A.C. 65.181-65. February 10, 1988. Regulation for Taking, Possessing, Transporting, Exporting, Processing, Selling, or Offering for Sale, or Shipping Endangered Species.

Texas Parks and Wildlife Department. Wildlife Division. State list of endangered and threatened species potential for Angelina, Cherokee, Nacogdoches, Rusk and Smith Counties.

Texas Organization for Endangered Species (TOES). 1987. Endangered, Threatened and Watch Lists of Plants of Texas. TOES Publications 6. Austin, Texas. 9pp.

Texas Organization for Endangered Species (TOES). 1987. Endangered, Threatened and Watch Lists of Vertebrates of Texas. TOES Publications 6. Austin, Texas. 16pp.

Texas Parks and Wildlife Department. Texas Natural Heritage Program. Computerized Special Species and Natural Community Occurrences, Maverick, County.

Texas Parks and Wildlife Department. Texas Natural Heritage Program. April, 1991. Special Plant and Animal Lists.

Bald Eagle

The Bald Eagle ranges over much of the U.S. and Canada. This eagle is primarily a fishing species and prefers habitat associated with large bodies of water. In Texas, wintering and nesting activity occurs mainly near large, freshwater impoundments with standing timber located in or around the water (Mabie, 1989). Bald Eagle research conducted by TPWD focuses upon nest survey, management, and post-fledgling survival and dispersal. Midwinter counts by 117 observers yield 199 Bald Eagle sightings at 15 standard survey locations. One nesting attempt has historically been documented by Mabie (1989) within the five county study area. This occurred on Lake Nacogdoches and the nest was active in 1983, produced no young, became inactive through 1986 and fell in 1987. However, 1989 surveys on Sam Rayburn revealed seven adults and seven immatures. The site coordinator for the Sam Rayburn Reservoir estimates these 14 birds as representative of only 20% of the total reservoir population. Much of the lake was inaccessible due to drought conditions. One other nest found in San Augustine County (adjacent to Angelina and Nacogdoches) was reported as inactive in 1987 and 1988 and fell in 1989.

Arctic Peregrine Falcon

The Arctic Peregrine Falcon is a medium to large cosmopolitan falcon which inhabits a variety of habitats. In Texas, this species rarely breeds and only a few migrants and winter residents are found. The Peregrine Falcon principally feeds on birds and is often found near seabird colonies (Oberholser 1971). The Peregrine nests on high cliff ledges in a variety of habitats. Oberholser (1971) cites a winter sight record in southeastern Smith County. Recent habitat status surveys have been conducted by TPWD on Matagorda Peninsula and Padre/Mustang Island (Mabie, 1990) but no work which we are aware of has been done on the Arctic Peregrine Falcon in East Texas.

Piping Plover

The Piping Plover is a small ringed (has a dark narrow breast band) plover which ranges from south-central Canada, the Great Lakes region, and coastally from Newfoundland to Virginia. This species winters coastally primarily from South Carolina to Texas. This plover tends to inhabit lake and seashores where it breeds and nests on sparsely vegetated expanses between dunes and high water lines. In Texas, Oberholser (1971) cites one specimen collected in the fall of 1972 from Sam Rayburn Reservoir in Angelina County; however, most occurrences are documented along the coast from Chambers to Cameron Counties. In conjunction with those for the Arctic Peregrine Falcon, habitat status studies have been conducted by TPWD on Matagorda Peninsula and Padre/Mustang Island (Mabie, 1990).

Red-cockaded Woodpecker

This fairly small woodpecker inhabits pine forests of the Old South from South Carolina to East Texas and Eastern Oklahoma. In its nesting and feeding habits, this species practices extreme habitat specialization. The bird chooses old pines (80 years or more), which are still living but inflicted with red-heart fungus disease, in which to excavate nesting cavities. Bark surrounding the entrance hole is removed creating a characteristic oozing apron of sap below. It is thought to possibly repel potential predators. The Red-cockaded Woodpecker tends to forage on trunks and upper limbs of shortleaf pines (*Pinus echinata*). Oberholser (1971) cites sight records in northwest Smith (breeding - questionable record) and northwest and southeast Nacogdoches (summer and winter, respectively) Counties.

Research concerning various aspects of this species' biology and management is currently ongoing. Surveys, augmentation and colony site management studies are being conducted by TPWD (Ortego, 1990a; 1990b; and 1990c). Survey findings yield 16 active colony sites out of 26 inspected. Although 34 were reported by the public and resource agency personnel, only 26 were accessible. Additionally, another 27 historical sites yielded 22 still active; indicating a 12 percent decline over two years. Within the five county study area, a report in Angelina County was not investigated due to time constraints and four active colonies occur in Fairchild State Forest in Cherokee County. Exhibit II.8 illustrates the Cherokee County location as reported by the TNHP.

Black Bear

The Black Bear was abundant and widely distributed in Texas before European settlement. This species has been extirpated from East Texas today. The last known individuals were killed between 1900 and 1940 in the swamps and thickets of Hardin County in the Big Thicket (Schmidley, 1983). Restocking efforts in Louisiana may result in some far-ranging individuals repopulating East Texas. In Texas, multiple valid sightings of the Black Bear still occur in the extreme West Texas Counties of Culberson, Brewster and Val Verde. A 1989 sighting 15 miles southwest of Athens (Henderson Co.) was investigated by TPWD and deemed "valid (unverified)" but possibly an escapee from a neighboring pen or zoo. (Taylor, 1990).

One species not found in Table II.42 is the Red Wolf (*Canis rufus*). This species once inhabited pine forests, bottomland hardwood forests, swamps and coastal prairies and marshes of Eastern Texas. It is now thought to be extinct except for in the coastal counties of Orange, Jefferson, Liberty, Chambers, Harris, Galveston and Brazoria (Schmidly, 1983).

Information regarding sensitive plants, wildlife and communities has been obtained from a file search of the Texas Natural Heritage Program's data base. This information is graphically illustrated in Exhibit II.8. These sitings do not represent an exhaustive search of the study area and serve only to document known occurrences. [Note: the Southern Redback Salamander (Plethodon serratus) and Crawfish Frog (Rana arcolata) are ranked by the TNHP as G5 S1 and G4 S3, respectively. See Table II.42 for a legend to TNHP global and state rankings.]

d. Summary

Of the five species listed as threatened or endangered by the USFWS, only the Red-cockaded Woodpecker and Bald Eagle have recent documented occurrences within the given five county study area. Although the known locations are not within the proposed area of inundation, the potential for their occurrence cannot, at this point, be excluded.

F. HISTORIC/ARCHAEOLOGICAL RESOURCES

This section addresses the potential occurrence of prehistoric and historic archeological sites within the study area. The possible universe of sites is first described through a discussion of current knowledge of the cultural history and archaeology of the central east Texas region. This section provides an idea of the kinds of archeological sites that may be encountered, and indicates how they may be recognized. On a more specific level, the likely distribution of such sites within the proposed reservoir basin is then assessed by an examination of the results of previous cultural resource surveys in nearby reservoirs. This section points out where in the reservoir sites will probably be found. A short discussion of survey methods, describing how sites may actually be discovered, is provided, followed by an outline of permitting procedures, which hopefully informs as to why archeological resources are required to be treated in the first place.

1. Cultural/Historic Background

Archeological researchers have been working throughout east Texas for over fifty years, recording thousands and excavating hundreds of prehistoric and historic sites, and generating so much information as to create a sense of the overwhelming complexity of the database. Recent synthetic and topical studies (e.g. Thurmond 1981, Story et al. 1990, Fields and Corbin ms., Fields and Tomka ms., Wykoff 1974, Schambach 1982) have begun to lay the groundwork for making sense out the mass of data. Major information gaps have been identified, and directions for future research are being outlined. The following discussion relies heavily on the most recent and comprehensive synthesis of data from the entire east Texas region (Story et al. 1990).

a. Paleoindian Period

The earliest human presence in central east Texas is attested by remains identifiable as belonging to the Clovis complex, the earliest well-defined cultural horizon in North America. Best known from sites on the central plains of the continent, the Clovis people are thought to have been wide-ranging, nomadic hunters who specialized in the harvesting of large herd animals, most of which went extinct at the close of the Pleistocene. The Clovis culture has been dated to between 9500-9000 B.C. (Story et al. 1990:178). The presence of these people in east Texas is documented by recovery of their distinctive fluted projectile points, which have been found thinly distributed over the region. A characteristic of the Clovis complex is the high quality of its tool kit; tools were made from carefully selected cherts and other chippable stones and were apparently curated and carried with the Clovis Indians as they moved from place to place. As a result, Clovis sites typically contain very few discarded tools and little chipping debris. Blackwater Draw Locality 1, one of the best known and most extensively excavated Clovis sites, for example, has to date yielded only 223 Clovis artifacts (Hester 1972:Table 36).

The Murphey site (41MR62), located near the dam at Lake o' the Pines on Big Cypress Creek northeast of the study area, yielded a Clovis point, found in association with mastodon remains. A few pieces of debitage attributable to Clovis technology were also recovered (Story et al. 1990:184-185; TARL files). The tools and debitage were made of a high quality Edwards chert, transported from the Georgetown area of central Texas, illustrating the selective lithic procurement strategies and wide-spread resource range of these hunter-gatherers. The limited assemblage indicates the ephemeral nature of these early sites. A Clovis point was recovered from 41RK70 on Bowles Creek, the headwater tributary of the Angelina River opposite Mud Creek, demonstrating the potential for the occurrence of Clovis sites in the study area. In addition to the diagnostic projectile points, early occupations may be suggested by debitage and unifaces made of high quality, non-local lithic material.

The Folsom complex (9000-8300 B.C.; Jodry 1987:2-6), which succeeded Clovis on the plains, is not well represented in east Texas. Very few of the diagnostic, fluted projectile points have been reported (Story et al 1990:Figure 26), and it is hypothesized that the region was not heavily occupied by Folsom peoples (Story et al 1990:189), possibly because the culture's specialized grassland adaptation caused them to overlook the resource potential of woodland areas.

The late PaleoIndian period is marked by a diversification of artifact assemblages. Whereas the Clovis and perhaps the Folsom complex appear to have been continent-wide phenomena, later complexes exhibit regional differences. For instance, the Dalton complex (8500-7500 B.C.; Morse and Morse 1983) follows Folsom in northeastern Texas and extends northward and eastward through Arkansas and into Missouri; the headwaters of the Neches and Angelina rivers appear at present to delimit the southern extent of the complex's distribution. Overlapping with the Dalton material in the Sabine-Sulphur River region but extending southward possibly as far as the upper Gulf coast is a complex dating to the same time period (8300-7300 B.C.; Story et al. 1990:202) which is identifiable by diagnostic San Patrice, rather than Dalton, projectile points. The frequency of sites in both areas is greatly increased over Clovis and Folsom distributions, suggesting an increase in population and a possibly concomitant restriction of group resource range resulting from increased competition for resources. Limits on a groups' access to land may have also limited interaction with other groups, resulting in the beginnings of regional differences in adaptive strategies, material culture, customs and possibly language. If the distribution of late PaleoIndian projectile point styles is in fact related to the emergence of group territories, then the proposed Lake Eastex may lie along a frontier between Dalton and San Patrice cultures. Sites dating to this period may yield information concerning interaction between early groups across such a boundary.

The Dalton complex appears to have been adapted to the woodland margins. Studies of raw materials suggest a resource range from the Ouachita Mountains in Oklahoma to the Edwards Plateau in Texas. The tool kit differs little from that of earlier PaleoIndians; sites related to this complex may be expected to contain, in addition to projectile points, a variety of formal and informal unifaces, true blades, bipolar cores, wedges and bifacial chipped stone adzes. Artifacts, as well as sites, are more numerous. Burned rock features may occur. Well-defined Dalton components have not been excavated in or near the study area, where the complex is known from Dalton materials found in mixed context with other components (Story et al. 1990:190). The closest well-studied Dalton component is at the Quince site (36AT101) in southeastern Oklahoma (Perttula 1985).

The San Patrice culture may have been less mobile than its Dalton counterpart. Its geographic region is smaller, and tools are most often made of locally available stone; there is less evidence of recycling and curation of tools. The tool kit is distinguished by the San Patrice point and the Albany knife, which are usually unifacially flaked, side-notched implements with asymmetrical, sickle-shaped blades (Story et al 1990:202). The Wolfshead site (41SA117) on the lower Angelina River contained a probable San Patrice component, isolatable from a somewhat mixed context. The site was located on a sand-capped clay knoll along a minor side tributary; it yielded, in addition to 36 San Patrice points, two Albany knives and a collection of probably associated scrapers, utilized flakes, bifaces and a grinding slab (Duffield 1963).

The latest PaleoIndian complex identified in the study area region is typified by Scottbluff projectile points, which are widely but thinly distributed over east Texas and which are more common in the northeastern portion of the state. Typical of the Cody complex of the central plains where they are frequently associated with bison kills, these points are tentatively dated in Texas to the period 7900-7100 B.C., and may represent the intermittent use of the region by Plains groups (Story et al. 1990:209).

b. Archaic Period

Dating from approximately 7000-200 B.C., the Archaic period of East Texas is very poorly understood. In general, the trend towards regionalization seen beginning during the late Paleoindian period accelerates, resulting in a proliferation of artifact styles and tool kits that vary both through time and across geographic areas, and too few well-stratified sites have been located or excavated to allow regional chronological sequences to be sorted out. Story (1990:213) describes the Archaic chronologies in east Texas as among the least well developed in North America. Without a chronological framework, cultural complexes and their adaptive strategies and technologies simply cannot be identified.

Archaic lifeways are thought to have centered around intensive exploitation of seasonably available resources in a restricted geographic area with which the inhabitants were intimately familiar. Keyed to the environment, Archaic cultures are expected to have changed primarily in response to changes in their resource base, a rather simplified interpretation which takes no account of inter-regional interaction, fluctuations in population size or technological innovations, but which serves as a general interpretive premise. Archaic sites typically contain large amounts of varied refuse, indicative of intensive use, and frequently contain evidence of repeated occupation over long periods of time, suggesting that land use strategies were highly patterned and slow to change. This pattern of reoccupation is responsible for the mixing of temporal components at many Archaic sites which contributes to the difficulty in making chronological distinctions.

Archaic assemblages tend to be functionally varied and relatively cheaply produced, dominated by task specific and expedient tools rather than carefully worked and curated multi-purpose implements typical of PaleoIndian tool kits. Sites frequently contain features such as rock hearths and baking pits.

Milling stones are common, and later components may include examples of pecked and polished stone technology (Story et al 1990:213). During the Late Archaic period, cemeteries were established in southeast Texas (Hall 1981; Vernon 1989; Story 1990:Table 54); repeated interments at a single site suggest a groups' territorial claim to that site and, presumably, the region surrounding it. Archaic cemeteries from central east Texas have not been documented, but the potential for their occurrence exists, based on the later Early Ceramic periods' cultural ties to the southeast and the relatively common occurrence of Early Ceramic burials in the study area region. Archaic sites of note in the central part of east Texas include the Jake Martin site (411UR12) on Cypress Creek (Davis and Davis 1960) and the Yarborough Site (41VN6) on the upper Sabine just north of the project area (Johnson 1962:155-234).

c. Early Ceramic Period

Ceramic technology appears to have been adopted in the east Texas region around 200 B.C., occurring first in the eastern part of the region and spreading to the west. The earliest types of pottery, found in the Sabine River valley and in the Galveston Bay area, are similar to Tchefuncte wares of the Lower Mississippi valley, and suggest that the technology, if not the actual wares, may have derived from the woodland cultures to the east of the study region (Story 1990:246-248). The pottery-making process appears to have been adopted and local traditions emerged and were established. In northeast Texas, the local wares were predominantly grog-tempered, undecorated vessels known as Williams Plain, dated from 100 B.C. to as late as 1000 A.D. In southeast Texas, a distinctive sand-tempered pottery was made, known as Sandy Paste or Goose Creek Plain; this tradition may have developed somewhat later than in the northeast, but was widespread across southeast Texas by 500 A.D. (Story 1990:247). As was the case during late PaleoIndian times, the proposed Lake Eastex lies within a frontier area between the two cultural traditions suggested by differing ceramic technologies.

This period also saw the adoption of the bow and arrow, commonly identified in archeological sites by the occurrence of smaller arrow points. Arrow points and dart points may frequently be found in the same components, suggesting that the spear and atlatl continued in use for some while after the introduction of the bow, although there is always the possibility that such associations were caused by post-depositional mixing of materials from separate time periods. The bow and arrow post-dated the adoption of ceramics in the study area; most researchers agree that its use began sometime around A.D. 500-700 (Aten 1983:306; Prewitt 1981:82-83).

The emergence of incipient agriculture and sedentary or semi-sedentary village life is also thought to date to the Early Ceramic period in east Texas, although direct evidence of the cultivation of plants is meager. Squash found at 41HP137 in Cooper Reservoir on the upper Sulphur River, believed to be a cultivar, has been radiocarbon dated to 2092 $\pm$ 31 B.P. (SMU-1917). This date is several hundred years earlier than the dated appearance of maize, which seems to have been grown at the George C. Davis site as early as A.D. 800, but which was probably well established as a crop by Caddoan times, ca. 900-1000 A.D. (Story 1990:254). The importance of maize by the Early Caddoan period implies that an experimental agricultural or horticultural stage probably preceded the general acceptance of cultivation. Logically, this could be expected to have occurred during the Early Ceramic period. Identified plant remains from good contexts dated to the period, however, are lacking, although recent research efforts have implemented collection techniques designed to enhance the recovery rates of macrobotanical material.

Evidence of the beginnings of sedentary lifeways may also be construed as indirect support of the practice of agriculture. Sedentism appears archaeologically at sites such as the Howle and Osborne sites (41WD74; 41WD73) in Lake Fork reservoir on the upper Sabine. These sites were dated to ca. A.D. 700-800, late in the Early Ceramic period. They contained trash middens, burials, pit features for possible storage, and lithic artifacts of local raw materials, and were interpreted as small, possibly single-family homesteads which were occupied relatively continuously for possibly as long as 100 years (Bruseth and Perttula 1981:141). These sites also yielded corn and nuts floated from feature fill. At Cooper Reservoir, the Hurricane Hill Site, 41HP106, exhibited similar features, including storage pits, burials with sufficient patterning to be classified as a small cemetery, possible post holes, and an occupation midden; this material was not radiocarbon dated, but is assigned with some confidence to the Early Ceramic period (Perttula 1988). These apparent homesteads appear to derive from the latest portion of the period. They resemble Early Caddoan rural sites in many particulars, and are certainly suggestive of the Caddoan dispersed village settlement pattern. In contrast, at Lake o'the Pines on Cypress Creek, Thurmond (1981) found Early Ceramic settlements to be thinly distributed, small sites, lacking features and suggestive of hunter-gatherer-like mobility.

Evidence for incipient agriculture and sedentism pertinent to the study area comes entirely from the northeast Texas region, and appear to be associated with the Fourche Maline tradition, an early ceramic complex largely defined by the distribution of grog-tempered Williams Plain pottery (Schrambach 1982). In the Neches-Angelina river valley, however, sites with Early Ceramic components, such as the DeShazo site (Story 1982) and the George C. Davis site (Creel 1979), just south of the study area, appear to have fallen within the cultural sphere of the southeastern Texas Early Ceramic complex, with its diagnostic sand-tempered pottery. Story (1990:256-291) refers to the archeology of the southeast Texas Early Ceramic as the Mossy Grove tradition, characterized by sand-tempered pottery, Scallorn arrow points, Gary and Kent dart points, non-specialized bifacial tools produced by direct reduction of cores, a general lack of unifaces, and less frequent groundstone milling implements as well as boat stones and other polished artifacts. Habitation sites generally lack occupation features. There is some evidence that burial mounds were part of this culture. Four possibly Early Ceramic burial mounds have been identified in the southeastern part of the state, including two in the Neches-Angelina valley area (e.g. Jonas Short Site, 41SA101; Jelks 1965:22-52). Burial mounds dating to the Late Ceramic period are more common in Texas. During the Early Ceramic period, they occurred mostly in Louisiana (Story 1990:Figure 41). Two very general types of mortuary behavior may be identifiable in the Early ceramic period, although they may be attributable to the geographically separate traditions of the northern and southern portions of east Texas. Both burials or cemeteries associated with habitation sites (examples given above are from the northeastern area of the state) as well as burial mounds occur.

Story (1990) draws the northern boundary of her proposed Mossy Grove cultural tradition directly through the proposed Lake Eastex. Early Ceramic sites, if found within the reservoir site, may possess characteristics similar to Mossy Grove sites, or they may reflect the possibly less nomadic traditions of the Fourche Maline cultures which dominate the Early Ceramic period to the north of the study area. They may best be identified by assemblages containing undecorated grog- or sand-tempered pottery associated with expanding-stemmed arrow points (e.g. Scallorn), late dart point types Gary and Kent, and lithic assemblages of predominantly locally available raw materials.

d. Late Prehistoric Period

The Late Prehistoric period, ca. A.D. 800-1680 (Story 1990:320), or Late Ceramic period, in central east and northeast Texas is generally referred to the Caddoan period, largely because the archeological remains attributed to this time period are believed to be ancestral to the historically known Caddoan Indians. Caddoan properly is an umbrella term which identifies a diverse group of Indians, including the Wichita and Pawnee of the plains, whose languages were closely related but whose cultures were divergent. Informally, the term Caddoan or "the Caddo" describes a group of tribes living in eastern Texas and Oklahoma and western Arkansas and Louisiana, who shared a general cultural tradition and probably spoke the same or closely related languages. Formally, these groups are classified as Southern Caddoan, and they included the Caddo proper, centered to the northeast of the study area, and the Hasinai, centered in central east Texas (Story 1990:320). In the upper Neches-Angelina valley, the Caddoan culture seems to have been an intrusion, appearing fully developed at the Davis site around A.D. 800, and displacing the earlier Mossy Grove tradition. Artifactual ties to the middle Sabine valley suggested an immigration of Caddoans from the east (Story 1990:227).

Archaeologically, the Caddoans are recognized by their ceramic tradition, characterized by vessel forms such as long-necked globular jars as well as by engraved decorations, among other attributes (Story 1990:247), and by their elaborate burial and ceremonial mound centers serving small, dispersed, agricultural habitation sites. Both settlement patterns and mortuary practices suggest a moderately stratified society, in which an elite, possibly a priesthood, were supported by and may have wielded power over a laboring agricultural class.

Caddoan site types include farmsteads or habitations sites, which are the most common type of site, larger community or ceremonial centers, burial grounds, and small, ephemeral, special purpose campsites (Story 1990:334). Habitation sites can generally be recognized by a general scatter of artifacts such as arrow points, drills, utilized flakes and polished or chipped stone celts, potsherds and pipe fragments. They may contain a midden accumulation of such trash. Features, especially storage pits, hearths and postholes are common. Family cemeteries may be found in or near the farmsteads. The DeShazo site, just southeast of the proposed Lake Eastex on the Angelina River, is an example of a well-excavated Caddoan habitation site (Story 1982). It dates, however, to Late Caddoan-Historic times and may not be representative of earlier Caddoan hamlets, which may be better represented by late Early Ceramic component such as the Hurricane Hill, Osborne and Howle sites.

Community or ceremonial centers are fairly common site types (Story 1990:340), which are most readily recognized by the presence of earthen mounds which formed platform bases for raised structures. Structural mounds can be differentiated from burial mounds through excavation, which commonly reveals patterned post holes on the flat crest of the platform. Occupational debris is sometimes found surrounding the mounds at these sites, and is sometimes lacking (Story:1990:341). The George C. Davis Site, south of the proposed reservoir on the Neches river, contained two large structural mounds as well as a burial mound situated within a large, fairly concentrated village recognizable by the post holes of numerous off-mound structures and dense habitation debris (Creel 1979).

Burial grounds range from individual interments and small cemeteries associated with habitation sites, to large cemeteries possibly serving a number of dispersed rural habitations, to elaborate shaft graves excavated into large burial mounds constructed, like the structural mounds, of earth. The burial mounds are fairly rare and seem to be unevenly distributed across the Caddoan region (Story 1990:339). The Washington Square site, on a tributary to the Angelina River in Nacogdoches, is an example of a Middle Caddoan burial mound located near the study area (Hart 1982; Corbin 1985).

Special purpose campsites, representing short-term habitations such as hunting camps are probably fairly common, but they are small, ephemeral, and probably difficult to locate and identify (Story 1990:338). They may consist of light artifact scatters of tools which represent a limited array of activities.

In the past these sites have received little investigation beyond the survey level; their function within the Caddoan settlement system is intuited rather than documented.

This brief synopsis merely characterizes Caddoan archeology in a manner designed to inventory probable resources in the study area. Changes in the nature of the record from early Caddoan through Historic times are specifically not addressed. More detailed treatment of Caddoan prehistory can be found in such studies as Wykoff (1974).

e. Historic Period

A summary of major historic events in the east Texas regions, as well as archeological investigations of historic sites, is available in Freeman (1990). The following encapsulation relies heavily on her synopsis.

Historic settlement in the east Texas region probably began with the establishment of two Spanish missions among the Hasinai on the Neches River in the 1690's. The preceding century had seen intermittent exploration of the area by both the Spanish and the French, which may have had some impact, through trade and other contacts, on the Indians of the region, but no incursions were made that could be regarded as settlements (Freeman 1990:367-368).

The seventeenth century saw continued exploration and occasional settlement of the area by emissaries of both nations. The Spanish repeatedly established and abandoned missions, including Mission San Francisco de los Tejas west of the Neches and Mission Nuestra Senora de la Purisima Concepcion on the Angelina. Roads serving these missions and facilitating transportation through the area were established, including El Camino Real and the Old San Antonio Road, which ran east-west to the south of the study area. Later in the century saw Spanish garrisoning of east Texas with a view towards protecting proposed civilian colonies. One such short-lived colony was established at Bucareli, near the crossing of the Trinity by the Camino Real. This colony failed after five years, but was re-established at present-day Nacogdoches. French activities in the region were more oriented towards trade and stemmed from French settlements in the Mississippi valley. French interest in the region frequently served as a catalyst for Spanish settlements in the interest of maintaining Spanish hegemony over the area. The early nineteenth century saw the beginnings of settlement of East Texas by Anglo-Americans.

In general, the colonial period (1500-1821; Freeman 1990:367) can be characterized by thinly distributed, intermittent European settlement. Archeological sites dated to this period are probably more likely to be Native American habitations than European, although Indian sites may well exhibit trade goods and other evidence of contact with the Spanish and French. The known presence of missions on the Angelina and Neches rivers, however, and the establishment of a Spanish colony at Nacogdoches, some 40 miles to the southeast, suggests the slim possibility of encountering direct evidence of European presence dating to the colonial period in the proposed reservoir basin.

After Mexico won her independence from Spain in 1821, settlement of east Texas by Anglo-Americans began in earnest. Settlement types ranged from the temporary homesteads of itinerant frontiersmen living an almost hunter-gatherer lifestyle (Bruseth et al. 1977:45), through farms to towns. With an economy based on livestock and the production of cotton, corn, cane and sweet potatoes (Mercado-Allinger et al. 1984:14), settlement was largely rural. But the dependence on cash crops such as cotton and cattle made townships important as distribution centers, and increased the dependency of settlement on transportation systems, as opposed to the arable land and potable water which are the primary requirements of a subsistence economy. The proliferation of the railroads in the 1870s and 1880s facilitated the timber industry and placed the economy of the region on a more industrial footing. In the late nineteenth and early twentieth centuries, lignite and later oil became important economic resources (Freeman 1990:379-381).

The economic history of central east Texas suggests a possible range of nineteenth and twentieth century archeological sites consisting of early homesteads and farmsteads, larger, later farmsteads or possibly plantations, cemeteries, small scale industrial sites such as sugar mills or cotton gins, and possibly logging camps. The east Texas oil fields are largely to the north and east of the reservoir area. A more detailed set of expectations could be generated with a more in depth study of local history; what is presented here is a regional overview.

2. Site Locations

Unless they are thoughtfully searched for, ephemeral PaleoIndian sites are only likely to be discovered fortuitously. PaleoIndian presence in the area may be indicated by a few artifacts mixed with more visible Archaic assemblages on stable landforms, but such mixed cultural contexts offer little in the way of information about PaleoIndian lifeways and cultural development. Early sites with reasonably good context may exist within the proposed reservoir, but they may be difficult to pinpoint.

Thus far, Clovis sites in east Texas tend to be found in upland settings or along small tributary streams (Story et al. 1990:182). This distribution reflects surface survey procedures and the modern exposure of landforms old enough to have been available for PaleoIndian occupation.

In the colluvially and fluvially dynamic sands of much of the reservoir site, the potential for burial of ancient surfaces, and the preservation of archeological remains resting upon them, may be high. The valley floors of side tributaries, where alluvium is not as formidably deep as along the main channels, and colluvial slumps along the valley margins may be the most practical areas to search for possible early sites.

Archaic period settlement systems are not sufficiently understood to make predictive statements about site locations appropriate.

In Bayou Loco Reservoir (Prewitt et al. 1972), on a tributary to the Angelina River 40 miles southeast of the proposed Lake Eastex, only one of the 16 sites located was a ceramic (41NA21). This site was a shallow lithic scatter located on the edge of a low terrace overlooking the floodplain. An additional four probable preceramic components were identified at sites which also yielded Early Ceramic diagnostics. These included one site on the floodplain against the valley wall, two sites on the terrace edge, slightly raised above the floodplain, and one site on an upland nose overlooking the valley floor. The strong co-occurrence of Archaic and Early Ceramic components suggests a continuity in settlement pattern and the possibility that Archaic sites may be found stratified beneath Early Ceramic sites on aggrading landforms.

Only one Archaic site was identified in the initial survey of Lake Palestine (Johnson 1958). Site 41HE19 was located on a hillslope along side a major tributary to the Neches River. This poor representation is likely the result of Archaic materials not being recognized when mixed with ceramic components. Sites may simply have been identified according to the type of ceramics they contained.

Among tested sites at Cooper Reservoir, Archaic components were numerous; however, there was only one Archaic site that did not also include a ceramic component (Doehner et al. 1978:Table 1). Tested Archaic components at Cooper occurred most commonly on the floodplain, frequently on remnant knolls above the floodplain, and least often on terrace edges. The data suggest that isolated (single) Archaic components visible to surface survey are likely to be rare, but that evidence of Archaic occupation in the proposed reservoir area may occur on all landforms. The potential for buried Archaic sites is unassessed.

Ceramic sites, both Early Ceramic and Caddoan, are likely to be common throughout the reservoir. Site distribution maps from Bayou Loco (Prewitt et al. 1972) and Sam Rayburn Reservoir (Stephenson 1948) indicate that sites visible to surface survey occur along the margins of major stream and tributary valleys, either on the floodplain at the foot of the valley wall, along low terraces edging the valleys, or on upland noses projecting over the valley floors. At Bayou Loco, sites with Late Ceramic components tended to occur where side tributaries entered the main tributary floodplain. At Sam Rayburn Reservoir (which was not 100% surveyed), sites appeared in clusters. Favored locations seem to be minor side tributaries and the terrace edges overlooking the Angelina River.

In the Lake Palestine Basin, sites recorded during the initial survey (Johnson 1958) were dominated by small, Late Caddoan habitations. These occurred on all landforms, but were most heavily concentrated along major tributaries to the Neches River, where they were observed on the floodplain, on hillslopes, on terrace edges, and in upland settings. Large, rich, probably multi-component sites were predictably found on upland noses created by the confluence of these major streams with the main stem of the Neches. At Cooper Reservoir, Pertulla (1988) observed that Early Ceramic components tended to occur on the terrace edge, while Early Caddoan sites tended to be found on the margins of the floodplain.

