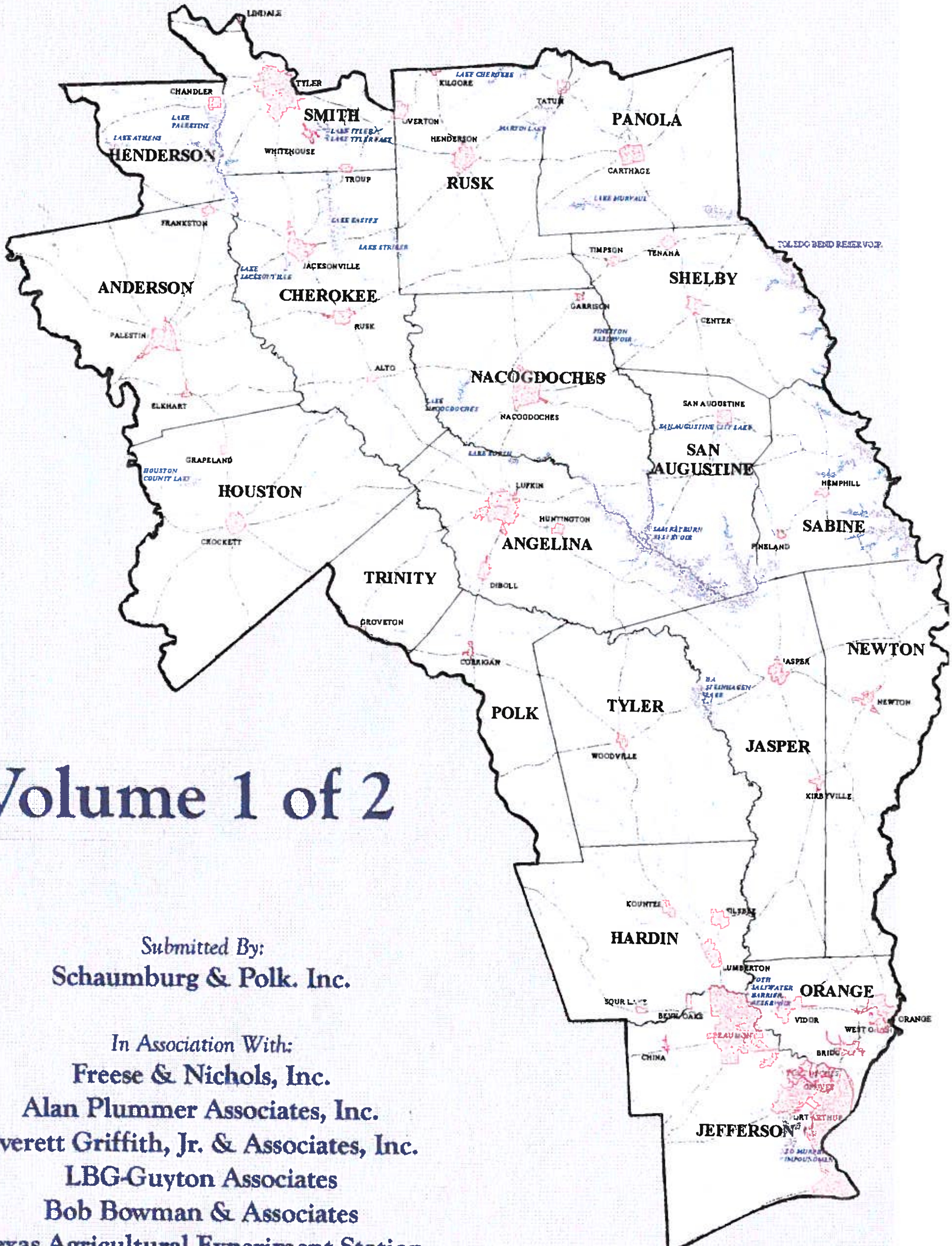
Regional Water Plan

East Texas Region



Volume 1 of 2

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ACKNOWLEDGEMENT

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East Texas Regional Water Planning Group

Executive Summary

Introduction

In June 1997, Governor George W. Bush signed into law Senate Bill 1 (SB1), a comprehensive water planning and management bill enacted by the 75th Texas Legislature. This comprehensive water legislation was an outgrowth of increased awareness and vulnerability of Texas to drought and to the limits of existing water supplies to meet increasing demands as population grows. The state's population is expected to increase from its current level of about 19 million to more than 36 million by the year 2050.

With the passage of SB1, the Legislature put in place a "bottom up" water planning process designed to ensure that the water needs of all Texans are met as Texas enters the 21st century. SB1 allows individuals representing 11 interest groups to serve as members of Regional Water Planning Groups (RWPGs) to prepare regional water plans for their respective areas. These plans will map out how to conserve water supplies, meet future water supply needs and respond to future droughts in the planning areas. The Texas Water Development Board (TWDB) has established 16 distinct planning areas that will be directed by 16 different RWPGs.

In accordance with SB1, the 16 regional water plans must be completed and adopted by September 1, 2000, and the TWDB must approve and incorporate the plans into a comprehensive state water plan by September 1, 2001. The water plans will be updated every five years.

The regional planning process includes the following major tasks:

1. Description of the Region
2. Development of Population and Demand Projections
3. Analysis of Current Water Supply
4. Comparison of Demand and Supply to Determine Needs
5. Development of the Plan, Including Identification and Evaluation of Water Management Strategies
6. Additional Recommendations, Including Unique Ecological Stream Segments, Reservoir Sites, Legislative and Regional Policy Issues
7. Plan Adoption, Including Public Participation

The East Texas Regional Water Planning Area covers all or a portion of 20 counties. Counties whose boundaries fall entirely in the region include Anderson, Angelina, Cherokee, Hardin, Houston, Jasper, Jefferson, Nacogdoches, Newton, Orange, Panola, Rusk, Sabine, San Augustine, Shelby, Tyler. Counties located within the ETRWPG and

Region H includes Polk and Trinity counties. Henderson County is located within the ETRWPG and Region C. Smith County is located within the ETRWPG and Region D.

The major water resources include groundwater from the Carrizo-Wilcox and Gulf Coast Aquifers and surface water from reservoirs and run-of-river located within the Neches and Sabine River Basins. The planning area also encompassed portions of the Trinity Basin, Neches-Trinity Coastal Basin and approximately one square mile in Cypress Creek Basin.

The study provides a review of the ecological resources identified by Texas Parks and Wildlife reports and other resources. The ecological resources identified include wetlands, bottomland hardwoods, endangered species and unique land holdings. One key ecological issue for which little existing information is known is the requirement for environmental flows in the Sabine Neches estuary. A review of this information is incorporated in Task 5, however, the ETRWPG feels further information is needed to ensure any future water plans provide adequate supply to meet this demand. SB1 allows for each regional planning group to designate ecologically unique river and stream segments. The ETRWPG recognizes the numerous ecological resources within the Region. However, several questions remain as to the ramifications of making such a designation and the ETRWPG feels that such designations should be delayed pending clarification of answers. The concerns of the unique stream segment designation are contained in Task 6.

Most counties in the region have significant prime farmlands. A review of the 1997 U.S. Department of Agricultural Data is summarized on a county basis to identify agricultural demands on water resources. The data is found on Table 1.16 of Task 1 and includes both a review of agricultural crops and livestock and poultry. Where possible, the ETRWPG encourages the use of minor aquifers (Queen City and Sparta) to meet agricultural water needs. Other than Jefferson County, most of the demands for agricultural and livestock use are by groundwater or small surface ponds.

Tasks 2 presents information for current and future water demands. The guidelines for the Regional Water Plan required water demands be developed for six major water user groups: municipal, manufacturing, irrigation, livestock, steam/electric power and mining. Figure 2-2 of the report provides an overall view of water consumption by the user groups. Municipal projections were developed based on population data as provided by the Texas Water Development Board. This data was reviewed and was amended where other sources (such as State Data Center or local studies) indicated differences. Water consumption was based on typical per capita use and included reductions in per capita to account for water conservation practices. The majority of the manufacturing of the manufacturing is in the three major population centers of East Texas; Beaumont-Port Arthur-Orange; Lufkin-Nacogdoches and Tyler. The TWDB projections for irrigation were reviewed and the ETRWPG presented a case to increase the water needs. Livestock is not a significant water use in the Region, however, counties involved in poultry production will see an increase in demand for livestock. Deregulation of the power industry has acted as a catalyst of construction of gas turbine generation plants. Current facilities (either operational or under construction) are located in Anderson, Jefferson, Orange and Rusk counties. Projected facilities are located in Cherokee, Nacogdoches and Tyler counties. Mining has the lowest consumptive use in the region and is not expected to increase significantly.

Task 3 reviewed availability of water supplies in the region. Two sets of data were developed. The first set included development of supply quantities based on gross volume of water. Reservoir supplies were based on firm yield, run-of-river diversions were based on water rights, local sources such as stock ponds were based on historical data and groundwater was based on current models. Groundwater models available for use were based on supply of maximum and do not represent actual quantities. The ETRWPG has recommended in Task 6 that groundwater availability models be undertaken to establish better groundwater information. The second set of data developed supply quantities based on delivery limitations of the raw water source (i.e. water well pumping capacity for groundwater and pumps/canals/pipes for surface water)

The information from Task 2 and Task 3 was compared to evaluate where shortages might occur in the 50 year planning period. This comparison is made in Task 4. Strategies were evaluated to select a cost effective method for meeting the shortages. These strategies are presented in Task 5.

A summary of the information presented in Tasks 2 through 5 is presented on a county by county basis in this executive summary.

Anderson

<u>Population</u>

Projections indicate a 43% increase in population. Approximately 65% of the growth is estimated to occur in the City of Palestine.

<u>Water Demand</u>

Power plant use is the largest change in water consumption. A power plant is currently under construction. The projected changes in demand over the 50 year planning period are shown in the following table.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	10206	77%	12842	48%
Manufacturing	153	1%	208	1%
Livestock	2138	16%	2138	8%
Irrigation	484	4%	484	2%
Power	0		11209	41%
Mining	252	2%	31	0%

Water Supply

Water supply for the county includes surface water from Lake Palestine and groundwater largely from the Carrizo-Wilcox aquifer. Existing supplies are adequate to meet the demands for the 50 year planning cycle. The demand for power will be provided from Lake Palestine with contracts through the City of Palestine. Detail review of individual entities indicated a need to increase municipal supply from the Carrizo-Wilcox by 3%. With the large quantity of water available from the Queen City and Sparta aquifers, small well users that do not require higher quality of water, such as livestock, should use these aquifers wherever possible.

Angelina

Population

The population in the Angelina County area is expected to increase by 97% during the 50 year planning period. Approximately 75% of the growth is anticipated to occur in the Lufkin area.

Water Demand

The projected use of water for the planning period is indicated in the following table.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	10640	26%	17253	27%
Manufacturing	30000	73%	45000	71%
Livestock	628	1%	773	1%
Irrigation	0		0	
Power	0		0	
Mining	36	0%	64	1%

Water Supply

All water, with the exception of local surface waters for manufacturing and livestock, is supplied from groundwater, mainly the Gulf Coast aquifer. The Gulf Coast aquifer is not adequate to provide wells of the capacity required to meet the density of growth in the Lufkin area. The City of Lufkin has recently studied acquiring water rights to obtain surface water from the Sam Rayburn Reservoir. This appears to be the best strategy to meet the demands for municipal and manufacturing demands in the Lufkin area. Temple-Inland, a major manufacturer, is currently involved in the Lake Eastex project. This project could be used to meet the demands of Temple-Inland.

Cherokee

Population

Projections indicate a 44% increase in population over the planning period. In terms of actual persons, there does not appear to be a specific growth location in the County. However, there are current small entities that will see a large percent increase in population such as New Summerfield and Bullard.

Water Demand

The major change in water consumption is for power use. There are no known plans for new projects in the county. The following table provides a summary of the changes in demand during the planning period.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	10378	52%	13413	34%
Manufacturing	334	2%	541	1%
Livestock	2469	12%	2469	6%
Irrigation	1753	9%	1753	5%
Power	5000	25%	20000	51%
Mining	77	0%	883	2%

Water Supply

Information generated in this study indicates that the Carrizo-Wilcox aquifer in this county is almost fully allocated. Further study of the Carrizo-Wilcox should be made to evaluate this observation. Wherever possible, the Queen City and Sparta aquifers should be used for wells requiring low volume and less quality, such as livestock. The major water strategy for this area is to continue with the Lake Eastex project, especially if the Power usage is required. There are 11 municipal users from Cherokee County currently participating in the Lake Eastex project. These 11 users account for approximately 21% of the Lake Eastex contributors. Increase of groundwater use should be considered as a temporary measure with the development of surface water sources being the primary strategy.

Hardin

Population

Hardin County population is expected to increase by 52% during the planning period. The largest single growth area is the Lumberton area that accounts for 26% of the growth.

Water Demand

The change in water demand during the planning period is summarized in the following table.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	5811	35%	7025	37%
Manufacturing	111	1%	147	1%
Livestock	123	1%	123	1%
Irrigation	2146	13%	4420	23%
Power	0		0	
Mining	8600	51%	7475	39%

Water Supply

With the exception of local surface supplies for livestock, mining and manufacturing, the supply for Hardin County is largely from the Gulf Coast Aquifer. The City of Beaumont, located in Jefferson County, also has two well sites in Hardin County. Increase in supplies are needed for both municipal and irrigation uses. The Gulf Coast aquifer has high chloride content to a point almost contiguous with the southern boundary of Hardin County. It is most likely that municipal users will want to continue use of groundwater to avoid the expense in treating surface water. Therefore, large irrigation interest should evaluate the use of surface water as the primary source for new demands.

Henderson

Population

The population in Henderson County, in the East Texas Region, is expected to increase by 27%.

Water Demand

Although the population shows an increase, the demand associated for the population is not significant due to the "water conservation" built into the demand projections. The water use in Henderson County is indicated in the table below.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	2535	77%	2586	77%
Manufacturing	2	0%	5	0%
Livestock	731	22%	731	23%
Irrigation	0			0
Power	0			0
Mining	13	1%	14	1%

Water Supply

Water supply in Henderson County is groundwater mainly from the Carrizo-Wilcox with the exception of local livestock surface water sources. Although the demand tables do not indicate Power demands, there is discussion on for an electric plant which will utilize 942 acre-feet/year. There appears to be adequate water in the Carrizo-Wilcox to meet the demands projected for the planning period.

Houston

Population

The population in Houston County is expected to increase by 119%. Over 40% of the growth is expected to take place in the Crockett and Grapeland area of the County.

Water Demand

The expected usage of water is indicated in the following table.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	3981	58%	6217	58%
Manufacturing	206	3%	364	3%
Livestock	1901	28%	2841	27%
Irrigation	591	9%	972	9%
Power	0		0	
Mining	189	3%	417	4%

Water Supply

The Cities of Crockett and Grapeland use water from Houston County Lake through Houston County WCID No. 1. Grapeland also continues to use wells in the Carrizo-Wilcox. Houston County WCID No. 1 currently has water rights to 3500 acre-feet of the 7000 acre-feet of yield from Houston County Lake. The District should continue to pursue rights to the additional 3500 acre-feet of yield in order to meet the demands for the period. A total of demand of 5100 acre-feet per year is supplied by Houston County

Lake at the end of the planning period. Other demands will be met by the Carrizo-Wilcox, Queen City, Sparta and Other-Undifferentiated aquifers. The percent increase from current supplies for each of the aquifers is 42%, 70%, 47% and 18%, respectively. The aquifers appear to be capable of supplying water to meet the demands.

Jasper

<u>Population</u>

The expected increase in population for Jasper County is 45%. There does not appear to be a single major point of growth.

<u>Water Demand</u>

The largest single use of water in Jasper County is for the paper mill located north of Silsbee. The demand for the various users groups is shown in the following table.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	5585	9%	6525	10%
Manufacturing	56531	90%	57224	89%
Livestock	289	1%	289	1%
Irrigation	158	0%	158	0%
Power	0		0	
Mining	4	0%	4	0%

<u>Water Supply</u>

The Gulf Coast aquifer presently provides the needed supplies, with the exception of local supplies. Due to moderate growth in population and decrease in manufacturing, mainly due to "water conservation" savings built into the demand projections, the Gulf Coast aquifer should continue to meet the projected demands.

Jefferson

<u>Population</u>

The population for Jefferson County is expected to increase by 20%. There are no central areas of growth.

<u>Water Demand</u>

The demand for water in Jefferson County is largely for manufacturing and Irrigation uses. The summary for each use is presented in the following table.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	43315	9%	44171	7%
Manufacturing	158590	34%	236435	41%
Livestock	488	0%	488	0%
Irrigation	259495	56%	283972	50%
Power	3000	1%	6000	1%
Mining	216	0%	34	0%

Water Supply

Water supply is mainly from the Sam Rayburn/B.A. Steinhagen reservoirs or run-of-the river diversion from the Neches River. A limited amount of water is taken from the Gulf Coast aquifer. These current supplies are adequate to meet the demands.

Nacogdoches

Population

Population in Nacogdoches County is expected to increase by 102%. 68% of the growth is projected to occur in the City of Nacogdoches.

Water Demand

There is a significant volume increase in the municipal and power usage. Large percentage increases are expected in manufacturing and livestock.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	13614	70%	27681	61%
Manufacturing	2040	11%	4042	9%
Livestock	2150	11%	4128	9%
Irrigation	1270	7%	1270	3%
Power	0		7505	17%
Mining	261	1%	415	1%

Water Supply

Current supplies are largely obtained from the Carrizo-Wilcox aquifer, with the exception of water produced from the City of Nacogdoches Water Treatment Plant. The City of Nacogdoches currently operates a 6.75 MGD water treatment plant on Lake Nacogdoches. This treatment capacity is well below the 18,750 acre-feet/year firm yield of Lake Nacogdoches. It is expected the City will continue to expand the water treatment capacity to meet its needs as well as the manufacturing needs and needs for nearby water supply corporations. The surface water is the best strategy for meeting the high demands in a densely populated area. More remotely and sparsely populated areas are expected to continue use from the Carrizo-Wilcox.

Newton

Population

The population in Newton County is expected to increase by 43%, with 40% of the total growth in the City of Newton.

Water Demand

The largest growth will be for municipal use.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	2201	47%	2664	52%
Manufacturing	122	3%	162	3%
Livestock	82	2%	82	2%
Irrigation	2200	48%	2200	43%
Power	0		0	
Mining	37	1%	42	1%

Water Supply

The majority of the water supplied in Newton County is from the Gulf Coast aquifer. Supplies should be able to be continued from this aquifer through the planning period. The demand table did no indicate projections of Power use. However, there has been a recent contract with the Sabine River Authority to provide 13,440 acre-feet/year from the SRA canal system.

Orange

Population

The projected population increase for Orange County is 34%. The City of Orange accounts for 27% of the total growth with the remaining growth being distributed throughout the County.

Water Demand

Demand for water extends mainly from manufacturing and power use. The following table provides a summary of current and projected demands.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	13268	17%	14976	12%
Manufacturing	54349	70%	78309	60%
Livestock	126	0%	126	0%
Irrigation	4086	5%	6109	5%
Power	6000	8%	30000	23%
Mining	8	0%	9	0%

Water Supply

Approximately 90% of the manufacturing and power water supply is presently taken from surface water. All of the future water supplies for manufacturing and power use will be from surface water sources, namely through contracts with the Sabine River Authority. With the exception of one entity, all of the municipal water is from the Gulf Coast Aquifer.

Panola

Population

Panola County population is expected to increase by 8%.

Water Demands

The single largest increase in use in Panola County is for mining.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	3656	35%	3337	14%
Manufacturing	685	7%	897	4%
Livestock	2816	27%	2816	12%
Irrigation	0		0	
Power	0		0	
Mining	3245	31%	16912	70%

Water Supply

The City of Carthage obtains its water supply from Panola County Fresh Water Supply District that has rights to Lake Murvaul. Water from Lake Murvaul is also supplied for manufacturing and mining usage. The remaining usages mainly rely on water from the Carrizo-Wilcox aquifer. A review of the data in this report indicates the aquifer is fully allocated. The aquifer should not be used to fulfill large demands for water. The demand for mining is to be filled from surface waters on Toledo Bend.

Polk

Population

Polk County is shown to have a population increase of 65%.

Water Demand

Future water demands are not expected to vary differently from the current demands.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	2214	64%	2719	64%
Manufacturing	825	24%	1090	26%
Livestock	203	6%	203	5%
Irrigation	242	7%	342	6%
Power	0		0	
Mining	0		0	

Water Supply

Water supply is mainly from the Gulf Coast aquifer. There appears to be adequate water from this source to meet the demands projected in this report.

Rusk

Population

Rusk County is expected to increase population by 34%. There is no apparent single location responsible for most of the growth.

Water Demand

The single largest increase in water use is for power generation. There are also increases in municipal and manufacturing usage.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	7365	18%	7736	14%
Manufacturing	344	1%	559	1%
Livestock	1237	3%	1345	2%
Irrigation	479	1%	479	1%
Power	30000	73%	45000	82%
Mining	1498	4%	14	0%

Water Supply

Other than power usage, the single largest source of water supply is the Carrizo-Wilcox. Future development of the Carrizo-Wilcox seems favorable except in the areas of existing oil well field development, around the Henderson, New London and Mount Enterprise areas.

Both the cities of Henderson and Kilgore have recently completed construction of surface water treatment plants. The City of New London is currently involved in the Lake Eastex project. Entities near the Henderson/New London/Mount Enterprise/Kilgore area should look to obtaining water surface sources either through contract with Henderson and Kilgore or through participation in the Lake Eastex project. Entities outside this area can continue to use water from the Carrizo-Wilcox. A more detail study should be made to delineate availability of groundwater since the Carrizo-Wilcox appears to be overallocated on a county wide basis.

Current power demands are provided through Martin Lake. A power plant is currently under construction in southern Rusk County. This demand is being met with the construction of a raw water line from Toledo Bend.

Sabine

Population

Population is expected to increase by 78% in Sabine County. There is not a particular location within the County that has been designated for growth.

Water Demand

There are three major groups of users in Sabine County. The demands are outlined in the table below.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	1412	39%	2062	41%
Manufacturing	1837	50%	2427	48%
Livestock	399	11%	558	11%
Irrigation	0		0	
Power	0		0	
Mining	0		0	

Water Supply

Surface water from Toledo Bend accounts for approximately 97% of the municipal supply. The remaining supply for municipal and manufacturing is from the Carrizo-

Wilcox aquifer. Future demands can be met by increasing supplies from the existing sources.

San Augustine

Population

Population is expected to increase by 29%, with 52% of the total growth occurring in the City of San Augustine.

Water Demand

Municipal demands requiring additional supply are located in the rural communities.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	1342	62%	1508	56%
Manufacturing	0		0	
Livestock	680	31%	1017	38%
Irrigation	154	7%	154	6%
Power	0		0	
Mining	0		0	

Water Supply

The City of San Augustine relies on both groundwater and surface water from San Augustine City Lake. The remaining entities rely on groundwater sources from various aquifers. Due to the small quantity of additional demand required, it is expected that these communities will continue to develop existing groundwater sources.

Shelby

Population

Shelby County is projected to increase population by 26%. 33% of the future growth is projected to occur in Center.

Water Demand

Significant increases are expected in the manufacturing and livestock sectors.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	3381	42%	3554	23%
Manufacturing	1535	19%	3319	22%
Livestock	3142	39%	8458	55%
Irrigation	41	1%	67	0%
Power	0		0	
Mining	0		0	

Water Supply

Approximately 65% of the municipal demand is from surface water sources, Lake Center, Lake Pinkston and Toledo Bend Reservoir. 96% of the manufacturing supply is from Lake Pinkston. Livestock supplies are divided between stock ponds and groundwater.

Future municipal demands will be met by using existing sources. Manufacturing is to be supplied from Lake Pinkston or Lake Center through contracts with the City of Center. Approximately 60% of the livestock demand should be fulfilled with surface water as there is limited availability of groundwater in the Carrizo-Wilcox. Smaller livestock demands can be met with stock ponds or water wells while any large use should obtain surface water from Toledo Bend through contracts with the Sabine River Authority.

Smith

Population

The expected population increase for Smith County is 78%. Approximately 54% of the growth is in the City of Tyler. Communities near Tyler would be also be expected to see similar growth.

Water Demand

The majority of future growth is from the municipal user group.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	27135	83%	39195	85%
Manufacturing	4356	13%	5679	12%
Livestock	653	2%	653	1%
Irrigation	502	2%	502	1%
Power	0		0	
Mining	265	1%	293	1%

Water Supply

With the exception of the City of Tyler, Resort Water Service, Inc and local sources for mining and livestock, water is supplied from the Carrizo-Wilcox. The City of Tyler currently utilizes groundwater to fulfill 15% of its needs. The City of Tyler also provides approximately 75% of the manufacturing demands. The City of Tyler currently has underway a project to supply treated water from Lake Palestine. The initial phase of construction will add approximately 30 mgd capacity. In addition, four entities from Smith County; City of Arp, Jackson WSC, city of Tyler and City of Whitehouse, are current participants in the Lake Eastex project.

Where feasible, surface water supplies from the City of Tyler are designated to be the selected strategy. Smaller communities are expected to continue to utilize the Carrizo-Wilcox.

Trinity

Population

Population growth in Trinity County, located in the East Texas Planning Region, is expected to increase by 25%.

Water Demand

Little change is expected in the water demands in that portion of Trinity County located in the East Texas Region. Groveton is on the border with Region H and is included in the Region H Plan at the request of the City.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	662	71%	718	73%
Manufacturing	0		0	
Livestock	282	29%	282	27%
Irrigation	0		0	
Power	0		0	
Mining	0		0	

Water Supply

Current supplies are adequate to meet future demands.

Tyler

Population

The population increase in Tyler County is expected to be 51%.

Water Demand

The major change in expected demand is for power generation usage.

User Group	Current Demand		2050 Demands	
	Ac-Ft/Yr	% Total	Ac-Ft/Yr	% Total
Municipal	2730	89%	3311	12%
Manufacturing	36	1%	57	0%
Livestock	275	9%	275	1%
Irrigation	18	1%	18	0%
Power	0		25000	87%
Mining	0		0	

Water Supply

With the exception of local ponds, water is supplied from the Gulf Coast Aquifer. Power is recommended to be provided by the Rayburn/Steinhagen system.

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Appendix A

Upper Neches River Municipal Water Authority Strategy for Developing Groundwater to Effectively Increase Yield of Surface Water Supplies, Promote Conjunctive Use of Groundwater and Surface Water and to Have Water Resources Quickly Available for Delivery to Public Water Supply During Times of System Failures or Capacity Shortfall

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Task 1

Description of the Region

1.1 East Texas Regional Water Planning Area

The East Texas Regional Water Planning Area (ETRWPA), also known as Region I, consists of all or portions of 20 counties located in the Neches, Sabine, and Trinity River Basins, and the Neches-Trinity Coastal Basin*. The region extends from the southeastern corner of the state for over 150 miles north and northwest as illustrated in Figure 1.1. Major cities in the region include Beaumont, Tyler, Port Arthur, Nacogdoches, Lufkin and Orange. See Table 1.1 for a list of the counties.

*Approximately one square mile falls in the Cypress Creek Basin.

Table 1.1
List of Counties in Region

Entirely within Region:	
Anderson	Newton
Angelina	Orange
Cherokee	Panola
Hardin	Rusk
Houston	Sabine
Jasper	San Augustine
Jefferson	Shelby
Nacogdoches	Tyler
Partially within Region:	
Henderson	Smith
Polk	Trinity

The region contains three metropolitan areas – the Beaumont-Port Arthur-Orange area at the south end, the Lufkin Nacogdoches area central to the region and part of the Tyler area including the city of Tyler at the north end. The combined metropolitan population (as of 1996) is 519,216, or 53% of the total population of 982,662.

In terms of topography, this region is generally characterized by rolling to hilly surface features except near the Gulf Coast. In terms of ground cover, the area occupied by the counties of the region is further subdivided into areas known as the Pine Belt, the Post

Oak Belt, and the Coastal Prairies. In terms of elevation, the region varies from sea level at its southern boundary on the Gulf of Mexico to 763 ft MSL at Tater Hill Mountain in Henderson County at its far northwest corner.

Most of the region falls within the Neches River Basin, which falls within the region except for small areas in Liberty and Van Zandt counties. The region also includes most of the Texas portion of the Sabine River Basin; portions of the Trinity River basin in two counties; and the portion of the Neches-Trinity Coastal Basin in Jefferson County. Approximately one square mile of the Cypress Creek Basin lies in the northeastern portion of Panola County. Streams in all the basins tend to flow from northwest to southeast.

The Sabine and Neches Rivers flow into Sabine Lake, a natural lake just inland from the Gulf of Mexico. Sabine Lake has been a saltwater body for many decades, although it reportedly contained fresh water before ship channel excavation near the beginning of the 20^{th} century. The Trinity River flows into Trinity Bay.

Note that the Sabine River forms approximately half of the boundary between Texas and Louisiana. The river heads in the northwestern part of East Texas, outside the region, flows through Texas for the first half of its length, and then follows the state line to its mouth.

Cypress Creek *(which does not itself fall within the region)*, one county north of the region, flows east and southeast to the Red River in Louisiana.

The East Texas Regional Water Planning Group (ETRWPG), which is the governing body for this region, consists of 22 representatives protecting the interests of the public, counties, municipalities, industry, agriculture, the environment, small business, electric generating utilities, river authorities, water districts and water utilities. The Deep East Texas Council of Governments (DETCOG), located in Jasper, Texas, has been selected as the administrative contracting agency for the East Texas Region. The ETRWPG has retained the services of a team of engineering firms and other specialists to prepare the regional plan. Table 1.2 provides a list of the ETRWPG representative and the engineering team involved in developing the regional plan.

Table 1.2
ETRWPG Members
And Engineering Team

Executive Committee		
Chair	Nick Carter	
Vice-Chair	George Campbell	
2^{nd} Vice-Chair	Tom Mallory	
Secretary	LaNell Larson	
Assistant Secretary	Edward McCoy	
At-Large	Judge Carl Griffith	
At-Large	David Alders	

Table 1.2
ETRWPG Members
And Engineering Team

Continued

Voting Membership		
Public	Glenda Kindle LaNell Larsen	Retired Retired
Counties	Judge R. C. VonDoenhoff Judge C. R. Griffith	Houston County Jefferson County
Municipalities	Dick Nugent Monty Shank	City of Nederland City of Tyler
Industries	Michael Harbordt Melvin Swoboda	Temple Inland Forest Products DuPont
Agricultural	David Alders Hermon E. Reed, Jr.	Carrizo Creek Corporation Cattlemen
Environmental	J. Leon Young	Stephen F. Austin University
Small Business	Ernest Mosby Edward McCoy, Jr.	Mosby Barber Shop McCoy Funeral Home
Electric Generating Utilities	Ken Deshotel	Entergy
River Authorities	Jerry Clark John Robinson Tom Mallory	Sabine River Authority Lower Neches Valley Authority Upper Neches River MWA
Water Districts	Nick Carter	Lumberton MUD
Water Utilities	Kelly Holcomb	Angelina WSC
Others	Bill Kimbrough George P. Campbell Bart Bauer	Port of Beaumont Nacogdoches County
Non-Voting Membership		
	James Alford	County of Trinity
	J. D. Allen	Imperial-Calcasieu Regional Planning & Development Commission of Louisiana
	J. D. Beffort	Texas Water Development Board
	Leroy Burch	Region C Water Planning Group
	Cullen Curole	Louisiana Governor's Office of Coastal Activities
	William R. Heugel	County of Sabine
	Jim Hughes	County of Newton
	David Jenkins	Region H Water Planning Group
	Robert McCarthy	City of Dallas
	Jerry Mambretti	Texas Department of Parks & Wildlife
	Mendy Rabicoff	Region D Water Planning Group
	Cliff Todd	Texas Department of Agriculture
	Judge Floyd "Dock" Watson	County of Shelby

Table 1.2
ETRWPG Members
And Engineering Team

Continued

Engineering Team		
	Schaumburg & Polk, Inc.	Lead Engineers
	Freese & Nichols, Inc.	Subconsultant
	Alan Plummer and Associates	Subconsultant
	Everett Griffith & Associates	Subconsultant
	LBG Guyton & Associates	Groundwater Specialists
	Bob Bowman & Associates	Public Relations
	Texas A & M University	Agricultural Specialists

1.2 Physical Subregions

Piney Woods. The majority of East Texas Regional Water Planning Group falls within the Pine Belt (or "Piney Woods") portion of the Texas Gulf Coastal Plains. Pine is the predominant timber of this region, although some hardwood timbers can be found interspersed amongst the pines and in the valleys of rivers and creeks. Longleaf, shortleaf, and loblolly pine are native to the region and slash pine (an introduced species) is widely known. Hardwoods include a variety of oaks, elm, hickory, magnolia, sweetgum, and blackgum. Lumber production is the principal industry of the area and practically all of Texas' commercial timber production comes from the Piney Woods region.

The soils and climate are adaptable to the production of a variety of fruit and vegetable crops. Cattle raising is widespread and is generally accompanied by the development of pastures. Economic growth in the area has also been greatly influenced by the large oil field which was discovered in Rusk and Smith Counties in 1931, and iron deposits are also worked in Rusk County. This area has a variety of clays, lignite coal, and other minerals that have potential for development.

Post Oak Belt. The extreme northwestern portion of the region (parts of Smith, Henderson, and Anderson Counties) falls within the Post Oak Belt portion of the Texas Gulf Coastal Plains. Principal trees of this area are hardwoods such as post oak, blackjack oak, and elm. The areas around streams often have growths of pecan, walnuts, and other trees which have high water demands. Area upland soils are sandy and sandy loam, while the bottomlands are sandy loams and clays. The Post Oak Belt is somewhat spotty in character, with some insular areas of blackland soil and others that closely resemble those of the Pine Belt. The principal industry of the area is diversified farming and livestock raising. The Post Oak Belt also has lignite, commercial clays, and some other minerals.

Coastal Prairies. The southern portion of the region (large sections of Jefferson and Orange Counties) is located within the segment of the Texas Gulf Coastal Plains known as the "Coastal Prairies." In general, this area is covered with a heavy growth of grass and the line of demarcation between the prairies and the Pine Belt forests is very distinct. The soil is heavy clay. Cattle ranching is the principal agricultural industry, although significant rice production is also present. The Coastal Prairie has seen a large degree of industrial development since the end of World War II. The chief concentration of this development has been from Orange and Beaumont to Houston, and much of the development has been in petrochemicals.

1.3 Climate

Data from the National Oceanic and Atmospheric Administration state climatologist indicates that the mean temperatures for the entire region varied from a minimum January temperature of 36 degrees Fahrenheit to a maximum July temperature of 93 degrees Fahrenheit. Similarly, the average growing season for the entire East Texas Regional Water Planning Group area was 247 days.

Precipitation and runoff generally increase from the northwest to southwest corners of the region, while evaporation increases in the opposite direction. Annual rainfall across the entire East Texas Regional Water Planning Group area averaged 48.7 inches, with the highest annual rainfall (58.3 inches) being recorded for Orange County and the lowest annual rainfall (38.9 inches) being recorded for Angelina County. Average annual runoff ranges from approximately 10 inches in the northwest to 17 inches in the southeast. Average annual gross reservoir evaporation *(the rate of evaporation from a reservoir)* ranges from approximately 41 inches in the southeast to 55 inches in the northwest.

Figures 1.2 through 1.4 depict average annual precipitation, runoff, and evaporation respectively for the entire state, including the East Texas Region.

1.4 Population

The population in the region increased approximately 11 percent from 1980 through 1996 to approximately 980,000 people. Projected year 2000 population is approximately 1.04 million. Growth in the region is expected to continue with approximately 1.56 million by the year 2050. The most recent historical data (1996), and projected year 2000 and 2050 population for the major cities located in the region are provided in Table 1.3. Major cities are defined as cities that contained at least two percent of the region's total population in 1996, or approximately 20,000. Refer to Appendix A for historical population data obtained from TWDB.

Table 1.3
Current and Projected Population
Of Major Cities

City	1996[1]	2000[2]	2050[2]
Beaumont	115,457	126,374	159,648
Tyler	81,294[3]	86,694[3]	149,806[3]
Port Arthur	58,232	62,646	72,126
Nacogdoches	32,587	36,709	80,574[3]
Lufkin	32,574	36,684[3]	94,013[3]
Orange	19,551	20,317	28,691
Region Total	***982,662***[3]	***1,040,503***[3]	***1,560,997***[3]
State Total	***19,128,261***	***20,230,384***	***36,670,967***

[1] Data obtained from TWDB historical records for the East Texas Regional Water Planning Groupncluding estimates from the years 1991 through 1996, except where noted otherwise.
[2] Data based on Regional Population Projections in Texas, TWDB, prepared before the 1996 estimates were available, except where noted otherwise.
[3]Population figures revised to match the requested Task 2 revisions.

See Figure 1.5 for 1996 population distribution by county.

The population figures above reflect the TWDB projections which have been made available for this study as of October 1999, along with the concurrent revisions for some communities approved by the TWDB in November 1999 after being submitted as part of Task 2 in October 1999.

Data from the United States Bureau of the Census count of 1990 indicates that the racial make-up of the population within the East Texas Regional Water Planning Group was approximately 71.6% white, 20.0% black, 0.3% American Indian, 0.8% Asian, and 2.5% from other races. Out of that number, the data indicates that approximately 4.8% of the population was of Hispanic ethnicity.

According to the 1990 census count, the most populous county in the region was Jefferson with a population of 239,397 people and the least populous county was San Augustine with a total population of 7,999 people. Information from the State Data Center of the Texas Department of Commerce for 1998 (as prepared by the Department of Rural Sociology at Texas A & M University and recorded in the Millennium Edition of the Texas Almanac) indicates sustained growth throughout the region since the 1990 census. Based on those population estimates, all counties in the region showed an average growth of 9.3% over the period between 1990 and 1998.

The largest percentage increase was noted for Polk County, whose population was estimated to have increased by 38.7% between 1990 and 1998. However, since portions of Polk County are located outside of the region area, it is somewhat difficult to determine how much of this growth is specifically applicable to this study. Out of those counties with their entire area located within the region, the largest percentage growth was indicated for Tyler County, whose population was estimated to have increased by 18.9% between 1990 and 1998. The lowest percentage growth was indicated for Houston County, whose population was estimated to have increased by only 3.5% between 1990 and 1998.

1.5 Economic Activities

The overall economy of the region consists primarily of agriculture, agribusiness, mineral production, wholesale and retail trade and varied manufacturing, particularly the timber and petrochemical industries. Major water-using industries and irrigated crops are listed in Table 1.4.

Table 1.4
Major Water Uses

Industries	Crops
Petroleum Refining	Rice
Chemical and Allied Products	Soybeans
Lumber and Wood	Hay/Alfalfa
Food and Kindred	Vegetables
Power Generation	Cotton

The Beaumont-Port Arthur-Orange metropolitan area, at the south end of the region, has an economy based primarily on petroleum refining and chemical plants including petrochemicals. Other industries include a steel mill and paper mills, as well as other timber products industries in Hardin County. Many Hardin and Orange County residents work at a paper mill in adjacent Jasper County. There are several seaports (Beaumont, Port Arthur, and Orange plus several industrial ports), along with small amounts of shipyard activity. Industrial construction, including $3 billion in Jefferson County since 1997, has provided a significant amount of local employment in recent years. The three major cities each contain a campus of Lamar University. Agriculture in the area includes cattle, rice, and soybeans. Oil and gas production are significant.

The Tyler metropolitan area, consisting of Smith County, lies partially within the north end of the region. Tyler, the only major city in the area, lies almost entirely within the region. Local manufacturing includes air conditioning/heating units, cast iron pipe, tires, and signs. However, the area is largely a commercial, educational, and medical center. Oil production and rose farming are prevalent in the area.

Lufkin and Nacogdoches, the other major cities in the region, do not presently fall in metropolitan areas but would do so by 2020 according to the population projections above. These cities, located in counties adjacent to each other, have many similarities including timber products industries, poultry processing, and higher education. Lufkin also has a foundry and a truck trailer manufacturer, while Nacogdoches has manufacturers of valves, transformers, sealing products, and motor homes.

The remainder of the region is largely forested and has various timber industries including paper mills. Oil production is scattered throughout the region, and beef cattle are prominent, being found in all of the counties in the region. Plant nurseries are common in the north part of the region. Poultry production and processing are prevalent in Shelby and Nacogdoches Counties and very significant in Angelina and Panola Counties. There is diverse manufacturing in addition to timber industries. Tourism is important in many areas, especially on large reservoirs; in the south end of the region near Sabine Lake and the Gulf of Mexico; in many timbered areas which offer hunting opportunities; and at various colleges and universities which have athletic events and other attractions.

The information from the Texas Department of Commerce, cited above for the population discussion, indicated that an average of 6.9% of the total workforce was unemployed throughout the region, with the highest unemployment (12.1%) occurring in Newton County and the lowest unemployment (4.1%) in Henderson County. Similarly, the average weekly wage for the total region was $442.38 per week, with the highest average wage ($571.96 per week) in Jefferson County and the lowest average wage ($351.99 per week) in San Augustine County.

1.6 Sources of Water

Groundwater. The Texas Water Development Board has identified two major aquifers and two minor aquifers in the region. The difference between the major and minor classification as used by the TWDB relates to the total quantity of water produced from an aquifer and not the total volume available.

The two major aquifers that underlie the region are known as the Carrizo-Wilcox and the Gulf Coast Aquifer. The two minor aquifers, the Queen City and Sparta aquifers, supply lesser amounts of water to the region. Figures 1.6 and 1.7 show locations of the major and minor aquifers respectively. The figures show the entire region to be underlain with aquifers, except for narrow belts across the middle of the region and in the coastal area.

Groundwater supplied approximately 25 percent of the total water used in the region in 1996.

The following generalized descriptions of the major and minor aquifers are based largely on the work of TWDB. A more thorough discussion of these aquifers, especially as it relates to water supply availability, will be provided in the Task 3 report.

Gulf Coast Aquifer. The Gulf Coast Aquifer forms an irregularly shaped belt along the Gulf of Mexico from Florida to Mexico. In Texas, the aquifer provides water to all or parts of 54 counties and extends from the Rio Grande northeastward to the Louisiana-Texas border. Figure 1.6 indicates the location of the Gulf Coast aquifer in the region. The Gulf Coast aquifer provides the sole source of groundwater in the seven southern counties of the region.

Total pumpage from the Gulf Coast aquifer in the region averaged approximately 93,274 acre-feet per year (ac-ft/yr) during 1995, 1996 and 1997. Heavy municipal or industrial pumpage has caused an updip migration, or saltwater intrusion, of poor quality water into the aquifer, especially in central and southern parts of Orange County. The heavy pumping has also resulted in significant declines in water levels in portions of the aquifer. Some of these declines have resulted in significant land-surface subsidence, especially in the nearby Houston-Galveston area.
With the exception of an area in the northeast part of the aquifer in southern Jasper and Newton counties, previous evaluations have determined that the Gulf Coast Aquifer will continue to be a viable water supply to meet the projected groundwater demands through the year 2050.

Carrizo-Wilcox Aquifer. The Carrizo-Wilcox Aquifer is formed by the hydrologically connected Wilcox Group and the overlying Carrizo Formation of the Claiborne Group. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana, providing water to all or parts of 60 counties in Texas. Figure 1.6, which shows the extent of the Carrizo-Wilcox aquifer in the region, illustrates that the Carrizo-Wilcox aquifer in the region occurs as a major trough caused by the Sabine Uplift near the Texas-Louisiana border.

Total groundwater pumpage from the Carrizo-Wilcox in the region averaged 76,607 acre-feet per year (ac-ft/yr) during 1995, 1996 and 1997. The largest urban areas dependent on groundwater from the Carrizo-Wilcox are located in central and northeast Texas and include the ETRWP Area cities of Lufkin (Angelina County), Nacogdoches (Nacogdoches County), and Tyler (Smith County). Wells yields of greater than 500 gpm are not uncommon.

Significant water-level declines have occurred in the region around Tyler and the Lufkin-Nacogdoches area. In some wells, declines in the artesian portion of the Carrizo-Wilcox in this area have exceeded 200 feet. However, evaluation of 46 Carrizo-Wilcox wells scattered throughout the region that have been monitored since the 1960's indicates that the average water level decline from the 1960's to the 1990's is about 51 feet and ranges from –20 feet to 263 feet.

Much of this pumpage has been for municipal supply, but industrial pumpage is also significant, especially for the paper mill northeast of Lufkin. However, pumpage from these industries has generally declined since the 1980's. Total pumpage from the Carrizo in Angelina and Nacogdoches counties has decreased since the 1980's and therefore, water levels have stabilized in these areas. In some wells, water levels have actually increased, although the wells are still being utilized.

Sparta Aquifer. The Sparta Aquifer extends in a narrow band across the state from the Frio River in South Texas northeastward to the Louisiana border in Sabine County. The extent and distribution of the Sparta Aquifer in the region is shown in Figure 1.7. The Sparta Formation is part of the Claiborne Group deposited during the Tertiary Period and consists of sand and interbedded clay with more massive sand beds in the basal section. Yields of individual wells are generally low to moderate, although most high-capacity wells average 400 to 500 gpm. Because the Carrizo aquifer underlies the Sparta, most public water supply wells and other large production wells are completed in the Carrizo, thus limiting the total pumpage from the Sparta.

The Sparta Aquifer produces water of excellent quality throughout most of its extent in the region; however, water quality deteriorates with depth in the downdip direction. Relatively large amounts of usable quality groundwater are contained within the rocks of the Sparta Aquifer. Historically, availability has been considered 5 percent of the average annual rainfall on the aquifer in the Neches and Sabine River basins.

Queen City Aquifer. Like the Sparta, the Queen City Aquifer extends in a band across most of Texas from the Frio River in South Texas northeastward into Louisiana. The extent and distribution of the Queen City Aquifer in the region is shown is Figure 1.7. The Queen City Formation is composed mainly of sand, loosely cemented sandstone, and interbedded clays. Although large amounts of usable quality groundwater are contained in the Queen City, yields are typically low, but a few exceed 400 gpm.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent, however, quality deteriorates with depth in the downdip direction. In the Neches, Sulphur, Sabine, and Cypress Creek basins, availability from the Queen City Aquifer based on recharge has been estimated at 5 percent of average annual precipitation. Because of the relatively low well yields, overdrafting of the aquifer has not occurred.

Springs. There are over 250 springs of various sizes documented in the region (Brune, 1981). Most of the springs discharge less than 10 gpm and are inconsequential for planning purposes. Based on discharge measurements collected mainly in the 1970's, approximately eight springs in the region discharge between 20 and 200 gpm and there are two springs that discharge between 200 and 2000 gpm. Records from Indian Springs, located about 5 miles (8 kilometers) northwest of Jasper in Jasper County, indicate a discharge of over 7.7 million gallons per day on February 20, 1978.

The Brune reference[27] does not indicate that any of the springs are used for water supply. The Jasper County spring was used as source water for a local TPWD fish hatchery in the 1970's.

Surface Water. Surface water for the region is currently provided by a number of water supply reservoirs in all three river basins. Refer to Figure 1.8 for reservoir locations. Table 1.5 contains pertinent data for the major water supply reservoirs in the region including eleven in the Neches River Basin, three in the Sabine River Basin and one in the Trinity River Basin. Surface water accounted for approximately 75 percent of the total water used in the region in 1996.

Table 1.5
Major Water Supply Reservoirs

Reservoir Name	Owner	Conservation Pool Elevation (ft. msl)	Area (ac)	Capacity (ac-ft)	Firm Yield (ac-ft/yr)(1)
Neches River Basin:					
Eastex Reservoir[2]	ANRA	315	10,000	187,839	85,000
Lake Athens	Athens MWA		1,520	32,690	7,100
Lake Jacksonville	City of Jacksonville	422	1,320	30,500	5,000
Lake Nacogdoches	City of Nacogdoches	279	2,219	41,140	22,000
Lake Naconiche[2]	Nacogdoches County	348	692	8708	7665[3]
Lake Palestine	Upper Neches River MWA	345	25,560	411,300	212,700
Lake Pinkston	City of Center	298	523	7,380	3,800
Lake Tyler/Tyler East	City of Tyler	375.4	4,880	73,700	38,500
Sam Rayburn	Corps of Engineers	164.4	114,500	2,898,300	820,000
B. A. Steinhagen	Corps of Engineers	83	13,700	94,200	131,800
Striker Creek Reservoir	Angelina-Nacogdoches WCID No. 1	292	2,400	26,960	20,600
Sabine River Basin:					
Lake Cherokee[4]	Cherokee Water Company	280	3,987	46,700	22,500
Lake Murvaul	Panola Co. FWSD No. 1	265	3,800	45,815	22,400
Toledo Bend Reservoir[5]	SRA	172	181,600	4,472,900	750,000
Trinity River Basin:					
Houston County	Houston Co. WCID No. 1	260	1,282	19,500	7,000

[1] Firm yield from Individual Water Rights for East Texas Regional Water Planning Group: Permitted and Actual Use, TWDB, unless otherwise noted.
[2] Eastex Reservoir and Lake Naconiche are permitted but not yet constructed.
[3] Firm yield for Lake Naconiche estimated.
[4] Lake Cherokee lies partially in Gregg County outside the region.
[5] Capacity and yield information obtained from SRA.

1.7 Water Providers

Table 1.6 provides a summary of the municipal water distributed for use in 1996 in the ETRWPA by end-supplier entity type. End-supplier entities are those entities that ultimately distribute water to the population for consumption. More detailed information is provided in Appendix B.

Table 1.6
Municipal End-Suppliers

Type of Entity[1]	Number of Entities	1996 Total Use (ac-ft)
Federal Agencies	2	12
Authorities[2]	1	128
Districts[3]	18	7386
Municipalities	63	122,472
Private[4]	117	11,003
Institutions[5]	16	5179
Water Supply Corporations	101	17,704
Total	***318***	***163,884***

1 Information in Appendix B is provided in seven tables for different classifications recognized by the Texas Water Development Board. The tables were compiled using the name of each entity to indicate the classification of that entity.

2 Upper Jasper County Water Authority, which appears to function as a large rural water district.

3 Various types of water districts.

4 Includes nonprofit property owners associations.

5 For this region, includes state facilities (prisons, hospitals, schools, other); country clubs; church encampments; parks; and school district.

Major water suppliers, as defined by the ETRWPG, are listed in Table 1.7, with addresses and contact information in Table 1.8. These suppliers, including river authorities, are the primary source of water for many of the end suppliers.

Angelina and Neches River Authority (ANRA). ANRA, headquartered in Lufkin, has jurisdiction over the middle portion of the Neches basin including the Angelina basin, as well as the portions of Jasper and Orange Counties in the Neches basin. ANRA holds the permit for the not yet constructed Eastex Reservoir, with rights to approximately 85,500 ac-ft/yr for distribution. ANRA serves as the lead agency in the Neches River Basin for the Clean Rivers Program.

City of Beaumont. The City draws water from two sources in roughly equal amounts. The three Loeb wells are located in southern Hardin County a short distance north of the City. The City also draws surface water from the Neches River at either of two points upstream from its water treatment plant. A portion of the raw water is transmitted to a refinery south of the City. The rest of the water is treated and fed into the City water system. Water in the system, whether from the wells or from the river, is used for in-City municipal customers; for various industries inside and outside the City; for wholesale customers including two nearby water districts; and for state, federal, and county correctional facilities south of the City. The City holds rights to 49,897 acre-feet per year from the Neches River.

City of Center. The City of Center currently obtains water from Lake Center and Lake Pinkston for use within the City and for distribution to its municipal and industrial customers. Wholesale customers include two water supply corporations partially supplied by the City, while local industries include a poultry plant, a hardwood flooring plant, and manufacturers of shelters and portable cooling equipment. The City owns and operates Lake Center, with annual rights to 1,460 acre-feet of municipal water. Water from Lake Pinkston is pumped from the Neches River Basin to the City, located in the Sabine River Basin. The City holds rights to 3,800 acre-feet per year of water in Lake Pinkston.

City of Jacksonville. The City draws water partially from wells and partially from Lake Jacksonville, from which it holds water rights of 5,000 acre-feet per year. *(The City also holds a total of 1200 acre-feet per year of water rights in Lake Acker.)* The City supplies several wholesale customers including the Afton Grove, Craft-Turney, Gum Creek, North Cherokee, and West Jacksonville Water Supply Corporations. The City also supplies water to local industries including feed mills, candy manufacturing, meat packing, timber products, furniture manufacturing, and metal industries.

City of Lufkin. The City currently draws its water from wells, but is securing funding for a surface water treatment plant on Sam Rayburn Reservoir to supplement the groundwater supply. In addition to its own municipal customers, the City supplies water to a number of industries as well as two wholesale entities – Burke Water Supply and the Angelina Fresh Water District.

City of Nacogdoches. The City draws part of its supply from wells located in and near the City, with the remainder coming from Lake Nacogdoches ten miles west of the City *(water rights of 22,000 acre-feet per year)*. An increasing percentage of the water comes from the lake as water demand increases and the wells approach the end of their useful life. The City supplies water to its own municipal customers, including SFA University and several hundred retail customers outside the City. The City also supplies various industries in and near the City.

Outside wholesale customers supplied by the City on a full time basis include one water district, three water supply corporations, and a property owners association. Two other water supply corporations are interconnected for emergency use.

City of Port Arthur. The City draws all of its water supply from the LNVA canal system which extends to the City. After treating the water in its newly constructed plant, it supplies water to a wholesale customer and to various nearby industries, some of which use City water only for domestic use.

City of Tyler. The City draws water partially from wells but primarily from nearby Lake Tyler and Lake Tyler East, which are interconnected by a channel so as to function as one lake. The City supplies a number of local industries including steel fabrication, plastics industries, machine shops, timber industries, air conditioners, food industries, industrial gases, signs, trailers, concrete products, tires, fishing lures, oil and gas refining, asphalt, soft drinks, iron pipe, refractory materials, and automotive equipment. The City also supplies several wholesale customers including the City of Whitehouse.

An older and smaller City lake, Lake Bellwood, provides raw water for two golf courses and for a tire manufacturer.

The City's water rights include 40,000 acre-feet per year from Lake Tyler/Tyler East and 2000 acre-feet per year from Lake Bellwood. The City also has contractual rights to 60 acre-feet/year from Lake Palestine.

Houston County WCID No.1. This district owns and operates Houston County Lake northwest of Crockett. The District has no retail customers other than one industry, but supplies water to several wholesale customers in the county. These customers consist of three cities (Crockett, Grapeland, and Lovelady) and Consolidated Water Supply Corporation. Consolidated WSC has a multicounty service area which includes over half of Houston County. The WSC has several thousand connections in Houston County as well as connections in neighboring counties.

The Cities of Grapeland and Lovelady have one well each to supplement the wholesale water supply, while the WSC has seven wells within the county. The City of Crockett is presently entirely dependent on the Lake Houston water.

The District has a 3 mgd surface water plant with water rights to 3,500 acre-feet/year.

Huntsman Chemical. Huntsman purchased several chemical plants in southern Jefferson County from Texaco Chemical several years ago. Most of the Huntsman plants draw water directly from the LNVA canal system. One of the plants, known as Plant C4 *(one of the old Neches Butane plants)*, located near Port Neches, resells a portion of the water to the Ameripol Synpol plant near Port Neches.

Lower Neches Valley Authority (LNVA). Formed in 1933, LNVA has rights to a total of 1,201,876 acre-feet per year from Sam Rayburn Reservoir and Lake B. A. Steinhagen *(both owned and operated by the Corps of Engineers)*. LNVA draws water from the Neches River downstream from the two lakes as well as from Pine Island Bayou. LNVA distributes through its canal system approximately 1.2 million ac-ft annually to cities, industries, and farmers in the Southeast Texas area. In particular, LNVA provides water for most of the cities in Jefferson County including Port Arthur.

Table 1.7
East Texas Region
Major Water Providers[1, 2]

Entity Name	1997 Municipal Water		1997 Industrial Water		Number of Customers	
	Amount Used (af/y)	Amount Sold (af/y)	Amount Used (af/y)	Amount Sold (af/y)	Municipal	Industrial
ANRA[3]	NA	NA	NA	NA	NA	NA
City of Beaumont	25,667	86	0	501	3	20
City of Center	3,018	181	0	1,456	2	5
City of Jacksonville	4,868	1,050	0	523	5	19
City of Lufkin	8,161	338	0	2,602	2	11
City of Nacogdoches	6,179	305	0	1,141	5	12
City of Port Arthur[4]	13,986	4	0	4,249	1	13
City of Tyler	21,155	638	0	2,352	3	18
Houston County WCID No.1	0	1,734	0	121	4	1
Huntsman Chemical[4]	0	0	3,651	259	0	1
LNVA	0	22,361	0	130,820	7	18
Motiva Enterprises[4]	0	0	18,054	418	0	2
Panola County FWSD	0	2,246	0	0	1	0
SRA	0	1,528	0	56,568	6	9
Upper Neches River MWA	0	3,637	0	0	2	0

[1] Major water providers are defined as entities who supply over one million gallons per day to users other than their own retail customers.
[2] Data are from the 1997 TWDB historical use records.[3] The ANRA is the permit holder for Lake Eastex; the reservoir has not yet been constructed.[4] The City of Port Arthur, Motiva, and Huntsman obtain all of their water from the LNVA through its canal system and resell some of the water.

Table 1.8
East Texas Region

Contact Information for Major Water Providers

Entity Name	Address	Telephone*	Contact Person
Angelina and Neches River Authority	P. O. Box 387 Lufkin, Texas 75902-0387	936/632-7795	Kenneth Reneau, Manager
City of Beaumont	P. O. Box 3827 Beaumont, TX 77704-3827	409/866-0026	Joe Majdalani, Water Utilities Director; Mark Goad, Assistant
City of Center	P. O. Box 1744 Center, TX 75935-1744	936/598-2055	Frank Simpson, City Manager
City of Jacksonville	P. O. Box 1390 Jacksonville, TX 75766-1390	903/586-3510	Mayor Tommy Dement; Kerry Cummings
City of Lufkin	P. O. Drawer 190 Lufkin, TX 75901-0190	936/633-0239	C. G. Maclin, City Manager
City of Nacogdoches	P. O. Drawer 630648 Nacogdoches, TX 75963-0648	936/564-5046	J. C. Hughes, City Manager
City of Port Arthur	P. O. Box 1089 Port Arthur, TX 77641-1089	409/983-8225	Steve Fitzgibbons, City Manager
City of Tyler	P. O. Box 2039 Tyler, TX 75710-2039	903/531-1239	Monty Shank
Houston County WCID No.1	P. O Box 1246 Crockett, Texas 75835-1246	936/544-3985	John Schenette, Manager
Huntsman Chemical	P. O. Box 847 Port Neches, Texas 77651-0847	409/724-4700	Ron Franklin, Plant Manager
Lower Neches Valley Authority	P. O. Box 5117 Beaumont, TX 77726-5117	409/892-4011	Robert Stroder, Manager
Motiva Enterprises	P. O. Box 712 Port Arthur, Texas 77641-0712	409/989-7001	Mike Killian
Panola County FWSD	Rt. 4, Box 242 Carthage, TX 75633-9421	903/693-6562	Harry Smith, Manager
Sabine River Authority*	P. O. Box 579 Orange, Texas 77631-0579	409/746-3286	Jerry Clark, Manager
Upper Neches River Municipal Water Authority	P.O. Box 1965 Palestine, TX 75802-1965	903/816-2237	Tom Mallory, Manager

* SRA operates Toledo Bend Reservoir jointly with Sabine River Authority of Louisiana, 15901 Texas Highway, Many, La 71449-5718, phone (318) 256-4112 or toll free (800) 259-LAKE (259-5253). Each authority sells water only to entities in its own state.

In addition to most of the lower portion of the Neches River Basin, the LNVA has jurisdiction over the Neches-Trinity Coastal Basin. The agency is headquartered in Beaumont.

Motiva Enterprises. Motiva operates a refinery near Port Arthur *(originally Texaco, then Star Enterprise before creation of Motiva)*. The refinery draws water from a reservoir supplied by the LNVA canal system. After treating the water for industrial use, it sells a portion of the water to the adjacent Huntsman Chemical Plant *(formerly Texaco Chemical)*.

Panola County Fresh-Water Supply District No. 1 (Panola County FWSD 1). The Panola County FWSD 1 owns and operates Lake Murvaul in the ETRWPA. Created in 1953, the district provides water exclusively to the City of Carthage from its rights to 21,280 acre-feet of municipal water and 1,120 acre-feet of industrial water in Lake Murvaul. Several other entities draw water from the lake.

Sabine River Authority (SRA). SRA, created in 1949 by the Texas Legislature, was originally formed as a conservation and reclamation district. SRA is responsible for controlling, storing, preserving and distributing the waters of the Sabine River and its tributaries throughout the Texas portion of the Sabine River Basin for beneficial use. SRA also serves as the lead agency for implementation of the Clean Rivers Program in the basin. The administrative headquarters are in Orange.

Within the region, the SRA owns and operates Toledo Bend Reservoir jointly with the Sabine River Authority of Louisiana. SRA supplies raw water via contracts with municipalities, water-supply corporations and industrial users in Texas. SRA holds rights to approximately 750,000 ac-ft/yr in the reservoir, which was constructed with equal participation between the two agencies.

The SRA also hold run-of-the-river rights, which are associated with SRA's Canal System. Those rights include 100,400 acre-feet/year for municipal and industrial use, and 46,700 acre-feet/year for irrigation use.

Upper Neches River Municipal Water Authority (UNRMWA). UNRMWA, headquartered at Lake Palestine, was created in 1953, and is the owner and operator of Lake Palestine. UNRMWA hold rights to some 238,000 ac-ft/yr in Lake Palestine, from which it distributes raw water to municipalities and other contract buyers in the region. It should be noted that the City of Dallas, located in the Trinity River Basin and Region C, has a contract to import 114,337 acre-feet from Lake Palestine. The City anticipates constructing the necessary importation facilities by 2015.

1.8 Current Water Demands

Table 1.9 provides a summary of population and water use data from 1996 for the region, as well as projected data for 2000 and 2050 developed by the TWDB. Refer to Appendix A for historical population and water use data. Actual use by water right (greater than or equal to 1,000 acre-feet) for the period from 1994 to 1996 is provided in Appendix C. Complete water rights listings for the region are provided in Appendix D.

Water for agricultural (irrigation and livestock) and industrial (manufacturing, power generation and mining) uses represented the largest water-use categories in the region, accounting for 37 and 41 percent of the total regional water use, respectively, in 1996. Municipal use accounted for 22 percent of the total water used in 1996.

Table 1.9
Historical and Projected Population and Water Use[1]

Category	1996	2000	2050	% Change 2000-2050
Population	982,662	1,041,503	1,560,997	+49.9
% of State Total	***5.13***	***5.14***	***4.25***	
Municipal Use[2]	164,734	171,358	219,417	+28.0
Manufacturing Use	247,305	312,056	436,465	+40.0
Power Generation Use	36,124	44,000	133,505	+203.4
Mining Use	13,756	14,701	26,607	+81.0
Irrigation Use	249,283	273,619	302,800	+10.7
Livestock Use	18,674	20,813	29,795	+43.2
Total Use	729,876	836,547	1,148,589	+37.3
% of State Total	***4.36***	***5.04***	***6.26***	

1 Water use in acre-feet per year.
2 Composite municipal use (below normal rainfall, expected and advanced conservation), as well as other categories of use, were developed by TWDB and modified to reflect approved revisions per Task 2

1.9 Agricultural and Natural Resources

General. The primary natural resource in the region is timber. An abundance of pine and hardwood forests is evidenced by the numerous national and state parks and forests including the Angelina National Forest, Big Thicket National Preserve, Davy Crockett National Forest and Sabine National Forest.

Groundwater should be considered a primary resource for the region. Other natural resources include oil, natural gas, sand and gravel, lignite, salt and clay.

Wetlands. Wetlands are areas characterized by a degree of flooding or soil saturation, hydric soils, and plants adapted to growing in water or hydric soils.[1] Wetlands are beneficial in several ways; they provide flood attenuation, bank stabilization, water-quality maintenance, fish and wildlife habitat, and opportunities for hunting, fishing, and other recreational activities.[1] There are significant wetland resources in the region, especially near rivers, lakes, and reservoirs. Figure 1-9 shows large wetland areas near Sabine Lake; along the Trinity, Neches, Angelina, and Sabine Rivers; along Village Creek and its tributaries; around Lake Palestine; and along tributaries to the Sabine River.

Figure 1.10 (a), taken from a U.S. Fish and Wildlife Service (USFWS) study,[2] shows the density of wetlands in the coastal part of the region. The USFWS study area, shown in Figures 1.10 (a-c), covered Jefferson and Orange Counties, most of Hardin County, the southern third of Jasper County, and the southern two-thirds of Newton County.

Texas wetlands types and characteristics are summarized in Table 1.10. Most Texas wetlands are palustrine bottomland hardwood forests and swamps, and most of the state's palustrine wetlands are located in the flood plains of East Texas rivers.[1] Table 1.11 shows the bottomland hardwood acreage associated with the four major rivers in the region.

Table 1.10
Texas Wetland Types and Characteristics

Wetland Classifications	Definition	Vegetation/Habitat Types
Palustrine	Palustrine wetlands are freshwater wetlands in which vegetation is predominantly trees; shrubs; emergent, rooted herbaceous plants; or submersed/ floating plants.[1] Palustrine wetlands can also refer to intermittently to permanently flooded open-water bodies of less than 20 acres in which water is less than 6.6 feet deep.[2]	Predominantly trees; shrubs; emergent, rooted herbaceous plants; or submersed/floating plants.[1]
Estuarine	Estuarine wetlands are tidal wetlands in low-wave-energy environments where the salinity of the water is greater than 0.5 parts per thousand (ppt) and is variable due to evaporation and mixing of freshwater and seawater.[1]	Emergent plants; intertidal unvegetated mud or sand flats and bars; estuarine shrubs; subtidal open water bays (deep water habitat).[2]
Lacustrine	A lacustrine system includes wetlands and deepwater habitats with all of the following characteristics[3]: (1) situated in a topographic depression or in a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30% areal coverage; (3) total area exceeds 20 acres.	One or more of the following: nonpersistent emergent plants, submersed plants, and floating plants.[2]
Riverine	Riverine wetlands are freshwater wetlands within a channel, with two exceptions[138]: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with salinity greater than 0.5 ppt.	One or more of the following: nonpersistent emergent plants, submersed plants, and floating plants.[2]

Table 1.10
Texas Wetland Types and Characteristics

Wetland Classifications	Definition	Vegetation/Habitat Types
Marine	Marine wetlands are tidal wetlands that are exposed to waves and currents of the Gulf of Mexico and to water having salinity greater than 30 ppt.[2]	Intertidal beaches, subtidal open water (deep water habitat).[2]

Table 1.11
1980 Geographical Distribution of Bottomland Hardwood Associated With Selected Rivers*

River	Area (acres)	Amount Located in East Texas Region
Trinity River	305,000	Small portion
Neches River	257,000	Almost all
Sabine River	255,000	Approximately half of the Texas portion of the Sabine River Basin is located in East Texas Region.
Angelina River	88,000	All

*Information from [4]

The TPWD, in a study of natural resources in Smith, Cherokee, Rusk, Nacogdoches, and Angelina Counties,[5] found the most extensive wetlands in the study area were water oak-willow oak-blackgum forests along the Neches, Angelina, and Sabine Rivers. In the same study, TPWD noted the presence of a significant bald cypress-water tupelo swamp along the Neches River in Angelina County.[5] TPWD identified specific stream segments in the region that they classify as being priority bottomland hardwood habitat;[6] these segments will be discussed in later sections.

TPWD reviewed bottomland hardwood areas which would be impacted by the development of new reservoirs recommended by the Texas Water Development Board (TWDB) in the 1984 state water plan.[7] Table 1.12 shows the bottomland hardwood areas that would be impacted in the region.

Table 1.12
Bottomland Hardwood Areas
Which Would Be Impacted By Reservoir Development*

Reservoir Site	Stream	Counties	Acreage
Eastex	Mud Creek	Cherokee	3,500
Rockland	Neches River	Angelina, Trinity, Polk, Tyler, Jasper	27,300
Weches	Neches River	Anderson, Cherokee, Houston	18,000
Bon Weir	Sabine River	Newton	14,600
Tennessee Colony	Trinity	Anderson, Henderson, Freestone, Navarro	34,800

*Information from [4]

In the coastal part of the region, palustrine wetlands such as swamps and fresh marshes occupy flood plains and line the shores of tidal freshwater reaches of sluggish coastal rivers.[1] Much of the palustrine wetlands area in Jefferson County is farmed wetlands used for rice growing. Figure 1.10 (b) shows the density of palustrine wetlands in the coastal part of the region.[2] In the USFWS study area, palustrine emergent wetlands were most prevalent in Jefferson County, palustrine forested wetlands were most prevalent in Newton, Jasper, Orange, and Hardin Counties, and palustrine scrub-shrub was most prevalent in Newton, Jasper, Orange, and Hardin Counties.[2] Some concentrations of palustrine shrub wetlands were also found in Jefferson County.[2]
Estuarine wetlands such as salt marshes and tidal flats are the next most prevalent type of wetland areas. Estuarine wetlands are very common in the area around Sabine Lake,[2] particularly the emergent kind. Figure 1.10 (c) shows estuarine wetlands in the coastal part of the region.

Three other kinds of wetlands cover a smaller area in the region but are ecologically significant:[2] lacustrine, riverine, and marine wetlands. See Table 1.10 for a description of these types of wetlands.

Section 404 of the Clean Water Act mandates that, when impacts to wetlands are unavoidable, the impacts to wetlands must be mitigated by replacing the impacted wetland with a similar type of wetland. Mitigation may include restoration and rehabilitation of native wetlands or construction of new wetlands.

One wetland mitigation project, the Blue Elbow Swamp Mitigation Project, was identified near the mouth of the Sabine River[9]. This mitigation project was established by the Texas Department of Transportation to compensate for future impacts to wetlands[9].

Estuaries. The Sabine-Neches Estuary includes Sabine Lake, the Sabine-Neches and Port Arthur Canals, and Sabine Pass.[10] The Sabine-Neches Estuary covers about 100 square miles. The Neches and Sabine River Basins and part of the Neches-Trinity Coastal Basin contribute flow to the estuary.[10]

In the estuary, freshwater from the Sabine and the Neches Rivers meets saltwater from the Gulf of Mexico. Although the estuary is influenced by the tide, it is protected from the full force of Gulf waves and storms due to its inland location. The Sabine-Neches Estuary is important for fish, shellfish, and wildlife habitat and for sport and commercial fishing.