Sites affiliated with European settlement do not appear to have been systematically recorded during the earlier reservoir surveys at Lake Palestine or Sam Rayburn Reservoir. At Bayou Loco, four historic sites were identified which were uniformly located on the upland rims overlooking the stream valley.

In general, sites of Archaic, Early Ceramic and Caddoan age may be expected to be visible along the perimeters of the proposed Lake Eastex, located on the upland valley rims, on slightly lower upland noses, on the edges of the low terraces rimming the floodplain, and on the outer margins of floodplain itself, back against the valley walls.

The presence of buried sites of all ages, preserved beneath colluvial slump or deeply buried in the floodplain is possible. The initial steps of the cultural resource permitting process requires an inventory of existing resources. It should be anticipated that at least a preliminary assessment of the likelihood of located buried sites in the reservoir basin will be requested by one or more of the permitting agencies.

3. Survey Methods

The cultural resource survey strategy should be designed to make a reasonably complete effort at locating the full complement of resources to be affected by impoundment of the proposed reservoir basin. It should be anticipated that a 100% pedestrian survey augmented by shovel tests will be requested by the Texas Antiquities Committee and/or the SHPOs office. Shovel testing is often used in east Texas because the dense vegetation obscures the ground surface and makes it difficult to visually identify archeological sites, which are normally marked by a scatter of artifacts across the ground surface. Shovel testing slows down areal coverage considerably, as does dense vegetation. It is estimated that one archeologist could cover an average of 20 acres per day under these conditions, and that therefore a complete cultural resources inventory of the approximately 10,000-acre proposed reservoir area would require 500 person days. Reporting of results would entail an additional 500-1000 person days, depending on findings. The regulations of the TAC contemplate that other methods can also be used.

It is strongly recommended that field reconnaissance be preceded by geomorphological investigation of the floodplain. Geomorphological studies normally entail the excavation of several deep backhoe trenches placed strategically throughout the floodplain. The sediment profiles are then studied by knowledgeable individuals who use them to approximate the geological structure of the valley. The field operations may take a minimum of ten days and involve the time of a geomorphologist and a backhoe operator. An additional 10-20 person days would need to be budgeted to the geomorphologist for interpretation and reporting, but the study is quite inexpensive.

Such analysis of the sedimentary history of the creek basin will help to define the ages of landforms, and assess the potential for buried sites, and can be extremely useful in streamlining the field survey. For instance, if it is determined that the upper meter of deposits on the floodplain are modern sediments, then there is no reason to shovel test for shallowly buried prehistoric remains in that environment. Subsurface soundings can be restricted to areas likely to yield results (Bousman 1991:Personal Communication).

Geoarchaeological investigations should provide guidelines as to the time periods likely to be archaeologically represented in the valley, the potential of the various landforms for containing sites of given ages, the potential for stratification of cultural remains, and may contribute to the understanding of the environmental history of the region. It is an excellent vehicle for refining expectations concerning the probable distribution of archeological sites in the area, and can be a good cost cutting tool which may direct the attention and the budget of the field survey to areas where they will be most effective.

4. Permitting

Cultural resources present in and inundated by the proposed Lake Eastex must be evaluated and planned for in compliance with the National Historic Preservation Act of 1966 (Public Law 89-665) as amended (Public Law 56-515), and the Reservoir Salvage Act (Public Law 86-523) as amended by the Archeological and Historic Preservation Act of 1974 (Public Law 93-291). Compliance is monitored by the State Historic Preservation Officer, for projects involving Federal funds, and by the Texas Antiquities Committee, for projects involving State funds. Regulations proscribed by the above Federal Laws are interpreted and implemented by the concerned Federal agencies, in this case the Army Corps of Engineers.

A permit for the construction of Lake Eastex will require that both the regulatory agencies (SHPO and TAC) and lead funding agency (COE) be satisfied that the laws governing the protection of cultural resources have been complied with. This will essentially involve negotiation of a cultural resources management plan between the contractors and the concerned agencies, and implementation of the agreed on plan by the contractors.

The language of the cultural resources protection acts is vague. Procedures of compliance have been established by major funding agencies, such as the Corps, the Bureau of Land Management and the Bureau of Land Reclamation. These procedures have entered the realm of custom and are generally accepted as adequate by state regulatory agencies. Specific procedural guidelines differ depending on the lead agency involved, but the general outline of the responsibilities of the contractor is consistent.

Vastly simplified, obtaining a cultural resources permit is a two-step process, which involves: 1) identification of all cultural resources in the proposed construction area and 2) design and implementation of a plan for managing those resources.

Step 1 is generally accomplished by funding a pedestrian survey of the construction area by trained archaeologists who undertake to locate all archeological sites in the area. This step is referred to as Phase I, or simply as survey, and it should result in a documented inventory of all existing prehistoric and historic archeological sites in the reservoir.

Step 2 primarily involves a) an assessment of the impact of the proposed construction on the inventory of cultural resources; and b) an assessment of the significance, or historical importance, of the resources involved. Significant cultural resources are those judged to be eligible for the National Register of Historic Places. If significant cultural resources are determined to exist, and if they will be adversely impacted by the proposed construction, the contractor is responsible for their management. Sites may be avoided or protected. If neither of these alternatives is possible, their loss must be mitigated. Comments on the permitting process more specifically applicable to the proposed reservoir may be found in the sections below.

5. Summary Of Potential Site Occurrence and Significance

Site density in the proposed Lake Eastex is unknown. The potential distribution of buried sites is unknown. There may be, in high density areas such as the western terrace systems just upstream from the proposed dam site, as many as seven sites per square mile. Some areas, where terraces are lacking and the upland slopes are steep above the floodplain, will probably contain few sites within the impoundment zone. Sites will lie on the upland margins and will not be subject to impact, and are therefore not the concern of the proposed development. Overall, however, it is best to plan for a high density; if these expectations are not met, then no budgets will be strained.

Site significance is determined by the State Historic Preservation Officer or the Texas Antiquities Committee, and hinges on a site's potential to contribute information to specific areas of archeological research, as discussed above. Three determinations are possible. Sites may be found to have no significance, to be eligible for the National Register of Historic Places, or it may be found that there is insufficient information to determine site significance.

Sites that are deemed insignificant require no further work beyond the recording they receive in the field during survey. Full site recording generally consists of the filing of a descriptive site form, a sketch map, optional photographs, and a plot of the site's exact location on a USGS quadrangle. These items are ultimately filed in the archives at the Texas Archeological Research Laboratory, UT-Austin.

Sites that are deemed significant, or eligible for nomination to the National Register, must be avoided, protected, or mitigated. Since avoidance is rarely possible for a site about to be flooded by a proposed reservoir, mitigation is usually the remaining option. This means that they must receive sufficient investigation, usually in the form of extensive excavations or, in the case of Historic era sites, archival research and excavations, so that the regulatory agencies are satisfied that the loss of information attendant on the site's inundation is mitigated. In other words, the information contained in the archeological resource must be extracted before the site is inundated.

In the proposed Eastex reservoir, site significance is likely to be a function of preservation and stratification. Shallow, disturbed sites provide little information. Probably 50-90% of the sites recorded during survey will be surface scatters with no depth and little information potential. Surface collections from a sample of such sites may be required, but this level of work is not labor intensive.

Sites likely to be considered significant include any Caddoan mound sites encountered, well preserved or stratified small-scale habitation sites, any stratified pre-ceramic site, and any site yielding PaleoIndian remains. Very large sites, containing remains from repeated occupations through long segments of prehistory, such as are commonly found on ridges overlooking major stream confluences, often contain mixed, difficult to interpret deposits, but may be deemed significant because of their size and artifact richness. However, it is actually the smaller sites containing remains from limited time periods that, if well preserved, may yield the highest quality of information.

The third determination, that insufficient data has been presented to assess the significance of a given site, requires that additional, usually subsurface investigations be carried out. This is referred to as site testing. Enough work must be performed to assess the extent and integrity of deposits at such sites, which usually involved the excavation of several test pits across the horizontal extent of the site, looking for the quality and location of the archeological deposits. In some cases, testing is implemented at sites already determined to be of significance, to guide the pending extensive excavations. Site testing is labor intensive and can be quite expensive, depending on the number of sites to be investigated.

Given the difficulty of identifying and assessing archeological sites in the dense east Texas vegetation, a testing phase in a project the size of the proposed Lake Eastex may well be unavoidable. However, a high-quality survey effort, with intelligent shovel testing directed at amassing information about the subsurface nature of identified sites, combined with geomorphological assessments of the preservation potential of specific environments, may go a long way towards defraying the costs of the intermediate testing step towards a cultural resource permit. It is thus advisable to design the survey to extract as much information as possible about the archeological sites encountered.

G. SOCIOECONOMIC CONDITIONS

This section of the regional planning study considers socioeconomic issues in the five county area for current and anticipated future conditions. Sources of information used in the following discussion include studies performed by private consultants, field investigations, and standard reference materials.

The primary areas included in the discussion include population, employment, land use, land ownership, transportation and cultural resources. The discussion of current conditions for each of these primary areas is based on recent research. Anticipated impacts due to the construction of Lake Eastex are discussed as well.

1. Population

High series population projections provided by the TWDB (1989) were used as the basis for this study. Historical and projected population for the five county study area is presented in Table II.43 and Exhibit II.13.

TABLE II.43

POPULATION INCREASES
FIVE COUNTY STUDY AREA

Year	Population[1]	Incremental Percent Increase	Cumulative Percent Increase[2]
1970	248,917		
		28	
1980	318,833		
		16	
1990	369,911		
		20	20
2000	442,289		
		13	35
2010	498,390		
		13	52
2020	564,095		
		14	74
2030	643,533		
		7	86
2040	687,936		

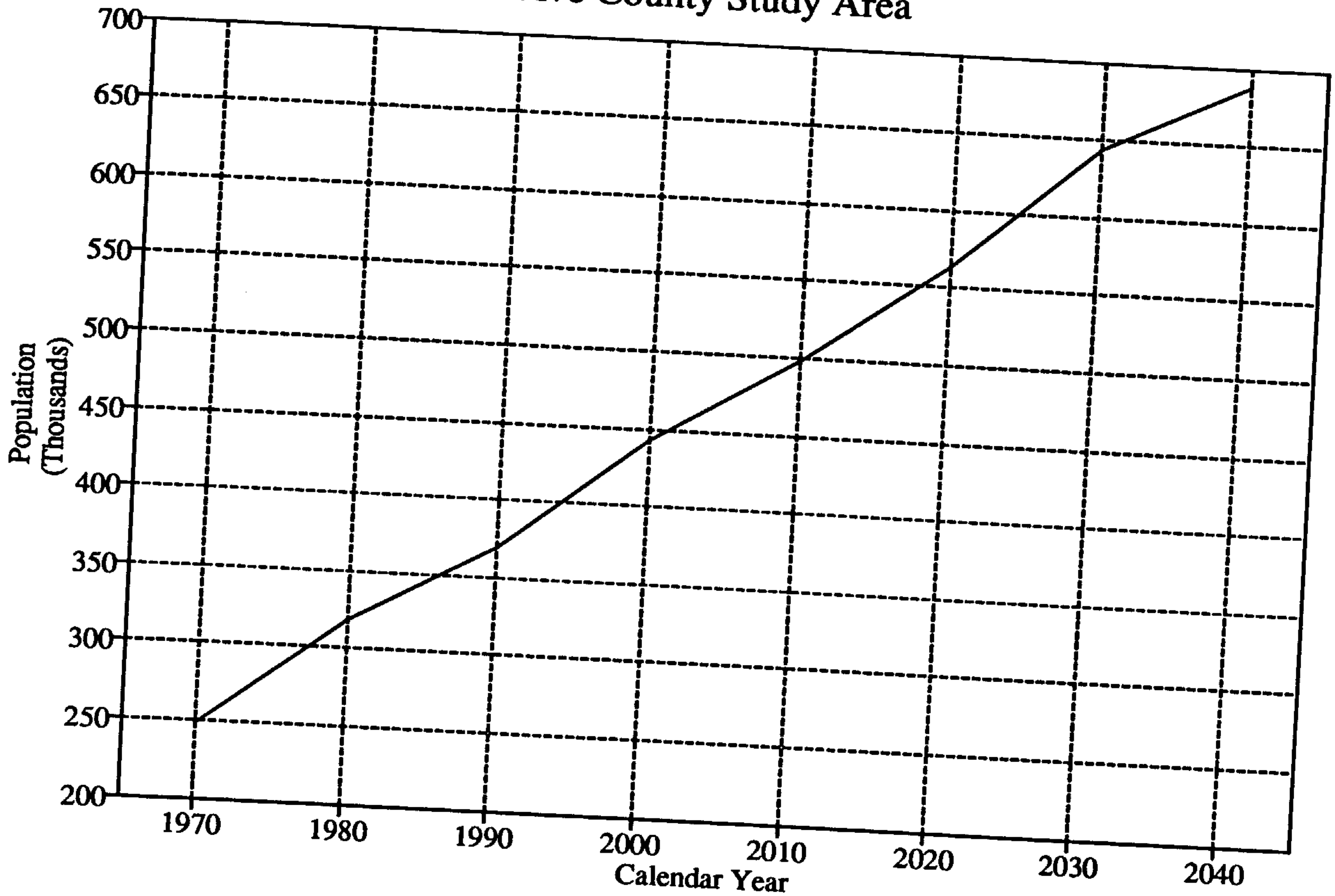
1 Values for 1970 and 1980 are historical; values for 1990-2040 are projected.

2 Based on 1990 estimated population.

Exhibit II.13

POPULATION

Five County Study Area



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The majority of the proposed Lake Eastex will be located in Cherokee County. The historical and projected population increases for Cherokee County are shown in Table II.44 and Exhibit II.14.

TABLE II.44

POPULATION INCREASES
CHEROKEE COUNTY

Year	Population(1)	Incremental Percent Increase	Cumulative Percent Increase(2)
1970	32,008		
		19	
1980	38,127		
		9	
1990	41,355		
		14	14
2000	47,079		
		10	25
2010	51,574		
		7	34
2020	55,394		
		8	41
2030	58,494		
		3	45
2040	60,110		

1 Values for 1970 and 1980 are historical; values for 1990-2040 are projected.

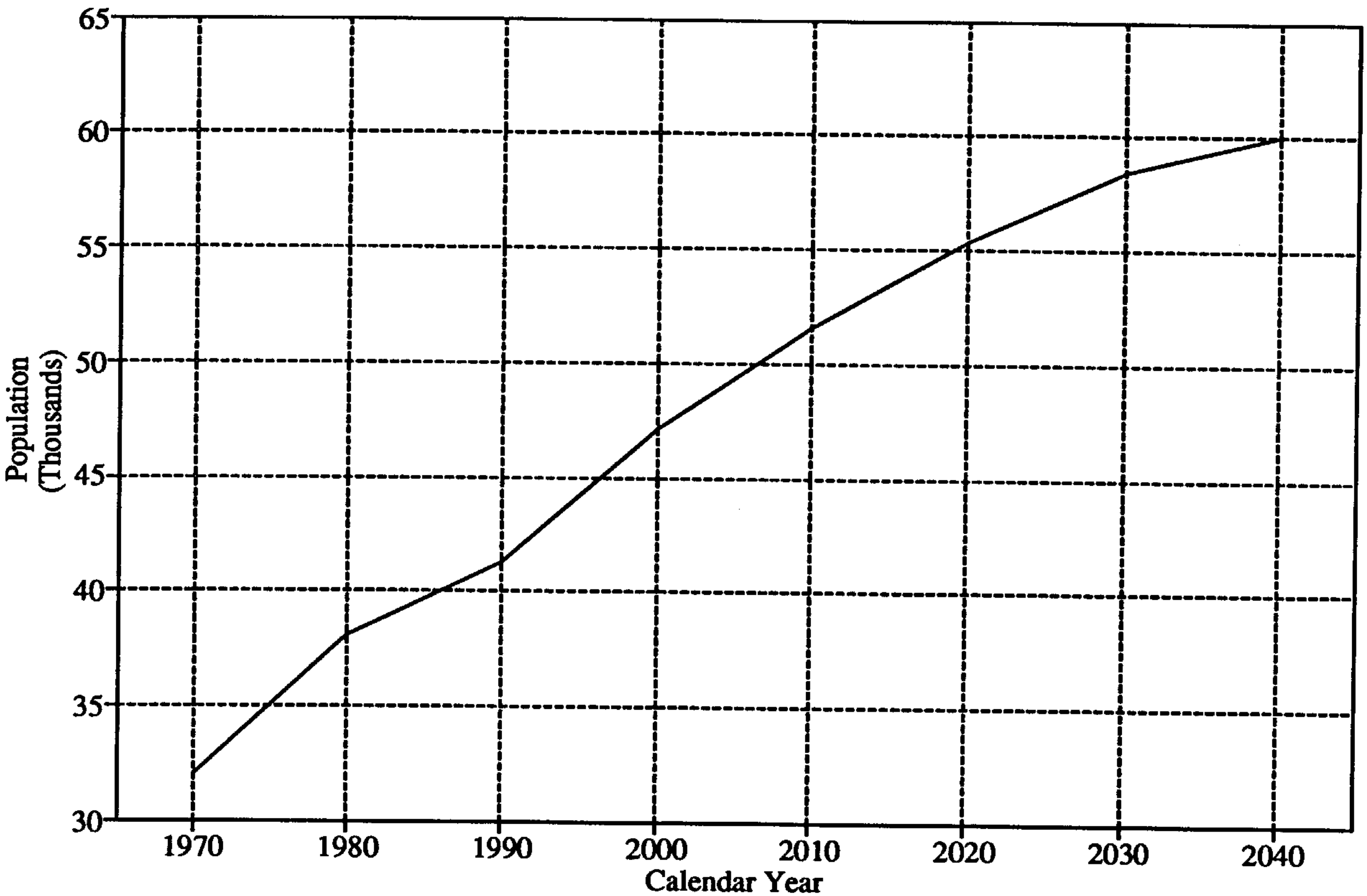
2 Based on 1990 estimated population.

The relatively small increases expected between 1980 and 1990 for Cherokee County and the study area are the result of economic setbacks experienced by the entire state in the early 1980's.

Exhibit II.14

POPULATION

Cherokee County



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2. Employment

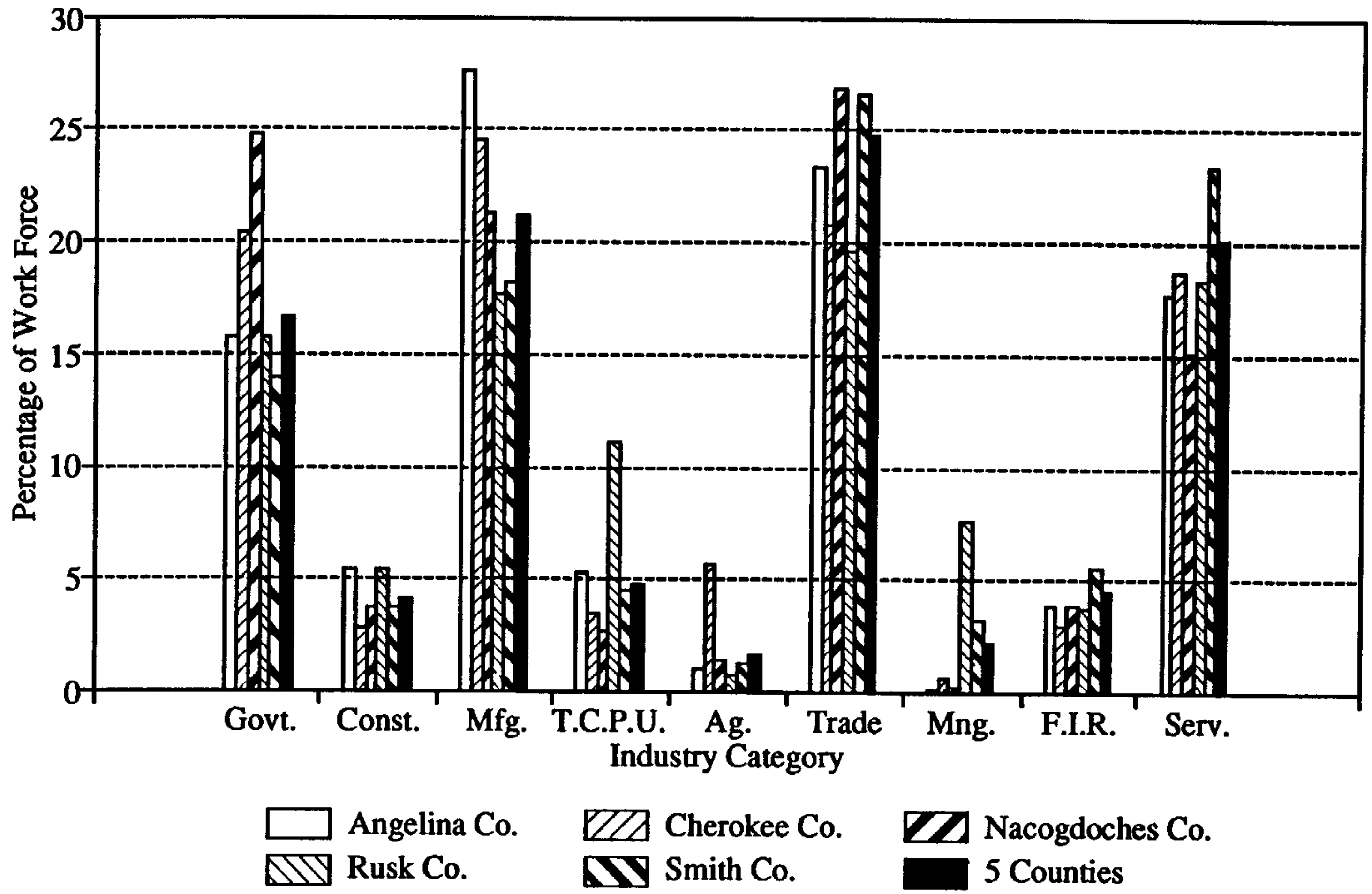
Employment characteristics for each of the five counties in the study area were investigated to determine the percentage of the total labor force within each county in each of the following major industries based on 1988 data:

Industry	Abbreviation
Government	Govt
Construction	Const
Manufacturing	Mfg
Transportation, Communication, and Public Utilities	TCPU
Agriculture	Ag
Trade	Trade
Mining	Mng
Financial, Insurance, and Real Estate	FIR
Service	Serv

Graphic results for each of the five counties along with the combined results of the entire study area are shown on Exhibit II.15.

Exhibit II.15

Employment by Industry
Five County Study Area



Most of the industry percentages for each of the five counties are similar. However, some notable exceptions include:

a) Transportation, Communication, and Public Utilities - Rusk County has an 11.1% percentage as compared to the other counties which show about 4-5%.

b) Agriculture - Cherokee County shows 5.7% of its labor force in this industry as compared to about 1% in the other counties considered.

c) Mining - Rusk and Smith Counties show 7.6% and 3.2% respectively. Other counties considered show about 1% or less.

d) Government - Nacogdoches and Cherokee Counties show 24.8% and 20.4% respectively. Other counties considered show about 15% or less.

The 1988 unemployment rate for the five county study area is about 7.4 percent (Dallas Times Herald, 1989).

A comparison of unemployment percentages for each county is presented on Exhibit II.16.

Projected labor force percentages were developed for several east Texas counties by M. Ray Perryman Consultants in an economic study for the East Texas area (1988). A graphic presentation of the anticipated labor force for Cherokee and Smith Counties in the year 2000 is shown on Exhibits II.17 and II.18. Major changes expected by the turn of the century include:

a) Reduction of government labor force proportion from 20.4% to 9.0%.

b) Increase in transportation, communication, and public utility labor force proportion from 3.5% to 12.5%.

c) Increase in the agricultural labor force proportion from 5.7% to 17.3%.

d) Decrease in trade labor force proportion from 20.9% to 10.3%.

e) Decrease in service labor force proportion from 19.7% to 12.1%.

Exhibit II.16

EMPLOYMENT BY INDUSTRY

Cherokee County

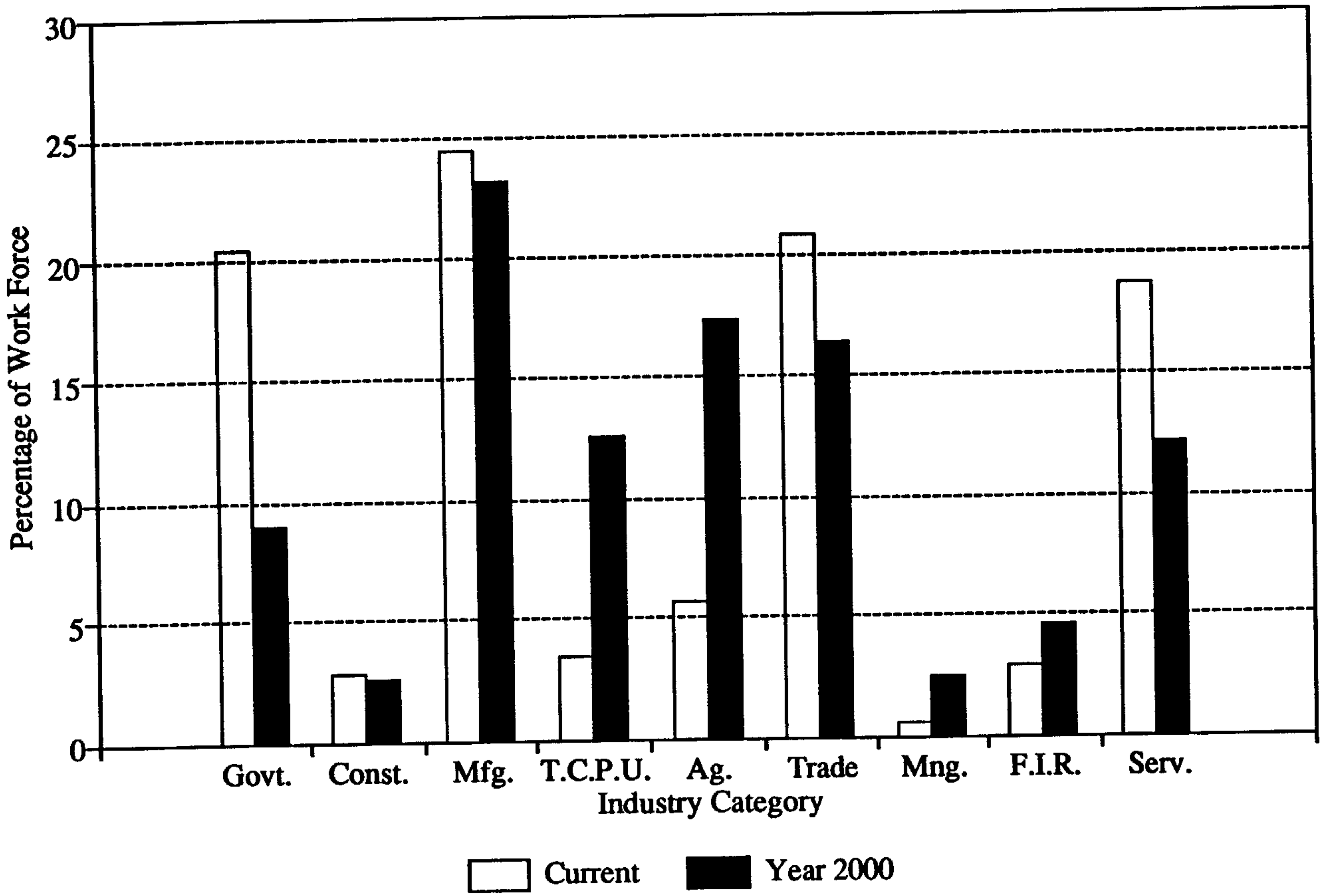


Exhibit II.17

EMPLOYMENT BY INDUSTRY

Smith County

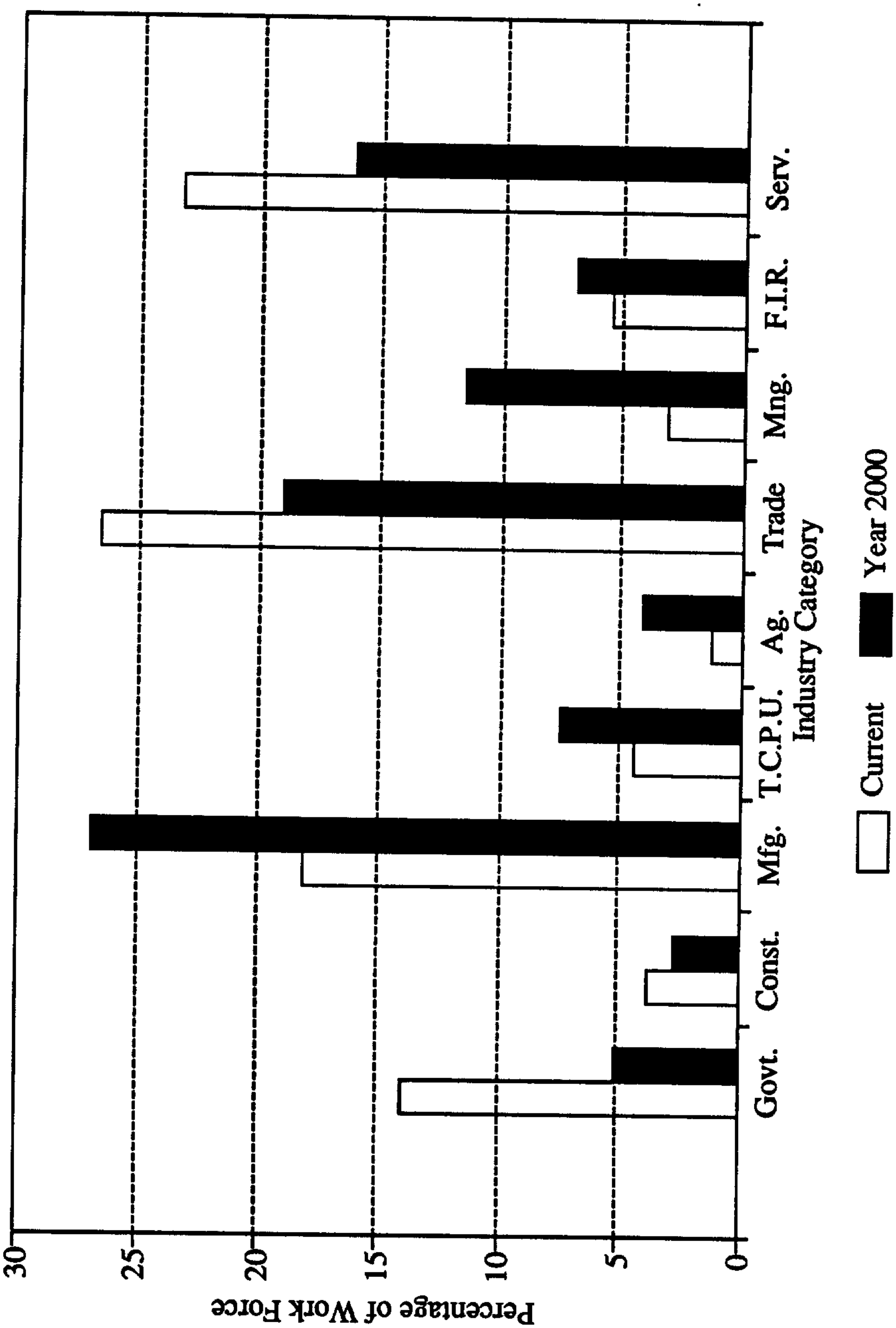
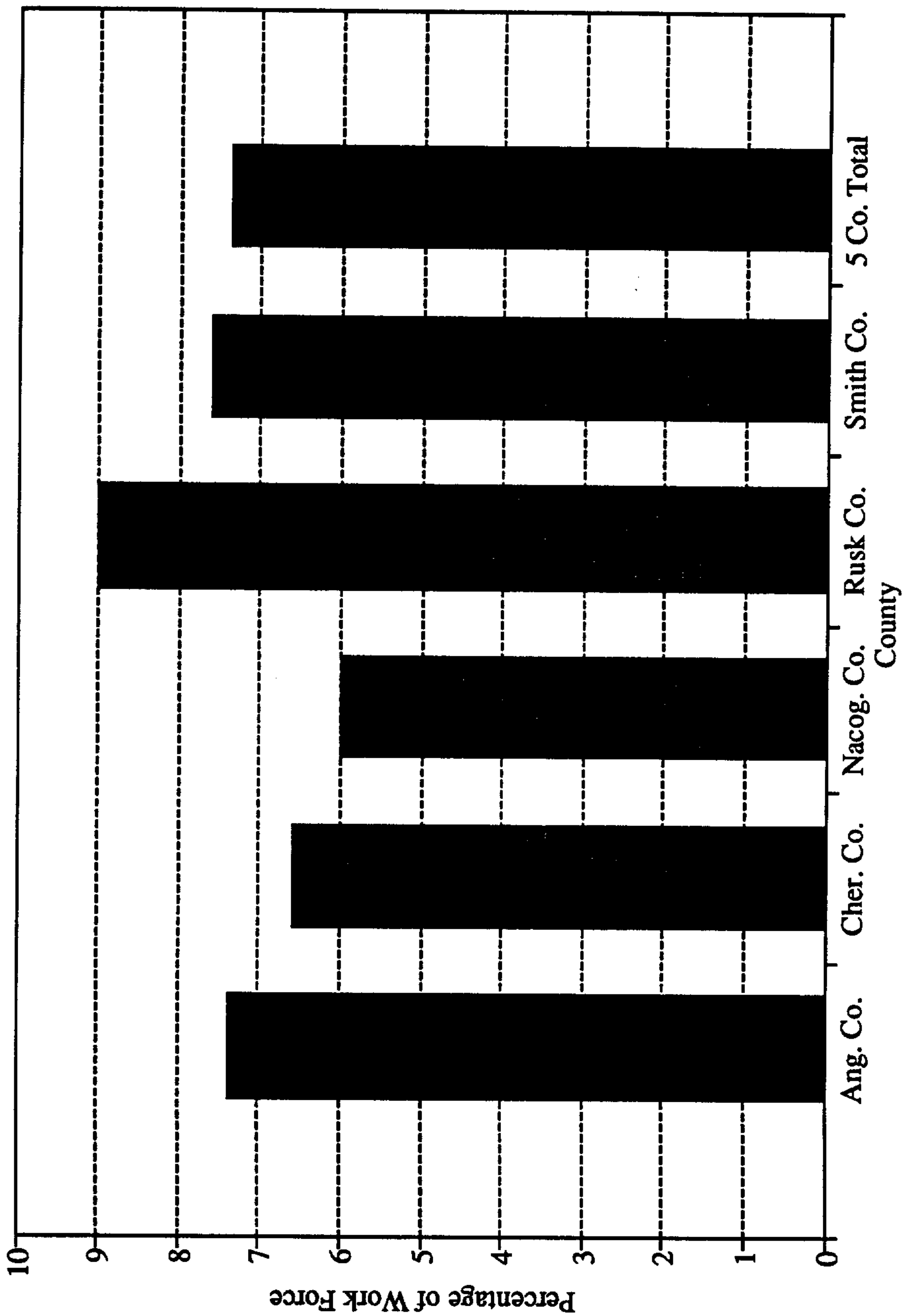


Exhibit II.18

UNEMPLOYMENT STATISTICS

Five County Study Area



H. LAND USE

The following section discusses existing land uses within and adjacent to the proposed Lake Eastex. The discussion focuses on the five-county region (Angelina, Cherokee, Nacogdoches, Rusk and Smith Counties) in a general manner, as well as on the immediate area around the lake (lake-specific) which will influence and be influenced by the proposed project. This latter area is defined as the land within 2000 horizontal feet of elevation 330.4, the "Probable Maximum Flood" (PMF) level of the lake.