Endangered or Threatened Species. The Texas Parks and Wildlife Department (TPWD) has identified species of special concern in the region (see Tables 1.13 and 1.14). These species are either listed as threatened or endangered at the state level or have limited range within the state. The TPWD maintains a list of species of special concern in the Texas Biological and Conservation Data System (TXBCD).

Table 1.13
Species of Special Concern*

	Species	Federal Status	State Status	Riparian-Wetland-, or Estuary-Dependent	Anderson	Angelina	Cherokee	Hardin	Henderson	Houston	Jasper	Jefferson	Nacogdoches	Newton	Orange	Panola	Polk	Rusk	Sabine	San Augustine	Shelby	Smith	Trinity	Tyler
Bir0ds	American peregrine falcon	LE	E	X			X	X			X	X			X	X		X	X			X		X
	Arctic peregrine falcon	E/SA	T	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
	Bachman's sparrow		T		X	X				X	X		X		X		X	X		X	X	X	X	
	Bald eagle	LT	T	X	X	X	X		X	X	X		X	X		X	X	X	X	X	X	X	X	
	Brown pelican	LE	E	X								X			X									
	Henslow's sparrow				X	X		X	X	X			X				X	X		X	X	X	X	
	Interior least tern	LE	E	X					X			X			X									
	Migrant loggerhead shrike								X															
	Piping plover	LT	T	X								X			X									
	Red-cockaded woodpecker	LE	E			X	X	X		X	X		X	X	X		X	X	X	X	X		X	X
	Reddish egret		T									X												
	Swallow-tailed kite		T	X		X				X			X				X			X	X		X	X
	White-faced ibis		T	X								X			X									
	Whooping crane	LE	E	X					X															
	Wood stork		T	X	X	X		X	X	X	X	X	X	X	X		X	X		X	X	X	X	
Insects	A purse casemaker caddisfly			X	X																			
	Big thicket emerald dragonfly			X						X									X	X	X		X	
	Holzenthal's philopotamid caddisfly			X	X																			
	Morse's net-spinning caddisfly			X	X																			
	Phylocentropus harrisi			X	X																			

Table 1.13
Species of Special Concern* (cont.)

	Species	Federal Status	State Status	Riparian-Wetland-, or Estuary-Dependent	County: Anderson	Angelina	Cherokee	Hardin	Henderson	Houston	Jasper	Jefferson	Nacogdoch	Newton	Orange	Panola	Polk	Rusk	Sabine	San	Shelby	Smith	Trinity	Tyler
Fish	Blue sucker		T	X							X			X					X					X
Fish	Creek chubsucker		T	X		X	X	X		X			X	X			X	X		X	X	X	X	X
Fish	Paddlefish		T	X		X				X			X				X	X		X	X	X	X	
Fish	Western sand darter			X				X			X			X					X			X		X
Fish	Suckermouth minnow			X												X		X			X			
Fish	Chestnut lamprey			X												X		X			X			
Fish	Iron-colored shiner			X												X		X			X			
Fish	Longnose shiner			X												X		X			X			
Mammals	Black bear	T/SA	T		X	X		X		X	X		X	X	X	X	X	X	X	X	X		X	X
Mammals	Louisiana black bear	LT	T		X	X		X			X		X	X	X	X		X	X				X	X
Mammals	Plains spotted skunk				X	X			X	X			X				X	X		X	X	X	X	
Mammals	Rafinesque's big-eared bat		T			X		X		X	X	X	X	X			X	X	X	X	X		X	
Mammals	Red wolf	LE	E					X				X		X	X									
Mammals	Southeastern myotis			X		X		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X
Reptiles and Amphibians	Alligator snapping turtle		T	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	
Reptiles and Amphibians	Atlantic hawksbill sea turtle	LE	E									X												
Reptiles and Amphibians	Green sea turtle	LT	T									X												
Reptiles and Amphibians	Gulf saltmarsh snake			X								X			X									
Reptiles and Amphibians	Kemp's ridley sea turtle	LE	E									X												
Reptiles and Amphibians	Leatherback sea turtle	LE	E									X												
Reptiles and Amphibians	Loggerhead sea turtle	LT	T									X												
Reptiles and Amphibians	Louisiana pine snake		T		X	X	X	X		X	X		X	X			X	X		X	X	X	X	X
Reptiles and Amphibians	Pig frog			X				X				X		X										
Reptiles and Amphibians	Scarlet snake		T					X	X		X	X		X					X			X		

Table 1.13
Species of Special Concern* (cont.)

	Species	Federal Status	State Status	Riparian-Wetland-, or Estuary-Dependent	County																			
					Anderson	Angelina	Cherokee	Hardin	Henderson	Houston	Jasper	Jefferson	Nacogdoches	Newton	Orange	Panola	Polk	Rusk	Sabine	San	Shelby	Smith	Trinity	Tyler
	Texas diamondback terrapin			X								X			X									
	Texas garter snake				X				X													X		
	Texas horned lizard		T		X	X	X		X	X		X	X		X	X	X	X	X	X	X	X	X	
	Timber/canebrake rattlesnake		T	X	X	X		X	X	X	X	X	X	X			X	X		X	X	X	X	
Vascular Plants	Bog coneflower			X		X					X			X					X		X			
	Boynton's Oak			X		X																		
	Corkwood			X								X												
	Drummond's yellow-eyed grass			X		X					X			X										
	Incised groovebur				X	X					X			X					X					
	Long-sepaled false dragon-head							X			X			X	X									X
	Navasota ladies' – tresses	LE	E	X							X													
	Neches River rose-mallow	C1		X			X			X													X	
	Rough-leaf yellow-eyed grass			X		X					X			X					X					
	Rough-stem aster			X	X		X		X													X		
	Sandhill woolywhite				X																			
	Scarlet catchfly							X			X	X		X			X		X		X			X
	Slender gay-feather					X		X			X			X	X				X	X				X
	Small-headed pipewort			X	X																			X
	Southern lady's slipper												X	X					X	X				
	Texas golden glade cress	C1																	X	X				
	Texas screwstem					X		X			X		X	X			X			X				X
	Texas trailing phlox	LE	E					X									X							X

Species	Federal Status	State Status	Riparian-Wetland-, or Estuary-Dependent	County																			
				Anderson	Angelina	Cherokee	Hardin	Henderson	Houston	Jasper	Jefferson	Nacogdoches	Newton	Orange	Panola	Polk	Rusk	Sabine	San Augustine	Shelby	Smith	Trinity	Tyler
Texas trillium			X						X			X			X		X				X		
Threeleaf cowbane			X				X																X
Tiny bog buttons			X							X			X										
White bladderpod	LE	E																	X				
White firewheel							X																

Information taken from [11]

LE = Federally listed endangered

E = State endangered

LT = Federally listed threatened

T = State threatened

E/SA, T/SA = Federally endangered/threatened by similarity of appearance

"blank" = Rare, but with no regulatory listing status

C1 = Federal candidate, category 1; information supports proposing to list as endangered/threatened.

Table 1.14
Habitat Information for Species of Special Concern*

	Common Name	Scientific Name	Habitat Description
Birds	American peregrine falcon	*Falco peregruinus anatum*	Potential migrant; nests in west Texas
	Arctic peregrine falcon	*Falco peregruinus tundrius*	Potential migrant
	Bachman's sparrow	*Aimophila aestivalis*	Open pine woods with scattered bushes or understory, brushy or overgrown hillsides, overgrown fields with thickets and brambles, grassy orchards; nests on ground against grass tuft or under low shrub
	Bald eagle	*Haliaeetus leucocephalus*	Found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds
	Brown pelican	*Pelecanus occidentalis*	Nests on small, isolated coastal islands
	Henslow's sparrow	*Ammodramus henslowii*	Wintering individuals (not flocks) found in weedy fields or cut-over areas where lots of bunch grasses occur along with vines and brambles; a key component is bare ground for running/walking
	Interior least tern	*Sterna antillarum athalassos*	Nests along sand and gravel bars within braided streams and rivers; also known to nest on man-made structures
	Migrant loggerhead shrike	*Lanius ludovicianus migrans*	Open and semi-open grassy areas with scattered trees and brush; breeding March-late August
	Piping plover	*Charadrius melodus*	Spends the winter along the Atlantic coast and Gulf coast from Florida to Mexico. Wintering Piping plovers in Texas feed on tidal mudflats or sandflats
	Red-cockaded woodpecker	*Picoides borealis*	Cavity nests in older pine (60+ years); forages in younger pine (30+ years); prefers longleaf, shortleaf, & loblolly
	Reddish egret	*Egretta rufescens*	Resident of the Texas Gulf Coast; brackish marshes and shallow salt pons and tidal flats; nests on ground or in trees or bushes, on coastal islands in brushy thickets of yucca and prickly pear.
	Swallow-tailed kite	*Elanoides forficatus*	Lowland forested regions, especially swampy areas, ranging into open woodland; marshes, along rivers, lakes, and ponds; nests high in tall tree in clearing or on forest woodland edge, usually in pine, cypress, or various deciduous trees
	White-faced ibis	*Plegadis chihi*	Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats
	Whooping crane	*Grus americana*	Potential migrant
	Wood stork	*Mycteria americana*	Forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

*Information taken from [11]

Table 1.14
Habitat Information for Species of Special Concern* (Continued)

	Common Name	Scientific Name	Habitat Description
Insects	A purse casemaker caddisfly	*Hydroptila ouachita*	Lotic systems, but specifics unknown
Insects	Big thicket emerald dragonfly	*Somatochlora margarita*	East Texas pineywoods; springfed creeks and bogs
Insects	Holzenthal's philopotamid caddisfly	*Chimarra holzenthali*	Trinity River basin in Anderson County
Insects	Morse's net-spinning caddisfly	*Cheumatopsyche morsei*	Lotic systems, but specifics unknown
Insects	No common name	*Phylocentropus harrisi*	Lotic systems, but specifics unknown
Fish	Blackside darter	*Percina maculata*	Usually found in streams in quiet reaches and pools with clear or slightly turbid waters, with gravelly substrates.
Fish	Blue sucker	*Cycleptus elongatus*	Prefer large, deep rivers and deeper zones of reservoirs, moderate to swift currents of narrow channels with gravel or rubble bottom.
Fish	Creek chubsucker	*Erimyzon oblongus*	Small rivers and creeks of various types; seldom in impoundments; prefers headwaters, but seldom occurs in springs; young typically in headwater rivulets or marshes; spawns in river mouths or pools, riffles, lake outlets, upstream creeks
Fish	Paddlefish	*Polyodon spathula*	Prefers large, free-flowing rivers, but will frequent impoundments with access to spawning sites; spawns in fast, shallow water over gravel bars; larvae may drift from reservoir to reservoir
Fish	Western sand darter	*Etheostoma clarum*	Texas range is Neches and Sabine drainages; spawns July-August
Fish	Suckermouth minnow	*Phenacobius mirabilis*	Inhabits mainly sand, gravel, and rubble-bottomed riffles in small to moderate-sized streams. Although generally associated with clear waters, in some areas this minnow appears to be tolerant of high levels of turbidity.
Fish	Chestnut lamprey	*Ichthyomyzon castaneus*	The chestnut lamprey can be found in large rivers and lakes. During spawning, it can be found in small rivers and creeks.
Fish	Iron-colored shiner	*Notropis chalybaeus*	Inhabits small, slow, acidic blackwater streams draining swamps and other types of vegetated wetlands.
Fish	Longnose shiner	*Notropis longirostris*	Most often found over shifting sand substrates of shallow shoals and quiet waters below riffle runs in coastal streams.
Mammals	Black bear	*Ursus americanus*	Bottomland hardwoods and large tracts of inaccessible forested areas; due to field characteristics similar to Louisiana Black Bear (LT, T), treat all east Texas black bears as federal and state listed Threatened
Mammals	Louisiana black bear	*Ursus americanus luteolus*	Possible as transient; bottomland hardwoods and large tracts of inaccessible forested areas
Mammals	Plains spotted skunk	*Spilogale putorius interrupta*	Catholic; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie
Mammals	Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	Roosts in cavity trees of bottomland hardwoods, concrete culverts, and abandoned man-made structures
Mammals	Red wolf	*Canis rufus*	Formerly known throughout eastern half of Texas in brushy and forested areas, as well as the coastal prairies (extirpated)
Mammals	Southeastern myotis bat	*Myotis austroriparius*	Roosts in cavity trees of bottomland hardwoods, concrete culverts, and abandoned man-made structures

* Information taken from [11]

Table 1.14 (Continued)
Habitat Information for Species of Special Concern*

	Common Name	Scientific Name	Habitat Description
Reptiles and Amphibians	Alligator snapping turtle	*Macroclemys temminckii*	Deep water of rivers, canals, lakes, and oxbows; also swamps, bayous, and ponds near deep running water; sometimes enters brackish coastal waters; usually in water with mud bottom and abundant aquatic vegetation; may migrate several miles along rivers; active March-October; breeds April-October
	Atlantic hawksbill sea turtle	*Eretmochelys imbricata*	Gulf and bay system
	Green sea turtle	*Chelonia mydas*	Gulf and bay system
	Gulf saltmarsh snake	*Nerodia clarkii*	Saline flats, coastal bays, and brackish river mouths
	Kemp's ridley sea turtle	*Lepidochelys kempii*	Gulf and bay system
	Leatherback sea turtle	*Dermochelys coriacea*	Gulf and bay system
	Loggerhead sea turtle	*Caretta caretta*	Gulf and bay system
	Louisiana pine snake	*Pituophis melanoleucus ruthveni*	Mixed deciduous-longleaf pine woodlands; breeds April-September
	Pig frog	*Rana grylio*	Found in large bodies of water such as lakes and marshes, amid floating vegetation
	Scarlet snake	*Cemophora coccinea*	Mixed hardwood scrub on sandy soils; feeds on reptile eggs; semi-fossorial; active April-September
	Southern redback salamander	*Plethodon serratus*	Found under rocks, rotten logs, and mosses in forested areas; in dry summer months occurs in and near damp areas; most active in spring and fall
	Texas diamondback terrapin	*Malaclemys terrapin littoralis*	Coastal marshes, tidal flats, coves, estuaries, and lagoons behind barrier beaches; brackish and salt water; burrows into mud when inactive; may venture into lowlands at high tide.
	Texas garter snake	*Thamnophis sirtalis annectens*	Wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August
	Texas horned lizard	*Phrynosoma cornutum*	Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September
	Timber/canebrake rattlesnake	*Crotalus horridus*	Swamps, floodplains, upland pine and deciduous woodlands, riparian zones, abandoned farmland; limestone bluffs, sandy soil or black clay; prefers dense ground cover, i.e. grapevines or palmetto

*Information taken from [11]

Table 1.14
Habitat Information for Species of Special Concern* (Continued)

	Common Name	Scientific Name	Habitat Description
Vascular Plants	Bog coneflower	*Rudbeckia scabrifolia*	Hillside seepage bogs and associated broadleaf semi-evergreen acid seep forests; usually on Catahoula Formation or near the Catahoula-Willis contact; flowering late summer-fall
	Boynton's Oak	*Quercus boyntonii*	Shrub layer of loblolly-pine forests on deep sandy soils in creek bottoms; possibly also in shallower soils of upland prairies
	Corkwood	*Leitneria floridana*	Found in narrow zone between brackish marsh and contiguous coastal pine-hardwood; brackish or freshwater swamps or thickets; flowers in spring.
	Drummond's yellow-eyed grass	*Xyris drummondii*	Wet sand or peaty sand on hillside seepage bogs on the Catahoula Formation
	Incised groovebur	*Agrimonia incisa*	Mixed deciduous-longleaf pine woodlands; breeds April-September
	Long-sepaled false dragon-head	*Physostegia longisepala*	Originally found in moist acid loams in the firemaintained transition zone between pine flatwoods and coastal prairies; now found primarily in secondary habitats such as wet borrow ditches along roadsides and moist areas in manmade clearings in pine woodlands.
	Navasota ladies' –tresses	*Spiranthes parksii*	Endemic; margins of and openings within post oak woodlands in sandy loams along intermittent tributaries of rivers; flowering late October-early November
	Neches River rose-mallow	*Hibiscus dasycalyx*	Endemic; wet alluvial soils in swamps or open riparian woodlands; flowering June-August
	Rough-leaf yellow-eyed grass	*Xyris scabrifolia*	Wet sand or peaty sand on hillside seepage bogs on the Catahoula Formation
	Rough-stem aster	*Aster puniceus ssp. Elliottii var. scabricaulis*	Endemic; wet unshaded habitats ranging from sphagnum bogs to roadside ditches; flowering in fall
	Sandhill woolywhite	*Hymenopappus carrizoanus*	Endemic; open areas in deep sands derived from Carrizo and similar Eocene formations, including disturbed areas; flowering late spring-fall
	Scarlet catchfly	*Silene subciliata*	Deep sandy soils at margins of dry upland longleaf pine savannas; also on sandbars and in moister sandy soils in various habitats, including roadbanks; flowering August-October
	Slender gay-feather	*Liatris tenuis*	Mostly in fire-maintained dry upland longleaf pine savannas on the Catahoula Formation; flowering June-August
	Small-headed pipewort	*Eriocaulon koernickianum*	Wet acid sands of upland seeps and bogs, often on sphagnum mats with little other vegetative cover; flowering/fruiting late May-late June
	Southern lady's slipper	*Cypripedium kentuckiense*	The only Cypripedium in east Texas; dry to mesic forests in various topographic positions; flowering April-June
	Texas golden glade cress	*Leavenworthia texana*	Early successional or unique edaphically influenced herbaceous communities in shallow calcareous soils in vernally wet glades on Weches Formation ironstone outcrops
	Texas screwstem	*Bartonia texana*	Sandy soils in dry mesic pine or mixed pine-oak forests and forest borders; usually in fire-maintained longleaf pine savannas, but also in more mesic habitats; flowering (June-?)

* Information taken from [11]

Table 1.14
Habitat Information for Species of Special Concern* (Continued)

Vascular Plants (cont.)	Texas trailing phlox	*Phlox nivalis ssp. Texensis*	Endemic; deep sandy soils in fire-maintained openings in upland longleaf pine savannas or bluejack oak woodlands; flowering March-early April
	Texas trillium	*Trillium pusillum var. texanum*	Acid hardwood bottoms and lower slopes, often in or downslope from acid sphagneous hillside seeps; flowering March-mid April
	Threeleaf cowbane	*Oxypolis ternata*	Wetland pine savannas and flatwoods
	Tiny bog buttons	*Lachnocaulon digynum*	Wet acid exposed sands or sphagnum mats of hillside seepage bogs, primarily on the Catahoula formation, usually among other low-growing graminoids; occasionally in wetland pine savannahs.
	White bladderpod	*Lesquerella pallida*	Seasonally wet, comparatively high pH sandy soils in natural openings or glades within pine/oak forests over Weches Formation ironside/glauconite; flowering April-May
	White firewheel	*Gaillardia aestivalis var. winkleri*	Deep loose well drained sands in openings in pine-oak woodlands and along unshaded margins; flowers in late spring and sporadically through early fall.

*Information taken from [11]

Stream Segments with Significant Natural Resources. In each river basin in Texas, the TPWD has identified stream segments that they classify as having significant natural resources.[6] Stream segments have been placed on this list because they have been identified by TPWD as having high water quality, exceptional aquatic life, high aesthetic value, fisheries, spawning areas, unique state holdings, endangered or threatened species, priority bottomland hardwood habitat, wetlands, springs, and pristine areas.

Stream segments in the Trinity River Basin that have been classified as having significant natural resources include the following:[6]

- Unique state holdings

    1) Gus Engeling Wildlife Management Area on Catfish Creek in Anderson County.

    2) Big Lake Bottom Wildlife Management Area on the Trinity River in Anderson County.

Stream segments in the Neches River Basin that have been classified as having significant natural resources include the following:[6]

- Priority bottomland habitat:

    1) Mud Creek from the SH 204 crossing to the confluence with the Angelina River (Cherokee County). This area has been designated as a Priority 1 bottomland hardwood area by the USFWS.[6]

    2) Angelina River between FM 1911 and US 59 (Nacogdoches, Angelina, and Cherokee Counties).

    3) Neches River between FM 1013 and the Tyler-Hardin County line (Jasper and Tyler Counties).

    4) Neches River from US 84 to the Trinity-Polk County line (Anderson, Houston, Cherokee, Trinity and Angelina Counties).

- Extensive freshwater wetland habitat:

    1. Neches River from the confluence with Pine Island Bayou to Sabine Lake (Orange and Jefferson Counties).

- Protected species:

    1) Neches River from SH 7 to Steinhagen Lake (Houston, Angelina, Trinity, Polk, Tyler, and Jasper Counties). Protected species are rose-mallow, slender gayfeather, bog coneflower, Drummond's yellow-eyed grass, and rough-leaf yellow-eyed grass.

2) Village Creek from the source to confluence with the Neches River (Polk, Tyler, and Hardin Counties). Protected species are Texas trailing phlox and white firewheel.

3) Neches River from Lake Palestine to Steinhagen Lake (Anderson, Cherokee, Houston, Angelina, Trinity, Polk, Tyler, and Jasper Counties). Protected species are paddlefish, creek chubsucker, and blue sucker.

- Recreation:

1) Neches River from Lake Palestine Dam to Steinhagen Lake (Anderson, Cherokee, Houston, Angelina, Trinity, Polk, Tyler, and Jasper Counties).

2) Angelina River from the East Fork of the Angelina River to Sam Rayburn Reservoir (Nacogdoches, Cherokee, and Angelina Counties).

3) Big Sandy Creek and Village Creek from the source to the confluence with the Neches River (Polk, Tyler, and Hardin Counties).

4) Neches River from Steinhagen Lake Dam to the confluence with Pine Island Bayou (Tyler, Jasper, Hardin, Orange, and Jefferson Counties).

5) Pine Island Bayou from FM 770 to the confluence with the Neches River (Hardin and Jefferson Counties).

6) Angelina River from Sam Rayburn Dam to Steinhagen Lake (Jasper County).

- Unique state holdings:

1) Mission Tejas State Park on San Pedro Creek in Houston County.

2) Angelina-Neches Scientific Area and Dam B Unit Wildlife Management Area on the Neches and Angelina Rivers in Jasper and Tyler Counties.

3) Village Creek State Park on Village Creekin Hardin County.

4) Caddoan Mounds State Historic Park on Bowles Creek in Cherokee County.

5) Lower Neches Wildlife Management Area on the Neches River in Orange County.

6) Upstream side of US 59 on the Neches River in Nacogdoches and Angelina Counties. This is a planned acquisition by the TPWD.

- Unique federal holdings:

    1) Neches River Corridor Unit of the Big Thicket National Preserve on the Neches River in Jasper and Hardin Counties.

    2) Little Pine Island Bayou Unit of the Big Thicket National Preserve on Little Pine Island Bayou in Hardin County.

Stream segments in the Sabine River Basin that have been classified as having significant natural resources include the following:[6]

- Priority bottomland habitat: Sabine River from the Rusk-Panola County line to the Louisiana state line (Panola County).

- Extensive freshwater habitat: Sabine River from IH 10 to Sabine Lake (Orange County

- Protected species:

    1) Sabine River from Gladewater to Toledo Bend Reservoir (Rusk, Panola, and Shelby Counties). Protected species are suckermouth minnow, chestnut lamprey, iron-colored shiner, and longnose shiner.

    2) Sabine River from Toledo Bend Reservoir to Sabine Lake (Shelby, Sabine, Newton, and range Counties). Protected species are paddlefish, creek chubsucker, and blue sucker.

- TPWD wetland acquisition development project: North Toledo Bend Wildlife Management Area on the Sabine River and Toledo Bend Reservoir in Shelby County.

Stream segments in the Neches-Trinity Coastal River Basin that have been classified as having significant natural resources include the following:[6]

- Unique state holdings:

    1) J. D. Murphree Wildlife Management Area on Big Hill Bayou in Jefferson County.

    2) Sea Rim State Park on the Gulf Coast in Jefferson County.

- Unique federal holdings:

    1) Texas Point National Wildlife Refuge on the Gulf Coast in Jefferson County.

    2) McFaddin National Wildlife Refuge on the Gulf Coast in Jefferson County.

- <u>State Holdings:</u> The TPWD operates several State Parks in the region:

    1. Martin Creek Lake State Park in Rusk County
    2. Rusk/Palestine State Park in Cherokee and Anderson Counties
    3. Texas State Railroad State Historical Park in Cherokee and Anderson Counties
    4. Jim Hogg State Historical Park in Cherokee County
    5. Caddoan Mounds State Historical Park in Cherokee County
    6. Mission Tejas State Historical Park in Houston County
    7. Martin Dies Jr. State Park in Jasper and Tyler Counties
    8. Village Creek State Park in Hardin County
    9. Sea Rim State Park in Jefferson County
    10. Sabine Pass Battleground State Historical Park in Jefferson County

The TPWD operates several wildlife management areas in the region:

1. Gus Engeling Wildlife Management Area in Anderson County
2. North Toledo Bend Wildlife Management Area in Shelby County
3. Bannister Wildlife Management Area in San Augustine County
4. Moore Plantation Wildlife Management Area in Sabine and Jasper Counties
5. Angelina-Neches/Dam B Wildlife Management Area in Jasper and Tyler Counties
6. Alabama Creek Wildlife Management Area in Trinity County
7. Lower Neches Wildlife Management Area in Orange County
8. J. D. Murphree Wildlife Management Area in Jefferson County.

The Texas Forest Service operates several state forests in the region:

1. E. O. Siecke State Forest in Newton County
2. Masterson State Forest in Jasper County
3. John Henry Kirby Memorial State Forest in Tyler County

4. I. D. Fairchild State Forest in Cherokee County

- **Federal Holdings:** The Army Corps of Engineers operates parks and other land around lakes in the region:

    1. Sam Rayburn Reservoir

    2. Town Bluff Dam, B. A. Steinhagen Lake

The U.S. Fish and Wildlife Service operates two national wildlife refuges in the region:

1. Texas Point National Wildlife Refuge on the Gulf Coast in Jefferson County.

2. McFaddin National Wildlife Refuge on the Gulf Coast in Jefferson County.

The National Forest Service operates three national forests in the region:

1. Angelina National Forest in San Augustine, Angelina, Jasper, and Nacogdoches Counties.

2. Davy Crockett National Forest in Houston and Trinity Counties

3. Sabine National Forest in Sabine, Shelby, San Augustine, Newton, and Jasper Counties.

The National Park Service operates Big Thicket National Preserve in Polk, Tyler, Jasper, Hardin, Jefferson, and Orange Counties.

Springs. A TPWD natural resources survey for Angelina, Cherokee, Nacogdoches, Rusk, and Smith Counties identified a number of small to medium sized springs. Table 1.15 shows the distribution and number of these springs. Information in Table 1.15 was current as of 1980. Former springs are springs that have run dry due to excessive groundwater pumping and sedimentation caused by surface erosion.[5]

Table 1.15
Distribution and Estimated Size of Springs and Seeps*

County	Medium (2.8 – 28 cfs)	Small (0.28 – 2.8 cfs)	Very Small (0.028 – 0.28 cfs)	Seep (less than 0.028 cfs)	Former
Angelina	NA	NA	NA	NA	NA
Cherokee	1	12	0	1	0
Nacogdoches	2	9	8	2	1
Rusk	1	12	6	0	0
Smith	1	11	0	3	1

*Information taken from [5]

Agriculture/Prime Farmland. Prime farmland and general agriculture are linked in this discussion because anything that threatens water supply for irrigation and agricultural household water use may also threaten to prevent the best use of prime farmland (where prime farmland is present).

Prime farmland is defined by the National Resources Conservation Service (NRCS) as "land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses."[12] As part of the National Resources Inventory, the NRCS has identified prime farmland throughout the country.

Figure 1.11 shows the distribution of prime farmland in the region. Each color in Figure 1.11 represents the percentage of prime farmland of any type. There are four categories of prime farmland in the NRCS STATSGO database for Texas: prime farmland, prime farmland if drained, prime farmland if protected from flooding or not frequently flooded during the growing season, and prime farmland where irrigated. Most counties in the region have significant prime farmland areas.

Table 1.16 shows 1997 agriculture statistics for the counties in the region[13] (portions of Henderson, Smith, Polk, and Trinity Counties are located in other Regions). The following general statements can be made regarding the region:[14]

- Approximately 40% of farmland is cropland

- Approximately 30% of cropland is harvested.

- Excluding Jefferson County, approximately 0.7% of cropland is irrigated. In Jefferson County, approximately 17.6% of cropland is irrigated.

- Poultry production generates the largest agricultural product sales in Angelina, Nacogdoches, Panola, Shelby, Sabine, and San Augustine Counties. In 1997, Shelby and Nacogdoches Counties ranked second and third in Texas in sales of poultry and poultry products.

- Cattle and calf production generates the largest agricultural product sales in Anderson, Houston, Henderson, Rusk, Trinity, Polk, Jasper, Tyler, Orange, Hardin, and Newton Counties.

- Nursery and greenhouse crops generate the largest agricultural product sales in Cherokee and Smith Counties. In 1997, Cherokee and Smith Counties ranked first and seventh in Texas in sales of nursery and greenhouse crops.

- Rice crops generate the largest agricultural product sales in Jefferson County. In 1997, Jefferson County ranked fourth in the state in sales of "rye, drybeans, and other grains."

Table 1.16
1997 U.S. Department of Agriculture Data*

Category		Anderson	Angelina	Cherokee	Hardin	Henderson	Houston	Jasper	Jefferson	Nacogdoches	Newton
Farms		1,542	790	1,429	354	1,630	1,369	639	562	1,200	294
Total Farm Land (acres)		353,969	117,920	283,241	65,442	367,096	440,228	87,079	433,597	372,451	62,108
Crop Land (acres)		138,317	47,705	140,367	17,617	155,335	168,450	26,116	180,719	101,669	10,376
Harvested Crop Land (acres)		47,101	12,080	51,190	5,326	58,000	53,714	9,186	46,709	26,482	3,936
Irrigated Crop Land (acres)		1,365	92	542	625	846	2,052	287	31,895	463	63
Market Value Crops ($1,000)		$3,410	$672	$60,086	$958	$10,105	$3,971	$991	$18,373	$1,251	$374
Market Value Livestock ($1,000)		$20,849	$15,242	$42,938	$1,915	$19,390	$23,417	$2,489	$7,584	$165,641	$1,072
Total Market Value ($1,000)		$24,259	$15,914	$103,024	$2,873	$29,495	$27,388	$3,480	$25,957	$166,892	$1,446
Livestock and Poultry:											
	Cattle and Calves Inventory	88,623	26,176	82,595	7,593	90,115	105,335	14,570	44,996	59,460	6,416
	Hogs and Pigs Inventory	(D)	243	123	363	816	(D)	319	131	480	88
	Sheep and Lambs Inventory	119	208	34	(D)	354	122	(D)	30	117	(D)
	Layers and Pullets Inventory	(D)	420	(D)	(D)	997	(D)	875	792	839,651	577
	Broilers and Meat-Type Chickens Sold	(D)	5,056,373	2,578,104	0	(D)	(D)	(D)	340	69,164,986	(D)
Crops Harvested (acres):											
	Corn for Grain or Seed	(D)	5	92	10	45	(D)	61	0	29	31
	Sorghum for Grain or Seed	(D)	(D)	0	0	0	(D)	0	(D)	0	0
	Wheat for Grain	(D)	92	(D)	0	(D)	(D)	0	(D)	0	0
	Rice	0	0	0	(D)	0	0	0	29,623	0	0
	Cotton	1,345	0	(D)	0	0	3,303	0	310	0	(D)
	Soybeans for beans	0	0	114	0	0	0	0	3,445	0	0
	Hay-Alfalfa, Other, Wild, Silage	43,188	11,895	49,242	4,491	53,861	43,001	8,715	12,517	26,210	3,804

Table 1.16 (Continued)
1997 U.S. Department of Agriculture Data*

Category	Orange	Panola	Polk	Rusk	Sabine	San Augustine	Shelby	Smith	Trinity	Tyler
Farms	334	866	551	1,296	194	291	1,017	1,844	518	463
Total Farm Land (acres)	87,871	202,258	135,988	267,448	25,103	65,250	187,728	250,855	98,748	53,225
Crop Land (acres)	25,669	84,141	42,208	131,072	12,568	25,628	86,490	127,336	49,188	24,995
Harvested Crop Land (acres)	6,207	21,616	11,675	30,662	3,788	7,149	22,463	44,129	14,082	6,942
Irrigated Crop Land (acres)	1,511	1,577	377	93	(D)	17	324	1,069	52	350
Market Value Crops ($1,000)	$1,420	$823	$444	$8,412	$226	$1,009	$2,182	$19,925	$411	$649
Market Value Livestock ($1,000)	$1,897	$45,075	$4,017	$20,639	$10,715	$24,118	$179,060	$18,427	$5,672	$2,466
Total Market Value ($1,000)	$3,317	$45,898	$4,461	$29,051	$10,941	$25,127	$181,242	$38,352	$6,083	$3,115
Livestock and Poultry:										
Cattle and Calves Inventory	10,020	45,041	22,056	57,513	6,915	11,135	46,895	59,968	26,016	13,769
Hogs and Pigs Inventory	118	785	963	537	78	39	60	241	152	172
Sheep and Lambs Inventory	18	(D)	22	262	0	12	(D)	63	(D)	(D)
Layers and Pullets Inventory	764	94,683	1,824	(D)	(D)	82,745	2,030,083	999	(D)	540
Broilers and Meat-Type Chickens Sold	0	19,404,090	(D)	3,774,113	5,566,080	11,792,703	72,928,627	0	0	(D)
Crops Harvested (acres):										
Corn for Grain or Seed	(D)	(D)	(D)	94	40	(D)	(D)	31	0	(D)
Sorghum for Grain or Seed	(D)	0	0	0	0	(D)	(D)	(D)	0	0
Wheat for Grain	0	220	0	0	0	0	0	(D)	(D)	0
Rice	1,446	0	0	0	0	0	0	0	0	0
Cotton	0	0	0	(D)	0	(D)	0	0	0	0
Soybeans for beans	(D)	0	0	0	(D)	0	(D)	0	0	0
Hay-Alfalfa, Other, Wild, Silage	4,645	21,281	11,538	29,337	3,562	6,083	20,637	41,511	13,796	6,643

TOTALS FOR ALL COUNTIES:	
Total Farm Land (acres)	3,957,605
Crop Land (acres)	1,595,966
Crop Land/Total Farm Land (%)	40.33%
Harvested Crop Land (acres)	482,437
Harvested/Total Crop Land (%)	30.23%
Irrigated Crop Land (acres)	43,600
Irrigated/ Total Farm Land (%)	2.73%

SPECIAL FOR JEFFERSON COUNTY:	
Irrigated/ Total Farm Land (%)	17.65%
COUNTIES OTHER THAN JEFFERSON:	
Irrigated Crop Land (acres)	11,705
Irrigated/ Total Farm Land (%)	0.73%

- Information taken from [13]

(D) Withheld to avoid disclosing data for individual farms

1.10 Archeological Sites.

The most prominent archeological site in the region is Caddoan Mounds State Historical Park, a 93.8-acre park in Cherokee County west of Nacogdoches. This area was the home of Mound Builders of Caddoan origin who lived in the region for 500 years beginning about A. D. 800. The park offers exhibits and interpretive trails through its reconstructed sites of Caddo dwellings and ceremonial areas, including two temple mounds, a burial mound, and a village area[15].