Existing land uses were derived from U.S. Geological Survey "Land Use and Land Cover" series maps, the Texas Department of Water Resources "Land Use/Land Cover Maps of Texas," (TDWR, 1977) and NASA satellite imagery, field verified for the lake-specific area.

1. Regional Land Use

Land use categories were aggregated and kept to a simplified format for purposes of this study, particularly at the regional level. The categories discussed include forested areas, agricultural areas, urbanized areas, and lake and reservoir areas.

Regional (five-county) Land Use

The five-county region surrounding the proposed Lake Eastex project is rural in nature with few, but well-defined urban centers scattered throughout. Exhibit II.19 and Table II.45 illustrate this characteristic.

The region is predominantly forested, with pasture/grazing lands interspersed in an irregular manner. The land is gently rolling to hilly, with well-drained elevated areas and low-lying stream floodplain valleys subject to periodic flooding. Streams generally flow to the southeast, the floodplain valleys are generally 100 to 150 feet lower in elevation than the adjacent uplands, and are from one to ten miles wide. The soils are clayey and poorly suited for row crops.

Changes in land use have historically been slow in the region with urbanization being incremental and largely adjunctive to existing urban centers. Classically rural "suburbanization" is found throughout the region, with "ranchette" development on small-acreage (5-20 acres) tracts along all-weather roads and not necessarily related to urban centers.

TABLE II.45

REGIONAL URBAN CENTERS

County	Urban Center	1980 Population**
ANGELINA (64,172 Total)	Lufkin*	28,562
	Diboll	5,227
	Huntington	1,672
	Hudson	1,659
	Fuller Springs	1,470
	Zavalla	762
	Burke	322
	Pollok	300
CHEROKEE (38,127 Total)	Jacksonville	12,264
	Rusk*	4,681
	Alto	1,203
	Wells	926
	New Summerfield	319
	Reklaw	305
	Maydelle	250
	Mount Selman	250
	Gallatin	230
	Tumey	100
	Forest	85
	Cuney	75
	Reese	75
	Ponta	50
NACOGDOCHES (46,786 Total)	Nacogdoches*	27,149
	Garrison	1,059
	Cushing	518
	Chireno	371
	Sacul	170
	Melrose	150
	Trawick	100
	Douglass	75
	Etoile	70
	Woden	70
RUSK (41,382 Total)	Henderson*	11,473
	Kilgore (Part)	2,543
	Overton	2,430
	Tatum	1,339
	New London	942
	Mount Enterprise	485
	Caledonia	451
	Minden	350
	Price	273
	Laneville	200
	Turnertown	76
	Concord	23
SMITH (128,366 Total)	Tyler*	70,508
	Lindale	2,180
	Whitehouse	2,172
	Troup	1,911
	Arp	939
	Bullard	681
	Winona	443
	Mount Sylvan	181
	Garden Valley	150
	Swan	150

*County Seat
**Last year of official census population

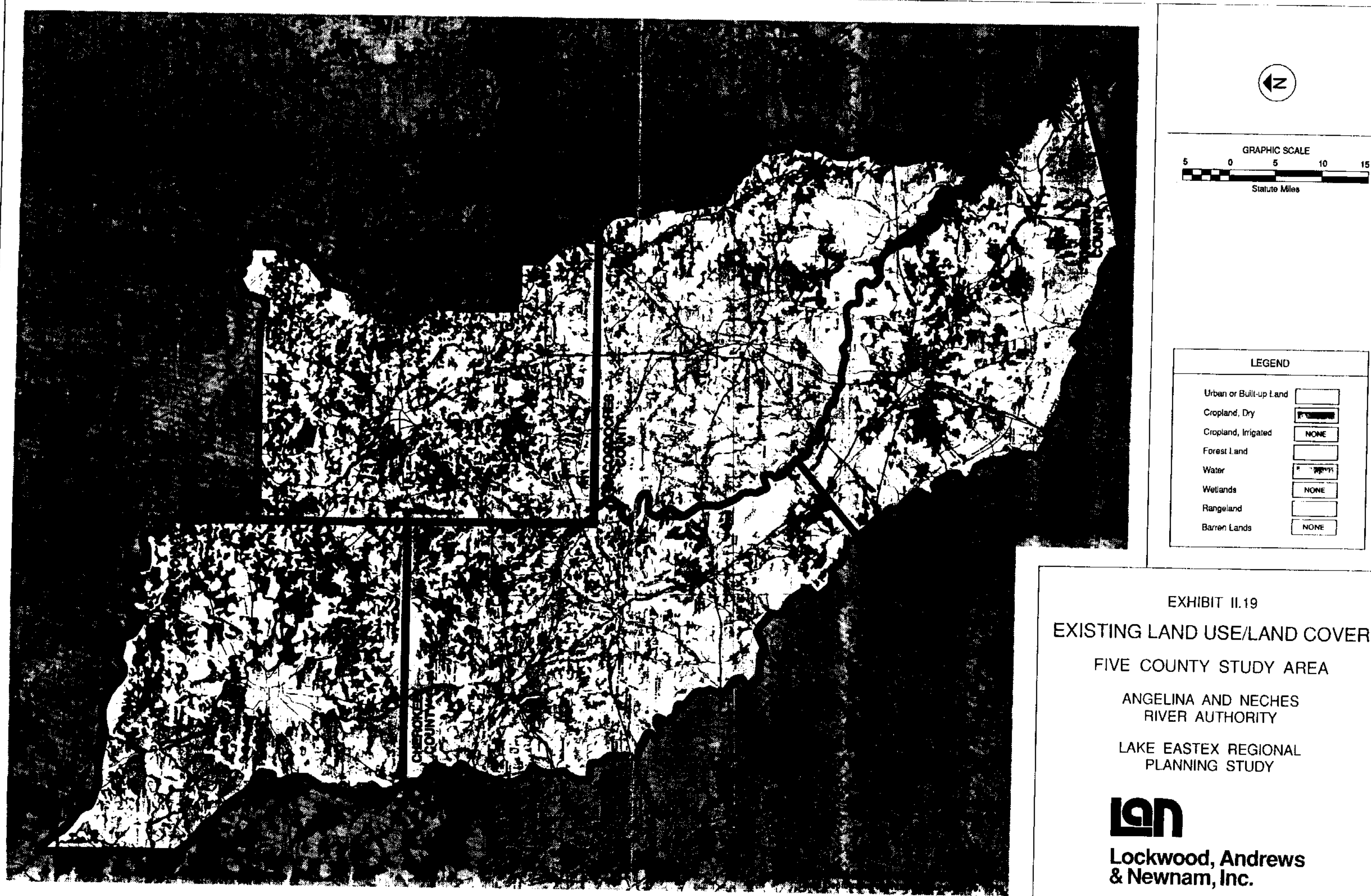


EXHIBIT II.19

EXISTING LAND USE/LAND COVER

FIVE COUNTY STUDY AREA

ANGELINA AND NECHES
RIVER AUTHORITY

LAKE EASTEX REGIONAL
PLANNING STUDY

Lockwood, Andrews
& Newnam, Inc.

Forested Areas - These areas are found throughout the region, with a total acreage of approximately 1,745,000 (about 56 percent of the study area, Table II.46). Forest cover is predominantly non-deciduous, chiefly southern pine, but with mixed hardwoods in bottomlands near perennial streams. Much of the pine is utilized as a cash crop, so that mature stands are regularly harvested, then allowed to recover and regenerate. Because of this, the pattern of heavily forested and cut-over forest land is continually changing, although the total amount of forested land remains relatively stable throughout the region.

TABLE II.46

LAND USE/LAND COVER STATISTICS FOR THE FIVE COUNTY STUDY AREA

Use/Cover	County					Total
	Angelina	Cherokee	Nacogdoches	Rusk	Smith	
Forest Land	69.9%	58.1%	59.0%	49.0%	42.2%	55.5%
Agricultural Land	21.4%	36.6%	33.6%	46.9%	40.6%	36.0%
Urban/Built-up	1.9%	2.6%	5.1%	2.3%	15.4%	5.5%
Water	6.8%	2.7%	2.3%	1.8%	1.8%	3.0%

Agricultural Areas - Primarily agricultural land use involves pastureland, grazing, and production of hay. The incidence of these open lands is greater in the more northern portion of the region (Smith County and the northern half of Rusk and Cherokee counties). The land becomes more heavily forested in the southern parts of Rusk and Cherokee counties, and in Angelina and Nacogdoches counties. Due to the erodibility of the soils and depletion of nutrients, very little of the lands are utilized for row crops. However, there are numbers of enclosed nursery operations ("plant farms") located throughout the middle portions of the region. The production of beef cattle and timber have consistently been the major long-term sustainable agricultural activities.

Urbanized Areas - The four larger (over 12,000 population) urban centers in the region evolved as "focal points" for a convergence of railroads and radially oriented highways. Originally agricultural-trade centers, and later affected by nearby oil and gas deposits, they have evolved into a more balanced urban center status with manufacturing and processing as major economic entities. The smaller urban centers remain basically rural/agricultural trade centers.

The land use patterns of the urban centers of all sizes have evolved in the traditional manner, outward from the original crossroads center. In the smaller more rural centers the patterns are generally static. Growth has been slow or even reversed. The larger centers have grown steadily but also slowly, and with commercial/industrial growth related directly to transportation arteries, rail and highway. The latter-day development of beltline highways has generated commercial/industrial growth adjacent to their corridors, representing, in many cases, "independent" new growth beyond older urban development. Thus many large undeveloped tracts are left between the older growth areas and the newer beltline growth corridors.

Residential land uses within the corporate boundaries of urban centers have also developed in the traditional manner, but beyond these centers two other patterns are apparent. The first is the increasing "ranchette" small acreage residential developments of 5 to 20 acres, possibly with part devoted to a pasture and/or garden plot. This type of development is common throughout the region along improved roads and is definitely not limited to close proximity to urban centers.

The second notable non-urban residential pattern in the region is in conjunction with reservoirs and impounded lakes. Residential development in small clusters is common on and adjacent to lakes and reservoirs throughout the region. Much of this development consists of weekend/vacation structures and is generally confined to locations on or near existing all-weather roads. In the Tyler area (Smith County), however, larger homesite developments on the larger lakes is common. The cost of the homes and the security measures provided the developments are directly proportional to their distance from Tyler. High-cost homes (many are year-round residences) and high-security compounds are closest to Tyler.

2. Lake-Specific Land Use

The proposed project would be located wholly within Smith and Cherokee counties, with more than 95 percent of its normal pool surface in Cherokee County. The land surface most directly affected by the lake has been defined as that area within 2,000 feet of the Probable Maximum Flood (PMF).

The actual area(s) which would be inundated by the proposed reservoir consists mainly of bottomland surrounding the numerous channels of Mud Creek and its tributaries. As such, it is currently subject to regular and frequent flooding. Very few (33 homesteads, 19 barns) permanent or occupied structures are located in the area below elevation 330.4 as a result. The land within this area is generally used for pasture or timber growth.

The primary impact area above elevation 330.4 is also largely devoted to agricultural or timber uses. It does contain scattered individual farm structures and some clusters of homes along with limited commercial and industrial development. There are a few large tracts of land offering individual homesites in anticipation of the reservoir but no development as yet.

There are no urbanized areas within the primary impact area, but several are located within three miles of it. These include Jacksonville, New Summerfield, Troup and Whitehouse. Several small rural clusters with place names are located within or partially within the primary impact area. These include Mixon, Tecula, Gould Community, Jacksonville Club Lake, Bolling Chapel, Earls Chapel, Taylors Chapel and Sweet Zion. Small rural cemeteries within the area are located near Bolling Chapel, New Summerfield and Troup.

Forested areas form approximately 51 percent of the land within the primary impact area. Much of the forest cover is located on land with slopes in excess of 15 percent. Some timbering operations are conducted in level and/or upland areas but replanting and regeneration following harvest has in past years kept the total acreage of timber at a relatively constant level.

Cleared agricultural areas in the bottomland as well as the uplands beyond the proposed lakesite are used for pasture or hay production. These areas form about 49 percent of the land within the primary impact area.

I. RECREATION

This section provides an overview of the recreational resources within the five county study area including identification of existing regional resources and projections of regional facility needs. The information presented in this section is based on data collected from a variety of sources including the TPWD's, and the Texas Department of Transportation (TxDOT). A discussion of the existing recreational resources and projected facility needs within the five county study area is presented below.

1. Recreational Resources

Recreational resources within the five county study area can generally be divided into four categories which include 1) reservoirs, 2) rivers and streams 3) parks and recreation areas and 4) other recreational resources. The various recreational opportunities within the study area are presented below by each of these categories. Recreational resources in the five county study area are presented graphically in Exhibit II.20.

Reservoirs

Nine reservoirs in the five county study area provide significant recreational opportunities for activities such as boating, fishing, picnicking, camping, swimming and skiing. These nine freshwater lakes ranging in size from 770 acres (Kurth Lake) to 114,500 acres (Sam Rayburn Reservoir) encompass approximately 160,567 surface acres throughout the five county study area. These major reservoirs in the study area include (in decreasing order of size):

Reservoir	Surface Acres
Sam Rayburn Reservoir	114,500
Lake Palestine	25,560
Martin Lake	5,020
Lake Tyler and Lake Tyler East	4,800
Lake Cherokee	3,987
Striker Lake	2,400
Lake Nacogdoches	2,210
Lake Jacksonville	1,320
Kurth Lake	770
Total surface acres	160,567

The geographic distribution of these reservoirs is presented in Exhibit II.20.

Rivers and Streams

A number of various sized rivers and streams are distributed throughout the study area. The major named rivers and streams include the Sabine River, Neches River, Angelina River, Attoyac Bayou, Mud Creek, Caney Creek, Bridge Creek, West Mud Creek, and Birches Creek. Several stretches along these creeks have been highlighted by the Texas Outdoor Recreation Plan as waterways (TORP, 1985). The TORP identifies a waterway has an area that has recreational, aesthetic, hydrologic, and natural habitat values which should be preserved by avoiding any further channelization, damming, and/or construction of septic systems along the banks or direct wastewater disposal. The rivers and streams within the study area that are highlighted in the TORP are presented below.

Proposed for Inclusion in a Natural Rivers System

Neches River - Highway 21 to Cherokee/Angelina County lines - approximately 27 miles in length.

Permanently Floatable

Sabine River - Highway 80 to Panola/Shelby County lines - approximately 80 miles in length.

Angelina River - Highway 21 to Cherokee/Angelina County lines - approximately 23.3 miles in length.

Neches River - Highway 79 to Cherokee/Angelina County lines - approximately 86.2 miles in length.

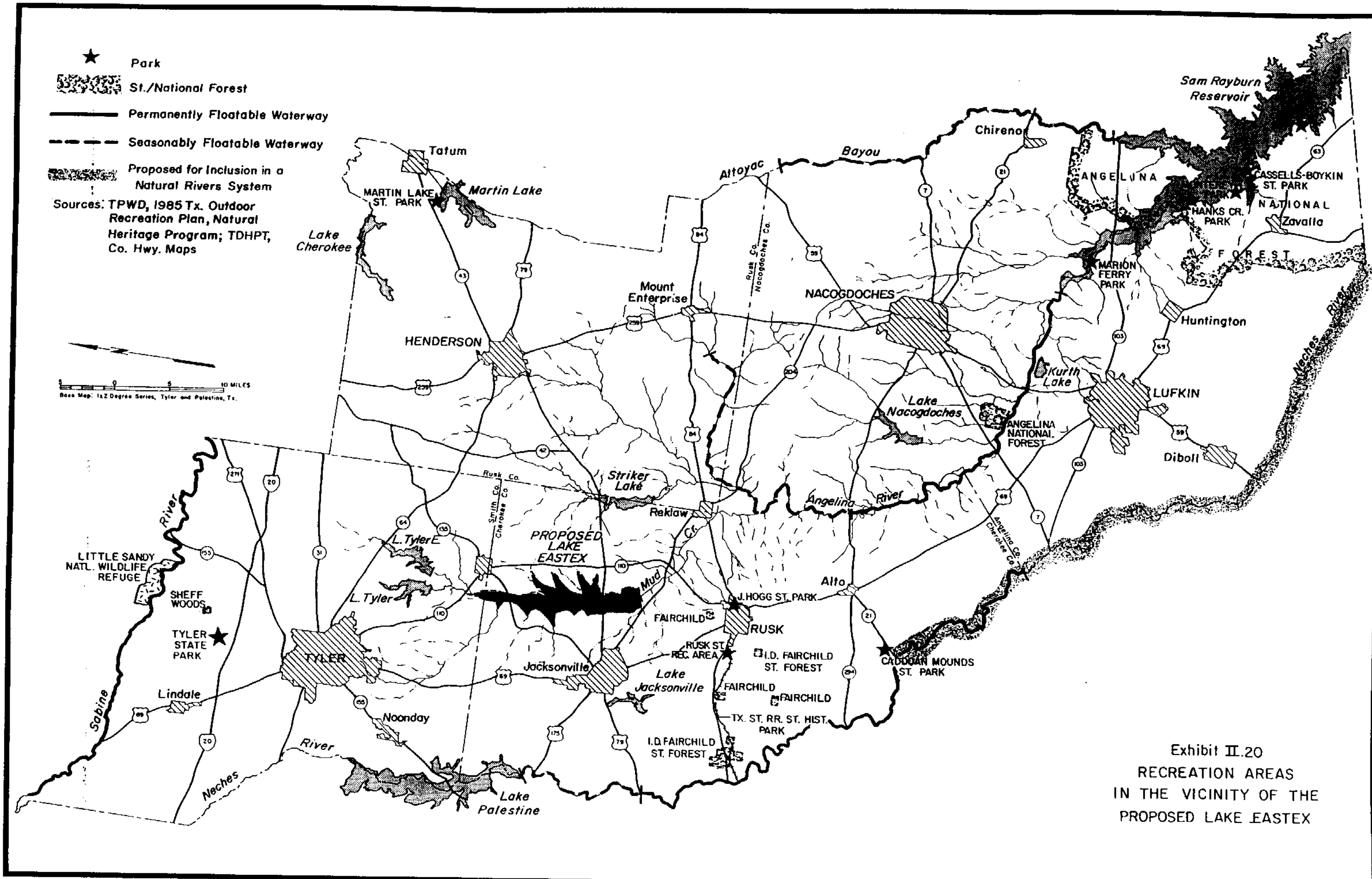


Exhibit II.20
RECREATION AREAS
IN THE VICINITY OF THE
PROPOSED LAKE EASTEX

Seasonably Floatable

Angelina River -	East fork to Highway 21 - approximately 21 miles in length.
Neches River -	Lake Palestine Dam to Highway 79 - approximately 20.8 miles in length.
Attoyac Bayou -	FM 138 to Highway 21 - approximately 41 miles in length.

The stretches of the rivers and stream designated as waterways by the TORP are illustrated in Exhibit II.20.

Parks and Recreation Areas

A number of parks and recreation areas are distributed throughout the five county study area. These areas include federal, state and local facilities of varying sizes. The major parks and recreational areas in the study area are identified below:

Tyler State Park
Caddoan Mounds State Park
Rusk State Recreational Area
J. Hogg State Park
Martin Lake State Park
Marion Ferry Park
Hanks Creek Park
Monterey Park
Casselles-Boykin State Park
Caney Creek Park
Texas State Railroad State Historical Park

Federal and state forests/refuges in the study area include:

I.O. Fairchild State Forest
Little Sandy National Wildlife Refuge
Angelina National Forest

The location of these facilities is presented in Exhibit II.20.

Other Recreational Areas

The TPWD provides a summary of recreational sites for each county in Texas. This summary includes a list of facilities provided by the various levels of the public (federal, state, local) and private sectors (quasi-public and commercial). Table II.47 presents this information for the five county study area.

TABLE II.47
RECREATIONAL SITES IN THE FIVE COUNTY STUDY AREA

Resource Facility	Federal Sites	State Sites	County Sites	Municipal Sites	Special District Sites	Quasi-Public Sites	Commercial Sites	Totals
Number Sites	11	12	5	83	0	2	45	158
Land Acres	82084	20350	39	2606	0	12	2768	107859
Developed Land	370	795	39	1285	0	12	1599	4100
Campsites	796	387	49	214	0	0	1196	2642
Pavilions	6	3	0	43	0	1	2	55
Single Tables	0	137	25	316	0	0	15	493
Group Tables	7	23	0	93	0	0	23	146
Playgrounds	0	5	0	65	0	1	13	84
Golf Courses	0	0	0	4	0	0	6	10
Courts	0	2	0	89	0	0	5	96
Fields	0	0	0	111	0	2	0	113
Swim Pools	0	0	0	14	0	0	8	22
Wading Pools	0	0	0	0	0	0	0	0
Sites w/ Impoundments	9	3	5	17	0	0	21	55
Sites w/ Streams	1	0	0	7	0	0	-	8
Boat Ramps	10	6	6	11	0	0	22	55
Launch Areas	0	0	0	10	0	0	8	18
Fishing Structures	0	4	0	16	0	0	16	36

Source: (TPWD, 1988)

2. Recreational Needs

According to the TORP most areas in the state have some supply deficits in recreational facilities. The TORP identifies additional facility needs by region to aid in establishing the magnitude of these deficits. The study area is located within two regions (Regions 6 and Region 14) as described in the TORP. In order to estimate facility needs for the five county area, the facility needs for each regions were reallocated in proportion equal to the percent of total population of the region covered by the counties in the study area. This estimate of facility needs for the years 1990 through 1995 is presented below in Table II.48.

TABLE II.48

RECREATIONAL FACILITY NEEDS IN THE FIVE-COUNTY STUDY AREA

Facility/Resource	1990	1995
Baseball Fields	36	42
Basketball Courts, Full	50	55
Bicycling Trl. Mi.	18	19
BFS Boat Ramp Lanes, FW	76	98
BFS Suitable Acres Lakes	0	0
Campsites	855	1014
Child's Playground Acres	13	15
Fishing, Lin YD FW PBM	1694	1892
Football Fields	29	31
Golf Holes	61	68
Horseback Riding TRL MI	5	5
Jogging, Running TRL MI	20	22
Motorcycling TRL MI	5	6
Picnic Tables	187	225
Soccer Fields	13	14
Softball Fields	57	62
Swimming, FW SQ YD (000)	399	442
Swimming, Pool SQ YD (000)	6	7
Tennis Courts, Doubles	25	29
Walking, Hiking TRL MI	51	54

Source: TORP, 1985

J. TRANSPORTATION

The transportation infrastructure in the region is extensive and reasonably adequate. Urban centers of practically any size are served by several highways. Rail service is available at all of the larger centers and publicly owned airports are located near most of the larger centers. A network of transmission lines, aerial and underground, is present. The following discussion will include regional and site specific transportation in the Lake Eastex vicinity.

1. Regional Transportation

Interstate Highway 20 (IH20) east and westbound passes just north of Tyler in Smith County. U.S. Highways 59, 69, 79, 84, 175, 259 and 271 pass through the region with extensive 4-lane segments. Most urban centers are served by at least one State highway. Multiple paved farm-to-market (FM) roads interconnect with all of the above. A multitude of county and local roads serve rural areas. Some of these are paved, but many are gravel-surfaced or graded-dirt roads.

The Union Pacific (including Missouri Pacific), Southern Pacific and St. Louis Southwestern railroads all have extensive trackage throughout the region, providing freight service to all of the major urban centers.

Publicly-owned airports are located near Henderson, Jacksonville, Lufkin, Nacogdoches and Tyler. The Pounds Airport at Tyler is provided with scheduled passenger service.

High-voltage aerial electrical transmission lines are located in each of the region's counties, as are liquid petroleum and natural gas underground transmission lines.

2. Lake Specific Transportation

U.S. 79 between Jacksonville and New Summerfield crosses the Mud Creek Valley (proposed reservoir site) on a fill section with two bridges over the two main channels of Mud Creek. SH 110 between Troup and Whitehouse also crosses Mud Creek at the upper end of the primary impact area on two bridges. It will be affected by the PMF level of the reservoir, but will not be affected by the normal water level or the 50-year flood.

SH 135 between Mixon and Troup crosses Mud Creek on two bridges. FM 2064 between Tecula and Gould Community also crosses Mud Creek, on one bridge. Both of these roads will be affected by the normal and PMF levels of the reservoir. Numerous county and other local roads cross either Mud Creek or its tributaries in areas where they will be affected by the normal water level and/or the PMF level of the reservoir.

Two Union Pacific railroad tracks cross through the primary impact area. The first runs between Troup and Whitehouse. It will be affected by the PMF level of the reservoir only. The second lies between Troup and Jacksonville, closely paralleling FM 2064. It will be affected by both the normal water surface level and the PMF level of the reservoir.

Three high-voltage aerial electric transmission lines cross the proposed reservoir site and would be affected by both normal and maximum water levels. All pass near New Summerfield on the east, coming from near Whitehouse, Tecula and Jacksonville on the west.

Four liquid petroleum and natural gas underground pipelines cross the primary impact area. Three of them generally run from near Jacksonville to near Troup and one runs north from Jacksonville toward Tyler. This latter one crosses the primary impact area twice. As it crosses Birches Creek near Taylors Chapel it also crosses a small portion of the PMF reservoir level. As it passes through the primary impact area about six miles further north it crosses West Mud Creek above the PMF line.

K. NOISE

The analysis of noise impacts is more easily understood when a comparison with known noise generators and their resulting noise levels is made. Exhibit II.21 depicts some typical sound levels frequently encountered and noise sources that generate those noise levels. Additionally, various entities have established allowable noise levels for different land use activities in the vicinity of neighboring properties or developments. The Noise Abatement Criteria (NAC), established by the Federal Highway Administration (FHWA), are presented in Table II.49.

Existing noise levels were field measured on March 9, 1989 and April 12, 1989. Four receptor sites were selected within the proposed Lake Eastex vicinity. The noise monitoring locations were selected as representative of different type of land uses which could be impacted by changes in noise levels. Table II.50 shows the results of the field monitoring effort.