The Texas Historical Commission (THC) keeps the Texas Historic Sites Atlas, a database containing historic county courthouses, National Register properties, historical markers, museums, sawmills, and neighborhood surveys[16]. This database contains a very large amount of data. The THC does not release information on archeological sites to the general public. When specific water management strategies are being evaluated, the RWPG should request that the THC characterize archeological sites that may be affected and a search of the Texas Historic Sites Atlas should be performed for particular areas.

1.11 Mineral Resources.

Oil and Gas Fields. Oil and natural gas fields are significant natural resources in portions of the region. There are low densities of producing oil wells in each county in the region (see Figure 1.12). The East Texas Oil Field, a portion of which is located in Rusk County, ranked third in Texas in oil production in 1997 (see Figure 1.13). There are high densities of producing natural gas wells in Rusk, Panola, Nacogdoches, Jasper, and Newton Counties, with lesser densities in the other counties in the region (Figure 1.14). Four of the 1997 top 20 producing natural gas fields in the state are located in the region (Figure 1.13):

- Carthage Gas Field in Panola County
- Oak Hill Gas Field in Rusk County
- Double A Wells Gas Field in Polk and Tyler Counties
- Brookeland Gas Field in Jasper and Newton Counties

Lignite Coal Fields. Figure 1.15 shows lignite coal resources located in the region.[18] The Wilcox Group of potential deep basin lignite (200-2,000 feet in depth) underlies significant portions of Henderson, Smith, Cherokee, Rusk, and Nacogdoches Counties. The Jackson-Yegua Group of potential deep basin lignite underlies significant portions of Houston, Trinity, Polk, Angelina, Nacogdoches, San Augustine, and Sabine Counties. Finally, bituminous coal underlies a small portion of Polk County in the region.

1.12 Threats to Agricultural and Natural Resources in the Region Due to Water Quality or Quantity Problems

Water Quality. Table 1.17 lists a number of reaches in the region which the TNRCC has documented concerns over water quality impacts to aquatic life, contact recreation, or fish consumption.

Drawdown of Aquifers. Overpumping of aquifers poses a threat to household water use and livestock watering in rural areas. As water levels decline, the cost of pumping water grows and water quality generally suffers. Wells that go dry must be redrilled to deeper portions of the aquifer. Significant water level declines have been reported in localized areas in both the Carrizo-Wilcox and Gulf Coast Aquifers,[20] the major aquifers in the region.

Overpumping of aquifers also poses a threat to estuarine wetlands. Between 1955 and 1992, approximately 19,900 acres of estuarine intertidal emergent wetlands were lost in Texas as a result of submergence (drowning) and erosion, probably due to faulting and land subsidence resulting from the withdrawal of undergroundwater and oil and gas.[2] These losses occurred primarily between Freeport and Port Arthur. There has been a conversion from groundwater to surface water use in many of the problem areas.[20]

Finally, overpumping of aquifers in coastal regions can lead to saltwater intrusion, where saltwater is drawn updip into the aquifer. This degrades the aquifer water quality. Saltwater intrusion into the Gulf Coast Aquifer has occurred previously in central and southern Orange County.[20]

Insufficient Flows. Certain flow quantities and frequencies are necessary to maintain the fish and wildlife habitat in the region. Insufficient flow quantities and patterns could pose a threat to fish and wildlife habitat. Additionally, certain flow quantities or a physical barrier are required to control upstream encroachment of saltwater. At times of low flow in the rivers, the 0.5 ppt isohaline (the dividing line between “freshwater” and “saltwater”) moves upstream; conversely, at times of high flow in the rivers, the 0.5 ppt isohaline moves downstream. Upstream saltwater encroachment can adversely affect freshwater habitat and the suitability of water quality for water supply purposes.

The 1997 state water plan recommended that a Neches River Salt Water Barrier be constructed at a location north of Beaumont below the confluence of the Neches River and Pine Island Bayou. The project would prevent saltwater from reaching the freshwater intakes of lower Neches River cities, industries, and farms during periods of low flow. The project will be a gated structure, designed to be open during high to normal flows and closed during low flows. It will also be equipped with a gated navigation channel to enable the passage of watercraft around the barrier.

Table 1.17
TNRCC 1999 303(d) List of Impaired and Threatened Water Bodies*

Segment Number	Name	Concern is for Aquatic Life	Contact Recreation	Fish Consumption	Description
503	Sabine River below Toledo Bend Reservoir	X	X		In the lower 25 miles of the segment, bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS). In the same 25 miles, concentrations of dissolved lead sometimes exceed the criterion established to protect aquatic life (M/NS).
504	Toledo Bend Reservoir			X	The fish consumption use is partially supported, based on a restricted-consumption advisory issued by the Texas Department of Health in November of 1995 due to mercury in fish tissue (M/PS).
505	Sabine River above Toledo Bend Reservoir	X		X	The fish consumption use is not supported in Martin Creek Reservoir (Rusk County) and in Brandy Branch Reservoir (Harrison County), based on a no-consumption advisory and a restricted-consumption advisory issued by the Texas Department of Health in May 1992 due to elevated levels of selenium in fish tissue (M/NS). In the lower 25 miles of the segment, concentrations of dissolved lead sometimes exceed the criterion established to protect aquatic life (M/NS).
508	Adams Bayou Tidal	X	X		Dissolved oxygen concentrations are sometimes lower than the standard established to assure optimum conditions for aquatic life (L/NS). Bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (L/NS).
513	Big Cow Creek	X			In the lower 25 miles of segment, concentrations of dissolved aluminum occasionally exceed the criterion established to protect aquatic life (M/PS).
603	B. A. Steinhagen Lake			X	The fish consumption use is partially supported, based on a restricted-consumption advisory issued by the Texas Department of Health in November 1995 due to mercury in fish tissue (M/PS).
610	Sam Rayburn Reservoir	X	X	X	The fish consumption use is partially supported, based on a restricted-consumption advisory issued by the Texas Department of Health in November 1995 due to mercury in fish tissue (M/PS). In the upper portion of the reservoir, dissolved oxygen concentrations are sometimes lower than the standard established to assure optimum conditions for aquatic life (M/NS). Also in the upper portion, bacteria levels sometimes exceed the criterion established to assure the safety of contact recreation (M/NS).
701	Taylor Bayou above Tidal	X			In the lower 25 miles of the segment, dissolved oxygen concentrations are occasionally lower than the standard established to assure optimum conditions for aquatic life (L/PS).
702A	Alligator Bayou (unclassified water body)	X			Ambient toxicity in water occasionally exceeds the criterion established to assure optimum conditions for aquatic life (L/PS). Toxicity in sediment sometimes exceeds the criterion established to assure optimum conditions for aquatic life (L/NS).
704	Hillebrandt Bayou	X			Dissolved oxygen concentrations are occasionally lower than the standard established to assure optimum conditions for aquatic life (L/PS).

- * Information taken from [19]

Inundation Due to Reservoir Development. The 1984 state water plan [7] recommended development of the following reservoirs:

- Eastex Reservoir on Mud Creek in Cherokee County.
- Rockland Reservoir on the Neches River in Angelina, Trinity, Polk, Tyler, and Jasper Counties.
- Weches Reservoir on the Neches River in Anderson, Cherokee, and Houston Counties.
- Bon Wier Reservoir on the Sabine River in Newton County, Texas and Beauregard Parish, Louisiana.
- Tennessee Colony Reservoir on the main stem of the Trinity River in Freestone, Navarro, Henderson, and Anderson Counties.

In addition, the 1997 state water plan mentions the following alternative reservoir development sites in the region:[21]

- Newton, Big Cow Creek, and Little Cow Creek in Newton County
- Dam A in Jasper County
- Rockland in Tyler County
- Cochino in Trinity County
- Big Elkhart, Hurricane Bayou, Gail, and Mustang in Houston County
- Fastrill and Catfish Creek in Anderson County
- Ponta in Nacogdoches, Cherokee, and Rusk Counties
- Attoyac in Nacogdoches County *(would overlap Shelby and/or San Augustine Counties)*
- Tenaha in Shelby County
- Stateline in Panola County
- Socagee Reservoir in Panola County
- Carthage Reservoir in Panola, Rusk, Harrison, and Gregg Counties
- Cherokee II in Rusk County
- Rabbit in Smith and Rusk Counties
- Kilgore in Smith, Rusk, and Gregg Counties

Other reservoir sites[9] are:

- State Highway 322 Stages I and II in Rusk County
- Fredonia Lake in Rusk and Harrison Counties

The Angelina and Neches River Authority has a state permit to construct Eastex Reservoir but does not yet have the necessary federal permits. The 1997 state water plan does not recommend any reservoir development projects in the region. The effects on natural resources of new reservoir construction at the five sites recommended in the 1984 state water plan[7] will be discussed below, because these reservoirs appear to be the most likely to be constructed.

Table 1.18 shows the impacts of new reservoir development at the five potential reservoir sites on the surrounding land and on protected species. TPWD divided the inundated acreage into Resource Categories, depending on the quality of the habitat.[4] Resource Category (1) habitat is categorized as high value habitat, unique habitat, or irreplaceable habitat for which mitigation is not possible. Resource Category (2) habitat is categorized as high value habitat, scarce habitat or becoming scarce, for which mitigation is possible with an established goal of no net loss of in-kind habitat value. From a practical standpoint, Category (2) habitat for the proposed reservoir sites depicts types of habitats such as wetlands and riparian bottomland forest areas that reflect high natural resource values and high sensitivity regarding destruction.

Category (3) habitat includes abundant and medium to high value habitat (for the evaluation species) with a mitigation goal of no net loss of habitat value while minimizing loss of in-kind habitat value. Category (4) habitat includes remaining medium to low value habitat for which minimization of habitat value deterioration would be anticipated.

Effects of the proposed Bon Weir Reservoir are shown in Table 1.18.

Table 1.18

Potential Impacts of Reservoir Development on Land Area and Protected Species*

Potential Impacts		Potential Reservoir Site				
		Eastex	Rockland	Weches	Bon Weir	Tennessee Colony
Inundated Land** (acres)	Mixed bottomland hardwood forest (2)	3,500	27,300	18,000	14,600	34,800
	Swamp/Flooded Hardwood Forest (2)	NA	NA	NA	2,300	NA
	Pine-hardwood forest (3)	3,000	50,800	21,000	10,400	NA
	Post Oak-Water Oak-Elm Forest (3)	NA	NA	NA	NA	19,200
	Grassland (4)	2,700	NA	4,800	NA	9,600
	Other	900	21,400	3,900	7,800	21,500
	TOTAL	***10,100***	***99,500***	***47,700***	***35,100***	***85,100***
Endangered Species Potentially Impacted	Arctic peregrine falcon	X	X	X	X	X
	Black-capped vireo					X
	Eskimo Curlew					X
	Interior least tern		X	X		
	Red-cockaded woodpecker	X	X	X	X	X
	Whooping crane			X		X
Threatened Species Potentially Impacted	Alligator snapping turtle	X	X	X	X	X
	American swallow-tailed kite	X	X	X	X	X
	Bachman's sparrow	X	X	X	X	X
	Bald Eagle	X	X	X	X	X
	Black bear	X	X	X	X	X
	Blue sucker		X		X	
	Creek chubsucker	X	X	X	X	
	Louisiana pine snake	X	X	X	X	X
	Northern scarlet snake	X	X	X	X	X
	Paddlefish	X	X	X	X	X

	Potential Impacts	Potential Reservoir Site				
		Eastex	Rockland	Weches	Bon Weir	Tennessee Colony
	Reddish egret		X		X	
	Texas horned lizard	X	X	X	X	X
	Timber rattlesnake	X	X	X	X	X
	White-faced ibis	X	X	X	X	X
	Wood stork	X	X	X	X	X

* Compiled from [4] and [11]

** Resource categories shown in parentheses after descriptions.

The proposed Eastex Reservoir site is categorized as excellent habitat for turkey and gray squirrel and modest habitat for deer.[6] In the proposed reservoir location, Mud Creek is a "pristine area that provides excellent stream habitat."[6] TPWD has identified Mud Creek as a significant stream segment due to its high bottomland hardwood resource value.[6]

The proposed Rockland Reservoir would impact the bottomland hardwood site known as the "Middle Neches River," which USFWS has identified as a Priority 1 preservation area.[4] In addition, three other USFWS Priority 2 bottomland hardwood preservation areas would be impacted: "Neches River South," "Piney Creek," and "Russell Creek."[4] The USFWS defines Priority 1 as "excellent quality bottomlands of high value to waterfowl" and Priority 2 as "good quality bottomlands with moderate waterfowl benefits."[4]

The proposed Weches Reservoir would impact the "Middle Neches River" and the "Neches River North" bottomland hardwood sites, which USFWS has identified as Priority 1 preservation areas.[4]

The Corps of Engineers designed the Tennessee Colony Reservoir in 1979, but the project encountered numerous concerns about conflicts with development of lignite in the area and with existing communities and water supply lakes. The project has been deferred pending removal of the lignite.[22]

The USFWS has identified two preservation areas that would be affected by construction of the Tennessee Colony Reservoir. The first is an area known as "Boone Fields," located adjacent to the Trinity River between Saline Branch Creek and Catfish Creek, which contains upland forest and some bottomlands. The USFWS has classified this site as a Priority 5 preservation site.[4] The reservoir would also affect a hardwood bottom known as "Tehuacana Creek." The USFWS has also classified this site as a Priority 5 preservation site.[4] The USFWS defines Priority 5 as "sites proposed for elimination from further study because of low and/or no waterfowl benefits."[4]

Construction of the Tennessee Colony Reservoir would inundate approximately 13,796 acres of bottomland, which comprise the Richland Creek Wildlife Management Area. The TPWD acquired this area as mitigation for wildlife losses associated with the construction of Richland-Chambers Dam and Reservoir.[4] The Richland Creek Wildlife Management Area is located in Region C.

The Tennessee Colony Reservoir is an alternative to two Region C water supply projects recommended in the 1997 state water plan. If the Tennessee Colony Reservoir were built, neither the Tehuacana Reservoir nor the diversion of water from the Trinity River would be necessary.[23]

1.13 Threats and Constraints on Water Supply

Interstate Allocation. The allocation of water in the Sabine River Basin between Texas and Louisiana is a vital factor in any water study involving the Texas portion of the basin. As noted earlier, the river forms the state line for the downstream half of its length after heading in Texas far from the state line. Almost all of the basin upstream from the state line is in Texas. However, Texas does not have completely unrestricted access to the water in that area.

The Sabine River Compact, executed in 1953, provides for allotment of the water between Texas and Louisiana. This agreement was not only ratified by the two state legislatures but also approved by Congress.

Texas has unrestricted access to the water in the upper reach of the river except for the requirement of a minimum flow of 36 cubic feet per second at the junction between the river and the state line. Texas may construct reservoirs in the upper reach and use their water either there or in the downstream reach without loss of ownership.

Any reservoir constructed on the downstream reach must be approved by both states. The ownership, operating cost, and water yield are proportional to the portions of the construction cost paid by the two states. To date, Toledo Bend is the only reservoir constructed in the lower reach. In the case of Toledo Bend, the states split the cost equally and have equal ownership of the lake and the water rights.

Any free water in the lower reach (not contained in or released from a reservoir) is divided equally between the two states. Since Toledo Bend extends to a point upstream from the junction of the river and the state line, the only water in that category is the water entering the river downstream from the dam.

The water in any reservoir on a tributary to the downstream reach can be used in the state where it is located, but that usage comes out of the state's share of the water in the river.

Diversion to Other Regions. The City of Dallas (Region C) has contractual rights to 114,337 acre-feet of water from Lake Palestine in the Neches basin. The City does not presently have the facilities to transport and treat the water, but anticipates the required construction by the year 2015.

Interception in Other Regions. It should be noted that large portions of the Sabine and Trinity basins are upstream from the region, as well as a small portion of the Neches basin. The upper Trinity basin includes the Dallas-Fort Worth area. The upper Sabine basin contains numerous medium sized cities as well as smaller communities. Large amounts of surface water are already being used by the upstream communities, and this usage can be expected to increase dramatically in the future along with population growth. Finally, the Sabine River Authority has contracts to provide over 300,000 ac-ft/yr to the Dallas area from reservoirs in the upper Sabine basin.

1.14 Drought Preparations

The entities listed in Table 1.19 have prepared water conservation plans. These plans are currently available from the TNRCC. Table 1.20 provides a listing of entities that have been required to file water conservation plans in order to receive funding from TWDB. SB1 requires that surface water right holders that supply or use 1,000 acre-feet or more per year for non-irrigation use and 10,000 acre-feet per year for irrigation use prepare a water conservation plan. Entities required to submit a plan in accordance with SB1 are identified in Table 1.21.

Table 1.19
Available Water Conservation Plans

Entity Name	
Athens MWA	City of Rusk
City of Nacogdoches	SRA

Table 1.20
Entities with Water Conservation Plans
Submitted for TWDB Funding

Entity Name	
Chalk Hill Special Utility District	City of Orange
City of Beaumont	City of Palestine
City of Bridge City	City of Whitehouse
City of Carthage	City of Woodville
City of Crockett	Hardin County WCID No. 1
City of Groves	Jefferson County WCID No. 1
City of Hemphill	Lumberton MUD
City of Huntington	Mauriceville SUD
City of Jasper	Orange County WCID No. 1
City of Lufkin	Orange County WCID No. 2
City of Nederland	

Existing water supplies and related drought preparations for various counties in the region are discussed briefly below.

General. Many larger communities and other suppliers supply water to neighboring systems on a wholesale basis, either full time or as a standby source. Most of these water suppliers are required to have water conservation plans, either as a condition for TWDB funding for water or sewer facilities and/or because they are users of surface water. In recent years, the TWDB has tended to require these wholesale suppliers to pass on water conservation and drought contingency requirements to their wholesale customers. The timing of these requirements may vary, but normally the requirements are imposed upon execution or renewal of a supply contract, or alternately the supplier notifies the wholesale customers that they may be imposed in the future if warranted.

Table 1.21
Entities Required to Submit Water Conservation Plans in Connection with Surface Water Usage

Entity Name	
Angelina-Nacogdoches WCID No. 1	Joe Broussard II, Et. Al.
ANRA	LNVA
Donohue Industries	M Half Circle Ranch Company
Chevron USA, Inc.	Mobil Oil Corporation
City of Center	Motiva Enterprise
City of Jacksonville	Panola County FWSD No. 1
City of Tyler	Temple-Inland Forest Products Corporation
E.I. DuPont De Nemours	Trinity County Regional WSS
Gulf States Utilities Company	Union Oil of California
Houston County WCID No. 1	United States Department of Energy
Huntsman Corporation	Upper Neches River MWD
Independent Refining Corporation	

Anderson County. The City of Palestine began using surface water from the Neches River released from Lake Palestine upstream from the intake in about 1968. Subsequently the City has abandoned two of its four wells and kept the other two on standby only. The standby wells draw from the Wilcox aquifer as did the abandoned wells. All well locations are within the City. The surface water plant is a short distance outside the City, with water pumped from the river intake approximately 11 miles away.

The City provides water service to its own area as well as to several hundred residents adjacent to the City. The City also supplies wholesale water service to three outside entities -- Dogwood Hills North Water Systems, Dogwood Hills East Water Systems; and Pleasant Springs WSC (water supply corporation). Four other water supply corporations are interconnected for emergency use -- Four Pines, Lone Pine, Neches, and Walston Springs. Nonresidential water customers include several industries, a country club, a junior college, a scientific balloon station, and a number of public schools, all within or adjacent to the City.

The City adopted a water conservation plan in January of 1996 in connection with an SRF loan administered by the TWDB. The plan includes the standard elements of education and information; a water rate structure which does not promote high water usage; universal metering; and leak detection. Also included is an emergency demand management plan. The plan includes measures such as rationing; surcharges; restrictions on outdoor usage, industrial process, cooling, and recreation; and activation of the standby wells. These measures can be taken during almost any emergency. However, the plan contemplates facility failure (power, transmission lines, surface water treatment, tanks, distribution system, etc.) more so than it does a shortage of raw water.

All or most other domestic water usage in the county is from groundwater. Consequently, the smaller communities are required to adopt water conservation plans only if they are seeking TWDB water or sewer funding in amounts over $500,000.

Note that the Upper Neches River MWD must maintain a plan as a supplier of surface water.

Angelina County. At the present time, the public water supply entities of Angelina County utilize groundwater for their primary source of water. The Carrizo Formation is the foremost water bearing unit in the County and it has been extensively developed in the Lufkin area. However, the use of the Carrizo is limited to the northwest portion of the county because of decreasing water quality and increasing depth of the formation to the south. Water systems in the south part of the County utilize water from the Yegua Formation, whose wells are typically lower in production and water quality is extremely variable. The *Angelina County Regional Water Study* (by Goodwin-Lasiter, Inc. - July 1998) indicates that seasonal peak production during dry periods currently exceeds the safe yield of the Carrizo Aquifer, and that present growth trends indicate that average production is likely to exceed the safe yield within the next 5 years.

The City of Lufkin is currently in the process of acquiring funding for the construction of a new surface water treatment plant on Sam Rayburn Reservoir. This will decrease the City's dependence on the Carrizo Aquifer while improving its ability to meet peak demands during drought conditions. In addition, the City of Lufkin maintains several emergency interconnections with surrounding public water suppliers. The improved capacity should make it possible for surrounding entities to purchase additional water from the City if their own supplies are insufficient to meet drought demands.

The City of Lufkin has adopted a water conservation plan. Other entities have been or may be required to adopt plans in connection with TWDB funding, or if they use surface water. Entities with plans include the City of Huntington, the Angelina-Neches WCID No. 1, and the ANRA.

Cherokee County. A portion of the water supply for Jacksonville comes from Lake Jacksonville. The use of surface water requires the City to adopt a water conservation plan. Other entities with plans include the City of Rusk.

Hardin County. The entire county is presently dependent on groundwater. However, several years ago several communities in the county participated in the *Regional Water Supply Study for Lower Neches Valley Authority*. The resulting report included long term plans for three new surface water plants, two of which would supply water for Sour Lake, Lumberton, and Kountze. One plant would draw water from the existing LNVA canal system, while the other would draw from Pine Island Bayou. Both plants would be constructed and operated by the LNVA using LNVA water rights.

Lumberton Municipal Utility District, serving over 10,000 residents, adopted a water conservation plan in February 1994 in connection with an SRF loan from the TWDB. The plan contains generally the same standard elements as the Palestine plan. Drought contingency measures are similar to those for Palestine and primarily contemplate power or facility failure. However, the possibility of drawdown or salt water intrusion in the aquifer is also addressed.

Emergency interconnection with the Beaumont water supply from the City wells within the District was considered, but may not be economical because of high rates charged by the City for out-of-City customers. The report also contemplated the need for additional water supplies during the design period through 2012, but at that time *(prior to the LNVA regional study)*, additional wells were anticipated.

Hardin County WCID No. 1 has adopted a water conservation plan in connection with TWDB sewer funding.

The cities of Kountze and Sour Lake have had to construct new wells during the last several years to replace older wells with contamination – radioactive materials in the case of Kountze and salt water in the case of Sour Lake.

Henderson County. Several small communities are located on the west shore of Lake Palestine, or near the lake, and some of these communities may draw surface water from the lake.

The only large community in the county is Athens, located in the Trinity basin outside the region.

Houston County. The *Water Supply Study for Houston County* (by Goodwin-Lasiter, Inc. - June 1999) states that water conservation and drought contingency plans have been adopted by some Houston County water suppliers. The purpose of those plans is to encourage conservation by the customers and to provide a methodology for allocating water supply during emergency conditions or periods of drought. However, the *Study* also notes that the impact of a water conservation plan is largely dependent on public education, and further states that the actual impact of water conservation on future demands cannot be predicted.

The study pointed out that the Houston County WCID No. 1, which supplies surface water for much of the county's needs, lost the industrial portion of its water rights in the Texas Water Commission's adjudication proceedings for the Trinity River Basin. Even if the water rights could be recovered for industrial or municipal use, the safe yield of the reservoir would be inadequate for the county's needs in the year 2025. Additional groundwater development, along with creation of a groundwater conservation district, was recommended.

Entities with water conservation plans include the Houston County WCID No. 1 and the City of Crockett.

Jasper County. The entire county depends on groundwater with the possible exception of small surface water withdrawal from Sam Rayburn Reservoir and Steinhagen Lake, both of which join the county. At least two entities have adopted water conservation plans – the City of Jasper and Rayburn Country MUD, both in the northern portion of the county – in connection with TWDB loans for wastewater facilities. Both plans contain the standard elements for water conservation and drought contingencies, contemplating short-term power loss or facility failure more than problems with the water sources.

Rayburn Country Municipal Water District, located on the shore of Sam Rayburn Reservoir, could draw reservoir water relatively easily if necessary, although the cost of surface water treatment would be much more than that of groundwater.

Jefferson County. Jefferson County is divided as to water usage. In the north part of the county, the City of Beaumont draws roughly half of its supply from large wells in southern Hardin County. The City of China and the Bevil Oaks and Meeker MUDs draw all of their water from local wells. However, Beaumont draws the remainder of its supply from the Neches River for treatment in its own plant. All other significant communities in the county, mainly south of Beaumont, draw raw water from the LNVA canal system and treat it with their own plants. Likewise, most industries in the county other than those supplied by Beaumont get raw water from the LNVA. Additionally, a number of farmers (mostly rice farms) are supplied through the LNVA canals. The LNVA draws all of its water from the Neches River and Pine Island Bayou.

The LNVA had a water conservation plan and drought contingency plan prepared in connection with TWDB funding for the regional water supply study. Additionally, the LNVA has certain water conservation provisions related to its rights to water in Sam Rayburn and Steinhagen Reservoirs, upstream from the LNVA intakes. One provision is that if the LNVA must obtain permission from the Corps of Engineers to lower Sam Rayburn Reservoir below the 149 foot level *(approximately 15 feet below normal level)*, it must take certain measures including cutting off water for irrigation.

At least four cities and one water district in the county have adopted water conservation plans in connection with TWDB water and/or sewer funding – the cities of Beaumont, Nederland, Port Neches, and Groves, and Jefferson County WCID No. 10. The City of

Port Arthur is required to have a plan because of surface water usage, as are several local industries.

Beaumont, China, and Bevil Oaks participated in the LNVA regional water study, which contains long-term recommendations for new LNVA surface water plants to meet at least part of the needs of those communities.

Nacogdoches County. The City of Nacogdoches adopted a water conservation plan in May of 1993 in connection with TWDB wastewater project funding. The plan contains the standard elements. The plan points out the current trend for the City to depend more on its surface water supply from Lake Nacogdoches and less on its local wells, several of which have already been abandoned.
The City supplies several entities on a full time or standby basis, including a water district, several water supply corporations, and a property owners association.

Most other entities in the county use groundwater, but some water conservation plans may be required for TWDB funding.

Newton County. Newton County depends on groundwater except for possibly surface water usage on Toledo Bend Reservoir. The South Newton Water Supply Corporation, serving an area overlapping Newton and Orange Counties, has adopted a water conservation plan in connection with FmHA funding for water system improvements. The plan contains some, but not all, of the elements of TWDB plans. Although the WSC is entering a TWDB-funded sewer project, the TWDB has indicated so far that the existing water conservation plan should be adequate for its purposes.

Orange County. Several entities in Orange County have adopted water conservation plans in connection with TWDB water and/or sewer funding – the cities of Bridge City and Orange; Orange County WCID No. 1 (Vidor); Orange County WCID No. 2 (West Orange) and Mauriceville Special Utility District. These plans contain the standard elements.

Orange County depends mainly on groundwater. However, the Sabine River Authority supplies water from the Sabine River through a canal system to at least one municipal user, to various farmers, and to several industries in the Orange area. The SRA and several industries have plans.

Panola County. The Panola County Fresh Water Supply District, which supplies all water to the City of Carthage, draws from Lake Murvaul. Several other water suppliers draw from that lake. Entities with water conservation plans include the City of Carthage and the FWSD.

Polk County. Most or all of the portion of Polk County in the region use groundwater. Some entities may have adopted water conservation plans in connection with TWDB funding.

Rusk County. The City of Henderson, which presently depends on wells, is constructing a 4.5 mgd surface water plant expected to start up in late 2000. The City of Kilgore, partially in the county, uses surface water in addition to wells. Both entities are required to prepare water conservation plans.

Many smaller systems in the county still use wells.

Sabine County. The City of Hemphill draws its water from Toledo Bend Reservoir, as do several small water suppliers. At least one user, the City of Hemphill, has adopted a plan.

San Augustine County. The City of San Augustine draws part of its water from San Augustine City Lake, which supplies all water for the Bland Lake WSC and the San Augustine Rural WSC. Consequently, the City of San Augustine must maintain a plan.

At the south end of the county, the Pineywoods Conservation Center, an outpost of SFA University, draws water from Sam Rayburn Reservoir.

Shelby County. The cities of Center, Joaquin, and Huxley, along with various smaller systems, use surface water, with other cities and rural water systems using groundwater. The City of Center has a water conservation plan, and the City of Huxley has had a plan developed. Note that the City of Center has had prior experience with water conservation during a drought of several years in the early to middle 1950's. For a time, all outdoor usage and plant watering with City water was prohibited in an effort to keep enough water for domestic use plus keep the City's industries operating.

A significant number of the Shelby County water suppliers are not currently meeting the minimum TNRCC requirements for capacity, and projected population growth indicates that many more will fall into this category in the near future. However, several of the County water suppliers have joined together and submitted a funding application to Rural Development in order to develop a regional water supply system based on surface water supplies. If that project is implemented, it will reduce the participants' reliance on groundwater supplies and will offer added security in times of drought.

Smith County. A portion of the water supply for the City of Tyler comes from surface water (Lake Tyler and Lake Bellwood). The City of Whitehouse also draws part of its water from Lake Tyler. At least these two cities have adopted water conservation plans.

Trinity County. A wide strip along the south side of the county is shown on TWDB maps as having neither a major or minor aquifer under the ground. Small amounts of groundwater are available, however, from local sands.

The western area of the county along Lake Livingston can draw surface water from that body. The eastern part of the county which falls in the region has no nearby surface water body, but must either import water from Lake Livingston or depend on wells. Such wells may be a number of miles from the communities which they serve.

One entity in the county with a water conservation plan is the Trinity County WSS.

Tyler County. Tyler County has little or no surface water usage for domestic purposes, although at least one farm draws irrigation water from a stream, and at least one other farm drew water from an on-site pond in the past. The county depends on groundwater for consumptive uses. The City of Woodville has a water conservation plan in connection with TWDB funding.

1.15 Existing Programs

Texas Clean Rivers Program (TCRP). TCRP was established with the promulgation of the Clean Rivers Act of 1991. TCRP provides for biennial assessments of water quality to identify and prioritize water quality problems within each watershed and subwatershed. In addition, TCRP seeks to develop solutions to water quality problems identified during the biennial assessments.

Safe Drinking Water Act (SDWA). The SDWA, passed in 1974 and amended in 1986 and 1996, allows the U.S. Environmental Protection Agency to set drinking water standards. These standards are divided into two categories: National Primary Drinking Water Regulations (primary standards that must be met by all public water suppliers) and National Secondary Water Regulations (secondary standards that are not enforceable, but are recommended). Primary standards protect water quality by limiting contaminant levels that are known to adversely affect public health and are anticipated to occur in water. Secondary standards have been set for contaminants that may pose a cosmetic or aesthetic risk to water quality (e.g., taste, odor or color).

Water for Texas. Developed by the TWDB, this comprehensive State water plan identifies current and prospective water uses, water supplies, water users and identifies needed water-related management measures, facility needs and costs and offers recommendations to better manage the State's water resources through the year 2050. This plan was adopted by the TWDB in August 1997.

Sabine River Basin. Comprehensive Sabine Watershed Management Plan, December 1999, prepared for Sabine River Authority of Texas in Conjunction with the Texas Water Development Board, Contract # 97-483-214; Freese and Nichols, Inc., Brown and Root, Inc., and LBG-Guyton Associates. This plan was developed over a period from 1996 through 1999 as an update to a 1985 master plan for the basin. The plan points out the two distinct geographic regions of the basin, upstream and downstream from the upstream end of Toledo Bend Reservoir in Panola County.

TWDB Consensus Planning population and water use projections showed water use in the Upper Basin to increase from 197,000 to 457,000 acre-feet per year from 1990 to 2050. Lower Basin use was shown to increase from 79,000 to 164,000 acre-feet per year from 1990 to 2050. No new water supplies for the Lower Basin were recommended. A total of 93,000 acre-feet per year of new supplies were recommended for the Upper Basin, including a proposed Prairie Creek Reservoir.

Neches River Basin. Water Availability Modeling for the Neches River Basin**,** Draft Report, April 1999; prepared for TNRCC by Brown and Root Services, Freese And Nichols, Espey – Padden, and Crespo Consultants. The study determined naturalized stream flows and developed a model to determine water available to meet water rights.

Naturalized stream flows averaged 6.3 million acre-feet/year, with a minimum of 1.4 acre-feet/year in 1967. Total water rights came to 4 million acre-feet/year. Cancellation of selected water rights would have little effect on reliability for the remaining rights.

Trinity River Basin. Trinity River Basin Master Plan, 1958, updated various times, most recently 1997. Water use projections show water use in the Upper Basin (*all counties north of Freestone and Anderson*) to increase from 904,000 acre-feet/year to 2,165,000 acre-feet/year from 1990 to 2040. Middle and Lower Basin use is shown to increase from 141,100 acre-feet/year to 302,400 acre-feet/year from 1990 to 2040. The groundwater component of the Middle and Lower Basin usage is shown to increase from 40 mgd to 63 mgd during the same period.

The firm yield of existing and under-construction major reservoirs within the Trinity Basin is 2,325,100 acre-feet/year. Several new reservoirs are recommended, including Wallisville and Tennessee Colony. The Wallisville reservoir (near the mouth of the Trinity River) is cited as having dual benefits. In addition to the water which it would impound, it would serve as a saltwater barrier and avoid the need to release water from Lake Livingston to keep saltwater out of the lower reaches of the river.

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Task 2

Task 2

Current and Projected Population and Water Demand Data for the Region

2.1. Introduction

This report describes Task 2, which is the development of population and water demand projections. In its guidelines for Senate Bill 1 planning, the Texas Water Development Board requires that each region develop two tables to present the information on population and water demand projections (TWDB Tables 1 and 2). TWDB Table 1 describes the population projections for East Texas Regional Water Planning Group. TWDB Table 2 presents the water demands for each water user group in the region.

2.2 East Texas Region Overview

The twenty East Texas counties comprising the East Texas Region contain three population centers. The three population centers are the Beaumont-Port Arthur-Orange area, the Lufkin-Nacogdoches area, and the Tyler area. The remaining communities are smaller and more rural in character. Water supplier of the smaller communities which are not specifically referenced in the report are included as "County-Other". A list of these entities is included as Appendix A to this section. The population of the region is projected to increase from 1,042,411 in the year 2000 to 1,562,155 in the year 2050, a growth rate of 49.9 %.

Per capita municipal water use for the region as a whole is projected to decline over the planning period from 147 gallons per capita per day (gpcpd) at present to 125 gpcpd in 2050. The reduction in personal consumption is attributed to water conservation measures, such as water saving fixtures, which are required to be incorporated into the demands. The savings due to the incorporated conservation measures amount to approximately 30,660 acre-feet/year or 2.7% of the total demand in the year 2050.

2.3 Population Growth (TWDB Table 1)

The East Texas Region's population growth is presented in TWDB Table 1 and summarized in Figure 2.1. The projections were determined by using the TWDB consensus projection as a base and updating using the latest population information published by the State Data Center for county populations and City and/or county population and water demand studies commissioned by individual cities and/or counties. A description of the derivation of the projections is presented as a forward to TWDB Table 1.

There are several reasons for the projected growth in the region over the planning period. The NAFTA Highway will run through the area most directly affecting the Lufkin Nacogdoches area. The petrochemical industry is dramatically increasing investment and capacity in the Beaumont-Port Arthur-Orange area which should reverse the loss of jobs in the area as this industry continues to streamline their operations. The Tyler area is favorably affected by the growth in the Dallas metropolis and is becoming a growth center for technology related companies.

2.4 Water Uses (TWDB Table 2)

Water use in the East Texas Region was developed in the categories required for this study by the TWDB. The water uses include municipal, manufacturing, steam/electric power generation, mining, agricultural, and livestock. The projected water use is provided in Appendix B (TWDB Table 2). Figure 2.2 shows the trends for use of water in each of the categories and total for the region over the planning period.

Water consumption is projected to increase approximately 61.1 % from 1990 to 2050. Figure 2.3 compares current water usage to the projected water usage in 2050.

2.5 Municipal Water Use

Municipal water use includes both residential and commercial water use. Residential covers both single family and multi family uses. Commercial use is composed of water used by small businesses, institutions, and public offices. It does not include water used by industry.

The total municipal water use for the East Texas Region is expected to increase from 171,431 acre-feet for the year 2000 to 219,493 acre-feet for the year 2050 (Figure 2.4). Although per capita water use is expected to decline due to water conservation efforts, the population within the region is expected to increase more than water conservation.

2.6 Manufacturing Water Use

Manufacturing or Industrial water use represents water used in the production of manufactured products, including water used for domestic purposes by employees. Manufacturing Water Use in the East Texas Region is a major use category comprising 39 % of the overall water use in East Texas. The projected use for the year 2000 is 312,056 acre-feet with an increase to 436,465 by the year 2050.

The majority of manufacturing water use is in the three population centers of East Texas. In the Beaumont-Port Arthur-Orange area refining and petrochemicals are the primary users of manufacturing water. Representative of these industries in this area are Mobil Oil, Mobil Chemical, Motiva, Huntsman Chemical, Fina, BASF, Chevron, and Ameripol-Synpol. In the Lufkin-Nacogdoches area the primary industries are timber and poultry related. In the Tyler area the major industries are refining and related businesses and basic product manufacturing such as Kelly-Springfield tires and Tyler Pipe.

In the past three years several billion dollars of industrial expansion has occurred in the Beaumont-Port Arthur-Orange area representing a large portion of the industrial expansion dollars spent statewide in the same timeframe. Figure 2.5 shows the projected manufacturing use in the Region through the year 2050.

2.7 Steam Electric Power Generation Water Use

Total water use for steam electric power generation for the East Texas Region is projected to be 55,209 acre-feet in 2000 and to increase to approximately 155,914 acre-feet in the year 2050. Current power generation facilities are located in Cherokee, Jefferson, Orange and Rusk counties. Projected facilities in the East Texas Region forecast for construction are located in Nacogdoches and Tyler counties. Other generation facilities may be constructed in the region. Deregulation of the power industry has acted as a catalyst for construction of gas turbine generation plants in Texas. The projections for water use for steam-electric power generation are also shown in Figure 2.5.

2.8 Mining Water Use

Mining activity in the East Texas Region is related to oil and gas production and lignite mining. The major use is in lignite mining. The counties with mining activity are Anderson, Angelina, Cherokee, Hardin, Henderson, Houston, Jasper, Jefferson, Nacogdoches, Newton, Orange, Panola, Rusk and Smith. Figure 2.5 illustrates mining water use in the East Texas Region. Mining accounts for approximately 2.3% of the water demand in the year 2050.

2.9 Irrigation Water Use

Irrigation water use in East Texas is a major water use. The revision in TWDB projections for irrigation in the East Texas Region is substantial. TWDB projections had irrigation water use for East Texas declining to approximately 117,000 acre-feet by the end of the planning period. The East Texas Regional Planning Group presented a case for a slight increase in irrigated acreage for rice production instead of a substantial decline. The pressure to remove acreage from rice production in order to convert irrigation water to municipal water is not apparent in the East Texas Region.

The two factors that will bear most significantly on the future of rice production in East Texas are the Federal Farm Program and trade embargos in the Middle East. The current Federal Farm Program is not favorable to the Rice Industry in East Texas. If the re-authorization of the farm program is more favorable to the industry, acreage for rice production could increase significantly in East Texas. Rice production would also benefit from a lifting of the trade embargos currently in place for Middle Eastern countries.

Figure 2.6 illustrates agricultural water use in the East Texas Region.

2.10 Livestock

Livestock is not a significant water use for the region as a whole. However, for the counties of East Texas involved with poultry production, water use for livestock is projected to increase significantly. Figure 2.6 above illustrates water use for livestock in the East Texas Region that will account for 2.5% of the water demand in the year 2050.

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Task 3

Task 3

Evaluation of Current Water Supplies in the Region

3.1. Introduction

This report describes Task 3, which is the analysis of the water supply currently available in East Texas Regional Water Planning Group. In its guidelines for Senate Bill 1 planning, the Texas Water Development Board requires that each region develop three tables to present the information on the current water supply (TWDB Tables 4, 5, and 6). TWDB Table 4 describes the total water supplies available to East Texas Regional Water Planning Group. TWDB Table 5 presents the supplies available to each water user group in the region, considering the limitation such as to deliver the raw water source such as firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions and infrastructure. TWDB Table 6 presents the water supplies available to major water providers considering the same limitations. All three TWDB tables have been developed assuming drought of record conditions with no new development.

3.2 Overall Water Supply Availability (TWDB Table 4)

Table 3.1 and Figures 3.1 and 3.2 summarize the overall water supply availability in East Texas Regional Water Planning Group. TWDB Table 4 and a description of its development is presented in TWDB Tables.

Table 3.1 and Figures 3.1 and 3.2 show a summary of the various water supply sources which include:

- Reservoirs
- Run-of-the-River Diversion
- Groundwater
- Local Sources (Mining, Irrigation, Livestock, Other)
- Reuse

Run-of-the-River Brackish water supplies, as identified in TWDB Table 4, are tidally influenced and are not considered a source of future supply. The brackish water supplies are limited to specific industrial uses and are expected to decline during the planning period. The supplies are not included in the above Tables and Figures.

The information in Table 3.1 and Figures 3.1 and 3.2 was developed on the basis of the following assumptions.

3.2.1 Reservoirs in East Texas Regional Water Planning Group. All major reservoirs in East Texas Regional Water Planning Group were included, as were some smaller reservoirs used for municipal supply. (Major reservoirs are those with over 5,000 acre-feet of conservation storage). The water supply available was limited to currently permitted diversions, firm yield or ability to provide supply from the water source, whichever is less. (The firm yield is the greatest amount of water a reservoir could have supplied on an annual basis without shortage during a repeat of historical hydrologic conditions, particularly the drought of record.) Both Sam Rayburn and Toledo Bend Reservoirs were constructed for multi-purposes. Although hydroelectric power is not considered to be a consumptive use of water, it can have an impact on water availability. The effect of hydroelectric power generation on water supplies from these two reservoirs is not considered in determining water supplies. It is recommended that future planning cycles attempt to identify and modify the affect of hydroelectric power on the reservoirs.

3.2.2 Unpermitted Reservoir Yields. TWDB Table 4 includes information on "unpermitted reservoir yields". This is in response to TWDB's requirement that the table be limited to permitted amount for all existing reservoirs, whether or not the existing water rights allow use of the full firm yield. The largest unpermitted reservoir yield in East Texas Regional Water Planning Group is Texas' share of the yield of Toledo Bend Reservoir which is more than 250,000 acre-feet per year. Other unpermitted yields are in Lake Jacksonville, Lake Murvaul, Lake Striker and Houston County Lake.

3.2.3 Run-of-the-River Diversion. Run-of-the-River Diversion was based on water rights and Neches WAM model. Included in River Diversion are water taken from the lower sections of the Sabine and Neches Rivers. These “brackish” supplies should not be considered available to meet future demands.

3.2.4 Groundwater. Groundwater is largely supplied in the Carrizo-Wilcox Aquifer in the northern region of the planning area and the Gulf Coast Aquifer in the southern region of the planning area. Figure 3.3 indicates the general location of the aquifers. The method of estimating groundwater supply is discussed in TWDB Table 4.

3.2.5 Local Supply (Power, Mining, Manufacturing, Irrigation, Livestock). The values represent surface water used from unpermitted stock ponds or directly from streams. The maximum historical use from these sources (according to TWDB records) is assumed to be available in the future.

3.2.6 Reuse. The reuse listed as available to the region is for existing projects based on current permits and authorizations. Categories of reuse include (1) currently permitted and operating indirect reuse projects, in which water is reused after being returned to the stream; (2) existing indirect reuse for industrial purposes; and (3) authorized direct reuse projects for which facilities are already developed. The specific reuse projects included are discussed in the text to TWDB Table 4. It is unlikely that reuse will increase dramatically in East Texas Regional Water Planning Group over the next 50 years.

3.2.7 Imports. The only import supply discovered is for the City of Joaquin which imports water from the City of Logansport, Louisiana. The specific sources for imports are described in TWDB Table No. 4.

3.3. Water Availability by Water User Group (TWDB Table 5)

TWDB Table 5 presents water availability for each water user group by county and river basin. (Water user groups are cities and "county other" municipal uses, and countywide manufacturing, irrigation, mining, livestock, and steam electric uses). Unlike the overall water availability figures in TWDB Table 4, the availability figures by water user group in TWDB Table 5 are limited by the ability to deliver the raw water. These limitations include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions and raw water delivery infrastructure. The table shows the amount of supply available to each user group from each source by decade based on existing physical facilities.

A graphical summary of the data in TWDB Table 5, using a variety of query methodologies, is presented in Figures 3.4 through 3.11. A summary of the information presented by each of the figures follows.

- Figures 3.4 through 3.6: The figures show the water supply available to various water supply groups. Data is presented for the overall Region for the planning period (Figure 3.4) and a summary of the water user groups by County (Figures 3.5 and 3.6). Figure 3.6 excludes Jefferson County so as to provide a better view of the information from other counties.

- Figure 3.7: Shows the distribution of supply for the planning period by surface and groundwater.

- Figure 3.8: Shows the various sources of surface water supply available to the Region in the year 2000.

- Figures 3.9, 3.10 and 3.11: Shows the supply of groundwater for the various aquifers. Figure 3.9 shows the information for the entire East Texas Region Water Planning Area. Figure 3.10 shows the information for counties which mainly rely on the Carrizo-Wilcox aquifer. Figure 3.11 shows data for counties which mainly rely on the Gulf Coast aquifer.

Important points, found during development of TWDB Table 5, regarding the availability of water for water users groups in East Texas Regional Water Planning Group are:

- The decrease in supply shown after the Year 2000 are attributable to following two items.
    - The Lower Neches Valley Authority contracts are written for limited time periods (one year municipal and five year for industrial and irrigation).
    - The City of Hemphill contract with Sabine River Authority expires after the year 2020.

- Brackish water is not included in TWDB Table 5. This source is not considered usable for future demands for water quality reasons.

3.4 Water Availability by Major Water Provider (TWDB Table 6)

TWDB Table 6 presents water availability for each designated major water provider. The designated major water providers in East Texas Regional Water Planning Group are Angelina Neches River Authority, Lower Neches Valley Authority, Sabine River Authority, Upper Neches River Municipal Water Authority, City of Beaumont, City of Jacksonville, City of Lufkin, City of Nacogdoches, City of Port Arthur, City of Tyler, Houston County Water Control Improvement District, Panola County Fresh Water Supply District, Huntsman and Motiva. Unlike the overall water availability figures in TWDB Table 4, the availability figures by major water provider in TWDB Table 6 are limited by the ability to deliver the raw water. These limitations include firm yield of reservoirs, well field capacity, aquifer characteristics, water quality, water rights, permits, contracts, regulatory restrictions and infrastructure. The Table shows the amount available to each major water provider from each source by decade based on existing physical facilities. A summary of each major water provider follows.

Angelina & Neches River Authority (ANRA): ANRA has a state permit to construct Lake Eastex. Table 3.2 lists the participating entities, their participation percentages, and the corresponding water supply amounts. The contract for each participant extends through the federal Clean Water Act Section 404 permitting process for Lake Eastex. After completion of this process, a new round of contracts for further development of the lake must be signed. ANRA estimates that development of the lake could be complete in 7 to 10 years. No supply is shown since the reservoir is not constructed.

City of Jacksonville: The City of Jacksonville obtains water supplies from Lake Acker, Lake Jacksonville and the Carrizo-Wilcox Aquifer. The surface water supplies for the City of Jacksonville are based on the firm yields from the Neches River WAM. The groundwater supplies are based on current well field production.

Four water supply corporations (WSCs) presently have contracts with the City of Jacksonville: Afton Grove WSC, Craft-Turney WSC, Gum Creek WSC, North Cherokee WSC, and West Jacksonville WSC.

Upper Neches River Municipal Water Authority (UNRMWA): The UNRMWA operates Lake Palestine. The UNRMWA maintains a total water rights of 238,110 acre-feet/year. Existing water supply contract amounts were determined from water rights permits and contracts on file with the TNRCC, from the UNRMWA *Regional Water Supply Plan* (HDR, August 1999), and from conversations with Mr. Tom Mallory, UNRMWA General Manager.

Neither the City of Tyler nor the City of Dallas has transmission facilities to transport water from Lake Palestine. It is estimated that the City of Tyler will complete transmission facilities in the next two years and that the City of Dallas will connect to the lake by approximately 2015. Only the City of Palestine and some other smaller users presently utilize this source. Therefore TWDB Table 5 reflects the current usage.

Lower Neches Valley Authority: The LNVA maintains water rights from Lake Sam Rayburn, Lake B.A. Steinhagen and Run-of-the-River diversion from the Neches River. The LNVA currently possesses the infrastructure to divert these water rights to its municipal, manufacturing and irrigation users.

The LNVA currently services the municipal demands from the City of Groves, City of Nederland, City of Port Arthur, City of Port Neches, Jefferson County Water Improvement Control District No. 10, Town of Nome and West Jefferson County MUD. Contracts for these entities are presently written on one year renewable basis with a minimum billing quantity stated in the contract. The supply available to each of the entities is based on the minimum billing quantity contained in the current contract. Since the contracts are renewable on a yearly basis, no supply is shown after the year 2000. Future supply to the City of Lufkin from Sam Rayburn Reservoir is anticipated in the near future, however, the infrastructure for the delivery of water is not presently in place. The supply for the City of Lufkin is not shown.

The LNVA also supplies water used for manufacturing in Jefferson County. Some of the manufacturers have water rights to brackish water supply rights downstream of the proposed salt water barrier. Since the infrastructure exist to supply the water to manufacturing, the total water rights is shown as the supply. Since the contracts are renewable on a two year basis, no supply is shown after the year 2000.

The LNVA supplies irrigation water used in Jefferson County. Since the infrastructure exists to supply the water for irrigation, the total water rights is shown as the supply. Contracts are written for five year periods, but an annual renewal process is required. The contracts do not state specific quantities of water, therefore, the supply is based on providing demand and not by specific contract. The supply shown in TWDB Table 6 is based on water rights.

City of Beaumont: The City of Beaumont supplies water from the Neches River and groundwater wells in Hardin County. The supplies shown in TWDB Table 5 are based on water rights and 50% of current well capacity.

The City provides treated water to Jefferson County Water Improvement District No. 1 and Northwest Forest MUD and the prison complexes. The City also serves industrial customers. The contracts do not specify quantities and therefore the demands are treated as internal direct demands.

City of Port Arthur: The City of Port Arthur receives raw water supply from the LNVA. Treated water is supplied to industrial users in addition to its citizens. The projections for supply are shown under the LNVA. Since the contract with LNVA is one year contract, no supply is indicated.

City of Tyler: The City of Tyler receives raw water supply from Lake Tyler and Tyler East. It possesses water rights to Lake Bellwood, however, the raw water from this source is used directly by industry or for irrigation. Water is not treated by the City from this source. The City plans to have facilities for the treatment of water from Lake Palestine on line during early 2003. It also obtains water from the Carrizo-Wilcox aquifer. It presently provides treated water to the City of Whitehouse.

Supplies in TWDB Table 6, for the various sources are based on the following:

- Lake Tyler and Tyler East:
- Lake Bellwood
- Carrizo-Wilcox

Motiva: Motiva receives water supply from the LNVA. The supply source for Star Enterprise is included in the "Manufacturing" category. A separate supply is not indicated since water is obtained through a short term contract with the LNVA.

Huntsman Chemical: Huntsman Chemical receives water supply from the LNVA and sells water to a neighboring rubber plant. The supply source for Huntsman Chemical is included in the "Manufacturing" category. A separate supply is not indicated since water is obtained through a short term contract with the LNVA.

Sabine River Authority (SRA): The SRA owns and operates Lake Tawakoni, Lake Fork, and the Toledo Bend Reservoir. In addition, the SRA maintains run-of-the-river rights from the Sabine in Newton and Orange County. The SRA provides water to municipal and industrial customers in Region C and Region D from Lake Fork and Lake Tawakoni, located outside of the East Texas Region. Water in the Lower East Texas Region is provided from Toledo Bend Reservoir and diversions from the Sabine River through the SRA Canal System. SRA holds water rights of 750,000 acre-feet per year from Toledo Bend Reservoir and 147,000 acre-feet per year from the Sabine River. Municipal customers include the Cities of Hemphill, Huxley and Rose City, and Beechwood WSC, El Camino Bay Property Owner's Association and Pendleton Utility Corporation. The largest manufacturing demands are for E.I. Dupont De Nemours Company, Inc., and Inland Paperboard and Packaging.

The numbers presented in TWDB Table 5 represent current supplies provided, including limits of contracts.

Panola County Fresh-Water Supply District No. 1 (Panola County FWSD 1): The Panola County FWSD 1 owns and operates Lake Murvaul in the ETRWPA. The district provides water exclusively to the City of Carthage from its water right of 21,280 acre-feet of municipal water and 1,120 acre-feet of industrial water in Lake Murvaul.

City of Center: The City of Center currently obtains water from Lake Center and Lake Pinkston for use within the City and for distribution to its municipal and industrial customers. The City owns and operates Lake Center, with annual rights of 1,460 acre-feet of municipal water. Water from Lake Pinkston is pumped from the Neches River Basin to the City, located in the Sabine River Basin. The City holds rights to 3,800 acre-feet of water in Lake Pinkston. The City's municipal customers include Sand Hills WSC and Shelbyville WSC. The primary customer for manufacturing water is Tyson Foods, Inc.

City of Lufkin: The City of Lufkin presently receives supplies from the Carrizo-Aquifer. Supplies for the City of Lufkin is based on 50% of its present well field total pumping capacity. The City presently has contracts to provide water to two water supply corporations: Angelina WSC and Burke WSC.

The City presently has a contract with the LNVA for 28,000 acre-feet/year of water rights from Lake Sam Rayburn. Information from the "Angelina County Regional Water Study (July 1998)" indicates surface water facilities to be constructed around the Year 2004. Supplies from this source are not included in Table 6.

Houston County WCID No. 1: Houston County WCID No. 1's water rights to Houston County Lake includes a right to divert 3,500 acre-feet/year at a rate not to exceed 6,300 gpm. The District recently lost industrial water rights in the amount of 3,500 acre-feet/year. Supply in TWDB Table 6 is limited by the water rights.

Houston County WCID No. 1 presently serves Consolidated WSC, City of Crockett, City of Grapeland, City of Lovelady and AMPACET (an industrial user).

City of Nacogdoches : The City of Nacogdoches obtains groundwater from the Carrizo-Wilcox aquifer and Lake Nacogdoches. The groundwater supply is based on maximum historical usage, which is approximately 70% of the current well field pumping capacity. The future groundwater supply is expected to remain constant for the planning period. The City currently has water rights to divert 22,000 acre-feet/year of water from Lake Nacogdoches.

The City currently provides water to Central Heights WSC, D&M Water Supply, Lilly Grove WSC, Nacogdoches County MUD No. 1, and Timber Ridge East.

3.5. Summary of Current Water Supply in East Texas Regional Water Planning Group

1. The projected overall reliable water supply available to East Texas Regional Water Planning Group in 2050 from current sources will be about 3,481,816 acre-feet per year. (This figure does not consider supply limitations due to the capacities of current raw water transmission facilities and wells nor does it include brackish water sources). The sources of supply for East Texas Regional Water Planning Group include:
    - 2,155,895 acre-feet per year (62%) from in-region reservoirs
    - 736,996 acre-feet per year (21%) from groundwater
    - 559,506 acre-feet per year (16%) from run of river diversion
    - 29,172 acre-feet per year (1%) from local suppliers
    - 247 acre-feet per year (0%) from reuse

2. Sources of supply will not be utilized fully during the period covered by this plan.

3. Based on limitations required for this study, the availability of water is severely limited by current contract conditions.

4. There are plans by several communities to improve water availability. These plans could not be considered in this Task report, but are presented for the purpose of information in considering future strategies.

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Tables

TABLE 3.1

REGION I SUPPLY SOURCES

Source	Value forYear 2000 of Supply from this Source (ac-ft/yr)	Value forYear 2010 of Supply from this Source (ac-ft/yr)	Value forYear 2020 of Supply from this Source (ac-ft/yr)	Value forYear 2030 of Supply from this Source (ac-ft/yr)	Value forYear 2040 of Supply from this Source (ac-ft/yr)	Value forYear 2050 of Supply from this Source (ac-ft/yr)
Reservoir	1,867,305	1,866,025	1,864,745	1,863,515	1,862,240	1,860,940
Reservoir (Unpermitted Yield)	302,815	301,217	299,629	298,071	296,513	294,955
Run of River Diversion	559,506	559,506	559,506	559,506	559,506	559,506
Groundwater	737,056	737,054	737,054	736,991	732,388	736,996
Irrigation Local Supply	12,895	12,895	12,895	12,895	12,895	12,895
Livestock Local Supply	12,582	12,582	12,582	12,582	12,582	12,582
Mining Local Supply	1,334	1,334	1,334	1,334	1,334	1,334
Other Local Supply	2,332	2,337	2,343	2,349	2,354	2,361
Direct Reuse	247	247	247	247	247	247
TOTAL	3,496,072	3,493,197	3,490,335	3,487,490	3,480,059	3,481,816

Table 3.2

ANRA PARTICPANTS IN THE DEVELOPMENT OF LAKE EASTEX

Participant	WUG	County	Percentage	Amount (ac-ft/yr)
Afton Grove WSC	County-Other	Cherokee	1.00%	855
City of Arp	Arp	Smith	0.05%	43
Blackjack WSC	County-Other	Cherokee	1.00%	855
Caro WSC	County-Other	Nacogdoches	1.50%	1,283
Cheokee County	County-Other	Cherokee	3.00%	2,565
Jackson WSC	County-Other	Smith	1.00%	855
City of Jacksonville	Jacksonville	Cherokee	5.00%	4,275
John Moore	County-Other	Cherokee	1.00%	855
City of Nacogdoches	Nacogdoches	Nacogdoches	10.00%	8,551
City of New London	New London	Rusk	1.00%	855
New Summerfield WSC	New Summerfield	Cherokee	1.00%	855
North Cherokee WSC	County-Other	Cherokee	1.00%	855
Reklaw WSC	County-Other	Cherokee	0.50%	428
City of Rusk	Rusk	Cherokee	1.00%	855
Rusk Rural WSC	County-Other	Cherokee	1.00%	855
Stryker Lake WSC	County-Other	Cherokee	0.50%	428
Temple Inland	Manufacturing	Angelina	10.00%	8,551
City of Troup	Troup	Smith	5.00%	4,275
City of Tyler	Tyler	Smith	10.00%	8,551
City of Whitehouse	Whitehouse	Smith	10.00%	8,551

TOTAL PARTICIPATION	64.55%	55,195
TOTAL ANRA WATER RIGHT FOR LAKE EASTEX		85,507

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Task 4

Task 4

Comparison of Water Demands with Water Supplies to Determine Needs

4.1. Introduction

This report describes the comparison of estimated current water supply for drought of record conditions (from Task 3) and projected water demand (from Task 2). From this comparison, water shortages or surpluses for drought of record conditions have been estimated.

In guidelines for Senate Bill 1 planning, the TWDB requires that each region develop four tables that describe the comparison of supply and demand (TWDB Tables 7, 8, 9, and 10). TWDB Table 7 presents the comparison of supply and demand for each water user group in the region. TWDB Table 8 presents the comparison of supply and demand for each major water provider.

TWDB Table 9 describes the social and economic impacts of water shortages for each water user group. TWDB Table 10 describes the social and economic impacts of water shortages for each river basin. The information was supplied, upon request of the ETRWPG, by the TWDB who developed a model for predicting social and economic impacts of water shortages.

The remaining sections of this report present the comparison of current water supply and projected water demand in East Texas. Section 4.2 presents a regional comparison of current supply and projected demand. Section 4.3 presents a county-by-county comparison of current supply and projected demand. Section 4.4 presents the comparison of current supply and projected demand for each water user group. Section 4.5 discusses shortages for the three major water providers in the Region. Section 4.6 presents a summary of existing and potential public water supply system water quality concerns. Section 4.7 is a summary of this report.

4.2. Regional Comparison of Supply and Demand

Table 4.1 and Figure 4.1 summarize the comparison of total currently available water supply and total projected water demand by county in East Texas. The region as a whole has a currently available surplus of 115,089 acre-feet per year (ac-ft/yr) in 2000, changing to a shortage of 369,385 ac-ft/yr by 2010, and declining to a shortage of 608,413 by 2050. In 2000, Henderson, Rusk and San Augustine Counties (3 out of 20 in the region) show a net shortage of currently available water when all uses are totaled. By 2050, only Jasper, Panola, and Trinity Counties show a net surplus when totaled over all uses.

Out of 317 water user groups (WUGs) in East Texas, 71 WUGs are projected to have a shortage of currently available water in 2000, growing to 112 WUGs with a projected shortage by 2050. The projected shortages assume drought of record conditions.

Table 4.2 summarizes regional surpluses and shortages by type of water use. The Irrigation and Steam Electric Power uses are projected to have net shortages in 2000. By 2010, only Municipal and Mining uses are projected to have net surpluses. From 2020 to 2050, only the Municipal water use is projected to have a net surplus of water. Even though the Municipal water use shows a net surplus in every decade of the planning period, there are individual cities that are projected to have shortages during the planning period.

A significant portion of the shortages shown in Tables 4.1 and 4.2 are caused by expiration of contracts. For example, the Lower Neches Valley Authority has contracts to supply municipal, irrigation, and manufacturing water users in Jefferson County. The total supply available to these water user groups in 2000 is 398,481 ac-ft/yr. However, these contracts expire between 2000 and 2010. Per TWDB guidelines, the total supply available to these water user groups decreases to zero for the remainder of the planning period, and these users are projected to have significant shortages from 2010 to 2050. On a regional basis, the large decrease in available supply between 2000 and 2010 due to short-term contract expiration is shown in Figure 4.2.

The comparison of currently available supply with demand ignores "unconnected" and "unpermitted" supplies. An "unconnected" water supply is not currently available due to infrastructure limitations or contract expirations, but it is permitted, because an entity holds a water right permit for that water. An "unpermitted" supply is a portion of the total yield of a reservoir for which no entity holds a water right permit.

Unconnected water supplies are identified by comparing the supplies available to each city and category (TWDB Table 5) to the current regional water supply sources (TWDB Table 4). Excluding unpermitted reservoir yields and brackish water, the difference between the total supply reported in TWDB Table 4 and the supply available to water user groups in TWDB Table 5 is more than 2.2 million ac-ft/yr in each decade of the planning period (Figure 4.3). There is an unpermitted supply of more than 300,000 ac-ft/yr in each decade of the planning period (Table 4.3 and Figure 4.3). There may be significant engineering, economic, and regulatory obstacles to obtaining unpermitted supplies.

4.3. Comparison of Supply and Demand by County

Table 4.4 shows the projected surpluses and shortages by county for each decade of the planning period. In general, the counties with projected shortages are spread throughout the region. Jefferson, Tyler and Cherokee Counties have the largest projected shortages by 2050. As mentioned earlier, a significant portion of the shortage in Jefferson County is caused by expiration of contracts.

Table 4.5 shows the projected surpluses or shortages as a percentage of demand. Jefferson County is expected to have the largest percentage shortage (88 percent) in 2050, and Trinity County is expected to have the largest percentage surplus (168 percent) in 2050.

4.4. Comparison of Supply and Demand by Water User Group

TWDB Table 7 shows the net surplus or shortage by decade for each water user group in the region. It is assumed that water user groups with surpluses will need no further water management planning. Table 4.6 shows each water user group that is projected to experience a shortage during some portion of the planning period. By 2050, the largest shortage is projected for the Irrigation water use in Jefferson County (283,972 ac-ft/yr).

Table 4.7 shows the ten East Texas water user groups with the largest projected shortages by the end of the "near-term" planning period, 2030. Of these groups, five are Steam Electric Power uses (Rusk, Orange, Tyler, Anderson and Newton Counties), two are Manufacturing uses (Jefferson and Orange County), one is Mining in Panola County, one is Irrigation in Jefferson County, and one is the City of Port Arthur in Jefferson County. In general, most of the largest shortages by 2030 are for industrial and agricultural uses. Shortages in Jefferson County are attributable to contractual issues.

Table 4.8 shows the ten East Texas water user groups with the largest projected shortages by the end of the "long-term" planning period, 2050. Of these groups, three are Manufacturing uses (in Jefferson, Orange, and Jasper Counties), four are Steam Electric Power uses (Orange, Tyler, Rusk and Cherokee Counties), one is Irrigation in Jefferson County, and one is Mining in Panola County. In general, the largest shortages in 2050 are for industrial and agricultural uses.

4.5. Comparison of Supply and Demand by Major Water Provider

The East Texas Regional Water Planning Group previously designated sixteen major water providers in the region: the Lower Neches Valley Authority, the Sabine River Authority (SRA), the Sabine River Authority (Toledo Bend), the Angelina & Neches River Authority, Huntsman Chemical, the City of Port Arthur, the City of Tyler, the Upper Neches River Municipal Water Authority, Motiva, the City of Beaumont, the City of Lufkin, the Houston County WCID No. 1, the City of Nacogdoches, the Panola County Fresh Water Supply District, the City of Jacksonville, and the City of Center.

TWDB Table 8 shows the comparison of current supply with projected demand for each major water provider by county and by river basin. Again, it is assumed that a major water provider showing no shortages does not need further water management planning. Table 4.9 shows the major water providers that are projected to experience a net shortage of water during some portion of the planning period.

Angelina & Neches River Authority (ANRA): In Table 4.9, ANRA is projected to have a shortage of 55,195 ac-ft/yr beginning in 2010. ANRA has contractual demands for water from Lake Eastex that are estimated to begin by 2010 (assuming that Lake Eastex is completed by 2010). ANRA has no currently available water supply. The potential management strategy to meet this shortage is construction of Lake Eastex.

City of Beaumont: Although the City of Beaumont indicates shortages in the Neches Trinity Basin, this demand can be met with surplus in the Neches Basin.

City of Center: Shortages are indicated in the Sabine Basin, however, surplus supply in the Neches Basin can meet the shortages.

City of Jacksonville: No shortages are indicated.

City of Lufkin: The City of Lufkin is projected to have a water shortage under drought of record conditions of 166 ac-ft/yr beginning in Year 2010, growing to 12,349 ac-ft/yr. for Year 2050. A potential water management strategy to meet this shortfall is to obtain surface water from Lake Sam Rayburn.

City of Nacogdoches: The City of Nacogdoches is projected to have shortages beginning in 2050, the end of the planning period. Expansion of the water treatment plant on Lake Nacogdoches will be required to provide access to the full yield of Lake Nacogdoches.

City of Port Arthur: The shortages shown for the City of Port Arthur are contractual in nature. Water is available from the Lower Neches Valley Authority.

City of Tyler: The City of Tyler does not indicate any shortages during the planning period. The supply used does not include the City's contract with the UNRMWA for water from Lake Palestine. The City is currently underway with projects which will allow it to utilize supply from Lake Palestine.

Houston County WCID No. 1: Immediate shortages in the Neches Basin can be met by surplus of supply in the Trinity Basin. However, by the end of the planning period the unpermitted yield of Lake Houston should be obtained.

Huntsman: The shortages shown are contractual in nature. Water is available from the Lower Neches Valley Authority.

Lower Neches Valley Authority(LNVA): The LNVA has sufficient supply to meet the demands. Entities served by the LNVA indicate shortages due to the short term contracts for water supply.

Panola Co. Fresh Water Supply District: No shortages are indicated

Sabine River Authority (SRA): No shortages are indicated. There are some entities served by SRA which indicate shortages due to terms of contract for supply.

Motiva: The shortages shown are contractual in nature. Water is available from the Lower Neches Valley Authority.

Upper Neches River Municipal Water Authority (UNRMWA): The UNRMWA shows no shortages. However, there is a projected shortage of 195,765 ac-ft/yr in every decade of the planning period to entities served by the UNRMWA. This shortage is based on infrastructure restrictions on the supply available from UNRMWA to the City of Dallas, the City of Tyler, and the City of Palestine. Potential management strategies for meeting this shortage include constructing pipelines from Lake Palestine to the Cities of Dallas and Tyler and increasing the capacity of the pipeline from the Neches River to the City of Palestine. The City of Tyler is currently underway with a project to obain some of the supply from Lake Palestine.

4.6. Socio-Eonomic Impacts of Not Meeting Project Water Needs

The Texas Water Development Board provided technical assistance to regional water planning groups in the development of specific information on the socio-econnomic impacts of failing to meet project water demands. This information is presented in TWDB Tables 9 and 10.

The TWDB analysis of socio-economic impacts is based on information provided to the TWDB in July 2000. The needs have been changed slightly by subsequent analysis, but the overall impacts should be similar. Table 4.10 and Figure 4.3 provides a summary of the TWDB analysis of the impacts of failing to meet the project demands.

The major portion of the impact is due to shortages created by short term contracts. The socio-economic impacts (and percent of total) due to shortages in 2050 created by the Lower Neches Valley Authority contracts in Jefferson County is as follows:

- Value of Need (acre-feet): 532,789 (70.6%)
- Impact on Employment: 322,894 (73.4%)
- Impact on Gross Business Output (million dollars): 46,293 (76.1%)
- Impact on Population: 513,000 (67.1%)
- Impact on School Enrollment: 147,802 (68.9%)
- Impact on Income (million dollars): 10,967.9 (73.9%)

4.7. Water Quality Concerns

There are both existing and potential water quality concerns in the East Texas Region. Existing water quality concerns are related violations of primary drinking water standards (30 TAC §290.103) in drinking water systems. Potential concerns are related to potential changes in primary drinking water standards for drinking water systems and to secondary drinking water standards (30 TAC §290.113).