TABLE II.49

NOISE ABATEMENT CRITERIA

Activity Category	Description of Activity	Criteria Levels -dB Leq(h) - L10(h)
A	Tracts of land in which serenity and quiet are of extraordinary significance and severe an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, open spaces, historic districts which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quite.	57 60 (exterior)
B	Picnic areas, recreation areas, playgrounds, active sports areas, and parks which are not included in Category A and residences, motels, hotels, public meeting rooms, schools, churches, libraries, and hospitals.	67 70 (exterior)
C	Developed lands, properties or activities not included in Categories A or B above.	72 75 (exterior)
D	Undeveloped lands. Predicated noise levels should be provided to local governments by which developers of land can design activities compatible with further noise levels.	-- --
E	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.	52 55 (interior)

TABLE II.50

EXISTING NOISE LEVELS

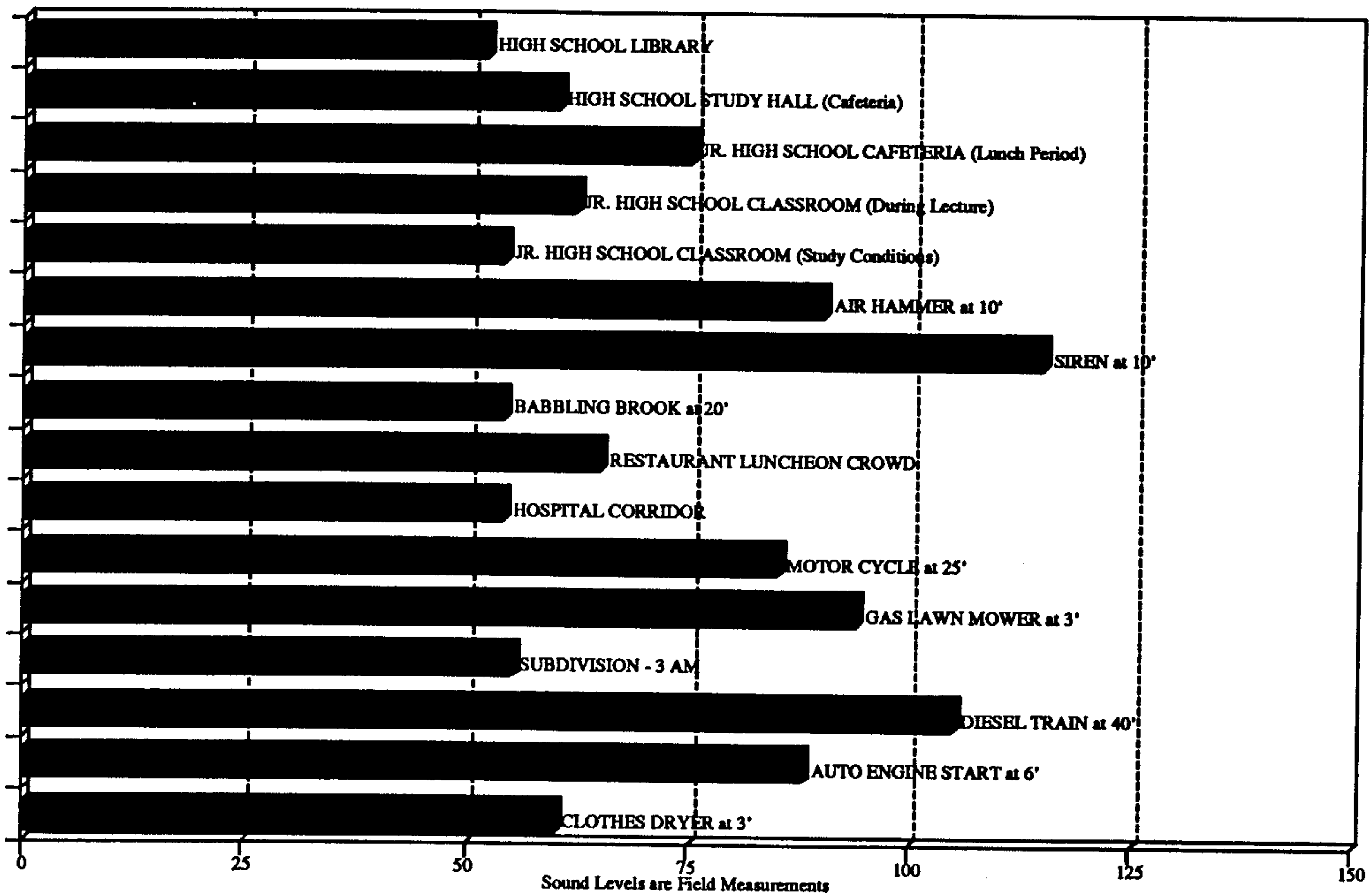
Date	Monitoring Site	Location	Noise Level
3-9-89	1	west end of dam	50.5
3-9-89	2	US 79 near Afton	73.4
4-12-89	3	CR 2138 - north end of lake	55.7
4-12-89	4	west of Gould	50.4

Noise levels show in this table are the result of 30 minutes of continuous monitoring. Existing noise levels are primarily natural or the result of roadway traffic.

Exhibit II.21

TYPICAL SOUND LEVELS

Sound Pressure in dB(A)



III. POTENTIAL ENVIRONMENTAL IMPACTS

III. POTENTIAL ENVIRONMENTAL IMPACTS

A. POTENTIAL IMPACTS TO GEOLOGICAL ELEMENTS

The development of the proposed reservoir will impact the geological elements in the study area in a variety of ways. The primary impact will be the inundation of about 10,000 acres. As discussed in Volume I of this report, some of the soil associations within the pool area have the potential to be designated as prime farmland. In addition, the soils within the floodplain of Mud Creek are typically deep alluvial soils, many with hydric characteristics. Finally, sediment transport may be impeded by the construction of the proposed dam.

Topographic features in and adjacent to the pool may also experience some alteration due to changes in the erosional and accretional processes both above and below the proposed dam.

B. POTENTIAL IMPACTS TO HYDROLOGICAL ELEMENTS

1. Surface Water

a. Hydrology

The development of the proposed reservoir will result in alternation of the overall flow regime within the pool and below the proposed reservoir. Portions of all direct tributaries of Mud Creek will be inundated and subsequently will not be as likely to experience extreme fluctuations in flow conditions. These tributaries will experience backwater effects from the proposed reservoir and be subject to a buildup of sediment and detrital matter.

Downstream of the proposed reservoir, the hydrologic regime is expected to undergo some alteration. As discussed in Section II.B.1.a., the area downstream of the proposed reservoir is characterized by a series of braided channels which include oxbows, sloughs, and some swampy areas. A change in the flow quantity and distribution may alter the drainage patterns below the proposed reservoir. The flow regime is typically determined through the use of a number of methods including review of median flows, review of 7Q2 (seven-day, two-year low flow) and/or the Instream Flow Incremental Methodology (IFIM). Each of these is discussed in more detail in Section III.E.3.b. A discussion of the water quality impacts of the proposed reservoir is presented below.

b. Water Quality

Reservoirs are important for water supplies, recreational activities and commercial fishing. Additional benefits often include flood control, hydroelectric power and low-flow augmentation. In order to maintain these multiple uses, pollution control measures need to be established and enforced. Municipal wastes and diffuse runoff contain organic matter which can have a direct impact on dissolved oxygen concentration and nutrients that promote eutrophication. With proper planning and operation, the benefits gained more than offset the perpetual care needed to maintain a manmade lake.

Absorption and dissipation of solar energy within the top few meters of reservoir leads to thermal stratification during summer months. The top layer (epilimnion) is warmed by sunlight and continuously circulated by wind. The cooler, bottom layer (hypolimnnion) is photosynthetically unproductive. The middle layer (thermocline or metalimnion) is the zone of maximum rate of decrease in temperature. Intensity of wind circulation, depth of light penetration, magnitude of solar heating and other climatic factors greatly influence the thickness of different layers. Lake Eastex has a potential for stratification but no serious problems are expected as a result of this condition.

Eutrophic Conditions

The chemical parameters important in assessing the trophic level of a reservoir are dissolved oxygen concentration and nutrient content. Excessive amounts of phosphorus and nitrogen compounds stimulate algae bloom proliferation. Upon mass die-off, high algae population can impact the aquatic environment leading to fish kills and objectionable taste and odor problems.

Reservoirs are classified into three states of eutrophication: eutrophic (nutrient-rich waters with occasional or frequent algal blooms), mesotrophic (moderate level of nutrients) and oligotrophic (nutrient-poor waters with rare cases of algae overgrowth). The generally accepted upper concentration limits at the time of spring overturn for lakes free of algae problems are 0.3 mg/L of inorganic nitrogen and 0.01 mg/L of orthophosphate phosphorus (Hammer, 1981).

Using the results obtained from the two sampling events conducted upstream of Lake Eastex, the trophic status of the lake was investigated. Because phosphorus load is usually limiting, critical and excessive loads of this parameter were calculated with the Vollenweider model (Vollenweider, 1970). The results are shown in Table III.1. The critical (permissible) loading is an indication of the maximum allowable input for a lake to remain oligotrophic. Excessive loadings define a lower boundary limit for a eutrophic state. Loading between these limits, defines the mesotrophic state. The nitrogen loadings provided in Table II.6 are based on a plant tissue analysis of phytoplankton and macrophytes which shows an approximate ratio of 1 Phosphorus:7 Nitrogen:40 Carbon per 100 dry weight (Hammer, 1981). As shown in the table, the current annual phosphorus loading is more than two times the recommended phosphorus limit and thus predicts a eutrophic state for the reservoir. It should be noted, however, that this projected eutrophic state is typical of Texas reservoirs, including the area lakes in the vicinity of the proposed Lake Eastex.

TABLE III.1

CRITICAL AND EXCESSIVE NUTRIENT LOAD VALUES FOR PROPOSED LAKE EASTEX

Elevation (ft)	Acreage (acre)	Permissible** Loading Rate Mg/m²/yr		Excessive Loading Rate mg/m²/yr		Critical Annual Load kgP/yr	Excessive Annual Load kgP/yr
		N	P	N	P		
Minimum (310)	8200	1.8	0.12	3.3	0.22	3.98 X 10^3	7.3 X 10^3
Median (315)	10000	2.1	0.14	3.6	0.24	5.67 X 10^3	7.96 X 10^3
Maximum (318)	11300	2.6	0.15	3.8	0.25	6.9 X 10^3	8.3 X 10^3

* From Vollenweider, 1970
** Based on minimum, median and maximum depths of 40, 45 and 48 ft., respectively.

Note: Stream data from sampling events no. 1 and 2:
Average inflow = 220 ft³/sec
Average ortho-P Conc. = 0.091 mg/L (Flow-weighted)
Average Loading = 1.76 X 10^4 kgP/yr

Conventional water quality parameters of the streams sampled are typical of surface waters in the East Texas region. Table III.2 provides a comparison of normal flow data with USGS data for rivers in the vicinity. Conventional water treatment techniques can easily bring down the levels of these parameters to suitable ranges for industrial and public uses. From a public health aspect, no problems are indicated from heavy metals or toxic organic chemicals. Excessive phosphorus loadings observed are mostly due to discharges from existing WWTP's. While the phosphorus levels of the streams feeding Lake Eastex exceed the recommended level of 0.01 mg/l, so do other rivers in the East Texas region as indicated in Table III.2. The projected eutrophic state should not be taken to mean that water quality is not suitable for downstream uses. In fact, these projections for Lake Eastex are not as severe as Lake Livingston, which ranked as the worst eutrophic lake of Texas in the national Eutrophication survey conducted by EPA (COE, 1987). In spite of this fact, Lake Livingston continues to be a major source of water supply for the City of Houston, Texas, and is used for boating, fishing and contact recreation.

TABLE III.2

USGS WATER QUALITY DATA FOR SELECTED EAST TEXAS RIVERS (OCT. 88 - SEPT. 89)

Location		P Total mg/L	BOD_5 mg/L	AllCal. mg/L as $CaCO_3$	Hardness Total mg/L as $CaCO_3$	TDS mg/L	pH Min/Max
08032000	Neches River near Neches	0.047	1.4	18	37	98	6.5/6.9
08035000	Neches River near Rockland	0.075	1.6	21	35	106	6.0/7.5
08040500	Neches River at Town Bluff	0.045	1.3	18	30	87	6.7/7.2
	Lake Eastex normal flow sampling event	0.13	1.7	12	32	145	6.1/7.1

The proposed Lake Eastex would be affected more by effluents from point sources along the tributaries discharging into Mud Creek. However, water quality data from the two sampling events suggest that the overall water quality should be good, and comparable to other reservoirs in the immediate vicinity.

Under current basin runoff conditions, a eutrophic state is predicted for Lake Eastex. However, modifications to upstream WWTP processes will result in mesotrophic conditions. Previous analyses and current data indicate no potential for industrial runoff into the lake. With respect to pesticides and heavy metals, Lake Eastex should not have any detrimental concentrations to end users or aquatic life. Conventional treatability parameters such as alkalinity and hardness do not show any cause for concern.

With respect to the eutrophication issue, it is recommended that phosphorus loading to streams be reduced. At the present time, WWTPs constitute the majority of phosphorus loading since there are no row crops and little input from agricultural runoff. In order to avoid a eutrophic condition for the lake, a 40 percent reduction in phosphorus loading is required to attain mesotropohic conditions. Process modification of existing upstream WWTPs as well as in-stream measures to encourage elective flora growth can be used to achieve mesotrophic conditions in the lake.

2. Ground Water

As mentioned in Section II.B.2, three significant water bearing formations, the Carrizo Sand, Wilcox, and Queen City aquifers lie directly under the proposed reservoir. Due to the location of the proposed Lake Eastex over the reservoir zone of most of these aquifers, no significant alteration to the flow conditions in either the contributing or recharge zone of any of these aquifers is expected. However, part of the proposed reservoir directly overlies the Queen City outcrop, suggesting a possible increase in the recharge to the aquifer. A more detailed survey of the areal extent of the significant features associated with these aquifers is necessary to more clearly quantify potential impacts to groundwater, and associated contributing, recharge and reservoir features.

C. POTENTIAL IMPACTS TO WETLANDS AND FLOODPLAIN

1. Wetlands

Existing wetlands upstream from the proposed Lake Eastex, within the proposed area of inundation and immediately downstream of the proposed lake will be altered if the project is completed.

The upper reaches of the proposed Lake Eastex (southern Smith Co.) will influence upstream hydrology by increasing backwater flooding in contributing drainages. The overall effect of this will be a decrease in intermittent riverine wetlands and an increase in permanent and semi-permanent riverine and palustrine wetland types. Vegetational shifts in newly inundated areas with semi-permanent to permanent water regimes should result in successional communities composed mainly of facultative wetland and obligate wetland species. More xeric adapted plant species will be lost since their roots will be subject to anaerobic conditions.

Within the proposed pool of the lake, all riverine and palustrine wetlands will be inundated and replaced by lacustrine and littoral types. After this occurs, only floating aquatic vegetation will persist in lacustrine zones and emergent aquatic species will colonize littoral zones over time. Within the pool, rough estimates indicate 3,000-5,000 acres of wetlands of varying classifications occur (as mapped by NWI, 1980).

Downstream from the proposed dam site, the wetland types consist of more extensive swampy oxbow lake areas. These swampy areas are palustrine wetlands of a semi-permanent nature and are vegetated by deciduous forest and scrub-shrub. The proposed dam axis location is almost immediately adjacent to these areas. These wetlands will be altered at a minimum in terms of their flow regime. This in turn will lead to vegetative changes with more terrestrial species entering the area.

More information regarding the wetland systems and flow regime of Mud Creek is necessary to predict the extent of actual project impacts. Delineation of the actual areal extent of wetlands may require field investigations and use of the Unified Federal Method. The need for detailed studies such as this will be determined during the scoping process if an Environmental Impact Statement (EIS) is required.

2. Floodplains

As previously mentioned in Section II.C., the existing 100 year floodplain of Mud Creek generally corresponds to the maximum flood pool for the proposed Lake Eastex. The development of the proposed reservoir will result in inundation of the major portion of the existing floodplain and cause some shift in the floodplain boundaries both above and below the proposed dam. The regulated nature of the flow regime is expected to increase the floodplain width above the dam and may result in a reduction in the floodplain width below the proposed reservoir. However, it should be noted that Lake Eastex is not a flood control reservoir and has no designated flood pool.

A modeling effort incorporating the proposed operating procedures, flow regime and historic precipitation data will be necessary to more accurately assess the areal effects on the floodplains above and below the proposed dam.

D. POTENTIAL IMPACTS TO CLIMATE AND AIR QUALITY

The proposed Lake Eastex is not expected to have any effect on the climate in the study area. The Texas Air Control Board has stated that Cherokee, Rusk, and Smith Counties meet or exceed the NAAQS for Sulfur Dioxide, Carbon Monoxide, Nitrogen Dioxide, and Total Suspended Particulate. Comparisons against Ozone standards were unclassifiable. The TACB further stated that the proposed Lake Eastex project should not be an effect on air quality in the area (TACB, 1990).

E. POTENTIAL IMPACTS TO BIOLOGICAL ELEMENTS

1. Vegetation

The purpose of this section is to identify potential impacts to the vegetation of the area due to the proposed project. These impacts include the effects on inundated areas, downstream effects and effects on important plant species. The following is an elaboration on these effects and recommendations for continuing the environmental study within the regulatory framework.

a. Effects on Inundated Areas

The main impact from inundation of the project site would be the resulting loss of present terrestrial habitats identified in Section II.E.1.b. Aquatic habitats would replace extant vegetative communities with the inundation of the area. The size of the area to be flooded is, therefore, directly related to the impacts to terrestrial habitats. Thus, 10,089 acres of terrestrial vegetation communities would be impacted with the inundation of the proposed project area. The two primary impacts to the vegetation would be ecological and commercial. Of particular ecological value in the reservoir site are the bottomland hardwood forests and the hydric habitats. Two estimates of the vegetation communities within the pool area are presented in Section II.E.1.c. Inundation of the forested areas within the proposed reservoir pool will remove current and potential commercially important timber resources.

When water levels rise to the normal pool levels, mortality of all cover vegetation left standing within the reservoir pool area will occur. The vegetation that would be lost includes bottomland hardwood forest and hydric habitats that are important to wildlife. These habitats typically occur in what would be the deepest parts of the proposed reservoir. Reservoir construction can modify and destabilize plant communities along the periphery of the lake as a result of fluctuating water levels (USFWS, 1985). Disturbance and an increase in available soil water along the reservoir shoreline is likely to increase the occurrence of such species as eastern cottonwood, black willow and common buttonbush. Upland forest and grassland/savannah will dominate the vegetation of the area surrounding the proposed reservoir after inundation.

Due to their value as harvestable timber, the loss of tree species (e.g. pines and hardwoods) within the pool area of the proposed reservoir may have a commercial impact. Because timber resources have not been quantified for the reservoir site, economic impacts on the timber industry (or other potential economic benefits) due to the proposed project have not been calculated.

b. Downstream Effects

Potential indirect downstream effects of the proposed project on terrestrial vegetation include long-term impacts to bottomland and wetland communities dependent on the existing flow of Mud Creek and its tributaries. The extent of these effects is dependent on the amount of flow controlled by the proposed dam, and the magnitude and frequency of releases from the dam. However, any significant modification to the existing hydrologic regime may have some effects in the habitat occurring downstream.

The establishment and operation of the proposed reservoir may moderate seasonal flooding in downstream areas. Reduction in flood frequency during periods of natural flooding may have some adverse effect on bottomland forest and hydric habitats dependent on periodic flooding. These adverse downstream effects may include potential bed and bank scour due to channelization by sporadic releases. Concurrently, bottomland vegetation bordering the channel may change to a more xeric species assembly due to this reduction in the frequency of overbank flooding. Since Lake Eastex is not a flood control reservoir, large flood flows will pass through the reservoir and spillway with only minor attenuation of the peak flow, depending on the level of the reservoir. Smaller events will likely be impacted to a greater degree.

c. Effects on Important Plant Species

Because there are no known occurrences of federally listed threatened or endangered species in the proposed pool area of the project, the impacts to these species would probably be insignificant.

Commercially important plant species will be lost within the reservoir site due to inundation. Harvestable timber, forage crops, and plant species associated with wildlife habitat would constitute the more significant losses. The losses of harvestable timber and forage crops may be consequential locally, although these species are fairly prevalent on a regional basis. Again, as mentioned in previous sections, the most significant ecological impact in the proposed reservoir pool area will be the loss of habitats important to wildlife (i.e. bottomland hardwood forests and wetlands).

d. Effects on Unique or Sensitive Communities

As mentioned above, bottomland hardwood forest and wetlands will be impacted in the proposed pool area as will the habitats that occur downstream of the project site. Because of their value as wildlife habitat and the occurrence of COE listed wetlands indicator species, these vegetation communities are considered ecologically sensitive. Essentially all of these areas occur in what would be the deepest portion of the proposed reservoir. Only limited areas where extant bottomland forest and the proposed reservoir shoreline coincide would the impact be less extensive. Bottomland hardwood forests and hydric habitat downstream of the proposed reservoir would be impacted due to a change in the normal hydrologic regime on which these areas depend.

Downstream of the proposed reservoir site an overcup oak vegetational series occurs that is listed as sensitive (G4S4) by the TNHP and is listed as a Priority 1 bottomland habitat area by USFWS (See Section II.E.1.d). This vegetational series is considered marginally rare globally as well as state-wide.

2. Terrestrial Wildlife

Wildlife and wildlife habitat in and around the proposed area of inundation will be altered if Lake Eastex is constructed and filled. Slightly more than 10,000 acres of grassland, savannah, wetlands, and forest will be covered by water. Additionally, downstream flow regimes will be permanently altered. These physical, biological and chemical alterations to terrestrial and aquatic systems affect wildlife in many ways.

Within the area of inundation, all terrestrial wildlife habitat will be lost. This includes losses of habitat varying from low quality (i.e., pasture) to high quality (i.e., bottomland hardwoods). Varying estimates of the different cover types present within the proposed pool are discussed in Section II.E.1.c. Note, as discussed previously, neither of these estimates is based on a current remote sensing source, and it can be expected that more recent aerial photography will provide a more accurate estimate of habitat types. However, these acreages do represent two studies conducted in the area of the proposed pool and provide ballpark estimates of the areal extent of each habitat type.

Sessile and slow-moving species of wildlife will likely be lost. Those capable of relocation will move into adjacent lands which may be occupied, or at carrying capacity. Aquatic (lacustrine and littoral) areas will expand and provide habitat for fish and wildlife species which utilize those types. However, streamside (riparian) habitat and attendant riverine and palustrine wetland habitats will be lost from within the proposed zone of inundation. The flow regime between the proposed Lake Eastex dam and the upper reaches of Sam Rayburn Reservoir may be altered. However, actual quantification impacts and areal extents have not been determined.

3. Aquatic Communities

a. Effect on Reservoir Development

The development of Lake Eastex would cause some change in the fishery and benthic populations. The fish population would change from an instream fishery to a reservoir type fishery.

Following the typical reservoir production cycle, Lake Eastex would begin as a highly productive reservoir and slowly drop off in productivity in the following years. In the productive years, Lake Eastex would provide an enhanced habitat for fish that prefer large bodies of water. The following fish are plentiful in a productive reservoir system: largemouth bass, channel catfish, yellow bullhead catfish, sunfish, buffalo, shad, gar, carp, bass, flathead catfish and to a lesser degree, paddle fish.

Many other species may be eliminated or limited throughout the reservoir. These would include species dependent upon stream habitat, including many of the darters, shiners, and some of the freshwater shrimp. The development of the reservoir would cause an increase in gamefish due to the stocking and high productivity that result from a newly formed reservoir.

In short, the overall aquatic habitat would be expected to experience a noteable increase related to the total increase in inundated area with a shift in habitat type from riverine/stream habitat to a lake/open water habitat. A corresponding shift in a aquatic populations (plankton, fish & invertebrates) could also be expected with the shift in habitat types.

b. Instream-Flow Issues

The development of the proposed Lake Eastex will likely result in some alteration of the existing flow regime downstream of the proposed reservoir. The flow regime will have a direct impact on the yield and habitat downstream (both terrestrial and aquatic) of the proposed reservoir. In addition, the instream flow regime may impact recreational opportunities, hydroelectric generation and the yield of downstream reservoirs if not properly determined. The multi-disciplinary nature of determining instream flow (coupled with a complex regulatory environment) make selection of the appropriate methodology critical to the development of a feasible instream flow regime. Several methods are currently used by the various regulatory agencies in determining instream flow regimes. These methods include the USFWS's Instream Flow Incremental Methodology (IFIM), the USFWS's Habitat Evaluation Procedure (HEP), analysis of median flows (on a seasonal basis) and the 7Q2 (seven-day, two-year low flow). Each of these methods evaluate separate criteria and provide some basis to project the required flow regime. A brief discussion of each of the methods is provided below. The IFIM is discussed in the most detail as it is the most complex of any of the models. The complexity associated with IFIM often limits its applicability in unique situations. Nevertheless, tasks associated with IFIM do provide a representation of the potential issues associated with determining instream flow needs.

The IFIM is the most commonly used official method in determining instream flow requirements. IFIM is based on the impacts of the changes in flow regime on fish and invertebrate habitat. IFIM is designed to incorporate both macrohabitat (temperature, water quality) and microhabitat (velocity, depth, substrate and cover) concepts. This complex multi-disciplinary approach can be broken down into 6 basic steps. The basic steps (as illustrated by Amour et al, 1986) include:

1. <u>Scoping</u>, which includes
   a. Definition of Study Objectives
   b. Delineation of the Study Boundaries
   c. Determination of Macrohabitat Variables
   d. Designation of the Evaluation Species
   e. Definition of Life Requirements of Evaluation Species

2. <u>Study Research Delineation and Site Selection</u>, which includes
   a. Identifying points of major inflows and diversions
   b. Delineation of major changes and transition zones of relief, water quality and distribution of the evaluation species
   c. Delineation of Critical reaches to be sampled
   d. Delineation of selected reaches that represent larger segments

3. <u>Data Collection</u> - The purpose of this effort is to characterize the hydraulic and instream microhabitat conditions through transect sampling

4. <u>Computer Simulation</u> - One component of IFIM is the Physical Habitat Simulation Model (PHABSIM), a computer simulation model which is used to generate data that describes the selected resources as a series of small cells

5. <u>Preparation of and Interpretation of Results</u> - The purpose of this effort is to optimize the combinations of flow conditions that yields the best overall mix of results.

6. <u>Recommendation of a Flow Regime</u> - The flow regime recommendations represent the culmination of the IFIM study. The flow regime is based upon the results of the IFIM and the interpretation and subsequent recommendations by biologists, water resource managers, and other parties that may be impacted by alterations in the existing flow regime.

The Habitat Evaluation Procedure (HEP) is a computerized method used in habitat inventory, planning, management, impact assessment and mitigation studies. HEP is a useful tool in evaluating the impacts of a proposed instream flow release. However, HEP is not recommended as a tool for designing flow regimes and negotiating flow releases nor is it recommended as a method of defining instream flow needs to maintain the existing fishery resources (Amour et al, 1986).

Other methods of determining instream flow needs include analysis of median flows (on a seasonal basis) and the 7Q2 (seven-day, two-year low flow). Some typical guidelines used to provide a ballpark estimate of instream flow requirements include maintaining 40 percent of the median winter flow and 60 percent of the median summer flow.

Obviously, more than one method exists to evaluate the instream flow requirements downstream of the proposed Lake Eastex. IFIM was discussed in the most detail due to the complexity of the approach. However, IFIM very well may not be the appropriate approach. The scoping process (with official agency participation) associated with the development of an Environmental Impact Statement (EIS) (for more detail, see Section V) is the first step in determining the proper methods and criteria to use in determining the flow regime necessary to satisfy yield requirements as well as instream use needs.

c. Bay and Estuary Inflow

Changes in the hydrologic regime through the construction of a dam have the potential to alter existing conditions in the receiving bays and estuaries (Sabine Lake). Alteration of freshwater inflows, and impediment of sediment and nutrient transport are some of the impacts that may occur subsequent to the construction of a proposed reservoir. These impacts are buffered somewhat by a variety of factors including: 1) distance from the proposed reservoir to the estuary; 2) number of regulated structures (i.e., dams and reservoirs) between the proposed reservoir and the estuary; 3) volume of existing freshwater inflows. Given the distance of the proposed Lake Eastex from Sabine Lake (over 150 miles), the existence of Sam Rayburn Reservoir downstream, and the expected minimal decrease in total annual flow to Sabine Lake, impacts at this time, are expected to be minimal.

F. POTENTIAL IMPACTS ON HISTORIC AND ARCHAEOLOGICAL RESOURCES

A review of the permitting and research issues and a summary of potential site occurrence and significance is presented in Sections II.F.4, II.F.5 and II.F.6.

G. POTENTIAL IMPACTS ON SOCIOECONOMIC CONDITIONS

1. Population

The population projections for the five county study area and for Cherokee County are based on an adequate water supply. The results of the discussion in section III.A. show a potential year 2040 deficit of 110,102 acre-feet/year and an inability for the five county area to meet demands between years 1990 and 2000. It is likely that the population projections given through the year 2040 are not realistically achievable unless an additional surface water supply, such as Lake Eastex, is developed. If sufficient supplies are developed to attract water intensive industries, it is possible that the growth rates presented in Section II.G.1 could be exceeded.

2. Employment

The employment by industry percentages for the five county area discussed in Section II.G.2 would not necessarily be affected by the development of Lake Eastex. However, the presence of a reliable water supply would better allow the area to attract water intensive and other manufacturers. The percentages shown for local Cherokee County could be significantly affected. Short term benefits to the local economy are great. Due to the influx of the work force associated with construction of the dam and reservoir, housing, food, supplies, and service industries will receive a noticeable boost. It is estimated that over 600 jobs will be created for local construction workers. It is also estimated that about 200 people will be temporarily relocated to the area and will need housing, food, entertainment, and other services supplied by the local economy. The development of Lake Eastex will stimulate a long term benefit, to some degree, to the recreation related trade and service industries in the lake vicinity. Without the additional water supply that Lake Eastex could provide, the growth previously expected for the area could begin to be inhibited within the next five to ten years.

3. Ad Valorem Taxes

It is anticipated that the initial loss of taxable property due to ANRA's purchase of land to be inundated by Lake Eastex will result in a small decrease in the short term (one to three years) ad valorem tax income for Cherokee and Smith counties of about 1 to 1.5% and 0.1%, respectively. However, it is further anticipated that the land in the lake vicinity will increase significantly in value due to the lake associated amenities. Therefore, the ad valorem tax income for Cherokee and Smith counties, after one to three years, will show a net increase as a result of the construction of Lake Eastex.

4. Sales Taxes

During the construction of the Lake Eastex Dam and the construction involved in resolving reservoir conflicts, a significant boost in construction related trade and service industry income is expected. This activity would provide a significant short term (two to three years) boost in the sales tax income for area municipalities. Smaller increases in sales tax income is expected for the long term due to the new recreation related trade and service locations which would be created as a result of the development of the lake.

5. Summary

The previous discussion of the potential impacts of Lake Eastex on population, employment, and the tax base lead to the following general conclusions:

a) Due to the current and future limitations on the area water supply, economic growth projected for the area would be inhibited within five to ten years, unless a water supply like Lake Eastex is developed,

b) Lake Eastex will allow the economic growth which has been projected for the area to occur.

c) Lake Eastex is expected to provide a short term boost to the local economy due to construction industry employment opportunities and housing, food and service needs for temporary relocated workers.

d) The presence of Lake Eastex would allow the area to be in a better position to attract manufacturers (esp. those which are water intensive), which provides the potential for a large economic boost to the local and regional area.

e) The only adverse socioeconomic impact identified is the very small short term decrease in ad valorem tax income for Cherokee and Smith counties.

H. POTENTIAL IMPACTS ON LAND USE

Future land uses are discussed in a similar fashion as the existing land use section previously described in Section II.H. Projections do not indicate any radical shifts or reallocations of land uses which would require a more intricate framework for analysis. Future land uses were extrapolated and projected based on data developed by the Texas Water Development Board, Texas A & M University, the East Texas Private Industry Council and both the East Texas and Deep East Texas Councils of Government.

1. Regional Land Use

The future pattern and distribution of land uses at the regional level is expected to reflect a continuation of past trends. Changes will be incremental, with the larger urban areas maintaining a steady growth (Exhibit III.1). This will occur particularly along transportation corridors and in areas naturally suited for urban expansion (i.e. areas without severe slopes, without high flooding potential, and which can be provided with normal urban services at reasonable cost). Somewhat higher densities of development are expected in keeping with the national trend to realistically assess and assign the true costs of growth, an aging population, the availability of "infill" properties, and the constraints imposed upon expansion by government environmental agencies.