Existing Water Quality Concerns

The primary drinking water standards in 30 TAC §290.103 specify maximum contaminant levels (MCLs) for certain contaminants. Data obtained from the Texas Natural Resource Conservation Commission (TNRCC) indicate recent MCL violations in five East Texas drinking water systems (Table 4.11). A discussion of the current situation for each of these systems follows.

The City of Lufkin, the Burke WSC, and the City of Rusk are all addressing concerns about asbestos in their water distribution systems. Because the source of the asbestos is asbestos-containing pipe, these concerns are not expected to impact the water supply planning.

The water systems for the Tempe WSC and the Chester WSC have been listed by the TNRCC as non-compliant with the radium and gross alpha particle activity MCLs. The TNRCC generally encourages such systems to seek other sources of water or to blend their water with compliant water. The United States Environmental Protection Agency (EPA) is currently revising its approach to these standards, and the TNRCC is not taking any enforcement action against violators until the new approach is finalized. Although the TNRCC does not anticipate that the standards or the non-compliance list will change significantly, it may take up to six years before the new standards are adopted and before the non-compliance list for these standards is confirmed. The radon and gross alpha particle activity violations listed for the Tempe WSC and the Chester WSC could potentially impact water supply planning. Depending on how EPA revises the primary drinking water standards, it may become necessary to identify alternate water source for the Tempe WSC and the Chester WSC.

Potential Water Quality Concerns

There is no existing drinking water standard for radon. The 1996 Amendments to the Safe Drinking Water Act required the EPA to create a new drinking water standard for radon. The EPA proposed two standards for radon, an MCL of 300 picocuries per liter (pCi/L) and an alternate MCL (AMCL) of 4,000 pCi/L. If the State of Texas develops a multimedia mitigation program (MMM) to address radon in indoor air, then the AMCL would apply. In the absence of a state MMM program, the MCL would apply. The EPA is expected to publish the final radon rule in August 2000.

Table 4.12 lists public drinking water systems in the East Texas Region that may potentially violate the proposed radon MCL, in the event that an MMM program is not developed. The State of Texas is preparing to develop an MMM program upon publication of the final radon rule. The State must notify the EPA that it will develop an MMM program within 90 days of publication of the final radon rule. At present, the TNRCC does not have sufficient information to determine how many water systems would potentially violate the radon AMCL, but this number is assumed to be much smaller than the number of potential MCL violators.

The existing drinking water standard for arsenic is 0.05 milligrams per liter (mg/L). The 1996 Amendments to the Safe Drinking Water Act required the EPA to revise the existing standard for arsenic. The process for determining the new standard takes into account possible adverse human health effects, cost-benefit analysis, and small system treatment technologies. The EPA is expected to publish the proposed rule on the arsenic drinking water standard in June 2000. Table 4.12 identifies potential ranges for the proposed arsenic standard and identifies public drinking water systems in the East Texas Region that may have problems meeting a proposed arsenic standard.

From Table 4.12, a total of ninety-one East Texas water systems may experience difficulties in meeting revised radon and arsenic drinking water standards. Once the final drinking water standards for radon and arsenic are established, each water system that experiences difficulty in meeting the standards may have to determine whether it is more economical to provide advanced water treatment or to obtain an alternate water supply.

In addition to primary drinking water standards (30 TAC §290.103), there are secondary drinking water standards (30 TAC §290.113). According to the TNRCC rules, "no drinking water supply which does not meet the Secondary Constituent Levels may be used without written approval from the commission." The TNRCC does not generally enforce the secondary drinking water standards. However, if alternate sources of water that meet the secondary standards are available to a public water supply system, the TNRCC encourages use of these alternate sources.

Another potential water quality problem is related to saltwater intrusion in the Neches River. During periods of low flow, saline water tends to move upstream in the Neches River. If no barrier is in place to block the upstream movement of the saltwater, this phenomenon can cause water at some intakes to become unusable due to high salinity. Currently, a temporary low level dam is constructed in the river during low flow periods to help prevent the saltwater intrusion. At times, extra water must be released from upstream reservoirs to help push back the saline water. The release of this water leaves less water in the reservoirs for other purposes. The United States Army Corps of Engineers (USACE) is designing a permanent salt water barrier for the lower Neches River. Construction of this saltwater barrier is planned to begin in September 2000 and to be completed three years later. The structure will have gates to control river flow during low flow periods and a lock to allow the passage of ship traffic. The Neches River Saltwater Barrier is designed to provide a permanent solution to the problem of saltwater intrusion.

4.8. Summary

A comparison of currently available supply (from Task 3) and projected water demands (from Task 2) has been presented in several ways:

- By region
- By county
- By city and category (TWDB Table 7)
- By major water provider (TWDB Table 8)

The regional comparison shows that the East Texas Region has an overall surplus of 115,089 ac-ft/yr in 2000, changing to a shortage of 369,385 ac-ft/yr by 2010, and increasing to a shortage of 608,413 by 2050.

Based on a comparison of TWDB Tables 4 and 5, there are unconnected supplies of 2.23 million ac-ft/yr in 2000, increasing to 2.62 million ac-ft/yr in 2050. In addition, there are unpermitted supplies in the amount of 302,815 ac-ft/yr in 2000, decreasing to 294,955 ac-ft/yr in 2050. There may be significant engineering, economic, and regulatory obstacles to obtaining unpermitted supplies.

The number of counties with net shortages changes from 3 out of 20 counties in 2000 to 17 out of 20 counties in 2050. As a percentage of demand, the largest shortage by 2050 is located in Jefferson County (88 percent), and the largest surplus is located in Trinity County (168 percent).

There are a total of 317 individual water user groups in the East Texas Region. Of these, 71 water user groups are projected to experience a shortage in 2000. The number grows to 112 by 2050.

The major water provider comparison showed shortages for Angelina and Neches River Authority, City of Lufkin, City of Nacogdoches, City of Port Arthur, Houston County WCID No. 1, Huntsman and Motiva. Every other major water provider is projected to have a surplus during each decade of the planning period.

There are five East Texas water systems that the TNRCC lists as being non-compliant with primary drinking water standards. There are ninety-one East Texas water systems that could experience difficulty in meeting revised radon and arsenic drinking water standards. Depending on the outcome of revisions to the primary drinking water standards, alternate water supply sources may need to be identified for some of these systems.

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TABLE 4.1
EAST TEXAS REGION NET WATER SURPLUS/(SHORTAGE) BY DECADE

CATEGORY	YEAR					
	2000	2010	2020	2030	2040	2050
EAST TEXAS REGION SURPLUS/SHORTAGE (acre-feet/year)	115,089	(369,385)	(423,015)	(487,371)	(543,798)	(608,413)
COUNTIES WITH SHORTAGES (20 COUNTIES TOTAL)	3	7	8	11	16	17
USER GROUPS WITH SHORTAGES (317 USER GROUPS TOTAL)	71	88	94	100	105	112

Note: Shortages shown in parentheses.

TABLE 4.2
EAST TEXAS REGION NET WATER SURPLUS/(SHORTAGE)
BY DECADE AND BY TYPE OF USE
(acre-feet per year)

Category	Year					
	2000	2010	2020	2030	2040	2050
Municipal and County-Other	108,199	84,978	76,960	65,127	53,416	39,128
Manufacturing	19,819	(145,794)	(164,295)	(179,164)	(211,321)	(244,143)
Steam Electric Power	(1,555)	(29,755)	(49,755)	(77,260)	(87,260)	(102,260)
Mining	2,934	5,613	(27)	(8,432)	(8,924)	(8,972)
Irrigation	(14,674)	(283,550)	(283,550)	(283,550)	(283,550)	(283,550)
Livestock	365	(878)	(2,349)	(4,093)	(6,160)	(8,617)
REGION I TOTALS	115,088	(369,386)	(423,016)	(487,372)	(543,799)	(608,414)

Note: Shortages shown in parentheses.

TABLE 4.3
SUMMARY OF UNPERMITTED EAST TEXAS WATER SUPPLIES

Category	Unpermitted Water Supply by Decade (ac-ft/yr)					
	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Lake Jacksonville	2,550	2,550	2,550	2,550	2,550	2,550
Lake Murvaul	3,790	3,100	2,420	1,770	1,120	470
Striker Lake	2,500	2,500	2,500	2,500	2,500	2,500
Houston County Lake	3,500	3,500	3,500	3,500	3,500	3,500
Toledo Bend Reservoir	290,475	289,567	288,659	287,751	286,843	285,935
TOTAL	302,815	301,217	299,629	298,071	296,513	294,955

TABLE 4.4
NET WATER SURPLUS/(SHORTAGE) FOR EACH COUNTY IN EAST TEXAS
(acre-feet per year)

Category	Basin Number	Year					
		2000	2010	2020	2030	2040	2050
Anderson	6/8	1,725	1,732	1,316	815	406	(229)
Angelina	6	16,742	13,570	9,969	5,496	507	(5,044)
Cherokee	6	446	(109)	(5,939)	(11,875)	(12,612)	(18,395)
Hardin	6/8	1,170	38	52	(193)	(549)	(1,229)
Henderson	6	(189)	(227)	(227)	(210)	(175)	(244)
Houston	6/8	898	20	(689)	(1,497)	(2,257)	(3,044)
Jasper	5/6	9,384	11,260	11,086	12,527	10,245	7,748
Jefferson	6/7	2,757	(440,154)	(451,487)	(461,617)	(481,401)	(501,720)
Nacogdoches	6	13,391	10,899	8,128	(3,249)	(7,445)	(12,315)
Newton	5/6	911	(10,467)	(10,560)	(10,619)	(10,679)	(10,797)
Orange	5/6	38,990	28,729	20,097	11,224	(724)	(13,180)
Panola	4/5	13,677	14,277	8,312	185	(105)	117
Polk	6	502	383	240	40	(108)	(269)
Rusk	5/6	(2,673)	(7,082)	(11,676)	(16,749)	(16,786)	(16,912)
Sabine	5/6	1,707	1,474	1,236	(911)	(1,198)	(1,534)
San Augustine	5/6	(48)	(130)	(197)	(334)	(424)	(551)
Shelby	5/6	4,151	2,951	1,792	337	(1,300)	(3,295)
Smith	6	7,999	5,066	2,271	1,181	(2,206)	(5,412)
Trinity	6	1,735	1,739	1,754	1,747	1,736	1,679
Tyler	6	1,815	(3,353)	(8,492)	(13,668)	(18,723)	(23,787)
REGION I TOTAL		115,089	(369,385)	(423,015)	(487,371)	(543,798)	(608,413)

Note: Shortages shown in parentheses.

TABLE 4.5
NET WATER SURPLUS/(SHORTAGE) AS A PERCENTAGE OF DEMAND
FOR EACH COUNTY IN EAST TEXAS

Category	Basin Number	Year					
		2000	2010	2020	2030	2040	2050
Anderson	6/8	7%	7%	5%	3%	2%	1%
Angelina	6	41%	31%	21%	10%	1%	(8%)
Cherokee	6	2%	(1%)	(22%)	(37%)	(38%)	(47%)
Hardin	6/8	7%	0%	0%	(1%)	(3%)	(6%)
Henderson	6	(6%)	(7%)	(7%)	(6%)	(5%)	(7%)
Houston	6/8	13%	0%	(8%)	(16%)	(23%)	(28%)
Jasper	5/6	15%	19%	18%	21%	17%	12%
Jefferson	6/7	1%	(86%)	(87%)	(87%)	(87%)	(88%)
Nacogdoches	6	69%	50%	33%	(9%)	(19%)	(27%)
Newton	5/6	20%	(65%)	(66%)	(66%)	(66%)	(66%)
Orange	5/6	50%	33%	21%	11%	(1%)	(10%)
Panola	4/5	131%	146%	53%	1%	(0%)	0%
Polk	6	14%	11%	6%	1%	(3%)	(6%)
Rusk	5/6	(7%)	(16%)	(23%)	(30%)	(31%)	(31%)
Sabine	5/6	47%	38%	30%	(21%)	(25%)	(30%)
San Augustine	5/6	(2%)	(6%)	(8%)	(14%)	(17%)	(21%)
Shelby	5/6	51%	32%	17%	3%	(10%)	(21%)
Smith	6	24%	14%	6%	3%	(5%)	(12%)
Trinity	6	184%	185%	190%	187%	184%	168%
Tyler	6	59%	(41%)	(64%)	(74%)	(79%)	(83%)
REGION I TOTAL		14%	(40%)	(43%)	(46%)	(49%)	(52%)

Note: Shortages shown in parentheses.

TABLE 4.6
WATER SHORTAGES DURING THE PLANNING PERIOD
FOR EAST TEXAS WATER USER GROUPS

Water User Group	County	Projected Shortage (acre-feet per year)					
		2000	2010	2020	2030	2040	2050
ELKHART	Anderson	(26)	(27)	(22)	(20)	(15)	(14)
FRANKSTON	Anderson	(12)	(8)	(3)	0	3	6
STEAM ELECTRIC POWER	Anderson	(11,209)	(11,209)	(11,209)	(11,209)	(11,209)	(11,209)
HUNTINGTON	Angelina	137	99	66	28	(12)	(60)
LIVESTOCK	Angelina	(1)	(22)	(46)	(75)	(108)	(146)
LUFKIN	Angelina	39	(747)	(1,673)	(2,995)	(4,544)	(5,949)
MANUFACTURING	Angelina	14,519	12,229	9,642	6,701	3,381	(481)
MINING	Angelina	(14)	(18)	(23)	(29)	(35)	(42)
ALTO	Cherokee	35	28	22	11	(2)	(16)
BULLARD	Cherokee	(25)	(28)	(43)	(47)	(53)	(65)
COUNTY-OTHER	Cherokee	(1,524)	(2,000)	(3,076)	(4,068)	(4,459)	(4,800)
IRRIGATION	Cherokee	(1,312)	(1,312)	(1,312)	(1,312)	(1,312)	(1,312)
MINING	Cherokee	7	32	(183)	(485)	(629)	(799)
NEW SUMMERFIELD	Cherokee	37	29	18	7	(6)	(21)
RUSK	Cherokee	40	16	5	(54)	(96)	(134)
STEAM ELECTRIC POWER	Cherokee	343	343	(4,657)	(9,657)	(9,657)	(14,657)
WELLS	Cherokee	(11)	(16)	(22)	(27)	(32)	(37)
COUNTY-OTHER	Hardin	284	379	299	97	(104)	(512)
IRRIGATION	Hardin	36	(2,238)	(2,238)	(2,238)	(2,238)	(2,238)
KOUNTZE	Hardin	11	2	(4)	(19)	(37)	(65)
LUMBERTON	Hardin	(23)	(314)	(343)	(387)	(428)	(493)
MANUFACTURING	Hardin	(9)	(14)	(21)	(27)	(36)	(45)
SOUR LAKE	Hardin	(6)	(11)	(16)	(24)	(38)	(61)
BROWNSBORO	Henderson	(22)	(19)	(17)	(16)	(15)	(17)
COUNTY-OTHER	Henderson	(211)	(246)	(249)	(228)	(192)	(245)
MANUFACTURING	Henderson	(2)	(3)	(3)	(4)	(4)	(5)
MURCHISON	Henderson	(21)	(20)	(17)	(19)	(23)	(29)
COUNTY-OTHER	Houston	(115)	(208)	(265)	(337)	(394)	(454)
COUNTY-OTHER	Houston	209	(70)	(239)	(456)	(625)	(808)
CROCKETT	Houston	(319)	(499)	(662)	(830)	(975)	(1,094)
GRAPELAND	Houston	7	(16)	(37)	(58)	(76)	(95)
IRRIGATION	Houston	14	(6)	(28)	(52)	(79)	(108)
IRRIGATION	Houston	23	(19)	(65)	(117)	(173)	(236)
LIVESTOCK	Houston	50	(4)	(61)	(123)	(189)	(262)
LIVESTOCK	Houston	(14)	(120)	(235)	(360)	(496)	(642)
MANUFACTURING	Houston	(10)	(12)	(14)	(16)	(19)	(21)
MANUFACTURING	Houston	(21)	(57)	(79)	(99)	(133)	(168)
MINING	Houston	0	(12)	(27)	(44)	(64)	(87)
MINING	Houston	(8)	(28)	(51)	(79)	(111)	(149)
BESSMAY-BUNA	Jasper	(84)	(104)	(104)	(101)	(108)	(122)
COUNTY-OTHER	Jasper	127	67	42	6	(22)	(87)
COUNTY-OTHER	Jasper	(1)	(106)	(152)	(214)	(266)	(379)
IRRIGATION	Jasper	(8)	(8)	(8)	(8)	(8)	(8)
KIRBYVILLE	Jasper	(100)	(129)	(136)	(136)	(149)	(155)
MANUFACTURING	Jasper	(10,830)	(8,637)	(8,707)	(7,179)	(9,310)	(11,523)
MINING	Jasper	(1)	(1)	(1)	(1)	(1)	(1)
BEAUMONT	Jefferson	(8,965)	(8,683)	(8,784)	(9,143)	(9,563)	(10,201)
BEVIL OAKS	Jefferson	0	5	3	0	(3)	(9)
COUNTY-OTHER	Jefferson	(212)	(178)	(148)	(162)	(158)	(188)
COUNTY-OTHER	Jefferson	456	(964)	(880)	(920)	(910)	(991)
GROVES	Jefferson	(180)	(405)	(391)	(385)	(373)	(374)
GROVES	Jefferson	(657)	(1,477)	(1,426)	(1,404)	(1,362)	(1,366)
IRRIGATION	Jefferson	(14,405)	(15,947)	(15,943)	(15,939)	(15,934)	(15,928)
IRRIGATION	Jefferson	(5,395)	(268,366)	(268,297)	(268,220)	(268,137)	(268,044)
LIVESTOCK	Jefferson	(4)	(4)	(4)	(4)	(4)	(4)
MANUFACTURING	Jefferson	(2,556)	(84,159)	(90,972)	(96,974)	(108,035)	(119,077)
MANUFACTURING	Jefferson	(7,581)	(86,907)	(91,742)	(95,583)	(104,018)	(112,176)
NEDERLAND	Jefferson	(40)	(73)	(71)	(69)	(67)	(67)
NEDERLAND	Jefferson	160	(2,503)	(2,437)	(2,377)	(2,323)	(2,327)
PORT ARTHUR	Jefferson	(66)	(365)	(364)	(361)	(359)	(364)
PORT ARTHUR	Jefferson	(1,989)	(10,509)	(10,456)	(10,392)	(10,314)	(10,462)
PORT NECHES	Jefferson	(281)	(886)	(853)	(826)	(810)	(813)
PORT NECHES	Jefferson	(209)	(662)	(638)	(618)	(606)	(608)

TABLE 4.6
WATER SHORTAGES DURING THE PLANNING PERIOD
FOR EAST TEXAS WATER USER GROUPS

Water User Group	County	Projected Shortage (acre-feet per year)					
		2000	2010	2020	2030	2040	2050
STEAM ELECTRIC POWER	Jefferson	(3,000)	(6,000)	(6,000)	(6,000)	(6,000)	(6,000)
COUNTY-OTHER	Nacogdoches	(641)	(972)	(1,350)	(2,014)	(2,577)	(2,901)
LIVESTOCK	Nacogdoches	0	(287)	(621)	(1,008)	(1,457)	(1,978)
MINING	Nacogdoches	(41)	(60)	(92)	(125)	(158)	(195)
NACOGDOCHES	Nacogdoches	13,725	11,872	9,844	7,079	3,938	(24)
STEAM ELECTRIC POWER	Nacogdoches	0	0	0	(7,505)	(7,505)	(7,505)
COUNTY-OTHER	Newton	(305)	(377)	(372)	(340)	(312)	(338)
MINING	Newton	(7)	(8)	(8)	(8)	(8)	(8)
STEAM ELECTRIC POWER	Newton	0	(11,200)	(11,200)	(11,200)	(11,200)	(11,200)
COUNTY-OTHER	Orange	36	7	123	144	13	(138)
IRRIGATION	Orange	693	(1,330)	(1,330)	(1,330)	(1,330)	(1,330)
LIVESTOCK	Orange	(9)	(9)	(9)	(9)	(9)	(9)
MANUFACTURING	Orange	(526)	(4,407)	(7,978)	(10,981)	(17,528)	(24,380)
MINING	Orange	(6)	(6)	(7)	(7)	(7)	(7)
ROSE CITY	Orange	368	366	364	(121)	(128)	(138)
STEAM ELECTRIC POWER	Orange	(5,037)	(9,037)	(14,037)	(19,037)	(24,037)	(29,037)
MINING	Panola	828	1,428	(4,624)	(12,839)	(13,106)	(12,839)
COUNTY-OTHER	Polk	73	34	(22)	(117)	(175)	(247)
MANUFACTURING	Polk	(155)	(209)	(263)	(316)	(369)	(420)
COUNTY-OTHER	Rusk	56	36	(83)	(228)	(284)	(353)
COUNTY-OTHER	Rusk	(199)	(220)	(344)	(496)	(555)	(627)
HENDERSON	Rusk	(51)	(49)	(40)	(34)	(33)	(40)
HENDERSON	Rusk	(161)	(124)	(25)	43	56	21
IRRIGATION	Rusk	(62)	(62)	(62)	(62)	(62)	(62)
LIVESTOCK	Rusk	18	11	2	(6)	(18)	(3)
LIVESTOCK	Rusk	21	12	3	(10)	(23)	(66)
MANUFACTURING	Rusk	(6)	(11)	(17)	(23)	(28)	(35)
NEW LONDON	Rusk	9	12	21	15	7	(4)
STEAM ELECTRIC POWER	Rusk	(4,960)	(9,960)	(14,960)	(19,960)	(19,960)	(19,960)
TATUM	Rusk	(13)	(6)	5	11	16	18
COUNTY-OTHER	Sabine	(28)	(67)	(104)	(148)	(181)	(314)
COUNTY-OTHER	Sabine	(124)	(135)	(147)	(162)	(173)	(113)
HEMPHILL	Sabine	1,481	1,455	1,427	(476)	(533)	(601)
LIVESTOCK	Sabine	67	48	25	(1)	(32)	(67)
LIVESTOCK	Sabine	(2)	(6)	(10)	(15)	(20)	(27)
MANUFACTURING	Sabine	(455)	(576)	(696)	(814)	(931)	(1,045)
COUNTY-OTHER	San Augustine	(100)	(98)	(97)	(98)	(97)	(98)
COUNTY-OTHER	San Augustine	(245)	(236)	(223)	(229)	(223)	(230)
IRRIGATION	San Augustine	(15)	(15)	(15)	(15)	(15)	(15)
LIVESTOCK	San Augustine	(25)	(31)	(39)	(47)	(57)	(68)
LIVESTOCK	San Augustine	26	(17)	(66)	(124)	(190)	(268)
COUNTY-OTHER	Shelby	(6)	(3)	4	0	2	(5)
IRRIGATION	Shelby	6	4	0	(3)	(6)	(10)
LIVESTOCK	Shelby	(161)	(739)	(1,469)	(2,303)	(3,349)	(4,625)
LIVESTOCK	Shelby	22	(88)	(197)	(386)	(586)	(830)
MANUFACTURING	Shelby	(28)	(385)	(742)	(1,098)	(1,455)	(1,812)
COUNTY-OTHER	Smith	966	78	(901)	(1,996)	(3,198)	(4,422)
LINDALE	Smith	3	(3)	(2)	(7)	(10)	(14)
TYLER	Smith	6,708	4,913	3,251	3,291	1,103	(866)
WHITEHOUSE	Smith	(22)	(236)	(378)	(403)	(386)	(382)
COUNTY-OTHER	Tyler	53	17	(75)	(179)	(184)	(182)
STEAM ELECTRIC POWER	Tyler	0	(5,000)	(10,000)	(15,000)	(20,000)	(25,000)

TABLE 4.7
EAST TEXAS WATER USER GROUPS
WITH THE LARGEST WATER SHORTAGES IN 2030

Water User Group	County	Projected Shortage (acre-feet per year)					
		2000	2010	2020	2030	2040	2050
IRRIGATION	Jefferson	(19,800)	(284,313)	(284,240)	(284,159)	(284,071)	(283,972)
MANUFACTURING	Jefferson	(10,137)	(171,066)	(182,714)	(192,557)	(212,053)	(231,253)
STEAM ELECTRIC POWER	Rusk	(4,960)	(9,960)	(14,960)	(19,960)	(19,960)	(19,960)
STEAM ELECTRIC POWER	Orange	(5,037)	(9,037)	(14,037)	(19,037)	(24,037)	(29,037)
STEAM ELECTRIC POWER	Tyler	0	(5,000)	(10,000)	(15,000)	(20,000)	(25,000)
MINING	Panola	828	1,428	(4,624)	(12,839)	(13,106)	(12,839)
STEAM ELECTRIC POWER	Anderson	(11,209)	(11,209)	(11,209)	(11,209)	(11,209)	(11,209)
STEAM ELECTRIC POWER	Newton	0	(11,200)	(11,200)	(11,200)	(11,200)	(11,200)
MANUFACTURING	Orange	(526)	(4,407)	(7,978)	(10,981)	(17,528)	(24,380)
PORT ARTHUR	Jefferson	(2,055)	(10,874)	(10,820)	(10,753)	(10,673)	(10,826)

Note: Shortages shown in parentheses.

TABLE 4.8
EAST TEXAS WATER USER GROUPS
WITH THE LARGEST SHORTAGES IN 2050

Water User Group	County	Projected Shortage (acre-feet per year)					
		2000	2010	2020	2030	2040	2050
IRRIGATION	Jefferson	(19,800)	(284,313)	(284,240)	(284,159)	(284,071)	(283,972)
MANUFACTURING	Jefferson	(10,137)	(171,066)	(182,714)	(192,557)	(212,053)	(131,253)
STEAM ELECTRIC POWER	Orange	(5,037)	(9,037)	(14,037)	(19,037)	(24,037)	(29,037)
STEAM ELECTRIC POWER	Tyler	0	(5,000)	(10,000)	(15,000)	(20,000)	(25,000)
MANUFACTURING	Orange	(526)	(4,407)	(7,978)	(10,981)	(17,528)	(24,380)
STEAM ELECTRIC POWER	Rusk	(4,960)	(9,960)	(14,960)	(19,960)	(19,960)	(19,960)
STEAM ELECTRIC POWER	Cherokee	343	343	(4,657)	(9,657)	(9,657)	(14,657)
MINING	Panola	828	1,428	(4,624)	(12,839)	(13,106)	(12,839)
MANUFACTURING	Jasper	(10,830)	(8,637)	(8,707)	(7,179)	(9,310)	(11,523)
STEAM ELECTRIC POWER	Anderson	(11,209)	(11,209)	(11,209)	(11,209)	(11,209)	(11,209)

Note: Shortages shown in parentheses.

TABLE 4.9
MAJOR WATER PROVIDERS WITH PROJECTED SHORTAGES

Major Water Provider	Surplus/ (Shortage) for 2000	Surplus/ (Shortage) for 2010	Surplus/ (Shortage) for 2020	Surplus/ (Shortage) for 2030	Surplus/ (Shortage) for 2040	Surplus/ (Shortage) for 2050
Angelina & Neches River Authority	0	(55,195)	(59,852)	(64,852)	(64,852)	(69,852)
City of Lufkin	(2,293)	(3,384)	(4,652)	(6,373)	(8,361)	(10,291)
City of Nacogdoches	13,644	11,748	9,671	6,820	3,595	(399)
City of Port Arthur	(2,055)	(10,874)	(10,820)	(10,753)	(10,673)	(10,826)
Houston County WCID No. 1	1191	874	624	356	113	(109)
Huntsman	0	(11005)	(11755)	(12389)	(13,645)	(14,882)
Motiva	0	(46785)	(49877)	(52489)	(57,665)	(62,761)

Note: Shortages shown in parentheses.

TABLE 4.10. RELATIONSHIP OF WATER NEEDS AND IMPACTS TO PROJECTIONS

WATER

Decade	Projected Demand	Projected Water Shortage	Percent Shortage
	(acre-feet)		
2000	836,663	75,998	9.1%
2010	911,850	542,151	59.5%
2020	965,513	579,495	60.0%
2030	1,027,582	632,835	61.6%
2040	1,084,068	670,200	61.8%
2050	1,148,708	717,461	62.5%

EMPLOYMENT

Decade	Baseline Employment	Employment With Water Shortage	Percent Loss
	(FTE jobs)		
2000	431,123	376,611	12.6%
2010	467,381	174,955	62.6%
2020	479,294	159,859	66.6%
2030	484,026	132,546	72.6%
2040	508,160	119,246	76.5%
2050	524,442	97,205	81.5%

POPULATION

Decade	Baseline Population	Population With Water Shortage	Percent Loss
2000	1,042,411	928,753	10.9%
2010	1,141,521	670,590	41.3%
2020	1,245,963	761,071	38.9%
2030	1,349,417	851,070	36.9%
2040	1,454,738	829,024	43.0%
2050	1,562,154	824,727	47.2%

INCOME

Decade	Baseline Income	Income With Water Shortage	Percent Loss
	(millions, 1999 $)		
2000	14,383	12,725	11.5%
2010	15,593	5,868	62.4%
2020	15,990	5,319	66.7%
2030	16,148	4,352	73.0%
2040	16,953	3,858	77.2%
2050	17,496	3,100	82.3%

TABLE 4.11
EAST TEXAS WATER SYSTEMS
NOT COMPLIANT WITH PRIMARY DRINKING WATER STANDARDS

Water System	County	Water Source	Constituent	Standard
City of Lufkin	Angelina	Carrizo-Wilcox Aquifer	Asbestos	7 million fibers* per liter
Burke Water Supply Corporation	Angelina	City of Lufkin	Asbestos	7 million fibers* per liter
City of Rusk	Cherokee	Carrizo-Wilcox Aquifer	Asbestos	7 million fibers* per liter
Tempe Water Supply Corporation	Polk	Gulf Coast Aquifer	Radium	5 pCi/liter
Tempe Water Supply Corporation	Polk	Gulf Coast Aquifer	Gross Alpha Particle Activity	15 pCi/liter
Chester Water Supply Corporation	Tyler	Gulf Coast Aquifer	Radium	5 pCi/liter
Chester Water Supply Corporation	Tyler	Gulf Coast Aquifer	Gross Alpha Particle Activity	15 pCi/liter

* Counting fibers longer than 10 microns.

TABLE 4.12
EAST TEXAS WATER SYSTEMS WITH POTENTIAL COMPLIANCE PROBLEMS UNDER POTENTIAL REVISED RADON AND ARSENIC STANDARDS

System ID	System Name	County	Potential Violators if Radon Standard is 300 pCi/L	Potential Violators if Arsenic Standard is 0.02mg/L	Potential Violators if Arsenic Standard is Between 0.01 mg/L and 0.02 mg/L	Potential Violators if Arsenic Standard is Between 0.005 mg/L and 0.01 mg/L
30002	Huntington City Of	Angelina	X			
30006	Walnut Ridge Estates Water System	Angelina	X			
1000001	Kountze City Of	Hardin	X			
1000002	Silsbee City Of	Hardin	X			X
1000015	North Hardin Water Supply Corp	Hardin	X			X
1000030	Quail Valley Estates Mobile Homes	Hardin				X
1000035	Lumberton Municipal Utility Dist	Hardin	X			
1000037	Enchanted Forest	Hardin				X
1000038	Whispering Pines Subdivision	Hardin	X			
1000055	West Hardin Water Supply Corp	Hardin	X			
1000060	Northwoods Subdivision	Hardin	X			
1000061	Country Wood Water System	Hardin			X	X
1000067	Bullocks Mobile Home Park	Hardin	X			
1000070	Ranchland	Hardin	X			X
1070162	Pinnacle Club	Henderson		X	X	X
1210002	Kirbyville City Of	Jasper	X			
1210016	South Kirbyville Water Supply Corp	Jasper	X			
1210019	Cougar Country Water System	Jasper	X			
1230001	Beaumont City Of - Water Util Dept	Jefferson				X
1230025	Hamshire Community WSC	Jefferson	X			
1760002	Toledo Water Supply Corp	Newton	X			
1810005	Orange County WCID No 1	Orange				X
1810023	Houseman Park	Orange				X
1810024	Inwood Addition	Orange		X	X	X
1810026	Lynnwood Addition Water System	Orange				X

TABLE 4.12
EAST TEXAS WATER SYSTEMS WITH POTENTIAL COMPLIANCE PROBLEMS UNDER POTENTIAL REVISED RADON AND ARSENIC STANDARDS

System ID	System Name	County	Potential Violators if Radon Standard is 300 pCi/L	Potential Violators if Arsenic Standard is 0.02mg/L	Potential Violators if Arsenic Standard is Between 0.01 mg/L and 0.02 mg/L	Potential Violators if Arsenic Standard is Between 0.005 mg/L and 0.01 mg/L
1810034	Sawmill Addition	Orange			X	X
1810049	Briarcliff Addition	Orange				X
1810061	Iwanda Mobile Home Park	Orange				X
1810064	Highway 12 Addition Water System	Orange				X
1810069	Hickory Hollow	Orange				X
1810070	Nagle Addition	Orange				X
1810103	Sugar Pines MHP	Orange				X
1810105	Brookhollow Subd-Orange Co WCID 1	Orange				X
1810123	Corbett Water System No 1	Orange				X
1810143	Claire Street Water System	Orange				X
1810164	Lexington Water System No 2	Orange				X
1810170	Timer Water System	Orange				X
1870001	Corrigan City Of	Polk	X			
1870003	Soda Water Supply Corporation	Polk	X			X
1870004	Woods Creek Water Supply Corp	Polk	X			
1870007	Leggett Water Supply Corporation	Polk	X			
1870009	Onalaska Water Supply Corporation	Polk	X			
1870012	Weaver's Cove Water System-LL	Polk	X			
1870019	Bass Bay Water System-LL	Polk			X	X
1870021	Indian Hills Estates Water System	Polk	X			
1870025	Pine Shadows Water System-LL	Polk	X			
1870027	Lake Livingston Estates No 4 & 5	Polk	X			
1870028	Sandy Ridge Water System-LL	Polk	X			
1870034	Canyon Park Owners Association	Polk	X			
1870040	Indian Springs Lake Estate-LL	Polk	X			

TABLE 4.12
EAST TEXAS WATER SYSTEMS WITH POTENTIAL COMPLIANCE PROBLEMS
UNDER POTENTIAL REVISED RADON AND ARSENIC STANDARDS

System ID	System Name	County	Potential Violators if Radon Standard is 300 pCi/L	Potential Violators if Arsenic Standard is 0.02mg/L	Potential Violators if Arsenic Standard is Between 0.01 mg/L and 0.02 mg/L	Potential Violators if Arsenic Standard is Between 0.005 mg/L and 0.01 mg/L
1870043	Alabama-Coushatta Indian Res No 1	Polk	X			
1870044	Crystal Lake Estates Water System	Polk	X			
1870045	Putnam's Landing-LL	Polk			X	X
1870046	Wiggins Village No 2-LL	Polk	X			
1870049	Hoot Owl Hollow Water System-LL	Polk	X			
1870055	Oak Terrace Estates Water System	Polk	X			
1870059	Forest Springs Water System	Polk	X			
1870064	Taylor Lake Estates Water System	Polk				X
1870065	Natasha Heights Water System-LL	Polk		X	X	X
1870067	Wild Country Lake Estates-LL	Polk	X			
1870068	Forest Hill Water System-LL	Polk			X	X
1870073	Lake Livingston Estates No 2 & 3	Polk				X
1870078	Sportsmans Retreat Water System	Polk				X
1870093	Green Acres	Polk			X	X
1870094	Impala Woods Water Company-LL	Polk	X			
1870105	Tempe Water Supply Corp	Polk	X		X	X
1870116	Magnolia Trailer Village & Rv Park	Polk	X			
1870124	Alabama-Coushatta Indian Res No 2	Polk	X			
1870125	Moscow Water Supply Corp No 2	Polk	X			
1870130	Pinwah Pines Water System	Polk	X			
1870131	Texas Water Supply	Polk	X			X
1870137	Lakeland Water System (Hideaway)	Polk				X
1870138	Country Wood Water System	Polk	X			X
1870139	Sleepy Hollow Water System	Polk				X
1870141	Beech Creek Village-LL	Polk	X			

TABLE 4.12
EAST TEXAS WATER SYSTEMS WITH POTENTIAL COMPLIANCE PROBLEMS
UNDER POTENTIAL REVISED RADON AND ARSENIC STANDARDS

System ID	System Name	County	Potential Violators if Radon Standard is 300 pCi/L	Potential Violators if Arsenic Standard is 0.02mg/L	Potential Violators if Arsenic Standard is Between 0.01 mg/L and 0.02 mg/L	Potential Violators if Arsenic Standard is Between 0.005 mg/L and 0.01 mg/L
1870142	Mangum Water Service Company	Polk	X		X	X
1870148	Creeklake Cove Water System-LL	Polk	X			
1870149	Spring Creek WS/Miller WS Inc	Polk		X	X	X
1870151	Texas Landing Utility Company	Polk	X			
1870155	Cedar Point	Polk	X			
2010039	South Rusk Co WSC-So Rusk & US 84	Rusk	X			
2020050	Shawnee Shores Water Supply	Sabine	X			
2280009	Pennington Water Supply Corp	Trinity	X			
2280010	Woodlake-Josserand Wtr Supply Corp	Trinity	X			
2290002	Chester Water Supply Corp	Tyler	X			
2290006	Warren Water Supply Corporation	Tyler	X			
2290010	Ivanhoe Subdivision Water System	Tyler	X			
2290012	White Tail Ridge Lakes Estates	Tyler	X			
2290015	Barlow Lake Estates	Tyler	X			
2290037	Tyler County Water Supply Corp	Tyler	X			X
2290038	Windmill Mobile Home Estates	Tyler	X			

FIGURE 4.1
EAST TEXAS REGION COMPARISON OF WATER SUPPLY AND DEMAND

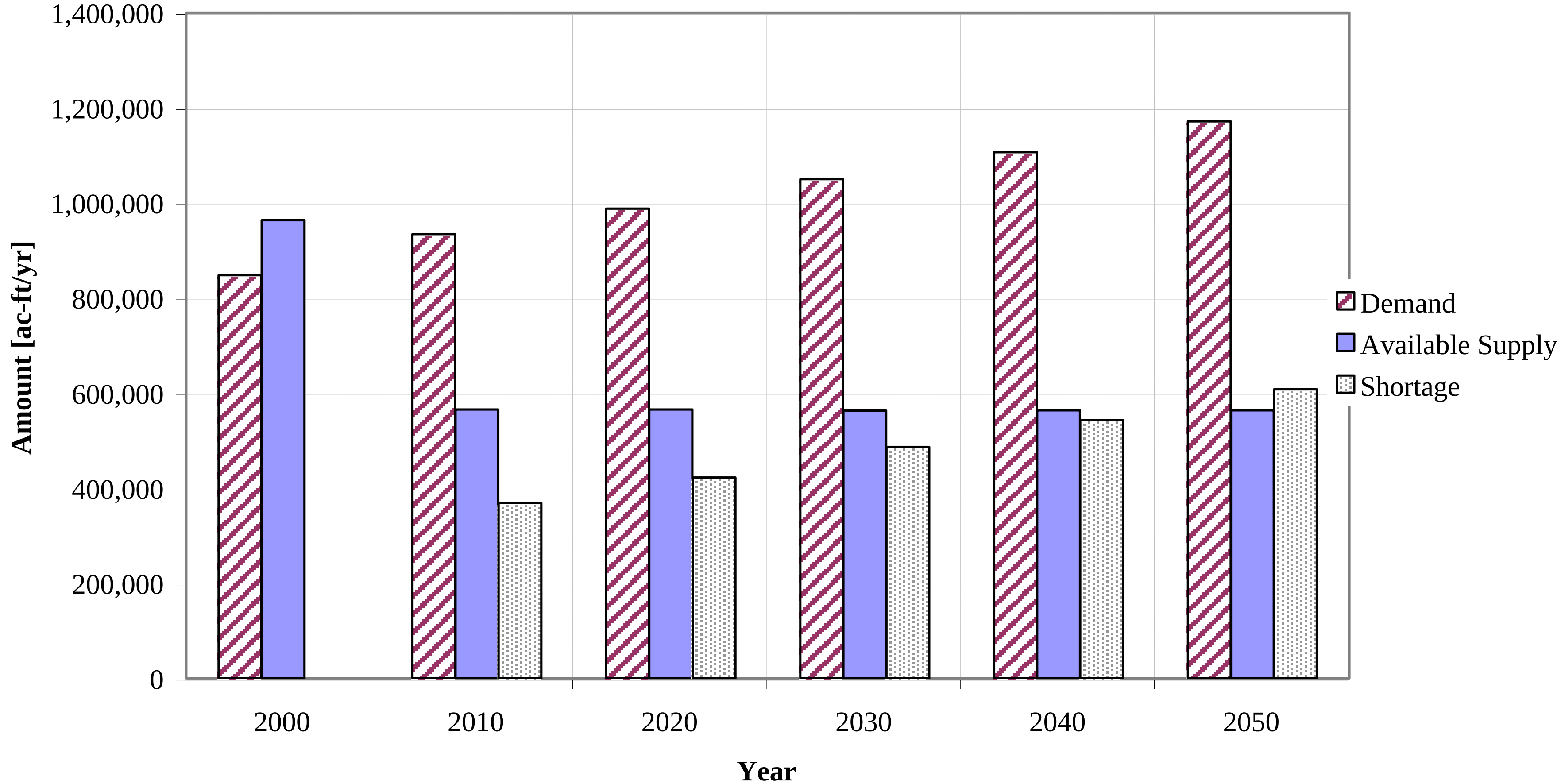


FIGURE 4.2
EAST TEXAS REGION UNCONNECTED AND UNPERMITTED SUPPLIES

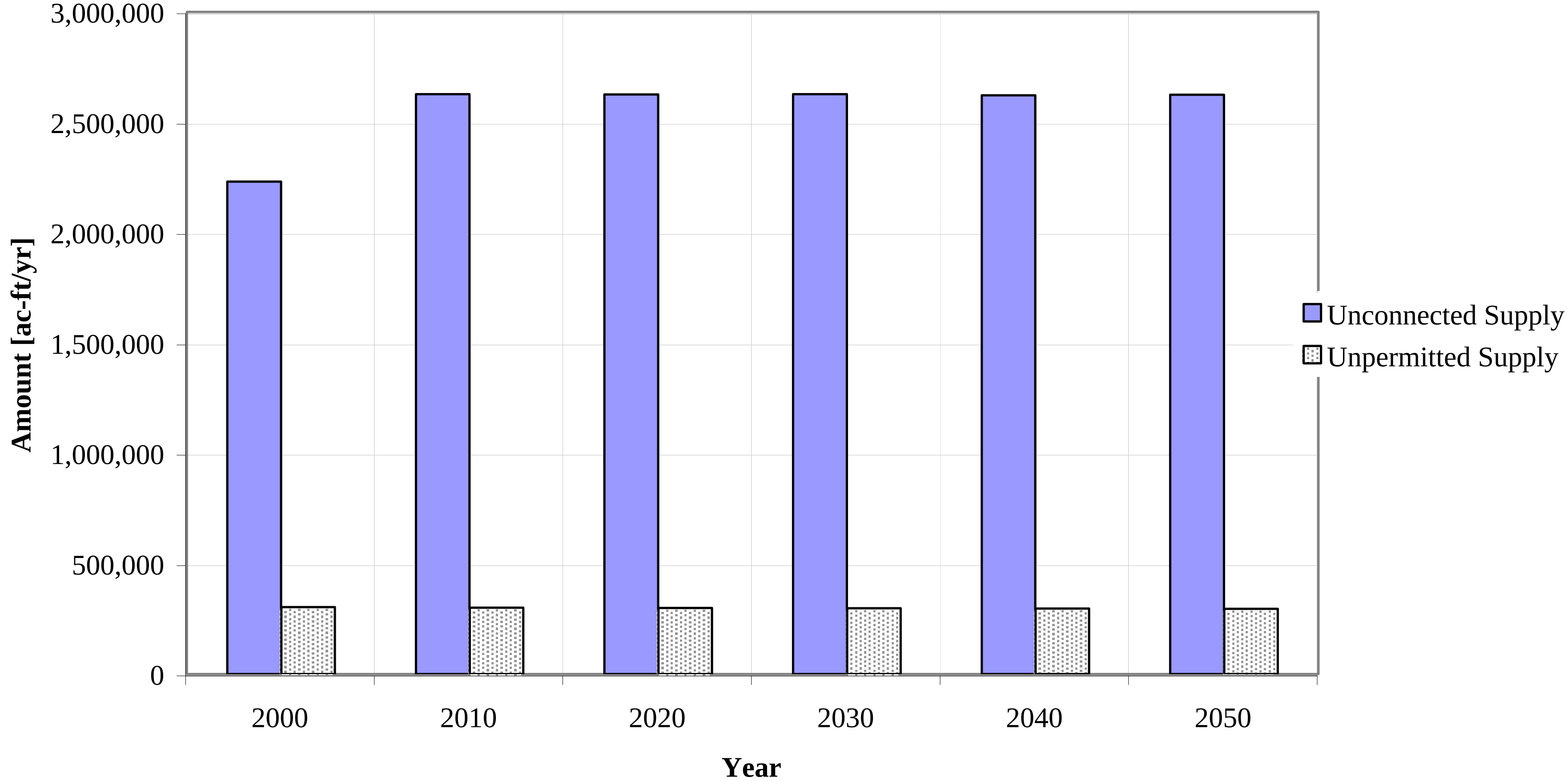
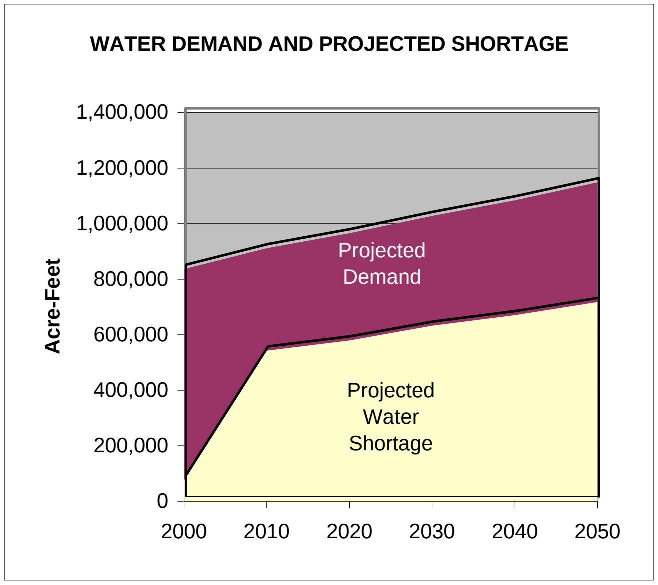
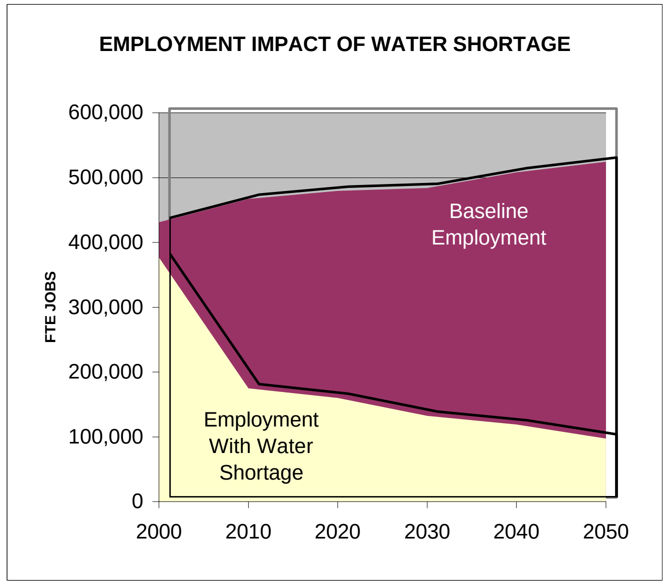
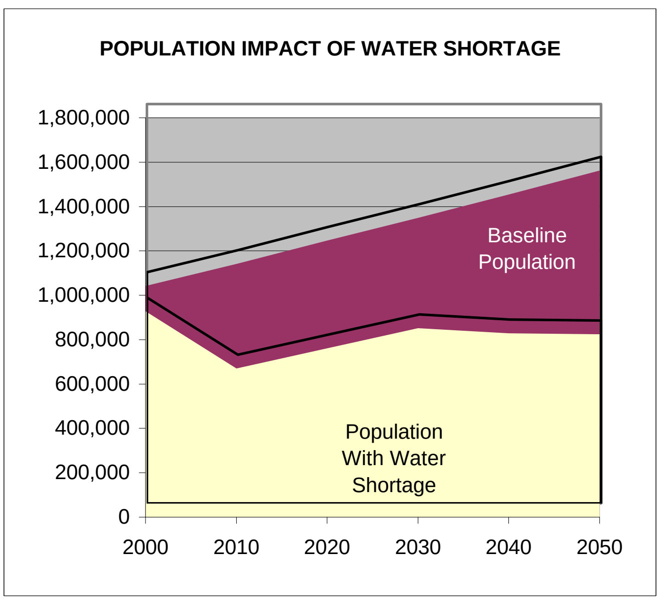
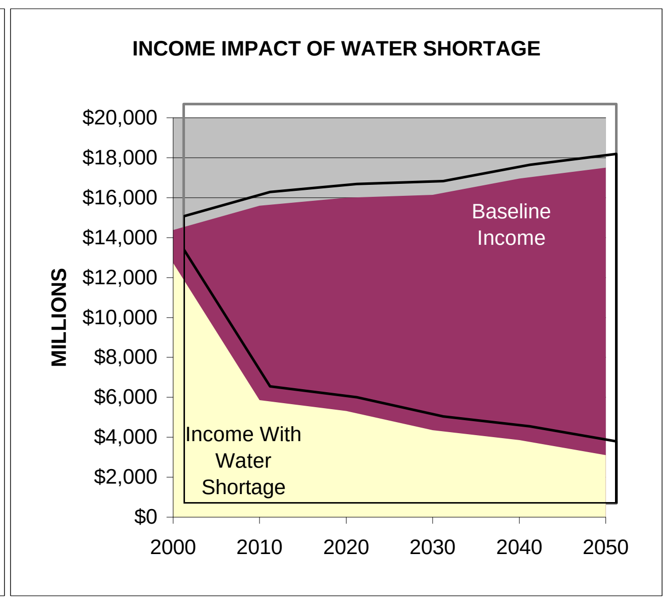


FIGURE 4.3. SUMMARY OF SOCIO-ECONOMIC IMPACTS OF NOT MEETING WATER NEEDS, EAST TEXAS REGION, 2000 - 2050









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Task 5

Task 5

Identification, Evaluation, and Selection of Water Management Strategies

5.1. Introduction

This report describes the water management strategies developed to meet the water shortages in TWDB Table 7. The strategies are outlined on a county basis with each of the various needs in the counties identified. For each user group with a defined shortage, a summary table is provided to review the projected demands and current supplies. This table also summarizes the recommended strategies and the supply delivered by the strategy. A second summary table provides an evaluation of the cost (capital, annual and unit) to deliver treated water to the user for all of the various strategies which were considered. A map for each county is presented at the end of each county section for reference purposes.

In guidelines for Senate Bill 1 planning, the TWDB requires that each region develop three tables that summarize the water management strategies (TWDB Tables 11, 12 and 13). TWDB Table 11 presents a summary of all potentially feasible Water Management Strategies. TWDB Table 12 presents the recommended water management strategies. Table 13 provides recommended water management strategies by Major Water Providers. A summary table of water demand, supply and surplus/needs for each water user group by County is provided in Section 14 of the TWDB Tables.

The strategy evaluations contained in this regional plan represent preliminary overviews and should not be considered as detailed feasibility analyses. Cost analyses in particular are speculative. Due to the forward looking nature of these types of planning efforts, it is understood and agreed that the cost estimates expressed herein by Schaumburg & Polk, Inc., in no way represent what actual costs may be to design, build, or operate such a system. Project specific analysis would have to be done at the time a project is undertaken to establish a more accurate estimate. Surface water uses requiring applications of less than 1,000 acre feet/year and which do not have a significant impact on the Region's water supply are considered to be consistent with this Plan even though it may not be specifically recommended. Water supply projects that do not require development of or connection to a new water source are considered consistent with the Plan even though it is not specifically recommended.

5.2. Water Management Strategies

5.2.1 Anderson County

There is limited additional water available from the Carrizo-Wilcox Aquifer in Anderson County. There is significant additional water available from both the Queen City and Sparta Aquifers in Anderson County. Supplies from these aquifers may be used instead of the Carrizo-Wilcox in the potential strategies below.

Texas Department of Criminal Justice (TDCJ) demands have been included in the water use projections.

Elkhart

The City of Elkhart water supply is currently from groundwater wells in the Carrizo-Wilcox Aquifer. The strategy selected to meet the future demands is to increase additional supplies from the Carrizo-Wilcox. The following table presents a summary of future water demands and the strategies to be used to meet the water demands.

	2000	2010	2020	2030	2040	2050
Population	1,228	1,303	1,345	1,357	1,370	1,379
Water Demand (ac-ft/year)	209	210	205	203	198	197
Current Supply (ac-ft/year)	183	183	183	183	183	183
Supply(+)-Demand(-) (ac-ft/yr)	-26	-27	-22	-20	-15	-14
Recommended Strategy EL-1 (ac-ft/year): Increase supply from Carrizo-Wilcox	121	121	121	121	121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
EL-1: Increase supply from Carrizo-Wilcox	121	$229,131	$32,766	$270	$ 0.83

Frankston

The City of Frankston water supply is currently from groundwater wells in the Carrizo-Wilcox Aquifer. The strategy selected to meet the future demands is to increase additional supplies from the Carrizo-Wilcox. The following table presents a summary of future water demands and the strategies to be used to meet the water demands.

	2000	2010	2020	2030	2040	2050
Population	1,244	1,281	1,316	1,329	1,334	1,336
Water Demand (ac-ft/year)	323	319	314	311	308	305
Current Supply (ac-ft/year)	311	311	311	311	311	311
Supply(+)-Demand(-) (ac-ft/yr)	-12	-8	-3	0	3	6
Recommended Strategy FR-1(ac-ft/year):Increase supply from Carrizo-Wilcox	121	121	121			

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
FR-1(ac-ft/year):Increase supply from Carrizo-Wilcox	121	$217,086	$34,267	$283	$ 0.87

Steam Electric Power

Louisville Gas & Electric is building a steam electric power plant near Palestine. This plant will require an annual average amount of 11,209 ac-ft/yr. The City of Palestine will supply this amount with water from Lake Palestine. As part of this project, the city will build a new pipeline from their current intake to the city's water treatment plant. LG&E will tap this line at the appropriate location. The project demands and water supply for the selected strategy is presented below.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	0	11,209	11,209	11,209	11,209	11,209
Current Supply (ac-ft/year)	0	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	0	-11,209	-11,209	-11,209	-11,209	-11,209
Recommended Strategy ADS-1 (ac-ft/yr): Contract with City of Palestine		11,209	11,209	11,209	11,209	11,209

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ADS-1 (ac-ft/yr): Contract with City of Palestine	11,209	$4,523,000	$3,116,102	$278	$ 0.85

See Arc View Map
Anderson County

5.2.2 Angelina County

City of Lufkin

The City of Lufkin currently receives all of its supply form the Carrizo-Wilcox Aquifer. The City is currently planning construction of a surface water treatment plant on Sam Rayburn Reservoir (where it will contract with the LNVA for 28,000 acre-feet/year). The City's existing well field will continue to be operated at or near its current capacity, but the proposed surface water plant will be expanded in a series of phases to meet rising future demands. The most recent plans for the timing of the phased development is as follows:

Year	Capacity (ac-ft/yr)
2006	11,200
2015	16,800
2025	22,400
2035	28,000

It is proposed that the future expansions will enable the City to service additional surrounding county water suppliers and to meet increasing manufacturing demands.

The following is a summary of the demands and supply provided by the selected strategy. The selected strategy is to construct a proposed surface water plant and transfer line to supply water from Sam Rayburn Reservoir. The general location of the improvements is indicated on the county map.

	2000	2010	2020	2030	2040	2050
Population	36,684	44,281	53,452	64,521	77,883	94,013
Water Demand (ac-ft/year)	5,712	6,498	7,424	8,746	10,295	11,700
Current Supply (ac-ft/year)	5,751	5,751	5,751	5,751	5,751	5,751
Supply(+)-Demand(-) (ac-ft/yr)	39	-747	-1,673	-2,995	-4,544	-5,949
Recommended Strategy LU-1 (ac-ft/year): Construct conveyance pipeline to Rayburn Reservoir and associated water treatment plant.		5,600	6,384	6,272	7,560	7,560

The supplies provided by recommended strategy are cumulative totals based on construction of phases as discussed above and do not include quantities supplied to meet manufacturing needs.

Only one strategy was considered to meet the future water demands. Expansion of groundwater was not considered to be a realistic alternative due to the demand required. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
LU-1: Construct conveyance pipeline to Rayburn Reservoir and associated water treatment plant.	7,560	$50,409,000	$4,064,256	$648	$ 1.98

City of Huntington

The City of Huntington currently receives supplies from the Yegua aquifer. The shortage shown in the year 2040 and beyond is based on limiting current supply to 50% of the current well pumping capacity. The shortage can be most easily met by additional wells if needed.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	2,273	2,756	3,202	3,670	4,120	4,601
Water Demand (ac-ft/year)	298	336	369	407	447	495
Current Supply (ac-ft/year)	435	435	435	435	435	435
Supply(+)-Demand(-) (ac-ft/yr)	137	99	66	28	-12	-60
Recommended Strategy HU-1 (ac-ft/year): Expand current supplies					60	60

The existing wells, with proper management and maintenance, are expected to continue servicing the needs of the City.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HU-1: Expand current supply	60	$176,773	$16,954	$283	$ 0.87

Livestock

Livestock is supplied from Queen City and Sparta and local supplies. The recommended strategy is to continue expansion of the current supplies.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	628	649	673	702	735	773
Current Supply (ac-ft/year)	627	627	627	627	627	627
Supply(+)-Demand(-) (ac-ft/yr)	-1	-22	-46	-75	-108	-146
Recommended Strategy ANL-1 (ac-ft/year): Expand current supplies	49	49	49	98	147	147

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ANL-1 (ac-ft/year): Expand current supplies	145	$66,570	$8,604	$69.49	$ 0.21

Manufacturing

Current supplies are from several sources with the following approximate distribution**;** 14,668 acre-feet/year from the Carrizo-Wilcox Aquifer, 851 acre-feet/year from the Yegua and 29,000 acre-feet/year from surface water sources. The City of Lufkin currently supplies approximately 12% of the current needs, however, it would be expected that the City's percentage of the supply would increase. The 19,000 acre-feet of surface water is controlled by a single manufacturing entity, Donohue. It is not expected that all of the growth will be limited to Donohue, which has the largest source of water supply. It is anticipated that growth will be supplied by the City of Lufkin and possibly Temple-Inland, which is currently under contract with ANRA for supply from Lake Eastex. It is expected that Temple-Inland would use the Lake Eastex supply as it became available.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	30,000	32,290	34,877	37,818	41,138	45,000
Current Supply (ac-ft/year)	44,519	44,519	44,519	44,519	44,519	44,519
Supply(+)-Demand(-) (ac-ft/yr)	14,519	12,229	9,642	6,701	3,381	-481
Recommended Strategy ANM-1 (ac-ft/year): Renew Contract with City of Lufkin.			2,006	4,947	6,400	6,400
Recommended Strategy ANM-2 (ac-ft/year): Obtain supply from Lake Eastex					8,551	8,551

The supply from the City of Lufkin is based on supplies available after meeting municipal demands by the City of Lufkin.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ANM-1 (ac-ft/year): Renew Contract with City of Lufkin.	6,400	$42,944,000	$3,193,344	$648	$ 1.98
ANM-2 (ac-ft/year): Obtain supply from Lake Eastex	8,551	$32,992,000	$3,180,972	$372	$ 1.14

Note: Cost reflect treated water for ANM-1 and raw water for ANM-2. ANM-1 is industrial portion of cost for water from City of Lufkin.

Mining

Water for mining is supplied from the Carrizo-Wilcox. Water strategy would be to continue use of the Carrizo-Wilcox.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	36	40	45	51	57	64
Current Supply (ac-ft/year)	22	22	22	22	22	22
Supply(+)-Demand(-) (ac-ft/yr)	-14	-18	-23	-29	-35	-42
Recommended Strategy ANN-1 (ac-ft/year):Increase supply from wells.	42	42	42	42	42	42

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ANN-1:Increase supply from wells	42	$33,936	$4,081	$96.00	$ 0.29

See Arc View Map
Angelina County

5.2.3 Cherokee County

The Carrizo-Wilcox Aquifer is almost fully allocated in Cherokee County. There are substantial amounts of additional water available from the Queen City and Sparta Aquifers, but these aquifers do not cover the entire county. Where feasible, water from the Queen City or Sparta Aquifers may be substituted for Carrizo-Wilcox water in the following potential water management strategies. However, the ETRWPG has made a policy decision that water from the Queen City and Sparta Aquifers will be used primarily for Livestock and Irrigation uses because of the unreliable supply and quantity. No proposed management strategies for municipal water shortages involve the Queen City and Sparta Aquifers.

Water obtained from the Queen City Aquifer may be acidic and may have levels of iron and manganese greater than TNRCC secondary drinking water standards. Water obtained from the Sparta Aquifer may have levels of sulfates greater than the TNRCC secondary drinking water standards, especially in far southern Cherokee County. Water quality in the Sparta Aquifer is best on the outcrop.

Alto

The City of Alto's water supply is currently from groundwater wells in the Carrizo-Wilcox Aquifer. Future population growth is expected to increase the demand for water. The strategy selected to meet the future demands is to increase additional supplies from the Carrizo-Wilcox.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	1,137	1,235	1,335	1,443	1,556	1,656
Water Demand (ac-ft/year)	205	212	218	229	242	256
Current Supply (ac-ft/year)	240	240	240	240	240	240
Supply(+)-Demand(-) (ac-ft/yr)	35	28	22	11	-2	-16
Recommended Strategy Al-1 (ac-ft/year): Increase supply from Carrizo-Wilcox					121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Al-1: Increase supply from Carrizo-Wilcox	121	$201,025	$32,181	$266	$ 0.81

Bullard

The City of Bullard's water supply is currently from groundwater wells in the Carrizo-Wilcox Aquifer, with some of the wells in Smith County. Future population growth is expected to increase the demand for water. The strategy selected to meet the future demands is to increase additional supplies from the Carrizo-Wilcox in Smith County.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	661	737	875	942	1,033	1,130
Water Demand (ac-ft/year)	141	144	159	163	169	181
Current Supply (ac-ft/year)	116	116	116	116	116	116
Supply(+)-Demand(-) (ac-ft/yr)	-25	-28	-43	-47	-53	-65
Recommended Strategy BU-1 (ac-ft/year): Increase supply from Carrizo-Wilcox	121	121	121	121	121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
BU-1 (ac-ft/year): Increase supply from Carrizo-Wilcox	121	$214,725	$35,126	$290	$ 0.89

New Summerfield

The City of New Summerfield currently obtains water supply from Carrizo-Wilcox Aquifer. Although near term needs are adequate, the City has a contract with ANRA for water from Lake Eastex, if it is developed. Development of plant farms in the New Summerfield area, with the City being the supplier of the water, will impact the City's need for new sources. The selected strategy is to obtain water from Lake Eastex. Improvements used in the evaluation of strategies are shown on the county map.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	604	681	767	864	974	1,097
Water Demand (ac-ft/year)	81	89	100	111	124	139
Current Supply (ac-ft/year)	118	118	118	118	118	118
Supply(+)-Demand(-) (ac-ft/yr)	37	29	18	7	-6	-21
Recommended Strategy SU-1 (ac-ft/year): Obtain water from Lake Eastex for support of local plant farm.		855	855	855	855	855

Most of the supply from Eastex (787 ac-ft/yr) is for resale to plant farm irrigation demands.

In addition to the recommended alternative, alternatives were also investigated for purchase of water through Cities of Jacksonville and Tyler. The evaluation of alternatives was based on providing a supply equal to the Lake Eastex contract amounts.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SU-1: Obtain water from Lake Eastex	855	$5,630,000	$518,985	$607	$ 1.86
SU-2: Obtain water from City of Jacksonville	855	$4,267,441	$839,610	$982	$ 3.00
SU-3: Obtain water from City of Tyler	855	$1,280,394	$692,550	$810	$ 2.48

Rusk

Current supplies are obtained from Carrizo-Wilcox Aquifer and Rusk City Lake. The City presently has a contract with ANRA for water from Lake Eastex, if constructed. The selected strategy is to obtain water from Lake Eastex. _Improvements used in the evaluation of strategies are shown on the county map.

	2000	2010	2020	2030	2040	2050
Population	4,645	4,945	5,237	5,651	5,952	6,182
Water Demand (ac-ft/year)	1,051	1,075	1,086	1,145	1,187	1,225
Current Supply (ac-ft/year)	1,091	1,091	1,091	1,091	1,091	1,091
Supply(+)-Demand(-) (ac-ft/yr)	40	16	5	-54	-96	-134
Recommended Strategy RU-1 (ac-ft/year): Obtain water from Lake Eastex				855	855	855

In addition to the selected alternatives, a supplementary alternative of strategy RU-2, will be to obtain water from the City of Jacksonville. The evaluation of alternatives were based on providing a supply equal to the Lake Eastex contract amounts

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
RU-1: Obtain water from Lake Eastex	855	$5,630,000	$518,985	$607	$ 1.86
RU-2: Obtain water from City of Jacksonville	855	$4,915,000	$940,500	$1,100	$ 3.36

Wells

Current supply is from Carrizo-Wilcox Aquifer. Due to the small quantity of projected future demand the selected strategy is to continue development of current supply.

	2000	2010	2020	2030	2040	2050
Population	824	874	929	976	1,026	1,078
Water Demand (ac-ft/year)	124	129	135	140	145	150
Current Supply (ac-ft/year)	113	113	113	113	113	113
Supply(+)-Demand(-) (ac-ft/yr)	-11	-16	-22	-27	-32	-37
Recommended Short Term Strategy WE-1 (ac-ft/year): Use additional water from Carrizo-Wilcox.	121	121	121	121	121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
WE-1: Increase supply from Carrizo-Wilcox	121	$233,146	$35,090	$290	$ 0.89

County-Other

Current supplies are from Carrizo-Wilcox Aquifer, Queen City Aquifer, Sparta Aquifer and Lake Jacksonville. Afton Grove WSC, Craft-Turney WSC, Gum Creek WSC, North Cherokee WSC, and West Jacksonville WSC could potentially renew contracts with Jacksonville for water from Lake Jacksonville. Afton Grove WSC, Blackjack WSC, Cherokee County, John Moore, North Cherokee WSC, Reklaw WSC, Rusk Rural WSC, and the Stryker Lake WSC have existing contracts with ANRA with option for water from Lake Eastex if developed. These contracts are sufficient to meet remaining County-Other demands.

	2000	2010	2020	2030	2040	2050
Population	27,594	30,767	34,070	36,654	39,042	41,279
Water Demand (ac-ft/year)	5,441	5,917	6,431	6,855	7,246	7,587
Current Supply (ac-ft/year)	3,917	3,917	3,355	2,787	2,787	2,787
Supply(+)-Demand(-) (ac-ft/yr)	-1,524	-2,000	-3,076	-4,068	-4,459	-4,800
Recommended Strategy CHC-1 (ac-ft/year): Use additional water from Carrizo-Wilcox	404					
Recommended Strategy CHC-2 (ac-ft/year): Overdraft Carrizo-Wilcox until sustainable supply obtained	1,211					
Recommended Strategy CHC-3 (ac-ft/year): Renew contracts with City of Jacksonville			562	1,130	1,130	1,130
Recommended Strategy CHC-4 (ac-ft/year): Obtain water from Lake Eastex		7,696	7,696	7,696	7,696	7,696

In addition to the above recommended strategies evaluation was also made of supplies from the Cities of Jacksonville and Tyler. The evaluation of alternatives were based on providing a supply equal to the Lake Eastex contract amounts

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
CHC-1: Use additional water from Carrizo-Wilcox	404	$637,740	$107,968	$268	$ 0.82
CHC-2: Overdraft Carrizo-Wilcox until sustainable supply obtained	1,211	$1,913,200	$323,905	$268	$ 0.82
CHC-3: Renew contracts with City of Jacksonville	1,130	$0	$548,050	$485	$ 1.48
CHC-4: Obtain water from Lake Eastex	7,696	$44,680,000	$4,055,792	$527	$ 1.61
CHC-5: Obtain water from City of Jacksonville for certain Lake Eastex participants	1,283	$6,403,657	$1,259,906	$982	$ 3.00
CHC-6: Obtain water from City of Tyler for Lake Eastex participants	855	$1,280,394	$692,530	$810	$ 2.48
CHC-7: Obtain water from City of Jacksonville for certain Lake Eastex participants	855	$4,915,000	$940,500	$1,100	$ 3.36

Notes: Eastex participants in various alternatives as noted below:
CHC-5: New Summerfield, Blackjack WSC, Stryker Lake WSC
CHC-6: Blackjack WSC and New Summerfield on extension of line from Whitehouse and Troup.
CHC-7: City of Rusk and Rusk Rural WSC

Irrigation

Current supply is from Carrizo-Wilcox Aquifer, Queen City Aquifer, Sparta Aquifer and Irrigation Local Supply. More than 90% of the irrigation water shortage is attributable to plant farm demands. Based on conversation with Joe Daniels of Powell Brothers Plant Farm and geographical extent of the Queen City Aquifer, it is assumed that 40% of the shortage can be met using additional supply from the Queen City Aquifer. The remaining 60% of the shortage can be met with water from Lake Eastex. There appears to be sufficient water in the New Summerfield contract with ANRA, and much of the plant farm demand is centered around New Summerfield.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	1,753	1,753	1,753	1,753	1,753	1,753
Current Supply (ac-ft/year)	441	441	441	441	441	441
Supply(+)-Demand(-) (ac-ft/yr)	-1,312	-1,312	-1,312	-1,312	-1,312	-1,312
Recommended Strategy CHR-1(ac-ft/year) Use additional water from the Queen City Aquifer	565	565	565	565	565	565
Recommended Strategy CHR-2(ac-ft/year) Overdraft Carrizo-Wilcox Aquifer until sustainable supply obtained	807					
Recommended Strategy CHR-3 (ac-ft/year) Obtain water from Lake Eastex (from New Summerfield)		787	787	787	787	787

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
CHR-1: Use additional water from the Queen City Aquifer	565	$1,130,800	$155,026	$274	$ 0.84
CHR-2 : Overdraft Carrizo-Wilcox Aquifer until sustainable supply obtained	807	$993,616	$92,866	$236	$ 0.72
CHR-3 : Obtain water from Lake Eastex	787	$0	$468,265	$607	$ 1.86

NOTE: CHI-3 is treated water supplied thru New Summerfield.