Smaller urban areas will remain moderately static or even decline as agricultural holdings continue to consolidate and increase in average size, and as acreage "ranchette" development continues. Thus land uses as physically represented on a map will not look significantly different from the existing patterns except that the larger urban centers will be somewhat larger than they are today.

Rural lands devoted to forested and agricultural uses will remain relatively stable except for the continuing slow encroachment by urban centers and the seemingly paradoxical increase in size of larger land holdings combined with the continuing development of smaller "ranchette" conversions of land. The proportion of forested acreage as compared to agricultural acreage is expected to remain relatively constant.

Lake/reservoir areas (including the proposed project) will remain desirable recreational and homesite attractions particularly near the expanding urban areas and where good all-weather road and highway access is provided.

Transportation facilities are projected to reflect the demands imposed by the moderate urban growth with incremental increases in capacity occurring. No curtailment of highway transportation is expected for this region.

2. Lake-Specific Land Use

Without construction of the proposed Lake Eastex, the portions of Cherokee and Smith counties will look essentially the same in the year 2040 as they do today. The only two exceptions to this will be that 1) the urbanized portions of Jacksonville, Troup and Whitehouse will be expanded moderately, and 2) there will be some additional "ranchette" development along improved roads with good access to the urban centers. This will be in keeping with regional trends of urban center growth and relatively static conditions in the rural areas.

With construction of Lake Eastex, however, the configuration of land uses within the two-county area would be different. Exhibit III.1 shows the general types of land use patterns which can be expected in the primary impact area in the year 2040. The most noticeable difference from the almost static "no-build" scenario is the presence of development nodes at or near the interface points of major highways and the lakeside. These are representative of the stronger potential for this part of the region to share in the population and economic stability and growth.

Recreation/marina/commercial nodes will be developed at points of interface between major roads and the lakeside. These will occur mainly at deeper water locations in Cherokee County. This is because at the upper, more shallow end of the lake in Smith County the distances between the PMF line and the normal water surfaces are large, in some cases over a quarter of a mile.

Residential development in the primary impact area will be markedly different with the reservoir than without it. "Ranchette" development will continue throughout the primary impact area but the average parcel size may be smaller due to property value increases. A new form of residential property development will occur, however, as the result of the lake. It will take the form of larger tracts of land developed into rural or recreational subdivisions. These will first occur adjacent to the shoreline where existing or relocated road access is good and utilities are available or easily provided. Most of these clustered developments will initially occur near the

GRAPHIC SCALE

5 0 5 10 15

Statute Miles

LEGEND	
Urban or Built-up Land	
Cropland, Dry	
Cropland, Irrigated	NONE
Forest Land	
Water	
Wetlands	NONE
Rangeland	
Barren Lands	NONE

EXHIBIT III.1

PROJECTED LAND USE/LAND COVER

CALENDAR YEAR 2040

FIVE COUNTY STUDY AREA

ANGELINA AND NECHES
RIVER AUTHORITY

LAKE EASTEX REGIONAL
PLANNING STUDY

LAN

Lockwood, Andrews
& Newnam, Inc.

deeper water in the Cherokee County end of the reservoir near Jacksonville. Some marina and related commercial activities are likely within the larger developments as adjunctive uses.

Large-scale development will occur more slowly at the upper end of the lake where the distance between the PMF line and the normal water surface will be greater. Other land not immediately accessible from the existing road system will also develop more slowly, pending provision of future access and services.

3. Land Ownership

The proposed Lake Eastex project will affect approximately 249 landowners and 416 parcels of land within Cherokee and Smith Counties. Table III.3 presents some of the key statistics concerning land ownership in the Lake Eastex site vicinity. The information presented in this table is based on information obtained from the Cherokee and Smith County Appraisal Districts dated March 1989 and June 1989, respectively. A complete listing of landowners is presented in Appendix G.

Parcels which have been indicated as affected by a full fee purchase have at least some portion below elevation 318.0 feet. Parcels which have been indicated as affected by an easement purchase have at least some portion below the 500-year flood elevation of 322.6 feet.

TABLE III.3
LAND OWNERSHIP STATISTICS
LAKE EASTEX SITE

	Cherokee County	Smith County	Both Counties
Parcels affected by full fee only	94	7	101
Parcels affected by easement only	46	48	94
Parcels affected by both full fee and easement	181	40	221
Parcels affected total	321	95	416
Landowners	184	65	249
Smallest parcel affected (acres)	1.0	0.8	0.8
Largest parcel affected (acres)	749.3	238.0	749.3
Average parcel affected (acres)	76.3	33.0	66.4
Parcels 100% affected	81	26	107
Parcels partially affected	240	69	309

4. Dislocations

The construction of Lake Eastex will impact over 15,000 acres of land in East Texas, excluding possible mitigation land. Much of the land which is to be purchased will be submerged by the normal pool level of the lake. Additionally, flood events in the area will cause increases in the pool elevation periodically as the storm runoff passes through the reservoir and dam and proceeds downstream. In recognition of this fact, it is recommended that the following guidelines be adopted concerning the purchase of property:

a) The area of the reservoir site at or below elevation 318.0 (normal pool elevation plus 3 ft.) should be purchased in fee.

b) The area within the reservoir site above elevation 318.0 but at, or below, the level of the 500 year flood (322.6 ft) should be obtained and utilized as a flowage easement.

In order to minimize the flooding potential to important structures, no construction of structures which would be damaged by flood water should be allowed below the 500 year flood level. All structures currently below the 500 year flood level should be relocated or abandoned.

Field investigations were conducted in March and April 1989 to determine the potential impacts on families and businesses located within the reservoir site. The objective of the field work was to quantify the number of affected structures at various levels surrounding the Lake Eastex normal pool. The results of the field work are presented in Table II.4.

TABLE III.4

STRUCTURES POTENTIALLY AFFECTED BY THE CONSTRUCTION OF LAKE EASTEX

Structure	Location			
	Below Normal Pool	Normal Pool to 500 yr	500 yr to PMF	PMF to 2000' Beyond
House or Trailer	9	13	11	129
Barn or Outbuilding	4	10	5	18
Commercial				4
Abandoned House	1			4
Total	14	23	16	156

The house or trailer category includes those dwellings where habitation presently occurs including a driveway or physical disturbance to the surrounding vegetation that was evident in the data. The number of outbuildings associated with these areas ranged from 0 to 5 with an average of 1.8 buildings per site.

The barn category includes those areas where disturbance due to equipment or livestock was evident without the influence of existing housing structures. However, barns or other outbuildings were associated with existing housing structures in 83% of the housing structures delimited.

The commercial areas include manufacturing and service related enterprises including one agrarian related enterprise.

According to the relocation policy previously described, 22 homesteads would be displaced as a result of the construction of Lake Eastex. No commercial buildings would be displaced.

Displaced property owners can be absorbed in currently available housing or new housing can be built in the general area to accommodate those who will be displaced.

I. POTENTIAL IMPACTS ON RECREATION

The proposed Lake Eastex will inundate approximately 10,089 acres and more than 16 linear miles along Mud Creek. The loss of this area will result in a proportional decrease in recreational opportunities such as hunting, stream fishing, hiking, and bird watching to the degree these opportunities are currently available. However, the development of the lake will provide additional recreational opportunities associated with freshwater lakes including fishing, boating, sailing, water skiing, picnicking and camping. Development of recreational facilities (such as boat launches, fishing piers, and picnicking and camping areas) would likely result in annual visitation resembling similar sized reservoirs throughout the state. Annual visitation for similar sized reservoirs operated by the COE are presented below.

Reservoir	Surface Acres	1980 Visitation
B.A. Steinhagen	13,700	585,100
Belton	12,300	2,490,100
Somerville	11,460	2,529,400
Canyon	8,240	1,354,700
Grapevine	7,380	5,419,600

As the wide disparity in these figures indicate, annual visitation is obviously dependent upon many variables other than lake size (such as distance to population centers, distance to competing reservoirs, and availability of recreational facilities). The figures do however, indicate that at a minimum the visitation can be expected to be in the hundreds of thousands. An actual annual visitation projection is beyond the scope of this study, but it is safe to assume that if recreational facilities are provided, recreational visitation will increase in some corresponding proportion.

In short, the development of the proposed Lake Eastex will result in the possible loss of some stream type recreation opportunities, but will also enhance the overall recreational opportunities in East Texas.

J. POTENTIAL IMPACTS ON TRANSPORTATION

Construction of the proposed reservoir will cause some immediate changes in the present infrastructure within the primary impact area. Except for bridge replacement, the most obvious of these changes will be relocation, abandonment, or construction of new roads due to the reservoir impoundment. Generally, roads which are other than numbered U.S. or State highways will not be bridged over the inundated portions. A few non-critical local roads will be abandoned, but most will be relocated around the 500-year flood level of the reservoir and will provide access to lakefront land. A more detailed discussion of the resolution of transportation conflicts is presented in Volume 1, Section IV.B.

K. POTENTIAL NOISE IMPACTS

Short term noise impacts can be expected as a result of construction of the Lake Eastex dam. Related construction projects intended to resolve lake vicinity conflicts and to provide water treatment and transmission facilities will also have short term impacts. In most cases, the types of construction methods and equipment required for the dam and related projects are similar to projects which have been constructed in the area previously and will continue as development occurs in the future. Additionally, impacts resulting from new noise generators will be minimized due to the pressure level attenuation caused by distance, terrain, and the surrounding wooded areas. Although construction of the dam will require more time than the related projects, it is located in a relatively unpopulated area. Virtually all residences remaining after the land acquisition process will be in excess of 0.5 miles from the dam site. Therefore, dam construction noise would have negligible impact on area business or residences.

Lake Eastex will have no direct, long term noise impacts directly. However, development and increased traffic levels which are anticipated to occur around the lake perimeter as a result of the construction of Lake Eastex will increase noise levels somewhat. These increases are expected to be consistent with those allowable for the changes in land use that are also expected to occur.

IV. MITIGATION

IV. MITIGATION

A. VEGETATION/WILDLIFE

The proposed Eastex reservoir will result in the loss of 10,089 acres of vegetation and wildlife habitat within the normal operating pool and in the periodic inundation of additional acreage within the flood pool. Acreages by vegetation community/habitat types and possible corresponding mitigation requirements have been identified in two separate studies on the proposed Lake Eastex. As discussed in Sections II.E.1.c and II.E.2.e, the results of these studies varied considerably and represent a wide range of the existing habitat types and corresponding mitigation requirements for the proposed Lake Eastex. The results of these two studies are summarized in Tables IV.1 and IV.2.

TABLE IV.1

HABITAT EVALUATION PROCEDURE RESULTS FOR THE PROPOSED LAKE EASTEX

Cover Type	Lost Acreage	Management Option (%)	Compensation Acreage
Improved Pasture	2,918	Minimum 25 Moderate 50 Maximum 100	1,146 713 361
Pine/Oak Forest	3,682	Minimum 25 Moderate 50 Maximum 100	2,981 1,490 755
Oak/Pine Bottomlands	2,832	Minimum 25 Moderate 50 Maximum 100	6,903 3,563 1,811
Oak Bottomlands	87	Minimum 25 Moderate 50 Maximum 100	751 370 194
Other Built-up	543		
		Minimum 25 Moderate 50 Maximum 100	11,781 6,136 3,121

Source: Frasier 1990

TABLE IV.2

WILDLIFE HABITAT APPRAISAL PROCEDURE RESULTS FOR THE PROPOSED LAKE EASTEX

Cover Type/ Resource Category	Lost Acres	Management Option	Compensation Requirements (Acres)
Grasses/Resource Category - 3	2,706	Minimum 25% Moderate 50% Maximum 100%	5,094 2,546 1,274
Pine-Hardwood Forest/ Resource Category - 3	2,999	Minimum 25% Moderate 50% Maximum 100%	19,568 9,784 4,892
Mixed Bottomland Hardwood Forest/ Resource Category 2	3,517	Minimum 25% Moderate 50% Maximum 100%	32,827 16,413 8,207
Other	867		
Total	10,089	Minimum 25% Moderate 50% Maximum 100%	57,489 28,744 14,373

Source: Frye and Curtis 1990.

As discussed in Section II, a more detailed inventory using recent aerial photography and full cooperation of appropriate federal and state agencies may be necessary to provide the final determination of possible mitigation requirements.

B. INSTREAM FLOW

The instream flow regime has a direct impact on the yield of the proposed reservoir and on downstream aquatic habitat. A determination of the flow regime (volumes and schedule of releases) through accepted methods is necessary prior to development of the proposed reservoir. A few of the methods used to determine the appropriate flow regime are discussed in Section III.E.3. The actual method to be utilized in the determination of the instream flow regime is best determined during the official scoping process associated with the development of an EIS.

C. CLEARING PLAN

A mitigation plan typically requires a clearing plan that identifies the proposed vegetational clearing that will occur. The clearing plan typically is designed to maximize aquatic habitat, while satisfying the water supply, navigational and recreational requirements of the proposed facility. Often, the clearing plan also includes identification of areas where stockpiling of vegetation will occur and the methods used to clear vegetation. Again, the actual clearing plan will be developed as necessary during the permitting process.

D. HISTORIC/ARCHAEOLOGICAL RESOURCES

The potential for sites and significance of sites within the pool area of the proposed Lake Eastex is discussed in Section II.F. In order to ensure both the applicant (ANRA) and the federal agencies have a full understanding it is suggested that ANRA and the appropriate agencies (COE and the Texas Historical Commission) develop a Memorandum of Agreement (MOA) prior to initiating any field investigations. The MOA should detail the requirements for the archaeological survey, and when necessary identify a treatment plan for the protection and/or mitigation of significant resources which may be eligible for the National Register of Historic Places.

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VI. APPENDICES

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APPENDIX	TITLE
A	Herpetofaunal Species of Known or Probable Occurrence Within The Five County Study Area
B	Avifaunal Species of Known or Probable Occurrence Within The Mud Creek Drainage Basin
C	Mammals of Known or Probable Occurrence In The Five County Study Area
D	Fish Species of Known or Probable Occurrence Within The Five County Study Area
E	Historical Landmarks Within the Five County Study Area
F	Archaeological Investigations in Cherokee and Smith Counties, Texas
G	Landowners Affected by the Development of Lake Eastex

APPENDIX A

HERPETOFAUNAL SPECIES OF KNOWN OR PROBABLE OCCURRENCE WITHIN THE FIVE COUNTY STUDY AREA

APPENDIX A

HERPETOFAUNAL SPECIES OF KNOWN OR PROBABLE OCCURRENCE WITHIN THE FIVE COUNTY STUDY AREA

Taxon	Habitat
American alligator (Alligator mississippiensis)	Ponds, swamps and rivers near water
Common snapping turtle (Chelydra s. serpentina)	Any aquatic situation preferably with mud and vegetation
Alligator snapping turtle (Macroclemys temminckii)	Deep water of rivers, oxbows, sloughs, swamps and sluggish streams
Stinkpot (Sternotherus odoratus)	Any permanent water
Razorback musk turtle (Sternotherus carinatus)	Streams and river swamps
Mississippi mud turtle (Kinosternon subrubrum hippocrepis)	Bayous, lagoons and river swamps
Yellow mud turtle (Kinosternon f. flavescens)	Mud bottoms of pools, ponds marshes, canals and cattle tanks
Three-toed box turtle (Terrapene carolina triunguis)	Open woodlands, thickets, and woodland edges
Ornate box turtle (Terrapene o. ornata)	Sandy areas of plains and prairies
Mississippi map turtle (Graptemys kohnii)	Slow moving rivers and lakes with dense vegetation
Sabine map turtle (Graptemys pseudogeographhica	Sabine and adjacent drainages in rivers, lakes and sloughs with sabinensis) aquatic vegetation
Red-eared slider (Pseudemys scripta elegans)	Prefers muddy bottomed, quiet water with dense vegetation

Taxon	Habitat
Texas river cooter (Pseudomys concinna texana)	Rivers, ditches and cattle tanks
Western chicken turtle (Deirochelys reticularia miaria)	Lentic waters of ponds, marshes and sloughs
Midland smooth softshell (Trionyx m. muticus)	Lakes, ponds and rivers
Pallid spiny softshell (Trionyx spiniferus pallidus)	Small streams, rivers, ponds and lakes
Mediterranean gecko (Hemidactylus turcicus)	Near human habitation where insects congregate
Green anole (Anolis carolinensis)	From wooded areas, cypress swamps and in shrubbery near human dwellings
Texas spiny lizard (Scleoporus olivaceus)	Usually arboreal from mesquite to live oak and cottonwood, fence posts, bridges or houses
Northern fence lizard (Scleoporus undulatus hyacinthinus)	Open pine woods, rail fences, rotting logs and stumps
Texas horned lizard (Phrynosoma cornutum)	Dry, flat land with sparse vegetation
Texas spotted whiptail (Cnemidophorus g. gularis)	Prairie grasslands, river floodplains, washes to rocky hillsides
Six-lined racerunner (Cnemidophorus s. sexlineatus)	Field, woods, thicket margins, rocky outcrops, or river bottoms
Ground skink (Scincella lateralis)	Dry pine or deciduous woods, clearings to moist streambanks
Five-lined skink (Eumeces fasciatus)	Dry to damp woods, brushy areas, rotten logs and stumps
Broadhead skink (Eumeces laticeps)	From swamp forests to empty urban lots strewn with debris

Taxon	Habitat
Southern coal skink (Eumeces anthracinus pluvialis)	From swamps to wooded hillsides under leaves, logs or brush
Southern prairie skink (Eumeces septentrionalis obtusirostris)	Sandy or gravelly areas of grassy hillsides to oak woodlands
Western slencder glass lizard (Ophisaurus a. attenuatus)	Oak and pine woodlands, fields, grassy areas and brush piles
Diamondback water snake (Nerodia r. rhombifera)	Near water of ponds, swamps and lakes and cattle tanks
Yellowbelly water snake (Nerodia erythrogaster flavigaster)	Near water of ponds, swamps and lakes
Broad-banded water snake (Nerodia fasciata confluens)	Permanent aquatic ponds, marshes and lakes
Gulf crayfish snake (Regina rigida sinicola)	Often in mud near edges of lakes, ponds, streams, swamps and marshes
Graham's crayfish sname (Regina grahamii)	Edges of creeks, sloughs, ponds, ditches under logs
Texas brown snake (Storeria dekayi texana)	Urban areas, swamps, hillsides and woods in both moist and dry areas
Florida redbelly snake (Storeria occipitomaculata obscura)	Open woods, bogs from sea level to mountains
Eastern garter snake (Thamnophis s. sirtalis)	Fields, marshes, meadows, gardens and roadsides and roadsides often near water
Western ribbon snake (Thamnophis p. proximus)	Near most permanent water of lakes, streams, swamps and rivers
Central lined snake (Tropidoclonion lineatum annectens)	Near water, old fields, rocky places and urban vacant lots
Western earth snake (Virginia valeriae elegans)	Dry or moist woodlands, fields, pastures and vacant lots

Taxon	Habitat
Rough earth snake (Virginia striatula)	Wooded bottomlands, rocks, hillsides and rubbish piles
Eastern hognose snake (Heterodon platyrhinos)	Open woods, uplands, hillsides, fields and dry, sandy areas
Dusty hognose snake (Heterdon nasicus gloydi)	Dry, sandy areas; prairies
Mississippi ringneck snake (Diadophis punctatus stictogenys)	Woodlands, near water, rock-covered hillsides and field edges
Western mud snake (Farancia abacura reinwardtii)	Marshes, swamps and ditches
Eastern yellowbelly racer (Coluber constrictor flaviventris)	Swamps, cultivated fields, grasslands brushy areas and open woods
Jan racer (Coluber contrcitor etheridgei)	Old field and longleaf pine forest edges
Eastern coachwhip (Masticophis f. flagellum)	Pine flatwoods, pastures, fields, roadsides and warm, dry uplands
Eastern Rough green snake (Opheodrys a. aestivus)	Streamside and roadside small trees and bushes
Corn snake (Elaphe g. guttata)	Woods, wood edges, cornfields, roadsides, prairies and urban areas
Texas rat snake (Elaphe obsoleta lindheimeri)	Dry or moist woods to rocky canyons
Texas plains glossy snake (Arizona elegans arenicola)	Sandy soil in woods, fields and plains
Louisiana pine snake (Pituophis melanoleucas ruthveni)	Dry sandy pine woods
Speckled kingsnake (Lampropeltis getulus holbrooki)	Woods, hayfields, pastures, meadows, roadsides and near water

Taxon	Habitat
Louisiana milk snake (Lampropeltis triangulum amaura)	Fields, open woods, riverbottoms under logs or in stumps
Prairie kingsnake (Lampropeltis c. calligaster)	Grassland prairies, open woodlands, and patches of prairie savannas
Northern scarlet snake (Cemophora coccinea copei)	Soil suitable for burrowing or under logs
Texas night snake (Hypsiglena torquata jani)	Arid to semiarid habitats
Flathead snake (Tantilla gracilis)	Streambanks, grassy plains and rocky hillsides
Texas coral snake (Micrurus fulvius tenere)	Fields, cedar brakes, rocky canyons and river bottoms
Southern copperhead (Agkistrodon c. contortrix)	Hillsides, upland woods, swamps and cypress-bordered streams
Western cottonmouth (Agkistrodon piscivorus leucostoma)	Lakes, streams, sloughs, swamps, marshes and rivers
Timber rattlesnake (Crotalus horridus)	Cane thickets and swamplands
Western pigmy rattlesnake (Sistrurus miliarius streckeri)	Bottomlands, swamps, marshes and wet prairies
Gulf Coast waterdog (Necturus beyeri)	Primarily in sandy,spring-fed streams
Three-toed amphiuma (Amphiuma tridactylum)	Any unpolluted mucky place within its range
Western lesser siren (Siiren intermedia netting)	Variety of shallow water habitats
Mole salamander (Ambystoma talpoideum)	Burrowing form in lowlands or under logs in moist areas

Taxon	Habitat
Marbled salamander (Ambystoma opacum)	Moist sandy areas to dry hillsides
Smallmouth salamander (Ambystoma texanum)	Any area where moisture is abundant
Spotted salamander (Ambystoma maculatum)	Beneath stones in moist environments
Eastern tiger salamander (Ambystoma t. tigriunum)	Shallow lakes, ponds, ditches or pools of rivers
Central newt (Notophthalmus viridescens louisianensis)	Swales, swamplands and wooded ponds, in riverbottoms
Southern ducky salamander (Desmognathus auriculatus)	Below Fall line around springs, swamps or muddy streams
Dwarf salamander (Eurycea quadridigitata)	Under logs and debris in low, damp places
Hurter's spadefoot (Scaphiopus holbrooki hurteri)	Wooded and savanna areas; also arid terrain in south Texas
East Texas toad (Bufo woodhouse velatus)	In sandy areas around lakes or river valleys
Gulf Coast toad (Bufo v. valliceps	Roadside ditches to barrier beaches
Northern cricket frog (Acris c. crepitans)	Edges of small, shallow streams and ponds
Northern spring peeper (Hyla c. crucifer)	Marshes, swamps and pools on low bushes, bushes and grasses in wooded areas
Green treefrog (Hyla cinerea)	Any place well supplied with water and dampness
Squirrel treefrog (Hyla squirella)	Buildings, gardens, fields and open woods

Taxon	Habitat
Cope's gray treefrog (Hyla chrysoscelius)	Ubiquitous in permanent and temporary water; found on trees and bushes in woodland edges woodland edges
Gray treefrog (Hyla versicolor)	Ubiquitous in permanent and temporary water; found on trees and bushes in woodland edges
Upland chorus frog (Pseudacris triseriata feriarum)	Grassy swales, moist woodlands, riverbottom swamps, ponds, bogs and marshes
Strecker's chorus frog (Pseudacris s. streckeri)	Prairies, pastures, swampy areas and flatwoods
Eastern narrowmouth toad (Gastrophryne carolinensis)	Fields, woodlands and margins of any water body
Great Plains narrowmouth toad (Gastrophryne olivacea)	Dry uplands, open woods, woodland edges and riverbottoms
Bullfrog (Rana catesbeiana)	Marshes, ponds, lakes and rivers
Bronze frog (Rana c. clamitans)	Swamps, brooks, streams, ponds, and edges of lakes
Southern leopard frog (Rana sphenocephala)	Rivers, lakes, streams, marshes and ponds
Pickerel frog (Rana palustris)	Grassy meadows, streams and ponds in cool, clear water
Southern crawfish frog (Rana a. areolata)	Flood plains, lowland meadows, burros and storm sewers

APPENDIX B

AVIFAUNAL SPECIES OF KNOWN OR PROBABLE OCCURRENCE WITHIN THE MUD CREEK DRAINAGE BASIN

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Taxon	Status	Habitat
Red-throated loon (Gavia stellata)	Scarce winter migrant	Bays, estuaries, lakes, ponds and ocean
Common loon (Gavia immer)	Uncommon winter migrant	Lakes, ponds and rivers; oceans and bays in winter
Western grebe (Aechmophorus occidentalis)	Casual winter resident	Lakes, inlets and bays
Horned grebe (Podiceps auritus)	Scarce winter resident	Marshes, ponds and lakes
Eared grebe (Podiceps nigricollis)	Rare winter resident	Open bays and ocean
Pied-billed grebe (Podilymbus podiceps)	Uncommon resident	Lakes, ponds, sluggish streams
American white pelican (Pelecanus erythrorhynchos)	Rare migrant	Marshy lakes and coastal lagoons
Brown pelican (Pelecanus occidentalis)	Casual migrant	Sandy coastal beaches and lagoons
Double-crested cormorant (Phalacrocorax auritus)	Common winter	Lakes, rivers, swamps and coasts resident
Anhinga (Anhinga anhinga)	Uncommon resident	Freshwater ponds and swamps with thick vegetation
Great blue heron (Ardea herodias)	Common resident	Lakes, ponds, rivers and marshes
Green-backed heron (Butorides striatus)	Locally common summer resident	Lake margins, streams, ponds and marshes

Taxon	Status	Habitat
Little blue heron (Egretta caerulea)	Rare resident	Freshwater swamps, lagoons and thickets
Cattle egret (Bubulcus ibis)	Common resident	Dry land in open fields, breeds near water with other herons
Great egret (Casmerodius albus)	Locally common resident	Freshwater and salt marshes, marshy ponds and tidal flats
Snowy egret (Egretta thula)	Irregular	Salt marshes, ponds, rice fields and shallow coastal bays
Tricolored heron (Egretta tricolor)	Irregular migrant	Swamps, bayous, coastal ponds, salt marshes, mud flats and lagoons
Black-crowned night heron (Nycticorax nycticorax)	Irregularly, fairly common resident	Marshes, swamps and wooded streams
Yellow-crowned night heron (Nyctanassa violacea)	Uncommon summer resident	Wooded swamps and coastal thickets
Least bittern (Ixobrychus exilis)	Rare resident	Freshwater marshes where cattails and reeds predominate
American bittern (Botaurus lentiginosus)	Uncommon winter resident	Freshwater and brackish marshes and marshy lake shores
Wood stork (Mycteria americana)	Rare migrant	On or near coasts
Glossy ibis (Plegadis falcinellus)	Scarce migrant	Marshes, swamps, flooded fields, coastal bays and estuaries
White-faced ibis (Plegadis chihi)	Scarce summer	Salt marshes, brushy coastal islands, and freshwater marshes
White ibis (Eudocimus albus)	Scarce summer migrant	Marshy sloughs, mud flats, lagoons and swamp forests
Tundra swan (Cygnus columbianus)	Rare accidental	Marshy lakes and bays

Taxon	Status	Habitat
Canada goose (Branta canadensis)	Scarce winter migrant	Lakes, bays rivers and marshes; often feeding in stubble fields
Greater white-fronted goose (Anser albifrons)	Scarce winter migrant	Salt marshes, coastal bays, grain fields and freshwater marshes
Snow goose (Chen caerulescens)	Scarce winter migrant	Salt marshes, coastal bays, grain fields and freshwater marshes
Mallard (Anas platyrhynchos)	Common winter resident	Ponds, lakes and marshes
American black duck (Anas rubripes)	Rare winter resident	Marshes, lakes, streams, coastal mud flats and estuaries
Gadwall (Anas strepera)	Locally common winter resident	Freshwater marshes, ponds, rivers and locally in salt marshes
Pintail (Anas acuta)	Uncommon winter resident	Marshes, prairie ponds and salt marshes in winter
Green-winged teal (Anas crecca)	Locally common winter resident	Marshes, ponds and marshy lakes
Blue-winged teal (Anas discors)	Locally common winter migrant	Marshes, shallow ponds and lakes
Cinnamon teal (Anas cyanoptera)	Scarce migrant	Ponds, marshes, reservoirs and sluggish streams
American wigeon (Americana)	Uncommon winter resident	Marshes, ponds, and shallow lakes
Northern shoveler (Anas clypeata)	Uncommon winter resident	Marshes, prairie potholes, salt brackish marshes
Wood duck (Aix sponsa)	Fairly common resident	Wooded rivers, ponds, swamps, and freshwater marshes
Redhead (Aythya americana)	Uncommon winter resident	Lakes, bays and often salt water in winter

Taxon	Status	Habitat
Ring-necked duck (Aythya collaris)	Common winter resident	Wooded lakes, ponds and rivers
Canvasback (Aythya valisineria)	Uncommon winter resident	Lakes, bays and estuaries
Greater scaup (Aythya marila)	Scarce winter resident	Lakes, bays, ponds and often wintering on saltwater bays
Lesser scaup (Aythya affinis)	Common winter resident	Lakes, rivers, ponds, marshes and saltwater bays
Common goldeneye (Bucephala clangula)	Scarce winter resident	Mainly along the coast in bays and inlets
Bufflehead (Bucephala albeola)	Uncommon winter resident	Mainly on salt bays and estuaries
Oldsquaw (Clangula hyemalis)	Rare winter resident	Open bays and inshore waters
Surf scoter (Melanitta perspicillata)	Rare winter resident	Almost entirely on the ocean and in large coastal bays
Ruddy duck (Oxyura jamaicensis)	Uncommon winter resident	Freshwater marshes,lakes, ponds salt bays and rivers
Hooded merganser (Lophodytes cucullatus)	Common winter resident	Wooded ponds, lakes, rivers and tidal channels
Common merganser (Mergus merganser)	Rare winter resident	Wooded rivers, ponds,and wintering on saltwater bays
Red-breasted merganser (Mergus serrator)	Uncommon winter resident	Principally on the ocean and salt bays
Turkey vulture (Cathartes aura)	Common resident	Mainly deciduous forests, woodland and adjacent farmlands
Black vulture (Coragyps atratus)	Common resident	Open country; breeds in light woodlands and thickets

Taxon	Status	Habitat
Mississippi kite (Ictinia mississippiensis)	Scarce summer resident	Open woodland and mixed scrub near water
Sharp-shinned hawk (Accipiter striatus)	Fairly common summer resident	Dense coniferous forests and sometimes in deciduous forests
Cooper's hawk (Accipiter cooperii)	Uncommon summer resident	Deciduous and coniferous forests, especially those with clearings
Red-tailed hawk (Buteo jamaicensis)	Common resident	Deciduous forest and adjacent open country
Red-shouldered hawk (Buteo lineatus)	Locally fairly common resident	Deciduous woodlands especially with standing water
Rough-legged hawk (Buteo lagopus)	Scarce winter	Open plains, agricultural areas and marshes
Broad-winged hawk (Buteo platypterus)	Rare resident	Chiefly deciduous woodland
Swainson's hawk (Buteo swainsoni)	Sporadic migrant	Open plains, grasslands and prairie
Golden eagle (Aquila chrysaetos)	Rare accidental	Mainly deciduous mountain forests; most any habitat during migration
Bald eagle (Haliaeetus leucocephalus)	Rare winter resident	Lakes, rivers, marshes and seacoasts
Marsh hawk (Circus cyaneus)	Common winter resident	Marshes and open grasslands
Osprey (Pandion haliaetus)	Casual winter resident	Lakes, rivers and seacoasts
Peregrine falcon (Falco peregrinus)	Scarce migrant	Open country, especially along rivers, near lakes and the coast

Taxon	Status	Habitat
Merlin (Falco columbarius)	Rare winter migrant	Coniferous forests
American kestrel (Falco sparverius)	Uncommon resident	Towns, cities, parks, farm lands and open country
Northern bobwhite (Colinus virginianus)	Fairly common resident	Pastures, grassy roadsides and farm lands
Ringneck pheasant (Phasianus colchicus)	Rare, introduced resident	Farmlands, pastures and grassy woodland edges
Wild turkey (Meleagris gallopavo)	Rare resident	Open woodlands and forests with scattered natural clearings
King rail (Rallus elegans)	Locally rare resident	Freshwater marshes, borrow ditches and salt marshes
Virginia rail (Rallus limicola)	Rare migrant	Cattails and reeds or fresh and brackish marshes
Sora (Porzana carolina)	Uncommon migrant	Flooded fields, wood flats and freshwater marshes
Purple gallinule (Porphyrula martinica)	Uncommon resident	Freshwater marches with lily pads, pickerel weed and other aquatics
Common gallinule (Gallinula chloropus)	Scarce resident	Freshwater marshes and ponds cattails and other aquatic plants
American coot (Fulica americana)	Common winter resident	Open ponds, marshes, saltwater bays and inlets
Killdeer (Charadrius vociferus)	Common resident	Open country; plowed fields, golf courses and short grass prairies
Piping plover (Charadius melodus)	Rare migrant	Mud flats, flooded fields,lake-shores and ponds

Taxon	Status	Habitat
Lesser golden plover (Pluvialis dominica)	Scarce spring migrant	Coastal beaches, mud flats, inlands, prairies and plowed fields
Black-bellied plover (Pluvialis squatarola)	Scarce migrant	Mud flats, lakeshores, ponds and flooded fields
American woodcock (Scolopax minor)	Scarce resident	Moist woodland and thickets near open fields
Common snipe (Gallinago gallinago)	Common winter resident	Freshwater marshes, ponds, flooded meadows and fields
Whimbrel (Numenius phaeopus)	Casual winter migrant	Flooded fields and mud flats
Upland sandpiper (Bartramia longicauda)	Rare migrant	Mudflats and lakeshores in migration
Spotted sandpiper (Actitis macularia)	Common migrant	Open country and wooded areas with water nearby
Solitary sandpiper (Tringa solitaria)	Casual migrant	Inland ponds, bogs, wet swampy places and woodland streams
Willet (Catoptrophorus semipalmatus)	Uncommon migrant	Coastal beaches, freshwater and salt marshes, lakeshores and wet prairies
Greater yellowlegs (Tringa melanoleuca)	Uncommon migrant	Pools, lakeshores and tidal and flats
Lesser yellowlegs (Tringa flavipes)	Uncommon migrant	Marshy ponds, lake and river shore
Purple sandpiper (Calidris maritima)	Rare migrant	Rocky coasts and promontories
Pectoral sandpiper (Calidris melanotos)	Common migrant	Wet, short-grass areas, grassy pools, salt creeks and meadows

Taxon	Status	Habitat
White-rumped sandpiper (Calidris fuscicollis)	Locally common migrant	Flats, grassy pools, wet meadows and shores in winter
Baird's sandpiper (Calidris bairdii)	Rare migrant	Inland areas with grassy pools, wet meadows, lake and river shores
Least sandpiper (Calidris minutilla)	Common migrant	Grassy pools, bogs, open marshes, flooded fields and mud flats
Dunlin (Calidris alpina)	Rare migrant	Beaches, extensive mud and sand flats, inland lake and river shore
Short-billed dowitcher (Limnodromus griseus)	Common migrant	Mud flats, creeks, salt marshes and tidal estuaries
Semipalmated sandpiper (Calidris pusillus)	Rare migrant	Lake and river shores, flats, salt marsh pools and coastal beaches
Buff-breasted sandpiper (Tryngites subruficollis)	Uncommon migrant	Short-grass fields, meadows and prairies
Marbled godwit (Limosa fedoa)	Rare migrant	Salt marshes, tidal creeks, mud flats and sea beaches
Hudsonian godwit (Limosa haemastica)	Rare migrant	Chiefly mud flats
American avocet (Recurvirostra americana)	Uncommon migrant	Freshwater marshes,lakes and salt and brackish marshes
Wilson's phalarope (Palaropus tricolor)	Scarce migrant	Prairie pools and marshes, lake and river shores; coastal pools
Red-necked phalarope (Phalaropus lobatus)	Rare migrant	Open ocean, beaches, flats, lake and river shores
Herring gull (Larus argentatus)	Uncommon migrant	Lakes, rivers, estuaries and beaches

Taxon	Status	Habitat
Ring-billed gull (Larus delawarensis)	Uncommon winter resident	Lakes, rivers and beaches in the winter
Franklin's gull (Larus pipixcan)	Fairly common migrant	Lakes, rivers, ponds and marshes
Bonaparte's gull (Larus philadephia)	Uncommon winter resident	Mud flats, lakes ponds and flooded fields
Forster's tern (Sterna forsteri)	Rare migrant	Salt and freshwater marshes
Common tern (Sterna hirundo)	Rare migrant	Lakes, ponds, rivers, coastal beaches and islands
Caspian tern (Sterna caspia)	Rare vagrant	Shores of lakes and large rivers; along seacoast
Black tern (Chlidonias niger)	Common migrant	Freshwater marshes, marshy lakes and sandy coasts
Rock dove (Columba livia)	Common resident	City parks, suburban gardens and farmland
Mourning dove (Zenaidra macroura)	Common resident	Open fields, parks and lawns with many trees and shrubs
Common ground-dove (Colombiana passerina)	Rare resident	Open areas, fields, gardens, farm land and roadsides
Inca dove (Columbina inca)	Rare resident	Farmlands, parks, gardens and open country with scattered trees and shrubs
Yellow-billed cuckoo (Coccyzs americanus)	Common summer resident	Moist thickets, overgrown pastures and sparse woodlands
Black-billed cuckoo (Coccyzus erythropthalmus)	Rare migrant	Moist thickets, orchards, willows and overgrown pastures
Roadrunner (Geococcyx californianus)	Uncommon resident	Open arid country with plenty of thickets

Taxon	Status	Habitat
Common barn-owl (Tyto alba)	Uncommon resident	Often around human habitations in open to partly open country
Screech owl (Otus asio)	Common resident	Open deciduous woods, orchards, suburban areas and lakeshores
Great horned owl (Bubo virginianus)	Uncommon resident	Ubiquitous, frequenting forest desert, open country, swamps and parks
Burrowing owl (Athene cunicularia)	Rare accidental	Plains, deserts, fields and air ports
Barred owl (Strix varia)	Uncommon resident	Low wet woods and swamp forest
Long-eared owl (Asio otus)	Scarce accidental	Deciduous and evergreen forests
Short-eared owl (Asio flammeus)	Scarce winter migrant	Freshwater and salt marshes, open grassland, prairies and dunes
Chuck-will's widow (Caprimulgus carolinensis)	Common resident	Open woodland and clearings near farming country
Whip-poor-will (Caprimulgus vociferus)	Uncommon summer resident	Dry open woodland near fields
Common nighthawk (Chordeiles minor)	Uncommon summer resident	Aerial, but open country generally; also cities and towns
Chimney swift (Chaetura pelagica)	Common summer resident	Breeds and roosts in chimneys
Ruby-throated hummingbird (Archilochus colubris)	Common summer resident	Suburban gardens, parks and woodlands
Belted kingfisher (Ceryle alcyon)	Common resident	Rivers, lakes and saltwater estuaries

Taxon	Status	Habitat
Northern flicker (Colaptes auratus)	Common resident	Open country with trees; parks and rural estates
Pileated woodpecker (Dryocopus pileatus)	Uncommon resident	Dense forests and borders
Red-bellied woodpecker (Melanerpes carolinus)	Common resident	Open and swamp woodland; parks and feeders during migration
Red-headed woodpecker (Melanerpes erythrocephalus)	Common resident	Open country, farms, rural roads, open woodlands and golf courses
Yellow-bellied sapsucker (Sphyrapicus varius)	Common resident	Young, open deciduous or mixed forest with clearings; also parks, yards and gardens
Hairy woodpecker (Picoides villous)	Common resident	Deciduous forest
Downy woodpecker (Picoides pubescens)	Common resident	Wood lots, parks and gardens
Ladder-backed woodpecker (Picoides scalaris)	Uncommon vagrant	Arid areas with thickets and trees
Red cockaded woodpecker (Picoides borealis)	Rare resident	Pine forests, especially yellow and longleaf
Eastern Kingbird (Tyrannus tyrannus)	Common summer resident	Open country, farms, orchards, roadsides, lake shores and rivers
Western Kingbird (Tyrannus verticalis)	Scarce migrant	Open country; ranches, roadsides streams and ponds with trees
Scissor-tailed flycatcher (Tyrannus forfic)	Common summer resident	Open country along roadsides; ranches with scattered trees and bushes; fence wires and posts

Taxon	Status	Habitat
Great crested flycatcher (Myiarchus crinitus)	Fairly common summer	Open forest, orchards and large trees near agrarian land
Eastern phoebe (Sayornis phoebe)	Uncommon resident	Open woodland near streams; bridges, cliffs and buildings with ledges
Yellow-bellied flycatcher (Empidonax flaviventris)	Fairly common migrant	Willow thickets and second growth woodlands
Acadian flycatcher (Empidonax virescens)	Uncommon summer resident	Wooded ravines; beech-maple forest
Willow flycatcher (Empidonax traillii)	Uncommon migrant	Swampy thickets; upland pastures and old abandoned orchards
Least flycatcher (Empidonax minimus)	Fairly common migrant	Open country, shade trees, parks, orchards, roadsides and forest edge
Eastern wood pewee (Contopus virens)	Fairly common summer resident	Forest, open woodland, orchards, shade trees and roadsides
Western wood pewee (Contopus sordidulus)	Uncommon migrant	Open woodland, woodland edges and orchards
Olive-sided flycatcher (Contopus borealis)	Fairly common	Near openings, burns, ponds and bogs
Vermilion flycatcher (Pyrocephalus rubinus)	Rare winter resident	Trees and shrubs in open river bottoms and along roadsides
Horned lark (Eremophila alpestris)	Scarce winter resident	Plains, fields, airports and beaches
Tree swallow (Tachycineta bicolor)	Common migrant	Rivers and streams near sand banks
Bank swallow (Riparia riparia)	Uncommon migrant	Rivers and streams near sand banks

Taxon	Status	Habitat
Southern rough-winged swallow (Stelgidopteryx ruficollis)	Uncommon summer resident	Streams and rivers in the vicinity of man-made structures and banks
Barn swallow (Hirundo rustica)	Uncommon summer resident	Agricultural land, suburban areas, marshes and lake shores
Cliff swallow (Hirundo pyrrhonota)	Uncommon summer resident	Open country, buildings, cliffs, lake shores and marshes
Purple martin (Progne subis)	Common summer	Open woodland, residential areas and agricultural land
Blue jay (Cyanocitta cristata)	Common resident	Oak forest, parks and yards
American crow (Corvus brachyrhynchos)	Common resident	Woodlands, farmland and suburban areas
Carolina chickadee (Parus carolinensis)	Common resident	Deciduous woodlands and residential areas
Tufted titmouse (Parus bicolor)	Common resident	Swamp or moist woodland and shade trees; city parks
White-breasted nuthatch (Sitta carolinensis)	Fairly common resident	Deciduous and mixed forest
Red-breasted nuthatch (Sitta canadensis)	Scarce winter resident	Coniferous forests
Brown-headed nuthatch (Sitta pusilla)	Common resident	Coniferous and mixed forests
Brown creeper (Certhia americana)	Uncommon winter	Deciduous and mixed woodlands resident
House wren (Troglodytes aedon)	Common winter resident	Parks, woodland edges, farmlands and residential areas
Winter wren (Troglodytes troglodytes)	Uncommon winter resident	Dense tangles and thickets in coniferous and mixed forests

Taxon	Status	Habitat
Bewick's wren (Thryomanes bewickii)	Uncommon winter resident	Thickets, brush piles, hedgerows, open woodlands, and scrubby areas
Carolina wren (Thryothorus ludovicianus)	Common resident	Woodland thickets, ravines and rocky slopes with brush
Marsh wren (Cistothorus palustris)	Scarce resident	Fresh and brackish marshes with cattails, bulrushes or sedges
Sedge wren (Cistothorus platensis)	Uncommon winter resident	Grassy freshwater marshes, brackish marshes and wet meadows
Northern mockingbird (Mimus polglottos)	Common resident	Parks, residential areas, farmlands and open country with thickets
Gray catbird (Dumetella carolinensis)	Uncommon summer resident	Thickets and brush, gardens and residential areas
Brown thrasher (Toxostoma rufum)	Fairly common resident	Thickets, fields with scrub and woodland borders
American robin (Turdus migratorius)	Common resident	Gardens, agrarian lands, cities and open woodland
Wood thrush (Hylocichla mustelina)	Fairly common resident	Moist deciduous woodlands with a thick understory, parks and gardens
Hermit thrush (Catharus guttata) thickets	Uncommon winter migrant	Coniferous and mixed forests; deciduous woodlands and
Gray-cheeked thrush (Catharus minima)	Uncommon migrant	Coniferous and mixed forests
Veery (Catharus fuscescens)	Scarce migrant	Moist deciduous woodlands and willow thickets

Taxon	Status	Habitat
Eastern bluebird (Sialia sialis)	Common resident	Open farm lands with scattered trees
Blue-gray gnatcatcher (Polioptila caerulea)	Fairly common summer	Open, moist woodland and brushy streamside thickets
Golden-crowned kinglet (Regulus satrapa)	Uncommon winter resident	Old, dense conifer stands, deciduous forest and thickets
Ruby-crowned kinglet (Regulus calendula)	Uncommon winter resident	Coniferous and deciduous forests; also thickets in water
Water pipit (Anthus spinoletta)	Fairly common winter resident	Beaches, barren fields, agrarian land and golf courses
Sprague's pipit (Anthus spragueii)	Scarce migrant	Short-grass plains and plowed fields
Cedar waxwing (Bombycilla cedrorum)	Irregularly common winter resident	Open woodlands, orchards and residential areas
Loggerhead shrike (Lanius ludovicianus)	Fairly common resident	Grasslands, orchards, open areas with trees, open grassy woodlands
Starling (Sturnus vulgaris)	Common resident	Cities, farmlands, ranches and suburban areas
White-eyed vireo (Vireo griseus)	Uncommon resident	Dense swampy thickets and hillsides with blackberry and briar tangles
Bell's vireo (Vireo bellii)	Uncommon summer	Dense bottomland thickets, willow scrub and mesquite
Yellow-throated vireo (Vireo flavifrons)	Fairly common summer resident	Forest edge in tall deciduous trees along streams, roadsides, orchards and parks
Solitary vireo (Vireo solitaris)	Uncommon migrant	Coniferous and mixed forests

Taxon	Status	Habitat
Red-eyed vireo (Vireo olivaceus)	Common summer resident	Deciduous forest and shade trees in residential areas
Philadelphia vireo (Vireo philadelphicus)	Rare migrant	Open second growth woodlands; clearings; river and lake thickets
Warbling vireo (Vireo gilvus) shade trees	Fairly common migrant	Deciduous woodlands near streams; isolated groves and
Black & white warbler (Mniotilta varia)	Locally common summer	Primary and secondary deciduous forest; parks, gardens and lawns with trees and shrubs
Prothonotary warbler (Prothonotaria citrea)	Uncommon	Wooded swamps, flooded bottomland forest and streams with dead trees
Swainson's warbler (Limnothlypis swainsonii)	Scarce summer resident	Wooded swamps and southern cane-brakes; rhododendron thickets
Worm-eating warbler (Helmitheros vermivorus)	Rare summer resident	Chiefly dry wooded hillsides
Golden-winged warbler (Vermivora chrysoptera)	Uncommon migrant	Moist situations of sapling stage, old fields and pastures
Blue-winged warbler (Vermivora pinus)	Rare migrant	Sapling stage old field and pasture thickets in heavy forests
Tennessee warbler (Vermivora peregrina)	Uncommon migrant	Open mixed woodlands; brushy areas during migration
Orange-crowned warbler (Vermivora celata)	Uncommon winter resident	Thickets and brushy woodlands
Nashville warbler (Vermivora ruficapilla)	Fairly common migrant	Woodland edges, thickets in open mixed forest or brushy borders of swamps

Taxon	Status	Habitat
Parula warbler (Parula americana)	Uncommon migrant	Coniferous and mixed woodlands
Yellow warbler (Dendorica petechia)	Common migrant	Most thickets along streams and in swampy areas and gardens
Magnolia warbler (Dendroica magnolia)	Fairly common migrant	Any place where shrubbery or trees occur
Black-throated blue warbler (Dendroica caerulescens)	Rare migrant	Mixed deciduous and evergreen woodlands with thick undergrowth
Yellow-rumped warbler (Dendroica coronata)	Fairly common migrant	Coniferous and mixed forests
Black-throated green warbler (Dendroica virens)	Uncommon migrant	Open stands of pine and various habitats during migration
Cerulean warbler (Dendroica cerulea)	Scarce migrant	Open woodland near streams
Blackburnian warbler (Dendroica fusca)	Uncommon migrant	Mixed forests
Yellow-throated warbler (Dendroica dominica)	Uncommon migrant	Dry uplands to swampy places of pine, oak, sycamore and cypress
Chestnut-sided warbler (Dendroica pensylvanica)	Uncommon migrant	Young, open second-growth woodlands and scrub
Bay-breasted warbler (Dendroica castanea)	Fairly common migrant	Coniferous and mixed forests
Blackpoll warbler (Dendroica striata)	Rare migrant	Coniferous forests and tall trees
Pine warbler (Dendroica pinus)	Fairly common resident	Pine forests

Taxon	Status	Habitat
Prairie warbler (Dendroica discolor)	Scarce summer resident	Open scrub, old pastures and hillsides
Palm warbler (Dendroica palmarum)	Rare winter resident	Open places, weedy fields and borders of marshes
Ovenbird (Seiurus aurocapillus)	Uncommon migrant	Mature, dry forest with little underbrush
Northern waterthrush (Seiurus noveboracensis)	Common migrant	Wooded swamps, lake shores and cool bogs
Louisiana waterthrush (Seiurus motacilla)	Uncommon local summer resident	Hillside brooks, river swamps and along sluggish streams
Kentucky warbler (Oporornis formosus)	Uncommon summer resident	Low, moist woodland with abundant undergrowth; often in ravines
Connecticut warbler (Oporornis agilis)	Rare migrant	Low wet woods and damp thickets
Mourning warbler (Oporornis philadelphia)	Scarce migrant	Forest clearings with briars; wet woods with thick undergrowth
Common yellowthroat (Geothlypis trichas)	Common migrant	Moist thickets and grassy marshes
Yellow-breasted chat (Icteria virens)	Common summer resident	Dense thickets, dry brushy hillsides and streamside tangles
Hooded warbler (Wilsonia citrina)	Fairly common summer resident	Mature, moist forest ravines with luxuriant undergrowth; wooded swamps
Wilson's warbler (Wilsonia pusilla)	Fairly common migrant	Moist woodland thickets along streams and bogs
Canada warbler (Wilsonia canadensis)	Common migrant	Cool, moist woodland with thick undergrowth

Taxon	Status	Habitat
American redstart (Setophaga ruticilla)	Common summer resident	Second-growth woodlands; thickets with saplings
House sparrow (Passer domesticus)	Common resident	Cities, towns and agrarian land
Bobolink (Dolichonyx oryzivorus)	Rare migrant	Prairies, meadows and marshes
Eastern meadowlark (Sturnella magna)	Common summer resident	Meadows, pastures, prairies and open country generally
Western meadowlark (Sturnella neglecta)	Rare migrant	Meadows, plains and prairies
Yellow-headed blackbird (Xanthocephalus xanthocephalus)	Uncommon migrant	Freshwater marshes
Red-winged blackbird (Agelaius phoeniceus)	Common summer resident	Marshes, swamps, wet and dry meadows, and pastures
Orchard oriole (Icterus spurius)	Common summer resident	Orchards, parks, gardens and trees along lakes and rivers
Northern oriole (Icterus galbula)	Uncommon summer	Deciduous woodland and shade trees
Rusty blackbird (Euphagus carolinus)	Uncommon winter resident	Wooded swamps and damp woods with pools
Brewer's blackbird (Euphagus cyanocephalus)	Uncommon winter resident	Wooded swamps and damp woods with pools
Great-tailed grackle (Quiscalus mexicanus)	Scarce resident	Marshes along the coast and inland farmlands
Bronzed cowbird (Molothrus aeneus)	Common resident	Forested regions; especially cutover areas
Brown-headed cowbird (Molothrus ater)	Common resident	Fields, woodland edges, suburban areas and agrarian areas

Taxon	Status	Habitat
Scarlet tanager (Piranga olivacea)	Uncommon migrant	Mature oak and pine woodland
Summer tanager (Pranga rubra)	Common summer resident	Open woodlands and shade trees
Northern cardinal (Cardinalis cardinalis)	Common resident	Woodland edges, thickets, brushy swamps and gardens
Rose-breasted grosbeak (Pheucticus ludovicianus)	Common migrant	Woodland-open field ecotone with tall shrubs; old orchards
Black-headed grosbeak (Pheucticus melanocephalus)	Very scarce migrant	River bottoms, lake shores and swampy places
Blue grosbeak (Guiraca caerulea)	Rare summer resident	Brushy, moist pastures and roadside thickets
Indigo bunting (Passerina cyanea)	Fairly common summer resident	Brushy slopes, old pastures, over grown farmland, woodland clearings and forest-field ecotone
Lazuli bunting (Passerina amoena)	Rare migrant	Dry, brushy ravines and slopes; cleared areas and weedy pastures
Painted bunting (Passerina ciris)	Scarce	Brushy tangles, hedgerows, briar patches, woodland edges and swampy thickets
Dickcissel (Spiza americana)	Uncommon summer resident	Open country in grain or hay fields and in weed patches
Evening grosbeak (Coccothraustes vespertinus)	Rare winter resident	Coniferous and deciduous woodland; suburban areas
Purple finch woodlands; (Carpodacus purpureus)	Uncommon winter resident	Mixed and coniferous ornamental garden conifers
Pine siskin (Carduelis pinus)	Uncommon winter resident	Coniferous and mixed woodlands, alder thickets and brushy pastures

Taxon	Status	Habitat
American goldfinch (Carduelis tristis)	Fairly common winter resident	Brushy thickets, weedy grasslands and nearby trees
Green-tailed towhee (Pipilo chlorura)	Casual resident	Brushy thickets
Rufous-sided towhee (Pipilo erythrophthalmus)	Common winter resident	Thickets and brushy woodland edges
Lark bunting (Calamospiza melanocorys)	Casual winter resident	Open plains and fields
Savannnah sparrow (Passerculus sandwichensis)	Common winter resident	Fields, prairies, salt marshes grassy dunes
Grasshopper sparrow (Ammodramus savannarum)	Rare winter resident	Open grassy and weedy meadows, pastures and plains
LeConte's sparrow (Ammodramus caudacutus)	Uncommon winter resident	Moist grassland and boggy dry fields in winter
Henslow's sparrow (Ammodramus henslowii)	Rare winter resident	Moist or dry grassland with scattered weeds and small shrubs
Vesper sparrow (Pooecetes gramineus)	Fairly common winter resident	Fields, pastures and roadsides in farming country
Lark sparrow (Chondestes grammacus)	Uncommon resident	Grassland with scattered bushes and trees; open country generally
Bachman's sparrow (Aimophila aestivalis)	Uncommon resident	Dry, open pine or oak woods, weedy fields and pastures
Dark-eyed junco (Junco hyemalis)	Common winter resident	Coniferous or mixed forests, fields, gardens, parks and roadway thickets
Tree sparrow (Spizella arborea)	Uncommon winter resident	Fields, weedy woodland edges and roadside thickets

Taxon	Status	Habitat
Chipping sparrow (Spizella passerina)	Common resident	Grassy woodland edges, gardens, city parks, brushy pastures and lawns
Clay-colored sparrow (Spizella pallida)	Rare migrant	Brushy grasslands and prairies
Field sparrow (Spizella pusilla)	Fairly common resident	Abandoned fields and pastures over grown with weeds, scattered bushes and small saplings
Harris' sparrow (Zonotrichia querula)	Common winter resident	Dense river-bottom thickets; woodland borders, clearings and brush piles
White-crowned sparrow (Zonotrichia leucophrys)	Common winter resident	Open woods and gardens
White-throated sparrow (Zonotrichia albicollis)	Common winter resident	Brushy undergrowth in coniferous woodland, pastures and suburbs
Fox sparrow (Passerella illiaca)	Fairly common winter resident	Dense woodland thickets, weedy pastures and brushy roadsides
Lincoln's sparrow (Melospiza lincolnii)	Common winter resident	Brushy bogs, pastures, willow or alder thickets
Swamp sparrow (Melospiza georgiana)	Common winter resident	Freshwater marshes, wooded swamps, weedy fields, parks and brush piles
Song sparrow (Melospiza melodia)	Common winter resident	Thickets, pastures, city parks and undergrowth in gardens
Lapland longspur (Calcarius lapponicus)	Scarce winter resident	Open windswept fields and grassy coastal dunes; coastal parking lots

Taxon	Status	Habitat
Smith's longspur (Calcarius pictus)	Casual winter resident	Open grassy plains
Chestnut-collared longspur (Calcarius ornatus)	Scarce winter resident	Dry elevated prairies and short grass plains

APPENDIX C

MAMMALS OF KNOWN OR PROBABLE OCCURRENCE IN THE FIVE COUNTY STUDY AREA

APPENDIX C

MAMMALS OF KNOWN OR PROBABLE OCCURRENCE IN THE FIVE COUNTY STUDY AREA

Taxon	Habitat
Oppossum (Didelphis virginiana)	Deciduous woodlands, prairies, marshes and farmlands
Eastern mole (Scalopus aquaticus)	Moist loamy soils
Short-tailed shrew (Blarina brevicauda)	Forested areas and their associated meadows and openings
Least shrew (Cryptotis parva)	Grasslands generally but occasionall under logs and leaf litter in moist forested areas
Southeastern bat (Myotis austroriparius)	Crevices between bridge timbers, culverts, drain pipes, barns, attics and hollow trees
Silver-haired bat (Lasionycteris noctivagans)	Forested areas in tree cavities
Eastern pipistrelle (Pipistrellus subflavus)	Woodlands
Big brown bat (Eptesicus fuscus)	Forested areas in hollow trees and crevices in buildings
Hoary bat (Lasiurus cinerus)	Forested areas
Red bat (Lasiurus borealis)	Forested areas and orchards
Seminole bat (Lasiurus seminolus)	Forested areas in association with Spanish moss

Taxon	Habitat
Northern yellow bat (Lasiurus intermedius)	Forested areas
Evening bat (Nycticeius humeralis)	Forested ares in hollow trees
Rafinesque's big-eared bat (Plecotus rafinesquii)	Hollow trees in forested region
Brazilian free-tailed bat (Tadarida brasiliensis)	Hollow trees in forested areas
Black bear (Ursus americanus)	Nearly impenetrable thickets along watercourses, escaping from release sites in Louisiana.
Raccoon (Procyon lotor)	Broad-leaf woodlands and mixed pine forests
Ringtail (Bassariscus astutus)	Less common in woodlands preferring rocky areas
Long-tailed weasel (Mustela frenata)	Variety of habitats from woodlands, thickets and grasslands
Mink (Mustela vison)	Associated with watercourses and lakes
River otter (Lutra canadensis)	Lakes and larger streams
Eastern spotted skunk (Spilogale putorius)	Woodlands to tall grass prairies
Striped skunk (Mephitis mephitis)	Wooded or brushy areas and associated farmlands
Red fox (Vulpes fulva)	Various woodland habitats

Taxon	Habitat
Gray fox (Urocyon cinereoargenteus)	Inhabitant of wooded areas, particularly mixed hardwood forests
Coyote (Canis latrans)	Desert scrub to grasslands into forested areas
Red wolf (Canis rufus)	Formerly from eastern Texas, now apparently restricted to Gulf Coast counties
Bobcat (Lynx rufus)	Thickets to rocky outcrops
Eastern gray squirrel (Sciurus carolinensis)	Bottomlands and hammocks of live and water oaks to mixed hardwood uplands
Fox squirrel (Sciurus niger)	Variety of forested habitas prefering upland forests of more open mixed hardwood
Eastern flying squirrel (Glaucomys volans)	Forested areas where den trees are available
Plains pocket gopher (Geomys bursarius)	Sandy soils where the topsoil is 4 inches or more in depth
Hispid poscket mouse (Perognathus hispidus)	Sandy or other friable soil covered with scattered to moderate herbaceous vegetation
Beaver (Castor canadensis)	Along streams, rivers, lakes and ponds
Eastern harvest mouse (Reithrodontomys humulis)	Ecotones and early successional stages
Fulvous harvest mouse (Reithrodontomys fulvescens)	Grassy areas with shrub-type vegetation
White-footed mouse (Peromyscus leucopus)	Various habitats within woodlands

Taxon	Habitat
Cotton mouse (Peromyscus gossypinus)	Woodland habitats along watercourses near open fields
Golden mouse (Ochrotomys nuttali)	Aboreal in forested habitats
Norhtern rice rat (Oryzomys palustris)	Marshy areas with grasses and sedges
Hispid cotton rat (Sigmodon hispidus)	Tallgrass areas of bluestem, cordgrass or sedges
Florida wood rat (Neotoma floridana)	Swamplands, forested uplands to arid plains
Pine vole (Pitymys pinetorum)	Woodland areas where leaf litter and lodged grasses affords protection
Muskrat (Ondatra zibethicus)	Marshy areas of creeks, rivers and lakes
House mouse (Mus musculus)	Various habitats particularly near human habitastion
Roof rat (Rattus rattus)	Various commensal habitats associated with man
Norway rat (Rattus norvegicus)	Various commensal habias associated with man
Nutria (Myocastor coypus)	Swamps, marshes and along rivers and lakes
Eastern cottontail (Sylvilagus floridanus)	Brushlands and marginal, ecotonal areas
Swamp rabbit (Sylvilagus aquaticus)	Poorly drained river bottoms and coastal marshes

Taxon	Habitat
White-tailed deer (Odocoileus virginianus)	Brushlands to forested areas
Feral hog (Sus scrofa)	Forested areas and thickets where introduced or escaped from farmlands
Nine-banded armadillo (Dasypus novemcinctus)	Various habitats where the soil is suitable

APPENDIX D

FISH SPECIES OF KNOWN OR PROBABLE OCCURRENCE WITHIN THE FIVE COUNTY STUDY AREA

APPENDIX D

FISH SPECIES OF KNOWN OR PROBABLE OCCURRENCE WITHIN THE FIVE COUNTY STUDY AREA

Taxon	Source*	Habitat
Brook lamprey (Ichthyomyzon gagei)	1,2	Below obstructions and sand bars in streams
Chestnut lamprey (Ichthyomyzon castaneus)	1	Reservoirs, large rivers and creeks
Alligator gar (Lepisosteus spatula)	1	Larger lakes, rivers and brackish waters of the Gulf Coast
Longnose gar (Lepisosteus osseus)	1	Lakes, bayous, oxbows and river backwaters
Shortnose gar (Lepisosteus platostomas)	1	Lakes, oxbows and larger rivers
Spotted gar (Lepisosteus oculatus)	1	Clear waters of lakes, bayous, oxbows and lotic backwaters
Bowfin (Amia calva)	1	Swamps, sloughs, borrow pits, lakes, ditches and sluggish steams
American eel (Anguilla rostrata)	1	Males near coastal waters, while females ascend to the source of most river systems
Skipjack herring (Alosa chrysochloris)	1	Lakes, steams, rivers and borrow pits of Gulf drainage; large numbers below dams
Gizzard shad (Dorosoma cepedianum)	1,2,3	Large rivers, reservoirs, lakes, swamps, floodwater pools and estuaries
Threadfin shad (Dorosoma petenese)	1	Large rivers, reservoirs and lakes

Taxon	Source*	Habitat
Goldeye (Hiodon alosoides)	1	Large reservoirs, rivers and lakes; deeper pools of smaller streams and creeks
Grass pickerel (Esox americana vermiculatus)	1,2,3	Natural lakes, sloughs, borrow pits, ditches and sluggish steams
Chain pickerel (Esox niger)	1	Non flowing waters with abundant vegetation; complimentary species to the grass pickerel
Stoneroller (Campostoma anomalum)	1	Moderate or high gradient permanent streams with well defined gravel to bedrock riffles
Goldfish (Crassius auratus)	1	Large reservoirs, lakes, streams and rivers
Common carp (Cyprinus carpio)	1	Reservoirs, lakes, sluggish streams, rivers and ditches
Mississippi silvery minnow (Hybognathus nuchalis)	1,2,3	Low-gradient sections of clear, moderately large streams; pools and blackwater areas
Creek chub (Semotilus atromaculatus)	1,2	Headwater creeks and spring branches where few other species exist
Silver chub (Hybopsis storerina)	1	Quite pools and backwaters of large streams, large reservoirs and natural lakes
Speckled chub (Hybopsis aestivalis)	1	Sand and gravel bottoms of large rivers and streams with relatively low gradients
Golden shiner (Notemigonus crysoleucas)	1,2,3	Lakes, ponds, sloughs, reservoirs and quiet pools of streams
Fathead minnow (Pimephales promelas)	1,3	Lakes, ponds and streams, but abundant only in pools of small intermittant streams
Bluntnose minnow (Pimephales vigilax)	1,3	Lakes and quiet pools or backwaters of streams with clear, warm, permanent flow

Taxon	Source*	Habitat
Pugnose minnow (Notropis emiliae)	1,2,3	Clear, vegetated waters without current; lakes, sloughs, borrow pits and ditches
Silverstripe shiner (Notropis lutrensis)	1,3	Impoundments, large creeks and rivers
Common shiner (Notropis cornutus)	1	Small moderately, clear streams having high gradients and gravel or rubble pools
Ribbon shiner (Notropis fumeus)	1	From smaller creeks to larger rivers over a sandy bottom
Emerald shiner (Notropis atherinoides)	1	Reservoirs and open channels of large, permanent, low gradient streams
Blacktail shiner (Notropis venustus)	1,2,3	From placid waters of lakes and bayous to swift waters of rivers and streams
Bigeye shiner (Notropis boops)	1	Sluggish mediums to large streams draining and clean sand, gravel or rock substrate
Pallid shiner (Notropis amnis)	1	Sluggish medium to large streams draining essentially level uplands
Redfin shiner (Notropis Umbratilis)	1	Relatively clear, warm water without strong currents
Mimic shiner (Notropis volucellus)	1,2,3	Open channels of large, moderately clear to turbid rivers; lower stream reaches
Ghost shiner (Notropis buchanani)	1	Low gradient sections of large creeks and rivers in larger pools and backwaters
Blackspot shiner (Notropis atrocaudalis)	1,2	Tributary waters in clear flowing streams
Weed shiner (Notropis texanus)	1,3	Low gradient rivers and ditches over sandy substrate with a noticable current

Taxon	Source*	Habitat
Sabine shiner (Notorpis sabinae)	1,2,3	Rivers over sand bars
River carpsucker (Carpoides carpio)	1,3	Impoundments, backwaters, oxbows and pools of low gradient streams
Bigmouth buffalo (Ictiobus cyprinellus)	1	Lakes, rivers, oxbows and sloughs
Smallmouth buffalo (Ictiobus bubalus)	1,3	Lakes, rivers, oxbows and large rivers
Spotted sucker (Minytrema melanops)	1,2,3	Larger impoundments to small creeks
Lake chubsucker (Erimyzon sucetta)	1,3	Lakes, bayous, oxbows and backwater pool areas of rivers and streams
Creek chubsucker (Erimyzon oblongus)	1,3	Smaller rivers, streams, creeks and rarely in impoundments
Blacktail redhorse (Moxostoma poecilurum)	1,2,3	Larger impoundments, streams and rivers
Gray redhorse (Moxostoma congestum)	1	Lakes and low gradient streams
Blue catfiush (Ictalurus furcatus)	1,3	Lakes, ponds, bayous, canals and larger streams
Channel catfish (Ictalurus punctatus)	1,2,3	Lakes, ponds, bayous, streams and rivers
Black bullhead (Ictalurus melas)	1,2,3	Farm ponds, lakes, oxbows and streams
Yellow bullhead (Ictalurus natalis)	1,2,3	Farm ponds, lakes and backwaters of streams and rivers

Taxon	Source*	Habitat
Tadpole madtom (Noturus gyrinus)	1	Lakes, ponds, oxbows, sloughs, creeks, streams and rivers
Speckled madtom (Noturus nocturnus)	1,2,3	Clear to moderately turbid streams having permanent flows
Flathead catfish (Pylodictis olivaris)	1,3	Reservoirs, large rivers, and low gradient streams
Pirate perch (Aphredoderus sayanus)	1,2,3	Sluggish waters of swamps, borrow pits, marshes over organic debris substrate
Starhead topminnow (Fundulus notti)	1,2	Lakes, ponds and quiet backwaters with streams
Blackspotted topminnow (Fundulus olivaceus)	1,2	Quiet waters near rooted aquatics or leaf litter
Blackstripe topminnoww (Fundulus notatus)	1,2	Quiet waters near rooted aquatic plants
Mosquitofish (Gambusia affinis)	1,2	Quiet waters of lakes, ponds, river back waters and oxbows among aquatic plants
Brook silverside (Labidesthes sicculus)	1,2	Lakes, bayous, oxbows, borrow pits, streams and rivers
White bass (Morone chrysops)	1	Deeper pools of streams and open water of lakes and reservoirs
Yellow bass (Morone mississippienisis)	1,3	Lakes, streams and major river drainages
Banded pygmy sunfish (Elassoma zonatum)	1,2	Older ponds, lakes, borrow pits, bayous and lotic backwater with abundant aquatic plants
Largemouth bass (Micropterus salmoides)	1,2,3	Lakes, ponds, reservoirs, sluggish streams or river backwaters

Taxon	Source*	Habitat
Spotted bass (Micropterus punctulatus)	1,2	Lakes, reservoirs, streams and main channels of large rivers
Warmouth (Lepomis gulosus)	1,2,3	Impoundments, bayous, oxbows, sloughs, swamps, and low gradient streams
Redear sunfish (Leopmis microlophus)	1,2	Lakes, ponds and protected pools in streams
Orangespotted sunfish (Lepomis humilis)	1,2,3	Borrow pits, drainage ditches, small bayous and low gradient silty streams
Spotted sunfish (Lepomis punctatus)	1,2	Lakes, bayous and streams with structure
Bluegill (Lepomis macrochirus)	1,2,3	Lakes, ponds, bayous, oxbows and with aquatic vegetation
Longear sunfish (Lepomis megalotis)	1,2,3	Reservoirs, lakes, streams and rivers associated with aquatic vegetation
Green sunfish (Lepomis cyanellus)	1,2,3	Lakes, poinds, bayous, rivers, oxbows and streams
Flier (Centrarchus macropterus)	1,2	Lakes, bayous, ponds and swamps
White crappie (Pomoxis annularis)	1,2,3	Larger lakes, ponds, rivers and streams
Black crappie (Pomoxis nigromaculatus)	1,2	Clearer lakes, rivers and streams
Western sand darter (Ammocrypta clara)	1,3	Sandy bottom rivers and streams
Scaly sand darter (Ammocrypta vivax)	1,2,3	Shallow, snady bottom streams

Taxon	Source*	Habitat
Logperch (Percina caprodes)	1,2,3	Lakes and moderate to large streams and rivers in pool areas
Blackside darter (Percina maculata)	1	Flowing water and in pools of moderate sized streams
Dusky darter (Percina sciera)	1,2,3	Rocky riffles and pools below riffles of streams
Bluntnose darter (Etheostoma chlorosomum)	1,2	Oxbows, bayous and backwaters of rivers
Slough darter (Etheostoma gracile)	1,2	Swamps, sloughs and sluffish streams
Freshwater drum (Aplodinotus grunniens)	1,3	Lakes, rivers and large impoundments

*Source

1 - Knapp, F.T. 1953. Fishes found in the freshwaters of Texas. Ragland Studio and Litho Printing Company, Brunswick, Georgia

2 - Dickens, F.A. 1950. A distributional study of fishes in the Nacogdoches area. M.A. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

3 - Castleberry, W.B. 1942. A biological investigation of the common fish of central east Texas. M.A. Thesis. Stephen F. Austin State University, Nacogdoches, Texas.

APPENDIX E

HISTORICAL LANDMARKS WITHIN THE REGION

APPENDIX E

HISTORICAL LANDMARKS WITHIN THE REGION

COUNTY/ Community	NAME	STATUS*	LOCATION
SMITH		1	Elkins Cemetery, 3.5 mi SE of Arp
Arp	John Franklin Overton		
Lindale	Vial-Fragoso Trail	1	3 mi E on U.S. 69
Mount Selman	Larissa College Site	4	3 mi W of FM 855
Tyler	Belzora Landing	1	17 mi N of FM 14
	Camp Ford	1	4 mi NE on U.S. 271
	Army of the Texas Republic Camp	1	22 mi NW of Tyler on U.S. 69; N of Old 69 and CR 484 Intersection
	City of Tyler	1	Courthouse lawn
	Colonel John Dewberry Home	1	12 mi SW on FM 346 in Teaselville
	County Agricultural Agents Service	1	Courthouse square
	Goodman-Legrande Home	1	624 North Broadway Street
	Loftin-Wiggins House	1	610 North Bois D'Arc Street
	Major John Dear House	1	Old Dear School Road, 8 mi W
	Marvin Methodist Church	1	South Bois D'Arc & West Erwin
	Smith County Rose Industry & the Tyler Rose Garden	1	Tyler Rose Park, East Texas Fairgrounds, West Front Street
	Tyler Confederate Ordnance Plant	1	Mockingbird Lane & Robertson Street
	Tyler Tap Railroad	1	North Broadway Street at railroad crossing near depot
	Yarbrough Building	1	Ferguson Street
	Colonel Bryan Marsh	2	Marsh Elementary School, 800 North Bois D'Arc Street
	Colonel Richard Hubbard	2	Hubbard Jr. High School, 1300 Hubbard Drive
	Colonel Thomas R. Bonner	2	Bonner Elementary School, 235 South Sanders
	Headache Springs, CSA	2	6 mi E on SH 64
	Major James P. Douglas	2	Douglas Elementary School, 1508 North Haynie Street
	Neches-Saline CSA	2	16 mi SW near intersection of SH 155 & FM 344
	Smith County CSA	2	Courthouse grounds
	Judge Stockton P. Donley	3	Oakwood Cemetery
	Camp Ford	4	4 mi NE on U.S. 271 in Roadside park

COUNTY/ Community	NAME	STATUS*	LOCATION
	Army of the Texas Republic Camp	4	10 mi S on U.S. 69, 6 mi SW on FM 346
	Confederate Arms Factory	4	Mockingbird Lane and Robertson St.
	Scouts of Texas Army	4	9 mi NE on U.S. 271 in churchyard
	Smith County	4	4 mi W on SH 64
	Vial-Fragoso Trail	4	17 mi N via U.S. 69 to Lindale then 7 mi N
Winona	Henry Gary House	1	Old Starville Ranch
	Nicholas Wren	1	Harris Creek Baptist Church
CHEROKEE			
Alto	Forest Hill Plantation	1	5.5 mi SW on SH 21
	Helena Dill Berryman	1	Private cemetery, FM 241, 8 mi NE
	Helena Dill Nelson	1	Family cemetery, off SH 21, 2 mi E
	Mound Prairie	1	SH 21, 6 mi SW
	Mr. Stella Salmon Hill	1	City Cemetery
	W. W. Durham Home	1	7 mi S on U.S. 69 on Old Forest-Alto Road
	William Roark Home	1	5 mi E on SH 21, 3 mi S
	Candace Midkiff Bean	3	Roark Cemetery, 4 mi S on SH 21
	Cherokee home of Grand Xinesi	4	1 mi S on U.S. 69, 1 mi E
	Mission San Francisco de los Tejas	4	6 mi SW off SH 20 on Felder S. Farm
	Delaware Indian Village site	4	1 mi SW on SH 21
	Lacy's Fort site	4	2 mi SW on SH 21
	Chief Bowles last home	4	3 mi NW near Red Lawn
	Neches Indian village site	4	5 mi SW on SH 21
	Angelina River	5	8 mi E on SH 21 at Angelina River
	Old Palestine Baptist Church	5	5 mi E on SH 21, 3 mi S
	Site of Linwood	5	6 mi W on SH 21
Dialville	George Washington Slover	1	5 mi W
	Rock Springs Missionary Baptist Church	1	5 mi W on FM 1910
Gallatin	Greenberry Jenkins Home	1	1.5 mi SE, off FM 768
Jackson-ville	Henry Turner Brown	1	Resthaven Cemetery
	Old Neches Saline Road	1	SH 175, 1 mi NW
	Old Rusk Tramway	1	FM 347, 4 mi S
	Old W. A. Brown Home	1	428 South Patton Street
	Union Grove Cemetery	1	FM 2138, 5 mi S of Jacksonville
	Chaplain Davis	2	First Presbyterian Church Grounds, 411 South Bolton

COUNTY/ Community	NAME	STATUS*	LOCATION
	Killough Indian Massacre	5	7 mi NW near Larissa
	Site of Old Jacksonville	5	1.5 mi SW on Pineda Street
New Summer-field	Site of Griffin	5	4 mi on SH 110, 2 mi E on FM
Rusk	Thomas Mitchell Campbell Birthplace	1	Old Rusk-Gallatin Road, 4 mi NE
	Dr. I. K. Fraze home	1	704 East 5th Street
	Gregg home	1	East 4th Street
	Old Bonner Bank Building	1	U.S. 69 & Euclid
	The Rusk Footbridge	1	East 5th and Lone Oak
	CSA Ironworks	2	8 mi S on FM 752, 0.5 mi on Old Alto-Palestine Road
	Cherokee County CSA	2	Courthouse grounds
	Cherokee Furnace Company CSA	2	8 mi S on FM 752, 0.5 mi on Old Alto-Palestine Road
	Prisoner of War Compound	2	2 mi S on FM 241
	Rusk	2	North city limits on U.S. 69
	Governor James Stephen Hogg birthplace	4	J. S. Hogg State Park
	Confederate Gun Factory	4	City limits on U.S. 84
	Cooks Fort site	4	4 mi SE on Old Alto Road
	New Birmingham site	5	1 mi SE on U.S. 69
	Glenfawn Cemetery	1	7.2 mi SE of Laneville Old Alto Road
Wells	James H. Bowman	3	Old Mount Cemetery, 1 mi N on Old Alto Road
RUSK		1	6 mi W on SH 64
Henderson	Daisy Bradford Discovery Well		
	General James Smith	1	Smith Park, South Main Street
	Howard-Dickinson Home	1	South Main Street
	M. Kangerga House	1	501 North High Street
	Pine Grove Cumberland Presbyterian Church	1	9 mi SE via U.S. 79 & FM 348
	Richard Brown	1	Pine Grove Cemetery, 5 mi SE of Henderson
	Captain Robert W. Smith	3	Pleasant Hill Cemetery, 7 mi W on SH 323
	General James Smith	3	South Main & Henderson Streets
	Discovery Well	4	6 mi W on SH 64 in Roadside Park
	Cherokee Indian Village	4	6.2 mi SW on U.S. 79
	Shawnee Town Site	4	0.5 mi SW on U.S. 79
	Thomas Jefferson Rusk Mon.	4	Courthouse grounds
	Trammel's Trace	4	13.5 mi E on U.S. 79

COUNTY/ Community	NAME	STATUS*	LOCATION
Mount Enterprise	Dr. William M. Ross Home	1	2.5 mi NE on Old Concord Road
	Joseph Charles Misner	1	Shiloh Cemetery
	Mont Verdi	1	12 mi E on U.S. 84 then 1 mi N
	Old Birdwell House	1	12 mi E on U.S. 84 then 1 mi N
Overton	Leverett House	1	4 mi NE via SH 42 on County Road near Leverett's Chapel
NACOG-DOCHES			
Chireno	Halfway House	1	3 mi NW on SH 21
Douglass	Brewster Cemetery	3	Family Cemetery off FM 227 on County Road
	John R. Clute	3	Douglass Cemetery
	Mission Concepcion site	4	6 mi S on FM 225
Melrose	Lyne T. Barrett	1	Melrose Cemetery
Nacog-doches	Adolphus Sterne House	1	211 South Lanana Street
	Ancient Mound	1	1516 Mound Street
	Charles Hoya Land Office	1	Pilar & Pecan Streets, Downtown
	Christ Episcopal Church	1	502 East Starr Avenue
	El Atascoso Ranch	1	8 mi E of Nacogdoches on SH 21
	Gingerbread house	1	21 mi SE on Chireno Loop of SH 21
	Old Nacogdoches University	1	Washington Square
	Old Spanish Cemetery	1	Courthouse grounds
	Old Stone Fort	1	Campus of Stephen F. Austin Univ.
	Oil Springs	1	3 mi NE on FM 226 on County Road
	Millard-Lee House	1	141 North Church Street
	Roland Jones House	1	141 North Church Street
	Texas Stage Coaches	2	East Main & Fredonia Streets
	Captain Hayden Arnold	3	Oak Grove Cemetery
	Charles Stanfield Taylor	3	Oak Grove Cemetery
	Dr. Robert Anderson Irion	3	Oak Grove Cemetery
	Elias E. Hamilton	3	Oak Grove Cemetery
	Haden Edwards	3	Oak Grove Cemetery
	Kelsey Harris Douglass	3	Oak Grove Cemetery
	Thomas J. Rusk	3	Oak Grove Cemetery
	Thomas Young Buford	3	Oak Grove Cemetery
	William Clark, Jr.	3	Oak Grove Cemetery
	John S. Roberts	3	Oak Grove Cemetery
	John Balch	3	Cove Springs Cemetery, 14 mi E on SH 21, 2 mi N

COUNTY/ Community	NAME	STATUS*	LOCATION
	William (Bill) Goyens	3	4 mi W on SH 21, then 0.2 mi S on Camino Real
	General Sam Houston Home	4	East Pilar & South Pecan Street
	Adolphhus Sterne Home	4	211 South Lanana Street
	Juan Antonio Padilla Home	4	Powers & North Street
	Peter Ellis Bean Home	4	4 mi E on SH 7, 0.5 mi S
	La Calle Real de Norte	4	North & Powers Street
	Mission Nuestra Senora de la Purisi 8A Concepcion	4	15 mi off RM 225, near Stripling Farm Road
	Mission Nuestra Senora de Guadalupe	4	North & Muller Street
	Nacogdoches County	4	3 mi N of U.S. 59
	Nacogdoches University	4	Washington Square
	Old North Church		4.3 mi N on U.S. 59, 0.3 mi E
	Old Red House	4	Pilar & North Street
	Old Stone House	4	Stephen F. Austin Univ. Campus
	Presidio Nuestra Senora de los Dolores	4	14 mi W on 225
	Antonio Gil y Barbo homesite	4	317 East Main Street
	Charles S. Taylor homesite	4	North & Mims Street
	James Dil homesite	4	North & Hospital Street
	John S. Roberts homesite	4	215 East Pilar Street
	Thomas J. Rusk homesite	4	North & Rusk Street
	William Clark, Jr. homesite	4	North & Rusk Street
	Old Soledad site	4	407 East Main Street
	Mount Sterling town site	4	12 mi W on FM 225, 2 mi S on Goodman Crossing Road
	Thomas F. McKinney	4	115 East Main Street
	Lyne T. Barrett	4	Stephen F. Austin Univ. Campus
	Old Nacogdoches University	5	Washington Square
ANGELINA			
Diboll	Pine Grove Missionary Baptist Church	1	1 mi E on FM 1818
	Ryan Chapel	1	1 mi N on U.S. 59, then 1.1 mi NW on FM 2487
Lufkin	Governor Allan Shivers Birthplace	1	Ellis Avenue & Kelley Street
	Calder Square	1	Calder Square, Lufkin
	Early logging equipment	1	1903 Atkinson Drive
	Gann House	1	Near SH 94, 7.5 mi W
	Kurth Home	1	1 mi N on U.S. 69
	Logging Railroad	1	1903 Atkinson Drive
	Lufkin	1	Kiwanis Park, Timberland Drive
	Southland Paper Mills, Inc.	1	3 mi E on SH 103
	Angelina County	4	0.5 mi S on U.S. 69

COUNTY/ Community	NAME	STATUS*	LOCATION
	Homer	4	6 mi SE on U.S. 69
	Jonesville	4	12 mi SE on U.S. 69
	Marion townsite	4	12 mi E on SH 103, 2.5 mi N on County Road
Zavalla	Henry Harvard Home	1	1.5 mi S on FM 1270

* Status - 1 Texas historical markers and recorded historic landmarks (including granite markers erected by the State)

2 Civil War markers (especially for the Centennial 1961-1965, erected by the State)

3 Texas Centennial (1936) and War for Independence gravemarkers

4 Texas Centennial (1936) and War for Independence markers

5 Privatem State-approved markers

APPENDIX F

ARCHEOLOGICAL INVESTIGATIONS IN CHEROKEE AND SMITH COUNTIES, TEXAS

APPENDIX F

ARCHEOLOGICAL INVESTIGATIONS IN CHEROKEE AND SMITH COUNTIES, TEXAS

Anderson, K.M., 1972. Prehistoric Settlement of the Upper Neches River. Bulletin of the Texas Archeological Society. 43:121-197.

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APPENDIX G

LANDOWNERS AFFECTED BY THE DEVELOPMENT OF LAKE EASTEX

APPENDIX G

LANDOWNERS AFFECTED BY THE DEVELOPMENT OF LAKE EASTEX

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
84	A-41	BLK1276	TR3	ADAMS, ROLAND	33.7	33.7
86	A-41	BLK1276	TR5	ADAMS, ROLAND	3.5	0.7
83	A-41	BLK1276	TR2	ADAMS, ROLAND	71.5	33.5
237	A-48	BLK1071	TR3	ADAMS, WILLIS EST	57.5	56.6
290	A-19	BLK773	TR9	ADA, LEE EST	36.5	1.5
146	A-47	BLK1081	TR2	ALEXANDER, SAM EST	168.0	152.3
43	A-41	BLK1272	TR2	ALLEN, CHANNIE	21.4	8.0
44	A-41	BLK1272	TR3	ALLEN, CHANNIE	21.9	3.8
289	A-19	BLK773	TR16	ALLEN, MACK EST	79.5	9.2
60	A-884	BLK1088	TR6	ALLEN, ROBERT LEE	5.0	5.0
167	A-1	BLK1080	TR8	ALLMAN, STEPHEN & SHARON	30.0	17.3
102	A-47	BLK1087	TR3	BAKER, STEWART F.	50.8	50.8
103	A-47	BLK1087	TR4	BAKER, STEWART F.	17.7	17.7
104	A-47	BLK1087	TR5	BAKER, STEWART F.	55.2	55.2
101	A-47	BLK1087	TR2	BAKER, STEWART F.	56.3	56.3
96	A-41	BLK1277	TR2	BAKER, STEWART F.	10.6	8.5
95	A-41	BLK1277	TR1A	BAKER, STEWART F.	44.4	42.0
118	A-47	BLK1086	TR1	BARHAM, RODNEY O.	229.7	227.4
119	A-47	BLK1086	TR2	BARHAM, RODNEY O.	129.7	129.7
266	A-507	BLK1059	TR6	BARNES, DAVID A.	70.0	13.5
267	A-507	BLK1059	TR7	BARNES, ISABEL	159.3	94.9
179	A-48	BLK1076A	TR12	BARNETT, RUDOLPH	48.6	48.6
176	A-48	BLK1076A	TR9	BARNETT, RUDOLPH	82.1	80.5
212	A-831	BLK1316	TR2	BARRON, VERNON & SON	297.0	92.9
148	A-8	BLK1282	TR1	BARTELS, ELMER A. & JESSIE A.	20.0	14.0
149	A-8	BLK1282	TR3	BARTELS, ELMER A. & JESSIE A.	15.0	8.8
58	A-884	BLK1088	TR4	BASS, JOHN M.	6.3	6.3
70	A-884	BLK1088	TR16	BEARDEN, MICHAEL L. & TERRI	6.0	6.0
211	A-48	BLK1074	TR4	BELL, SAM H.	50.0	4.5
49	A-41	BLK1273	TR9A	BREWER, CHARLIE C.	3.5	1.0
50	A-41	BLK1273	TR10	BREWER, CHARLIE C. JR.	15.8	14.7
114	A-45	BLK771	TR4	BROWN, EDWIN W.	240.9	61.1
42	A-41	BLK1272	TR1	BROWN, HULON B.	151.8	76.4
120	A-47	BLK1086	TR3	BROWN, SAM E. JR.	149.7	99.8
108	A-47	BLK1040	TR2	BROWN, WAYNE	461.1	406.9
145	A-47	BLK1081	TR1	BROWN, WILLIS G.	135.0	103.8
130	A-47	BLK1084	TR1	BROWN, WILLIS G.	122.6	122.6
129	A-47	BLK1042	TR1	BRUNO, D. B. TRUST.	322.8	102.2

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
303	A-831	BLK1314	TR6	BURKETT, OSCAR LEROY	12.2	2.0
304	A-831	BLK1314	TR7	BURKETT, OSCAR LEROY	24.0	0.5
248	A-1	BLK1067	TR7	BURNS, TAYLOR	26.2	26.2
277	A-41	BLK1274	TR13	BUTLER, MARY RUTH	30.8	0.8
17	A-538	BLK1090	TR4	CARDEN, FLOYD	15.3	15.3
22	A-271	BLK1091	TR6	CARDEN, FLOYD	37.0	10.8
262	A-507	BLK1059	TR2	CASEY, ETHEL AILEEN	49.6	33.1
200	A-8	BLK1335	TR2	CAUTHEN, BENNIE L. MRS.	80.0	26.9
45	A-41	BLK1273	TR2	CAVENESS, JOE B.	30.8	11.3
278	A-41	BLK1280	TR10	CAVENESS, JOHN	79.9	5.1
97	A-41	BLK1280	TR12	CAVENESS, JOHN	140.7	23.2
75	A-714	BLK1039	TR1A	CEMETERY	1.0	1.0
67	A-884	BLK1088	TR13	CHAMBERLAIN, JIMMY D. & MARILYN	2.0	2.0
274	A-45	BLK772	TR4	CHANDLER, MACK EST	24.3	4.9
117	A-47	BLK1041	TR1	CHILDS, LEO	247.0	16.9
245	A-1	BLK1067	TR3	CLEMENS, J. C. SR	24.0	17.9
88	A-19	BLK774	TR1A	COLLINS, T. H. HEIRS	16.0	3.6
299	A-18	BLK1323	TR4	CRISP, DOYLE	157.2	14.0
26	A-884	BLK1035	TR1D	CULP, HILDE	12.5	2.8
243	A-1	BLK1069	TR5	CUNNINGHAM, F. GARY & REBEKAH	207.4	43.7
124	A-47	BLK1281	TR5	CUNY, THOMAS BACON JR.	15.0	7.0
309	A-831	BLK1291	TR4	DAVENPORT, JAMES R.	43.8	1.0
125	A-47	BLK1281	TR6	DAVIS, CHARLES WAYNE	14.0	6.5
285	A-47	BLK1043	TR15	DAVIS, ELMER	6.0	3.0
284	A-47	BLK1043	TR14	DAVIS, ELMER	6.0	2.5
85	A-41	BLK1276	TR4	DAVIS, STACY	40.0	40.0
235	A-48	BLK1071	TR2A	DEAN, NORA MRS. EST	6.4	4.4
247	A-1	BLK1067	TR6	DICKEY, JERRY DON	10.0	8.0
253	A-736	BLK1062	TR1	DIMOND, JOHN W.	329.2	213.6
8	A-882	BLK1092	TR11	DIXON, KENNETH	11.7	11.7
9	A-882	BLK1092	TR12	DIXON, KENNETH	11.5	11.5
72	A-487	BLK1037	TR2	DOTSON, GLYN	50.0	47.0
55	A-884	BLK1088	TR1	DOTSON, GLYN	10.2	10.2
53	A-763	BLK1036	TR2	DOTSON, JIM	40.0	13.0
40	A-884	BLK1089	TR5C	DOWLING, HERBERT	14.0	14.0
168	A-1	BLK1044	TR7	DUNCAN,LINDSEY H.	112.0	20.1
18	A-538	BLK1090	TR5	EMERSON, L. B.	19.0	19.0
2	A-882	BLK1092	TR2	EMERSON, L. B.	105.8	10.6
157	A-1	BLK1079	TR2	FIELDER, J. C.	124.6	123.0
159	A-1	BLK1079	TR4	FIELDER, J. C.	90.0	78.5
156	A-1	BLK1079	TR1	FIELDER,OSCAR LEE JR.	124.6	124.6
249	A-1	BLK1067	TR8	FIRST GILBRALTOR BANK, FSB	7.3	7.3
175	A-48	BLK1076A	TR8	FITCH, R. & LINDELL	97.4	68.5

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
183	A-1	BLK1077	TR4	FITCH, R. & LINDELL	67.0	67.0
161	A-1	BLK1080	TR2	FITCH, R. & LINDELL	27.2	27.2
160	A-1	BLK1080	TR1	FITCH, R. & LINDELL	68.0	61.3
162	A-1	BLK1080	TR3	FITCH, R. & LINDELL	40.8	40.8
276	A-41	BLK1269	TR1	FLETCHER, JOE & DEBRA	24.2	0.5
56	A-884	BLK1088	TR2	FOWLER, LARRY W. & CAROL	6.3	6.3
171	A-1	BLK1044	TR17	FREEMAN, ARENDA	33.3	20.0
1	A-882	BLK1092	TR1	FREEMAN, BILLY W. & SHIRLEY	20.9	20.9
3	A-882	BLK1092	TR3	FREEMAN, BILLY W. & SHIRLEY	30.0	30.0
77	A-714	BLK1039	TR6	GARNER, ANN	1.9	0.6
52	A-41	BLK1273	TR12	GARNER, LARRY	35.0	35.0
51	A-41	BLK1273	TR11	GARNER, LARRY L. & PATRICIA	2.0	2.0
314	A-455	BLK1305	TR7	GARRETT, ART	104.9	1.0
241	A-1	BLK1069	TR1	GASTILLO, RICHARD V. & GINNA F.	9.2	6.1
321	A-1	BLK1044	TR16	GATLIN, BILLY JOE	6.3	1.0
153	A-1	BLK1078	TR4	GAY, EARLE M. & WIFE	40.0	36.5
152	A-1	BLK1078	TR3	GAY, EARLE M. & WIFE	80.0	23.5
185	A-8	BLK1285	TR1	GAY, EARLE M. & WIFE	120.0	40.6
190	A-8	BLK1336	TR1	GAY, EARLE M. & WIFE	63.0	23.5
133	A-47	BLK1083	TR3	GILBERT, DERRELL W. & CHARLOTTE	11.8	3.8
11	A-167	BLK1032	TR1	GILLESPIE, RANDO JO	355.8	71.2
12	A-1008	BLK1033	TR1A	GILLESPIE, RANDO JO	199.9	60.0
7	A-882	BLK1092	TR7	GOODSON, EDITH D. MRS.	111.8	33.5
282	A-337	BLK1353	TR3	GRAY, JAMES L.	77.8	1.0
281	A-730	BLK1354	TR1	GRAY, JAMES L.	75.5	6.5
71	A-487	BLK1037	TR1	GREGORY, LEEMAN T. & MARION	127.4	81.9
73	A-475	BLK1038	TR3	GREGORY, LEEMAN T. & MARION	73.3	34.8
92	A-19	BLK774	TR5	GREGORY, LEEMAN T. & MARION	70.2	12.5
184	A-1	BLK1077	TR5	GRIMES, BRYAN	40.8	40.8
151	A-1	BLK1078	TR2	GRIMES, BRYAN	196.5	158.9
150	A-1	BLK1078	TR1	GRIMES, BRYAN	53.5	34.4
46	A-41	BLK1273	TR5	HACKER, J. F.	24.0	12.5
76	A-714	BLK1039	TR2	HAMILTON, GLENN T. ET AL	93.3	33.4
208	A-1	BLK1075	TR4	HAM, DAVID S.	96.4	26.6
259	A-718	BLK1295	TR3	HANNAH, KENNETH	52.9	4.1
261	A-455	BLK1304	TR4	HANNAH, KENNETH	98.5	20.4
138	A-47	BLK1082	TR3	HARRIS, CHARLES H. & CONNIE R.	39.5	39.5
132	A-47	BLK1083	TR2	HARRIS, CHARLES H. & CONNIE R.	2.5	2.5
288	A-19	BLK773	TR15	HARRIS, WILLIAM A.	80.0	8.6
81	A-714	BLK1039	TR10	HAWS, BERT	22.7	21.5
79	A-714	BLK1039	TR8	HAWS, BERT	6.5	3.8
80	A-714	BLK1039	TR9	HAWS, BERT	6.5	3.8
78	A-714	BLK1039	TR7	HAWS, FERN	16.0	8.0

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
180	A-1	BLK1077	TR2	HEFFER, DOROTHY	270.3	171.7
110	A-19	BLK774A	TR8	HENDERSON, VAUGN H. & JIM AKINS	163.8	44.3
242	A-1	BLK1069	TR2	JONES, L. F. LIFE EST	18.6	3.9
173	A-48	BLK1047	TR4	KARCHER, J. PAUL	145.0	85.3
172	A-48	BLK1047	TR3	KARCHER, J. PAUL	193.0	112.3
210	A-48	BLK1074	TR3	KARCHER, J. PAUL	100.0	94.0
204	A-48	BLK1076	TR1	KARCHER, J. PAUL	400.0	137.5
319	A-48	BLK1047	TR1	KARCHER, PAUL	68.0	10.5
318	A-48	BLK1076A	TR1	KARCHER, PAUL	119.1	9.8
163	A-1	BLK1080	TR4	KELLUM, VITTORIO	62.3	37.8
164	A-1	BLK1080	TR5	KELLUM, VITTORIO	82.1	53.9
291	A-8	BLK1282	TR4	KIMBRELL, MARY ANN	40.1	3.0
169	A-1	BLK1044	TR12	LACY, THERESA	33.3	23.6
10	A-167	BLK1032	TR2	LEMASTER, THOMAS A.	320.0	64.0
178	A-48	BLK1076A	TR11	LINDSEY, CURTIS	48.7	14.3
265	A-507	BLK1059	TR5	LOCKRIDGE, CURTIS	84.2	9.4
316	A-295	BLK1063	TR14	LOCKRIDGE, CURTIS	86.9	3.0
195	A-8	BLK1337	TR1	MAXWELL, DON G. & CHRISTENE	42.5	21.2
123	A-47	BLK1281	TR3	McCAULEY, MATTHEW & CHARLENE	24.5	19.3
154	A-1	BLK1078	TR5	McELYEA, CLEO MRS.	40.0	23.0
155	A-1	BLK1078	TR6	McELYEA, CLEO MRS.	30.0	9.5
293	A-8	BLK1284	TR6	McELYEA, CLEO MRS.	5.0	0.5
275	A-19	BLK775C	TR14	McGEE, ROBERT H.	111.3	3.6
68	A-884	BLK1088	TR14	MCLEOD, HUBERT & MARGUERITE	4.0	4.0
209	A-48	BLK1074	TR2	McMOYLE, A. W.	117.2	49.3
238	A-48	BLK1071	TR4	MITCHELL, NORMA C.	150.0	21.9
136	A-47	BLK1082	TR1	MONROE, LARRY LEE & PEGGY	34.1	34.1
33	A-884	BLK1089	TR1	MONTGOMERY, C. W.	26.5	26.5
34	A-884	BLK1089	TR2	MONTGOMERY, C. W.	5.5	5.5
6	A-882	BLK1092	TR6A	MOORE, JOHN E.	69.9	69.9
5	A-882	BLK1092	TR6	MOORE, JOHN E. & JOANN	11.7	2.9
4	A-882	BLK1092	TR4	MOORE, JOHN E. & JOANN	50.0	40.0
69	A-884	BLK1088	TR15	MOSELEY, CLIFFORD T. & MELDA	2.9	2.9
225	A-1	BLK1070	TR9	MOULTON, DONALD BRIAN	74.3	66.9
191	A-8	BLK1336	TR2	MURRAY, E. L.	61.5	35.0
193	A-8	BLK1344	TR8	MURRAY, TOMMY L. & JOE DAN	32.1	8.9
194	A-8	BLK1344	TR9	MURRAY, TOMMY L. & JOE DAN	32.1	4.2
283	A-47	BLK1043	TR4	MUSICK, LLOYD R. & CHERYL A.	22.7	2.5
320	A-48	BLK1048	TR1	NEELY, THOMAS W. & JEANETTE	132.1	4.0
182	A-1	BLK1077	TR3A	NORTHCUTT, BEN MRS. EST	25.0	18.0
301	A-18	BLK1287	TR3	NORTHCUTT, BEN MRS. EST	100.0	12.4
181	A-1	BLK1077	TR3	NORTHCUTT, JEWELL	100.0	72.0
187	A-8	BLK1286	TR2	NORTHCUTT, JEWELL	37.5	5.0

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
186	A-8	BLK1286	TR1	NORTHCUTT, JEWELL	5.0	5.0
189	A-8	BLK1286	TR4	NORTHCUTT, JEWELL	120.0	40.5
188	A-8	BLK1286	TR3	NORTHCUTT, JEWELL	5.0	5.0
203	A-8	BLK1335	TR5	NORTHCUTT, JEWELL	14.9	5.2
199	A-8	BLK1335	TR1	NORTHCUTT, JEWELL	40.0	18.2
177	A-48	BLK1076A	TR10	NORTHCUTT, W. B. MRS.	10.8	3.7
223	A-1	BLK1070	TR7	NORTHCUTT, W. B. MRS.	81.5	74.9
300	A-18	BLK1323	TR1	NOT LISTED IN APPRAISAL BOOK	2.8	2.8
192	A-8	BLK1344	TR7	OWENS, C. W. JR.	76.0	23.1
141	A-47	BLK1082	TR6	OWENS, KATHLEEN	37.0	22.5
139	A-47	BLK1082	TR4	OWENS, KATHLEEN	65.7	65.7
142	A-47	BLK1082	TR7	OWENS, KATHLEEN	49.8	25.5
134	A-47	BLK1083	TR4	OWENS, KATHLEEN	29.0	10.7
89	A-19	BLK774	TR2	OWEN, D. B. MRS.	28.0	5.6
90	A-19	BLK774	TR3	OWEN, D. B. MRS.	28.0	6.3
87	A-19	BLK774	TR1	OWEN, D. B. MRS.	52.0	6.1
115	A-45	BLK771A	TR2	PARSLEY, EMERY & MARTHA	344.9	50.5
197	A-8	BLK1337	TR3	PAVETICH, PHILIP	50.0	19.3
196	A-8	BLK1337	TR2	PAVETICH, PHILIP	24.0	7.8
298	A-8	BLK1334	TR1	PIERCE, WESLEY	71.8	11.0
258	A-718	BLK1295	TR2	PITTS, V. A.	99.2	17.7
82	A-41	BLK1276	TR1	POWELL PLANT FARM	399.5	244.7
111	A-45	BLK771	TR1	POWELL PLANT FARM	127.2	109.9
113	A-45	BLK771	TR3	POWELL PLANT FARM	105.0	78.8
112	A-45	BLK771	TR2	POWELL PLANT FARM	29.0	21.8
109	A-19	BLK774A	TR6	POWELL PLANT FARM	31.0	12.6
286	A-45	BLK751	TR3	POWELL, BILLY	90.0	1.0
287	A-45	BLK751	TR3A	POWELL, BILLY	35.0	7.5
19	A-271	BLK1091	TR1	PRIEFERT, MARGARET	50.0	35.5
20	A-271	BLK1091	TR2	PRIEFERT, MARGARET	48.8	28.3
126	A-47	BLK1281	TR17	RAY, CLAUDEAN & MARTHA	14.9	11.4
250	A-1	BLK1067	TR9	READ, ALMA	137.5	122.2
317	A-1	BLK1067	TR2	READ, ALMA	18.0	1.5
240	A-1	BLK1066	TR2	READ, HENRY G.	48.0	48.0
13	A-938	BLK1034	TR4	RODMAN, EARL G. JR.	482.0	457.9
32	A-884	BLK1035	TR7	RODMAN, EARL G. JR.	100.0	75.0
35	A-884	BLK1089	TR3	RODMAN, EARL G. JR.	120.0	120.0
36	A-884	BLK1089	TR4	RODMAN, EARL G. JR.	104.0	104.0
41	A-884	BLK1089	TR6	RODMAN, EARL G. JR.	196.0	185.5
15	A-538	BLK1090	TR2	RODMAN, EARL & SHIRLEY	369.0	369.0
14	A-538	BLK1090	TR1	RODMAN, EARL & SHIRLEY	235.0	235.0
292	A-8	BLK1284	TR5	ROSS, HARRY	5.0	1.0
140	A-47	BLK1082	TR5	ROSS, HARRY LEE	43.8	43.8

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
143	A-47	BLK1082	TR9	ROSS, HARRY LEE	43.4	10.2
264	A-507	BLK1059	TR4	RUCKER, WILLIAM LEON	82.2	63.8
270	A-507	BLK1060	TR3	SCHUTT, RUTH GRIMES	140.5	80.7
63	A-884	BLK1088	TR9	SCOGGINS, PAT	6.0	6.0
65	A-884	BLK1088	TR11	SCOGGINS, PAT	10.4	10.4
57	A-884	BLK1088	TR3	SCOGGINS, PAT ET AL	6.5	6.5
59	A-884	BLK1088	TR8A	SCOGGINS, PAT ET AL	263.4	263.4
62	A-884	BLK1088	TR8	SCOGGINS, PAT ET AL	749.3	749.3
64	A-884	BLK1088	TR10	SCOGGINS, PAT ET AL	8.6	8.6
297	A-8	BLK1340	TR5	SCOGIN, JANICE	114.1	12.4
23	A-884	BLK1035	TR1A	SHURLEY, RUTH T.	25.0	0.8
147	A-47	BLK1043	TR1	SILMON, WADE	24.5	9.7
217	A-1	BLK1070	TR1	SIMPSON, D. W.	87.0	26.4
37	A-884	BLK1089	TR5	SIMS, MARGARET EST	17.4	17.4
313	A-455	BLK1305	TR1	SMITH, HERBERT G.	64.5	3.5
251	A-1	BLK1068	TR1	SOUTH, J. M. MRS.	130.7	128.8
252	A-1	BLK1068	TR3	SOUTH, J. M. MRS.	33.8	10.9
255	A-262	BLK1294	TR1	SOUTH, J. M. MRS.	22.6	11.7
256	A-262	BLK1294	TR3	SOUTH, J. M. MRS.	7.0	5.3
131	A-47	BLK1083	TR1	STATON, JOE B. & ET AL	237.3	207.6
94	A-41	BLK1277	TR1	STATON, JOE B. & GEORGE D.	424.0	249.2
99	A-41	BLK1279	TR3	STATON, JOE B. & GEORGE D.	59.6	8.9
91	A-19	BLK774	TR4	STATON, JOE B. & GEORGE D.	69.9	28.5
116	A-45	BLK751A	TR2	STEPHENS, DUANE G. & GRADY POND	106.4	48.6
135	A-47	BLK1083	TR8	STOCKTON, C. E.	134.0	3.8
174	A-48	BLK1076A	TR7	STOUT, WILLIAM D.	147.9	87.5
236	A-48	BLK1071	TR2C	ST. CLAIR, F. D.	6.4	4.4
48	A-41	BLK1273	TR9	TAYLOR, BILL W.	16.6	16.6
310	A-1	BLK1069	TR7	TAYLOR, L. L.	43.8	5.8
219	A-1	BLK1070	TR3	TAYLOR, L. L.	39.1	39.1
218	A-1	BLK1070	TR2	TAYLOR, L. L.	39.1	38.2
230	A-1	BLK1070	TR14	TAYLOR, L. L.	20.0	20.0
220	A-1	BLK1070	TR4	TAYLOR, L. L.	31.1	31.1
137	A-47	BLK1082	TR2	TEDDER, C. W.	107.6	107.6
144	A-47	BLK1082	TR2A	TEDDER, C. W.	41.3	41.3
165	A-1	BLK1080	TR6	TEDDER, STEVEN W.	50.0	16.7
166	A-1	BLK1080	TR7	TEDDER, STEVEN W.	42.4	25.4
98	A-41	BLK1279	TR2	TEDDER, STEVEN W.	35.8	19.0
202	A-8	BLK1335	TR4	TENNISON, JAMES C.	27.8	9.6
201	A-8	BLK1335	TR3	TENNISON, JAMES C.	27.7	11.8
121	A-47	BLK1086	TR6	THAMES, JAMES HAROLD SR.	24.5	10.8
122	A-47	BLK1086	TR7	THAMES, JAMES HAROLD SR.	24.5	24.5
47	A-41	BLK1273	TR8	THOMPSON, CAROL L.	19.0	2.0

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
231	A-1	BLK1070	TR17	THOMPSON, T. M.	44.7	26.2
308	A-831	BLK1291	TR3	THOMPSON, T. M.	16.5	2.0
271	A-507	BLK1060	TR4	THRASH, WILTON E. ET AL	37.0	6.5
268	A-507	BLK1060	TR1	THRASH, WILTON E. ET AL	66.5	66.5
273	A-507	BLK1060	TR6	THRASH, WILTON E. ET AL	81.3	12.7
272	A-507	BLK1060	TR5	THRASH, WILTON E. ET AL	38.0	8.7
254	A-912	BLK1061	TR1	THRASH, WILTON E. ET AL	504.0	223.2
257	A-718	BLK1295	TR1	THRASH, WILTON E. ET AL	65.0	41.7
260	A-455	BLK1304	TR1	THRASH, WILTON E. ET AL	35.0	18.0
311	A-455	BLK1304	TR2	THRASH, WILTON E. ET AL	40.0	12.6
312	A-455	BLK1304	TR3	THRASH, W. E.	58.0	24.0
27	A-884	BLK1035	TR2	TILLEY, MARGARET ET AL	20.2	20.1
54	A-763	BLK1036	TR3	TILLEY,P. T. ET AL	40.0	38.5
170	A-1	BLK1044	TR15	TILLMAN, IKE EST	17.0	5.2
31	A-884	BLK1035	TR5	TIPTON, DICK EST	85.6	55.9
30	A-884	BLK1035	TR4	TIPTON, DICK EST	85.0	53.5
29	A-884	BLK1035	TR3	TIPTON, DICK EST	68.0	53.3
38	A-884	BLK1089	TR5A	TIPTON, DICK EST	35.0	35.0
24	A-884	BLK1035	TR1B	TIPTON, ELLA MAE	25.0	1.8
39	A-884	BLK1089	TR5B	TIPTON, E. B. EST	7.6	7.6
280	A-47	BLK1281	TR18	TOBLER, CHARLES & BETTY	11.1	0.5
279	A-47	BLK1281	TR2	TODD, CLAUDE WAYNE	24.5	1.0
158	A-1	BLK1079	TR3	TOUCHY, HARRY T.	90.0	83.4
296	A-8	BLK1340	TR4	TRAVIS, NELL FLOYD	114.1	14.6
198	A-8	BLK1337	TR4	TRAYLOR, SIMON	49.0	15.1
16	A-538	BLK1090	TR3	WAITES, FRANK E. & ERNEST E.	4.8	4.8
21	A-271	BLK1091	TR5	WAITES, FRANK E. & ERNEST E.	53.0	18.0
232	A-48	BLK1071	TR1	WELLS, DON L. & HELEN B.	31.2	9.2
239	A-1	BLK1066	TR1	WHITTON, HOLLIS DALE	106.2	30.7
66	A-884	BLK1088	TR12	WIEGMAN, DONALD & KIMBERLY	5.3	5.3
25	A-884	BLK1035	TR1C	WILCOX, PATRICIA CAROL	12.5	2.2
246	A-1	BLK1067	TR4	WILEY, P. L.	22.4	19.9
263	A-507	BLK1059	TR3	WILKINSON, BILLIE	82.8	49.7
234	A-48	BLK1071	TR2B	WILKINSON, EMERY EST	6.4	4.4
233	A-48	BLK1071	TR2	WILKINSON, GERALD E.	25.7	14.1
28	A-884	BLK1035	TR2A	WILLIAMSON, EDGAR A.	79.8	61.9
306	A-831	BLK1315	TR9	WILLSON, BRUCE G.	96.5	1.0
224	A-1	BLK1070	TR8	WILSON, JASPER L. EST	1.0	1.0
229	A-1	BLK1070	TR13	WILSON, JASPER L. EST	35.0	33.2
226	A-1	BLK1070	TR10	WILSON, JASPER L. EST	7.0	7.0
222	A-1	BLK1070	TR6	WILSON, JASPER L. EST	55.0	55.0
228	A-1	BLK1070	TR12	WILSON, JASPER L. EST	20.0	20.0
221	A-1	BLK1070	TR5	WILSON, JASPER L. EST	8.0	8.0

AFFECTED LANDOWNERS IN CHEROKEE COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
227	A-1	BLK1070	TR11	WILSON, JASPER L. EST	18.0	18.0
216	A-831	BLK1288	TR1	WILSON, JASPER L. EST	154.0	8.5
215	A-831	BLK1289	TR3	WILSON, JASPER L. EST	76.0	36.2
214	A-831	BLK1289	TR2	WILSON, JASPER L. EST	62.4	40.4
213	A-831	BLK1289	TR1	WILSON, JASPER L. EST	20.0	5.5
307	A-1	BLK1070	TR15	WILSON, JASPER L. EST	18.0	1.0
207	A-1	BLK1075	TR3	WILSON, JASPER L. EST	80.0	5.5
205	A-1	BLK1075	TR1	WILSON, JASPER L. EST	218.0	218.0
206	A-1	BLK1075	TR2	WILSON, JASPER L. EST	164.5	93.7
294	A-8	BLK1340	TR1	WILSON, O. E.	12.6	0.5
295	A-8	BLK1340	TR2	WILSON, O. E.	12.6	0.5
305	A-831	BLK1315	TR8	WOMACK, H. L. LIFE EST	69.4	2.0
302	A-831	BLK1316	TR1	WOMACK, H. L. LIFE EST	1.5	1.5
61	A-884	BLK1088	TR7	WORLEY, M. C. & ALICE	13.2	13.2
269	A-507	BLK1060	TR2	WYLIE, EARL ET AL	14.0	11.2
315	A-864	BLK1297	TR1	WYLIE, EARL ET AL	100.0	2.0
107	A-47	BLK1040	TR1	YOUNG, F. A. MRS.	200.0	191.5
128	A-47	BLK1085	TR2	YOUNG, F. A. MRS.	125.0	93.1
127	A-47	BLK1085	TR1	YOUNG, F. A. MRS.	126.0	43.2
100	A-47	BLK1087	TR1	YOUNG, F. A. MRS.	223.0	198.1
105	A-47	BLK1087	TR6	YOUNG, F. A. MRS.	70.0	70.0
106	A-47	BLK1087	TR6A	YOUNG, F. A. MRS.	30.0	30.0
93	A-19	BLK774	TR7	YOUNG, F. A. MRS.	274.0	95.5
74	A-714	BLK1039	TR1	YOUNG, F. A. MRS.	160.0	160.0
244	A-1	BLK1067	TR1	ZIEGLER, JOE DARWIN	26.5	15.6
				TOTAL	24,493.4	13,735.9
		CHEROKEE		MINIMUM	1.0	0.5
		COUNTY		MAXIMUM	749.3	749.3
		TOTALS		AVERAGE (AFFECTED)	76.3	42.8
				AVERAGE (TOTAL)	58.9	33.0
				NUMBER	321.0	321.0

AFFECTED LANDOWNERS IN SMITH COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
95	A-1101	M#00600	TR	*	1.7	1.6
94	A-69	M#04030	TR	*	25.0	2.5
5	A-1101	M#00600	TR25	BATTENFIELD, LILLIAN P.	60.2	30.1
4	A-1101	M#00600	TR24	BATTENFIELD, WILLIAM D.	141.8	42.5
20	A-1101	M#00600	TR2.3	BRAND, B. WINSTON	4.0	4.0
83	A-69	M#04030	TR63B	BROWN, BEATRICE	5.0	2.2
24	A-1101	M#00600	TR17	BURGINS, R.H.	7.2	6.5
37	A-69	M#04070	TR91	CHESNUT, MELVIN L.	19.0	3.8
36	A-69	M#04070	TR91.	CHESNUT, MELVIN L.	25.8	25.8
35	A-69	M#04070	TR91.	CHESNUT, MELVIN L.	15.7	9.4
30	A-69	M#04070	TR114	CLARK, RAYMOND J.	7.8	2.3
7	A-1101	M#00600	TR6A	CROSS, FAE	29.1	4.9
92	A-638	M#02140	TR45A	DEAN, E. & WALTER SANDERS	53.4	18.7
64	A-69	M#04050	TR131	DODD, MARGIE	2.5	2.5
65	A-69	M#04050	TR131	DODD, MARGIE	9.6	3.4
60	A-69	M#04050	TR131	DODD, MARGIE ETAL	11.1	3.3
78	A-69	M#04030	TR61	DODSON, DAVE M.	29.9	9.0
58	A-69	M#04050	TR130	DONALD, FRED	15.1	1.7
85	A-69	M#04030	TR100	DRAKE, J.D.& B. REAGAN	25.0	25.0
91	A-638	M#02140	TR37	EDWARDS, FANNIE EST	19.6	9.8
21	A-1101	M#00600	TR2A	FAIN, DONALD	5.0	4.8
54	A-638	M#02180	TR50	FIELDS, DAN	93.7	4.7
52	A-638	M#02180	TR51	FIELDS, R.D.	68.0	6.8
53	A-638	M#02180	TR51.	FIELDS, R.D.	25.7	21.9
84	A-69	M#04030	TR63A	FRANKLIN, LAURA E.	5.0	2.0
70	A-69	M#04050	TR69	FRANKLIN, MILES&ESTELLE	35.7	10.7
86	A-69	M#04030	TR62	FRANKLIN, WAYNE	25.0	2.5
18	A-1101	M#00600	TR2	GEORGE, C. LACY	3.3	3.3
15	A-1101	M#00600	TR2.2	GEORGE, C. LACY	30.9	26.3
82	A-69	M#04030	TR63	GREEN, PATRICIA	5.0	3.5
57	A-69	M#04050	TR130	HAGEN, NELLIE BEDAIR	14.9	0.7
62	A-69	M#04050	TR131	HAMMONDS, CLYDE D.	10.0	4.0
67	A-69	M#04050	TR131	HAMMONDS, WILLIAM F.	9.0	2.7
66	A-69	M#04050	TR131	HAMMONDS, WILLIAM F.	3.1	3.1
90	A-638	M#02140	TR12	HARDY, ROBERT L.	79.3	63.4
87	A-638	M#02160	TR12.	HARDY, ROBERT L.	40.2	4.0
61	A-69	M#04050	TR131	HOGENMILLER, BOBBIE	12.1	3.6
45	A-69	M#04070	TR87B	HUMPHREYS, ETHEIAL	5.6	0.1
46	A-69	M#04070	TR132	HUMPHREYS, ETHEIAL	16.7	0.3
76	A-69	M#04030	TR61C	IVERSON, KENNETH	7.1	2.8
55	A-638	M#02180	TR9	LEWIS, GUY V.	55.5	2.8
50	A-69	M#04050	TR93	LEWIS, GUY V.	35.0	17.5
49	A-69	M#04070	TR93.	LEWIS, GUY V.	49.9	49.9

AFFECTED LANDOWNERS IN SMITH COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
63	A-69	M#04050	TR131	MALDNE, SHIRLEY	12.1	4.2
59	A-69	M#04050	TR131	MAPLES, WANDA	12.1	3.0
89	A-638	M#02160	TR7	McDONALD,JOHN B.	141.6	7.1
22	A-1101	M#00600	TR18	McELROY, BOBBY	4.9	4.9
17	A-1101	M#00600	TR18.	McELROY, HAROLD ETAL	2.6	2.6
16	A-1101	M#00600	TR18.	McELROY, HAROLD ETAL	8.9	8.9
80	A-69	M#04030	TR63D	McGEE, MATTIE	5.0	4.2
31	A-69	M#04070	TR114	MOODY,KENNETH	18.6	1.9
74	A-69	M#04030	TR65	MORBY, GLENN H.	34.0	34.0
75	A-69	M#04030	TR64	MORBY, GLENN H.	50.0	40.0
71	A-69	M#04050	TR68	MORBY, GLENN H.	35.7	28.6
41	A-69	M#04070	TR70	MORBY, GLENN H.	184.9	110.9
40	A-69	M#04070	TR70.	MORBY, GLENN H.	9.8	9.8
42	A-69	M#04070	TR70.	MORBY, GLENN H.	0.8	0.8
69	A-69	M#04050	TR71A	MORRISON PIPE & ENGR. PROD.	14.9	3.7
68	A-69	M#04050	TR71A	MORRISON, BILLY JACK	42.8	27.8
88	A-638	M#02160	TR2	MOSLEY, GRADY W. ET AL	83.6	8.4
72	A-69	M#04030	TR37	NEWSOME, H. EST	52.0	5.2
81	A-69	M#04030	TR63C	PATTON, LUELLA	5.0	3.5
73	A-69	M#04030	TR66	QUINTOINETTE WARE	25.0	25.0
51	A-69	M#04070	TR92	RIDER, MARSHALL	20.0	11.0
12	A-101	M#00620	TR13.	ROACH, MAVIS L.	6.1	0.3
13	A-1101	M#00600	TR16	ROSCOE, KRISTALYNN K.	7.2	0.7
14	A-101	M#00620	TR16.	ROSCOE, KRISTALYNN K.	9.1	0.5
6	A-1101	M#00600	TR6	SADLER, GERALD	116.4	40.7
25	A-1101	M#00600	TR14	SELF, VERA MRS.	6.8	3.1
27	A-69	M#04070	TR88.	SELF, VERA MRS.	15.0	15.0
29	A-101	M#00620	TR1	SOKOLOSKI, FLOYD F.	11.1	2.2
28	A-69	M#04070	TR114	SOKOLOSKI, FLOYD F.	8.6	8.6
33	A-69	M#04070	TR90.	SORRELL, BILLY D.	16.7	16.7
34	A-69	M#04070	TR90	SORRELL, BILLY D.	54.1	25.4
77	A-69	M#04030	TR61	SOUTHSIDE STATE BANK	18.9	1.9
23	A-1101	M#00600	TR16A	STEPHENS, DUANE G.	2.8	2.8
26	A-69	M#03930	TR85/1	STEPHENS, DUANE G.	137.8	20.7
32	A-69	M#04070	TR87	STEPHENS, DUANE G.	72.0	25.2
39	A-69	M#04070	TR87.	STEPHENS, DUANE G.	2.6	2.6
38	A-69	M#04070	TR87.	STEPHENS, DUANE G.	12.3	12.3
10	A-1101	M#00600	TR18A	STEPHENS, DUSTIN G.	14.2	7.1
9	A-1101	M#00600	TR18A	STEPHENS, DUSTIN G.	30.4	30.4
56	A-69	M#04050	TR130	ST. CLAIR, WALKER L. SR.	15.9	0.2
79	A-69	M#04030	TR63E	THOMAS, ALLIE A.	5.0	5.0
1	A-1101	M#00600	TR20	TRASH, AFTON EST.	61.7	58.6
2	A-1101	M#00600	TR21	TRASH, AFTON EST.	86.6	86.6

AFFECTED LANDOWNERS IN SMITH COUNTY

ITEM	NUMBER			NAME	TOTAL ACREAGE	TOTAL AFFECTED ACREAGE
11	A-101	M#00620	TR4	TUCKER, JOHN JR.	148.8	74.4
47	A-69	M#08250	TR9	TYER, RICHARD W. DR.	9.3	8.4
44	A-69	M#08250	TR10	TYER, RICHARD W. DR.	17.9	17.9
48	A-69	M#08250	TR8	TYER, RICHARD W. DR.	5.4	0.5
43	A-69	M#08250	TR11	TYER, RICHARD W. DR.	13.4	13.4
19	A-1101	M#00600	TR26	UNGERECHT, ROBERT D.	2.0	2.0
8	A-1101	M#00600	TR12	WARREN, B. D.	12.2	1.8
93	A-638	M#02140	TR13	WILEY, BIBBIE EST	68.1	3.4
3	A-828	M#03900	TR2	WYLIE, EARL TRUSTEE ETAL	238.0	9.5

* TRACK NUMBER AND OWNER INFO. WAS UNAVAILABLE.

SMITH COUNTY TOTALS	TOTAL	3,134.5	1,293.8
	MINIMUM	0.8	0.1
	MAXIMUM	238.0	110.9
	AVERAGE (AFFECTED)	33.0	13.6
	AVERAGE (TOTAL)	33.0	3.1
	NUMBER	95.0	95.0

COMBINED COUNTY TOTALS	TOTAL	27627.9	15029.7
	MINIMUM	0.8	0.1
	MAXIMUM	749.3	749.3
	AVERAGE (AFFECTED)	66.4	36.1
	AVERAGE (TOTAL)	66.4	36.1
	NUMBER	416.0	416.0