Mining

Current supply is from Carrizo-Wilcox Aquifer and Mining Local Supply. Recommended strategy is to obtain water from the Queen City Aquifer.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	77	52	267	569	713	883
Current Supply (ac-ft/year)	84	84	84	84	84	84
Supply(+)-Demand(-) (ac-ft/yr)	7	32	-183	-485	-629	-799
Recommended Strategy CHN-1 (ac-ft/year): Use water from Queen City.			807	807	807	807

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
CHN-1: Use water from Queen City.	807	$1,723,838	$231,367	$287	$ 0.88

Steam Electric Power

Current supplies are from the Carrizo-Wilcox Aquifer and Striker Creek Lake. Construction of Lake Eastex could meet the entire future demand.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	5,000	5,000	10,000	15,000	15,000	20,000
Current Supply (ac-ft/year)	5,343	5,343	5,343	5,343	5,343	5,343
Supply(+)-Demand(-) (ac-ft/yr)	343	343	-4,657	-9,657	-9,657	-14,657
Recommended Strategy CHS-1 (ac-ft/year): Obtain water from Lake Eastex.		14,657	14,657	14,657	14,657	14,657

Besides Lake Eastex, no single alternative can provide the entire demand. A review of the supply from alternative strategies is as follows:

Alternative	Approx. Qty. (ac-ft/yr)
Lake Striker	5,600
Reuse of wastewater from Jacksonville	1,934
Reuse of wastewater from Tyler	7,123

The comparison of the alternatives is as follows:

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
CHI-S: Obtain water from Lake Eastex.	14,657	$30,857,000	$3,136,598	$214	$ 0.65
CHS-2: Striker Creek Lake	5,600		$1,187,200	$212	$ 0.65
CHS-3: Reuse from City of Jacksonville	1,934	$4,618,000	$555,982	$302	$ 0.92
CHS-4: Reuse from City of Tyler, South	7,123	$15,689,000	$1,942,276	$497	$ 1.52
CHS-5: Reuse from City of Tyler, West	5,862	$26,855,000	$3,546,518	$605	$ 1.85

See Arc View Map
Cherokee County

See Arc View Map
Proposed Lake Eastex

5.2.4 Hardin County

The Gulf Coast Aquifer supplies most users in Hardin County. According to analyses performed by LBG-Guyton, there is sufficient water available from the Gulf Coast Aquifer to meet water shortages in Hardin County. The Irrigation shortage in Hardin County is a result of anticipated rice farming in the county.

Kountze

Current supply is from Gulf Coast Aquifer. The selected strategy is to obtain additional supply from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population	2,540	2,790	3,018	3,256	3,545	3,859
Water Demand (ac-ft/year)	313	322	328	343	361	389
Current Supply (ac-ft/year)	324	324	324	324	324	324
Supply(+)-Demand(-) (ac-ft/yr)	11	2	-4	-19	-37	-65
Recommended Strategy KO-1 (ac-ft/year):Use additional water from Gulf Coast Aquifer.			121	121	121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
KO-1: Use additional water from Gulf Coast Aquifer.	121	$192,995	$25,898	$214	$ 0.65

Lumberton

The City of Lumberton is served by Lumberton MUD. Current supply is from Gulf Coast Aquifer. The selected strategy is to obtain additional supply from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	9,510	12,865	13,779	14,475	15,341	16,138
Water Demand (ac-ft/year)	1,193	1,484	1,513	1,557	1,598	1,663
Current Supply (ac-ft/year)	1,170	1,170	1,170	1,170	1,170	1,170
Supply(+)-Demand(-) (ac-ft/yr)	-23	-314	-343	-387	-428	-493
Recommended Strategy LM-1 (ac-ft/year): Use additional water from Gulf Coast Aquifer.	726	726	726	726	726	726

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
LM-1 (ac-ft/year): Use additional water from Gulf Coast Aquifer.	726	$760,871	$128,675	$177	$ 0.54

Sour Lake

Current supply is from Gulf Coast Aquifer. The selected strategy is to obtain additional supply from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population	1,834	2,015	2,179	2,351	2,559	2,787
Water Demand (ac-ft/year)	232	237	242	250	264	287
Current Supply (ac-ft/year)	226	226	226	226	226	226
Supply(+)-Demand(-) (ac-ft/yr)	-6	-11	-16	-24	-38	-61
Recommended StrategySL-1 (ac-ft/year): Use additional water from Gulf Coast Aquifer	75	75	75	75	75	75

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SL-1: Use additional water from Gulf Coast Aquifer	75	$171,474	$19,533	$269	$ 0.82

County-Other

Current supplies are from Gulf Coast Aquifer and Other-Undifferentiated Aquifer. The selected strategy is to obtain additional supply from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population	28,573	29,547	32,581	36,105	40,438	45,292
Water Demand (ac-ft/year)	3,032	2,937	3,017	3,219	3,421	3,829
Current Supply (ac-ft/year)	3,317	3,317	3,317	3,317	3,317	3,317
Supply(+)-Demand(-) (ac-ft/yr)	285	380	300	98	-104	-512
Recommended Strategy HAC-1 (ac-ft/year): Use additional water from Gulf Coast Aquifer.					646	646

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HAC-1: Use additional water from Gulf Coast Aquifer	646	$979,697	$138,101	$214	$ 0.65

Irrigation

The current supply for irrigation use is from Gulf Coast Aquifer and Irrigation Local Supply. The selected strategy is to obtain supply from Sam Rayburn/B.A. Steinhagen system.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	2,146	4,420	4,420	4,420	4,420	4,420
Current Supply (ac-ft/year)	2,200	2,200	2,200	2,200	2,200	2,200
Supply(+)-Demand(-) (ac-ft/yr)	54	-2,220	-2,220	-2,220	-2,220	-2,220
Recommended Short Term StrategyHAR-1 (ac-ft/year): Obtain water from Rayburn.		2,238	2,238	2,238	2,238	2,238

An additional alternative is to obtain supply from the Neches River. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HAR-1: Obtain water from Rayburn	2,238	$0	$44,760	$20	$ 0.06
HAR-2 (ac-ft/year): Obtain water from Neches River	2,238	$0	$44,760	$20	$ 0.06

Note: Unit cost only includes an estimate of cost for LNVA Water Supply.

Manufacturing

Current supply is from the Gulf Coast Aquifer

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	111	116	123	129	138	147
Current Supply (ac-ft/year)	103	103	103	103	103	103
Supply(+)-Demand(-) (ac-ft/yr)	-8	-13	-20	-26	-35	-44
Recommended Short Term StrategyHAM-1 (ac-ft/year): Use additional water from Gulf Coast Aquifer	45	45	45	45	45	45

The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HAM-1: Use additional water from Gulf Coast Aquifer	45	$103,000	$12,105	$269	$ 0.82

See Arc View Map
Hardin County

5.2.5 Henderson County

Substantial additional groundwater supplies are available from the Carrizo-Wilcox and Queen City Aquifers in Henderson County.

There has been discussion that a steam electric plant under construction with plans to use approximately 35,000 gallons per hour, equating to 942 ac-ft/yr. This demand is not included in the demand projections, but there is sufficient water available in the Carrizo-Wilcox Aquifer to meet this demand.

Brownsboro

Current supply is from the Carrizo-Wilcox Aquifer. The strategy is to use additional groundwater from the Carrizo-Wilcox Aquifer.

	2000	2010	2020	2030	2040	2050
Population	562	571	589	603	613	633
Water Demand (ac-ft/year)	99	96	94	93	92	94
Current Supply (ac-ft/year)	77	77	77	77	77	77
Supply(+)-Demand(-) (ac-ft/yr)	-22	-19	-17	-16	-15	-17
Recommended Short Term Strategy BR-1 (ac-ft/year): Use additional water from Carrizo-Wilcox	81	81	81	81	81	81

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
BR-1 (ac-ft/year): Use additional water from Carrizo-Wilcox	81	$212,535	$27,464	$340	$ 1.04

Murchison

Current supply is from the Carrizo-Wilcox Aquifer. The strategy is to use additional groundwater from the Carrizo-Wilcox Aquifer.

	2000	2010	2020	2030	2040	2050
Population	595	618	631	656	693	730
Water Demand (ac-ft/year)	128	127	124	126	130	136
Current Supply (ac-ft/year)	107	107	107	107	107	107
Supply(+)-Demand(-) (ac-ft/yr)	-21	-20	-17	-19	-23	-29
Recommended Short Term Strategy MU-1 (ac-ft/year): Obtain water from Carrizo-Wilcox	121	121	121	121	121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
MU-1 (ac-ft/year): Obtain water from Carrizo-Wilcox	121	$201,025	$31,190	$258	$ 0.79

County-Other

Current supplies are from Carrizo-Wilcox Aquifer and Queen City Aquifer. The strategy is to use additional groundwater from the Carrizo-Wilcox Aquifer.

	2000	2010	2020	2030	2040	2050
Population	15,531	17,054	18,315	18,710	19,001	19,774
Water Demand (ac-ft/year)	1,932	1,967	1,970	1,949	1,913	1,966
Current Supply (ac-ft/year)	1,721	1,721	1,721	1,721	1,721	1,721
Supply(+)-Demand(-) (ac-ft/yr)	-211	-246	-249	-228	-192	-245
Recommended Short Term Strategy HEC-1 (ac-ft/year): Obtain water from Carrizo-Wilcox	363	363	363	363	363	363

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HEC-1: Obtain water from Carrizo-Wilcox	363	$627,167	$95,770	$264	$ 0.81

Manufacturing

There is no current supply listed for Manufacturing. The recommended strategy is to use water from the Carrizo-Wilcox Aquifer.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	2	3	3	4	4	5
Current Supply (ac-ft/year)	0	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	-2	-3	-3	-4	-4	-5
Recommended Strategy HEM-1 (ac-ft/year): Obtain water from Carrizo-Wilcox	121	121	121	121	121	121

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HEM-1 (ac-ft/year): Obtain water from Carrizo-Wilcox	121	$209,056	$31,293	$264	$ 0.81

See Arc View Map
Henderson County

5.2.6 Houston County

Houston County Water Control and Improvement District No. 1 is the major water supplier in Houston County. The District obtains its water from Houston County Lake and treats it prior to distribution. At the present time, the District services five customers: (1) Consolidated WSC, (2) AMPACET (an industrial user); (3) the City of Crockett; (4) the City of Grapeland; and (5) the City of Lovelady. The ability of the District to meet these water demands is directly tied to the expansion of the Houston County WCID's surface water treatment plant and water rights. The District recently lost water rights for 3,500 acre-feet/year earmarked for industrial usage. The District currently plans to reacquire that water for municipal purposes, which would give them access to a total of 7,000 acre-feet of water per year. That is in excess of the estimated year 2050 demand for the District's current customers. Therefore, the primary water strategy for the five entities listed above is to aid the Houston County WCID in its application to the State for water rights and funding for plant expansion and to revise their contracts as necessary.

City of Crockett

The City of Crockett currently purchases all of its water from the Houston County Water Control and Improvement District No. 1. The City is in the process of constructing a 750 gpm new water well to augment its water supply. The well is intended for use during the peak season and will not affect the City's contract with the Houston County WCID. The City has an old well that still provide adequate water and may be placed into service for use as a source of non-potable water (i.e. for industrial use). The new well and renewal of contracts are expected to provide adequate supply.

	2000	2010	2020	2030	2040	2050
Population	7,509	8,868	10,194	11,877	13,846	16,063
Water Demand (ac-ft/year)	1,439	1,619	1,782	1,950	2,095	2,214
Current Supply (ac-ft/year)	1,120	1,120	1,120	1,120	1,120	1,120
Supply(+)-Demand(-) (ac-ft/yr)	-319	-499	-662	-830	-975	-1,094
Recommended Short Term Strategy CR-1 (ac-ft/year): Construction of new well	400	400				
Long Term Scenario CR-2 (ac-ft/year): Renewal of contract with HCWCID No. 1.		499	662	830	975	1,094

No additional alternatives were investigated.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Recommended Short Term Strategy CR-1 (ac-ft/year): Construction of new well	400	$751,084	$70,800	$177	$ 0.52
Long Term Scenario CR-2 (ac-ft/year): Renewal of contract with HCWCID No. 1.	1,094	$0	$897,080	$820	$ 2.51

Grapeland

A shortage is indicated in the Neches Basin with a surplus in the Trinity Basin. The existing distribution system should allow for easy transfer of the water between the basins. This "interbasin transfer" is indicated as the selected strategy.

County-Other

Specific information from the public water supplier listing and the Houston County Water Study indicates that the Carrizo Aquifer is tapped by wells of the Consolidated WSC. The data also indicates that the Sparta Sands is tapped by wells from the Consolidated WSC, City of Kennard, Pennington WSC, TDCJ - Eastham Unit, and USFS Ratcliff Recreation Area. The City of Kennard also has a well tapping the Queen City Aquifer. Pennington WSC is also listed as having a well in the Yegua Formation. Finally, the Consolidated WSC and the Ratcliff WSC are also listed as having wells obtaining water from the Spiller Formation. Public water suppliers obtaining water from the Houston County Water Control and Improvement District No. 1 should renew and extend their contracts in order to meet their needs and assist the Houston County WCID in attaining water rights and constructing water treatment plant. Other entities will have to rely on expansion of wells.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	12,928	15,354	17,824	20,998	24,701	29,113
Water Demand (ac-ft/year)	2,230	2,602	2,828	3,117	3,343	3,586
Current Supply (ac-ft/year)	2,324	2,324	2,324	2,324	2,324	2,324
Supply(+)-Demand(-) (ac-ft/yr)	94	-278	-504	-793	-1,019	-1,262
Recommended Strategy HTC-1 (ac-ft/year): Renew contracts with Houston Cty. WCID1 (Trinity Basin)		70	239	456	625	808
Recommended Strategy HTC-2 (ac-ft/year): Expand well supplies	130	227	290	370	420	454

The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HTC-1 (ac-ft/year): Renew contracts with Houston Cty. WCID1	808	$0	$1,034,840	$820	$ 2.51
HTC-2 (ac-ft/year): Expand well supplies	454	$2,335,920	$131,080	$454	$ 1.39

Irrigation

Supplies are from groundwater Carrizo-Wilcox, Queen City and Sparta Aquifers. The selected strategy is to continue to increase supplies from the aquifers.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	591	653	721	797	880	972
Current Supply (ac-ft/year)	564	564	564	564	564	564
Supply(+)-Demand(-) (ac-ft/yr)	37	-25	-93	-169	-252	-344
Recommended Strategy HTRI-1 (ac-ft/year): Increase groundwater supplies.	32	96	180	296	320	416

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HTRI-1 (ac-ft/year): Increase groundwater supplies	416	$228,930	$14,580	$81	$ 0.25

Livestock

Supplies are from groundwater Carrizo-Wilcox, Queen City and Sparta Aquifers. The selected strategy is to continue to increase supplies from the aquifers.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	1,902	2,061	2,233	2,420	2,622	2,841
Current Supply (ac-ft/year)	1,938	1,938	1,938	1,938	1,938	1,938
Supply(+)-Demand(-) (ac-ft/yr)	-36	-124	-296	-483	-685	-904
Recommended Strategy HTL-1 (ac-ft/year): Expand current supplies	36	128	320	483	704	992

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HTL-1 (ac-ft/year): Expand current supplies	992	$545,910	$38,880	$81	$ 0.25

Manufacturing

The major industrial entity in Houston County is AMPACET (a plastics producer). Information obtained from the Houston County WCID indicates that the AMPACET facility is located near the surface water treatment plant in the Trinity Basin. The District generally expects the facility to utilize about 3,600,000 gallons of water per month (or about 132.6 acre-feet/year). Manufacturer's that currently obtain water from public water suppliers should renew and extend their contracts in order to meet their needs. If feasible, drill new water wells to expand local supplies.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	206	244	268	290	327	364
Current Supply (ac-ft/year)	175	175	175	175	175	175
Supply(+)-Demand(-) (ac-ft/yr)	-31	-69	-93	-115	-152	-189
Recommended Strategy HTM-1 (ac-ft/year): Renew and expand current contracts	21	57	79	99	133	168
Recommended Strategy HTM-2 (ac-ft/year): Expand well supplies	32	32	32	32	32	32

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HTM-1: Renew and expand current contracts	168	$0	$137,760	$820	$ 2.51
HTM-2: Expand well supplies	32	$47,700	$3,040	$95	$ 0.29

Note: Unit cost is estimated for treated water.

<u>Mining</u>

Supply is from groundwater Continue to develop new wells where feasible

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	189	221	259	304	356	417
Current Supply (ac-ft/year)	181	181	181	181	181	181
Supply(+)-Demand(-) (ac-ft/yr)	-8	-40	-78	-123	-175	-236
Recommended Strategy HTN-1 (ac-ft/year): Increase groundwater usage.	32	44	128	128	192	256

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost	Unit Cost ($/Thou. Gal.)
Strategy HTN-1: Increase groundwater usage	256	$190,775	$12,160	$95	$ 0.29

See Arc View Map
Houston County

5.2.7 Jasper County

Water supply is from the Gulf Coast Aquifer with the exception of some surface water supplied to manufacturing.

Bessmay-Buna

Current supply is from the Gulf Coast Aquifer. Future demands can be met by use of additional groundwater from Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	2,735	3,033	3,214	3,275	3,421	3,594
Water Demand (ac-ft/year)	405	425	425	422	429	443
Current Supply (ac-ft/year)	321	321	321	321	321	321
Supply(+)-Demand(-) (ac-ft/yr)	-84	-104	-104	-101	-108	-122
Recommended Strategy BB-1 (ac-ft/year): Use of additional water from Gulf Coast	122	122	122	122	122	122

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
BB-1: Use of additional water from Gulf Coast	122	$170,964	$19,642	$161	$ 0.49

County-Other

Current supply is from the Gulf Coast Aquifer. Future demands can be met by use of additional groundwater from Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	22,504	25,539	28,119	30,367	32,264	34,508
Water Demand (ac-ft/year)	2,726	2,891	2,962	3,060	3,140	3,318
Current Supply (ac-ft/year)	2,852	2,852	2,852	2,852	2,852	2,852
Supply(+)-Demand(-) (ac-ft/yr)	126	-39	-110	-208	-288	-466
Recommended Strategy JAC-1 (ac-ft/year): Use of additional water from Gulf Coast Aquifer.		242	242	242	484	484

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
JAC-1: Use of additional water from Gulf Coast Aquifer.	484	$324,458	$23,474	$97	$ 0.30

Irrigation

Current supply is from the Gulf Coast Aquifer. Future demands can be met by use of additional groundwater from Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	158	158	158	158	158	158
Current Supply (ac-ft/year)	150	150	150	150	150	150
Supply(+)-Demand(-) (ac-ft/yr)	-8	-8	-8	-8	-8	-8
Recommended Strategy JAR-1 (ac-ft/year): Increase supply from Gulf Coast Aquifer	20	20	20	20	20	20

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
JAR-1: Increase supply from Gulf Coast Aquifer	20	$21,210	$3,060	$153	$ 0.47

City of Kirbyville

Current supply is from the Gulf Coast Aquifer. Future demands can be met by use of additional groundwater from Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	2,339	2,594	2,750	2,800	2,926	2,977
Water Demand (ac-ft/year)	509	538	545	545	558	564
Current Supply (ac-ft/year)	409	409	409	409	409	409
Supply(+)-Demand(-) (ac-ft/yr)	-100	-129	-136	-136	-149	-155
Recommended Strategy KI-1 (ac-ft/year): Use additional supply from Gulf Coast Aquifer.	155	155	155	155	155	155

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
KI-1: Use additional supply from Gulf Coast Aquifer.	155	$175,365	$21,700	$140	$ 0.43

Manufacturing

A shortage is indicated in the Neches Basin with a surplus in the Sabine Basin. Wells located in the Sabine Basin are currently meetings needs in the Neches Basin. This operation is expected to continue and is indicated as an "interbasin transfer" to meet the demands. No additional cost is required to implement the strategy.

Mining

A shortage is indicated in the Sabine Basin with a surplus in the Neches Basin. Wells located in the Neches Basin are currently meetings needs in the Sabine Basin. This operation is expected to continue and is indicated as an “interbasin transfer” to meet the demands. No additional cost is required to implement the strategy.

See Arc View Map
Jasper County

5.2.8 Jefferson County

Water supply is largely provided by the Lower Neches Valley Authority with the exceptions of water taken from the City of Beaumont from the Neches River and from wells in Hardin County and wells for Bevil Oaks, China, and Meeker MUD.

City of Beaumont

Current supplies are from groundwater and surface water. Although a shortage is shown in the Neches-Trinity Basin the City can easily supply the shortage by transfer of surplus in Neches Basin to the fill demands in Neches Trinity Basin through existing water distribution infrastructure.

City of Bevil Oaks

Current supply is from the Gulf Coast Aquifer. Future demands can be met by use of additional groundwater from Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	1,493	1,566	1,710	1,839	1,944	2,055
Water Demand (ac-ft/year)	152	147	149	152	155	161
Current Supply (ac-ft/year)	152	152	152	152	152	152
Supply(+)-Demand(-) (ac-ft/yr)	0	5	3	0	-3	-9
Recommended Strategy BO-1 (ac-ft/year): Use additional supply from Gulf Coast Aquifer					9	9

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
BO-1: Use additional supply from Gulf Coast Aquifer	9	$39,448	$4,050	$450	$ 1.38

County-Other

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	23,160	23,998	24,835	25,350	25,928	26,553
Water Demand (ac-ft/year)	2,867	2,740	2,626	2,680	2,666	2,777
Current Supply (ac-ft/year)	3,111	1,598	1,598	1,598	1,598	1,598
Supply(+)-Demand(-) (ac-ft/yr)	244	-1,142	-1,028	-1,082	-1,068	-1,179
Recommended Strategy JEC-1 (ac-ft/year): Renew contracts with LNVA		1,142	1,028	1,082	1,068	1,179

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost	Unit Cost ($/Thou. Gal.)
JEC-1: Renew contracts with LNVA	1,179	$0	$43,599	$36.98	$ 0.11

City of Groves

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	18,011	18,663	19,314	19,715	20,124	20,441
Water Demand (ac-ft/year)	1,957	1,882	1,817	1,789	1,735	1,740
Current Supply (ac-ft/year)	1,120	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	-837	-1,882	-1,817	-1,789	-1,735	-1,740
Recommended Strategy GR-1 (ac-ft/year): Renew contracts with LNVA	837	1,882	1,817	1,789	1,735	1,740

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost	Unit Cost ($/Thou. Gal.)
GR-1 (ac-ft/year): Renew contracts with LNVA	1,740	$0	$64,345.20	$36.98	$ 0.11

City of Nederland

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	17,084	17,162	17,489	17,606	17,782	17,960
Water Demand (ac-ft/year)	2,680	2,576	2,508	2,446	2,390	2,394
Current Supply (ac-ft/year)	2,800	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	120	-2,576	-2,508	-2,446	-2,390	-2,394
Recommended Strategy NE-1 (ac-ft/year): Renew contract with LNVA		2,576	2,508	2,446	2,390	2,394

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NE-1: Renew contract with LNVA	2394	$0	$88,530.12	$36.98	$ 0.11

City of Port Arthur

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	62,646	65,153	67,548	69,061	70,577	72,126
Water Demand (ac-ft/year)	11,017	10,874	10,820	10,753	10,673	10,826
Current Supply (ac-ft/year)	8,962	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	-2,055	-10,874	-10,820	-10,753	-10,673	-10,826
Recommended Strategy PA-1 (ac-ft/year): Renew contract with LNVA	2,055	10,874	10,820	10,753	10,673	10,826

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
PA-1: Renew contract with LNVA	10,826	$0	$290,894	$26.87	$ 0.08

City of Port Neches

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	14,237	14,548	14,952	15,171	15,414	15,661
Water Demand (ac-ft/year)	1,610	1,548	1,491	1,444	1,416	1,421
Current Supply (ac-ft/year)	1,120	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	-490	-1,548	-1,491	-1,444	-1,416	-1,421
Recommended Strategy: PN-1 (ac-ft/year): Renew contract with LNVA	490	1,548	1,491	1,444	1,416	1,421

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
PN-1: Renew contract with LNVA	1421	$0	$52,548	$36.98	$ 0.11

Irrigation

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	259,495	284,313	284,240	284,159	284,071	283,972
Current Supply (ac-ft/year)	239,695	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	-19,800	-284,313	-284,240	-284,159	-284,071	-283,972
Recommended Strategy JER-1 (ac-ft/year): Renew contract with LNVA	19,800	284,313	284,240	284,159	284,071	283,972

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost	Unit Cost ($/Thou. Gal.)
JER-1: Renew contract with LNVA	283,972	$0	$3,791,026	$13.35	$ 0.04

Manufacturing

Current supply from Lower Neches Valley Authority. Current contracts are for a period of one year. Renewal of contracts will provide necessary supply to meet shortages.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	158,590	176,248	187,896	197,739	217,235	236,435
Current Supply (ac-ft/year)	148,453	5,182	5,182	5,182	5,182	5,182
Supply(+)-Demand(-)(ac-ft/yr)	-10,137	-171,066	-182,714	-192,557	-212,053	-231,253
Recommended Strategy JEM-1 (ac-ft/year): Renew contract with LNVA	10,137	171,066	182,714	192,557	212,053	231,253

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost	Unit Cost ($/Thou. Gal.)
JEM-1: Renew contract with LNVA	231,253	$0	$6,213,768	$26.87	$ 0.08

Steam Electric Power

A co-generating facility owned by Reliant Energy/Air Liquide began operation in September 1999. The facility is purchasing water from LNVA.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	3,000	6,000	6,000	6,000	6,000	6,000
Current Supply (ac-ft/year)	0	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	-3,000	-6,000	-6,000	-6,000	-6,000	-6,000
Recommended Strategy JEI-1 (ac-ft/year): Use additional water from the Neches River	3,000	6,000	6,000	6,000	6,000	6,000

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
JEI-1: Use additional water from the Neches River	6000	$0	$233,410	$38.90	$ 0.12

Note: Unit cost only includes an estimate of cost of supply from LNVA.

Livestock

A shortage is indicated in the Neches Basin with a surplus in the Neches-Trinity Basin. Wells located in the Neches-Trinity Basin are currently meetings needs in the Neches Basin. This operation is expected to continue and is indicated as an "interbasin transfer" to meet the demands. No additional cost is required to implement the strategy.

See Arc View Map
Jefferson County

5.2.9 Nacogdoches County

City of Nacogdoches

The City of Nacogdoches obtains water from both ground and surface water sources. The City has eight water wells which tap the Carrizo-Wilcox Aquifer. The City also operates a surface water plant located on Lake Nacogdoches. The current water plant is rated for 6.75 mgd. Plans are currently in process to expand the surface water facility to a capacity of 15 to 18 MGD. In addition to its own demands, the City of Nacogdoches provides almost all manufacturing demands and provides water to surrounding water supply corporations.

The numbers indicated in the supply table (TWDB Table 5) included all water rights to Lake Nacogdoches even though the City cannot currently treat the entire water rights. The City will need to construct wells and improve the water surface treatment plant to meet demands. The table does indicate the City should consider other sources of water, in addition to Lake Nacogdoches, in the later portions of the planning period. The selected strategy to obtain long-term water supplies is to obtain water from Lake Eastex. The current plant is to release water from Lake Eastex into the Angelina River and divert the flows from the Angelina River to Lake Nacogdoches.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	36,709	42,959	50,274	58,834	68,851	80,574
Water Demand (ac-ft/year)	9,033	10,551	12,264	14,622	17,366	20,780
Current Supply (ac-ft/year)	22,758	22,423	22,108	21,701	21,286	20,756
Supply(+)-Demand(-) (ac-ft/yr)	13,725	11,872	9,844	7,079	3,938	-24
Recommended Strategy NA-1 (ac-ft/year): Obtain supply from Lake Eastex						9,834

Note: Strategy NA-1 includes 1,283 ac-ft/yr for Caro WSC located just north of Nacogdoches

Other strategies evaluated included obtaining water from Toledo Bend with a regional treatment facility located at Center.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NA-1 (ac-ft/year): Obtain supply from Lake Eastex	9,834	$121,727,275	$11,929,660	$853	$ 2.61
NA-2 (ac-ft/year): Obtain supply from Toledo Bend in conjunction with Center and San Augustine	9,834	$155,686,675	$15,188,457	$1,544.48	$ 4.72

NOTE: Strategy cost includes water treatment and transport cost to treat additional water from Lake Nacogdoches in addition to water from Lake Eastex.

County-Other

Appleby WSC, Caro WSC, D&M WSC, Etoile WSC, Libby WSC, Lilbert-Looneyville WSC, Lilly Grove WSC, Melrose WSC, Sacul WSC, Swift WSC, and Woden WSC obtain their groundwater from the Carrizo Wilcox Aquifer. The remaining supplies are from the Queen City, Sparta Sands, or other *undifferentiated* aquifers. The City of Nacogdoches provides wholesale water to D&M, Lilly Grove, Appleby, Woden, Timber Ridge Association, Woodland Hills and Central Heights, and Nacogdoches County MUD. For the majority of the County-Other entities, the best means for supply is to continue use of groundwater and expansion of contracts with the City of Nacogdoches.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	24,923	28,622	32,635	37,904	42,717	45,337
Water Demand (ac-ft/year)	4,199	4,530	4,908	5,572	6,135	6,459
Current Supply (ac-ft/year)	3,558	3,558	3,558	3,558	3,558	3,558
Supply(+)-Demand(-) (ac-ft/yr)	-641	-972	-1,350	-2,014	-2,577	-2,901
Recommended Strategy NAC-1 (ac-ft/year): Use additional groundwater	780	1,040	1,300	1,820	2,340	2,600
Recommended Strategy NAC-2: Expand contract with City of Nacogdoches	77	116	162	241	309	343

Other strategies included for evaluation are determining the feasibility of developing surface water sources in the area (such as apply to State agencies for potable use of Lake Naconiche). Cost for this alternative was not developed. Caro WSC has an existing contract with ANRA with option from water for Lake Eastex if developed. The cost for Caro WSC was analyzed within the City of Nacogdoches water management strategies.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NAC-1: Use additional groundwater	2,600	$3,997,095	$204,100	$157	$ 0.48
NAC-2: Expand contract with City of Nacogdoches	348	$0.00	$227,923	$654.95	$ 2.00

Livestock

Supply is from the Carrizo-Wilcox, Sparta and Queen City Aquifers. Expansion of current supplies by drilling new wells and/or constructing ponds for livestock is the best strategy. Livestock producers that currently obtain water from public water suppliers (either as an emergency back-up or primary provider) should continue to renew their contracts.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	2,150	2,437	2,771	3,158	3,607	4,128
Current Supply (ac-ft/year)	2,150	2,150	2,150	2,150	2,150	2,150
Supply(+)-Demand(-) (ac-ft/yr)	0	-287	-621	-1,008	-1,457	-1,978
Recommended Strategy NAL-1 (ac-ft/year): Expand current supplies		287	861	1,148	1,722	2,009

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Strategy NAL-1: Expand current supplies	2,009	$481,058	$67,732	$59	$ 0.18

Mining

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	261	280	312	345	378	415
Current Supply (ac-ft/year)	220	220	220	220	220	220
Supply(+)-Demand(-) (ac-ft/yr)	-41	-60	-92	-125	-158	-195
Recommended Strategy NAN-1 (ac-ft/year): Increase groundwater usage	96	96	96	195	195	195

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NAN-1: Increase groundwater usage	195	$146,880	$10,176	$106	$ 0.32

Steam Electric Power

No current supply exists and no immediate need was identified. The largest and closest source of water is from Rayburn Reservoir.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	0	0	0	7,505	7,505	7,505
Current Supply (ac-ft/year)	0	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	0	0	0	-7,505	-7,505	-7,505
Recommended Strategy NAI-1: (ac-ft/year): Obtain water from Sam Rayburn				7,505	7,505	7,505

Alternative source of supply is for the construction of a pipeline from Toledo Bend Reservoir. However, transportation distance is farther than Sam Rayburn Reservoir.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NAI-1: Obtain water from Sam Rayburn	7,505			$28.14	$ 0.09

Note: Unit cost include only estimate of cost for raw water supply.

See Arc View Map
Nacogdoches County

5.2.10 Newton County

Most of the water user groups in Newton County use groundwater from the Gulf Coast Aquifer. According to the groundwater availability estimates, there are 28,765 acre-feet per year (af/y) of total availability in the Gulf Coast Aquifer in Newton County. Currently less than 4,000 af/y is being used. Therefore there is substantial groundwater available for development.

County-Other

Includes the entities of: Bon Wier WSC, Burkeville WSC, East Newton WSC, Jamestown WSC, South Newton WSC, Tall Timbers WSC, East Texas Baptist Encampment, and Toledo Village Subdivision. Current supply is from the Gulf Coast Aquifer. Future demands can be met by use of additional groundwater from Gulf Coast Aquifer. The cost estimate assumes that half of the entities will drill one additional well each for a total of four new wells.

	2000	2010	2020	2030	2040	2050
Population	13,367	14,972	15,986	16,423	17,162	17,472
Water Demand (ac-ft/year)	1,682	1,754	1,749	1,717	1,689	1,715
Current Supply (ac-ft/year)	1,378	1,378	1,378	1,378	1,378	1,378
Supply(+)-Demand(-) (ac-ft/yr)	-304	-376	-371	-339	-311	-337
Recommended Strategy NWC-1 (ac-ft/year): Use additional supply from Gulf Coast Aquifer	377	377	377	377	377	377

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NWC-1: Additional Groundwater Wells	377	$235,611	$37,194	$98.06	$ 0.30

Mining

Current supply is from the Gulf Coast Aquifer and a very small, unidentified surface water source (28 af/y). (There are no mining water rights in Newton County). If this need is for existing facilities, those existing supplies could most likely be capable of supplying the need. If the need is for new facilities, those new facilities will need to develop a new supply. The recommended strategy is a small well from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	37	38	39	40	41	42
Current Supply (ac-ft/year)	34	34	34	34	34	34
Supply(+)-Demand(-) (ac-ft/yr)	-3	-4	-5	-6	-7	-8
Recommended Strategy NWN-1 (ac-ft/year): Use additional supply from Gulf Coast Aquifer	8	8	8	8	8	8

Only one strategy was considered to meet the future water demands. The cost of the strategy is presented in the following table.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
NWN-1: Additional Groundwater Well	8	$39,448	$3,600	$450	$ 1.38

Steam Electric Power

There are no demands for steam electric power listed in Table 2; however, Cottonwood Energy Co., LP, a steam electric power generator, has recently contracted with the Sabine River Authority to purchase a minimum of 6 mgd and a maximum of 12 mgd from the SRA Canal. When this contract expires in 2040, Cottonwood should renew the contract. Cottonwood's facility will be located in extreme southern Newton County, and the average use is projected to be 10 mgd (or 11,200 af/y). Cottonwood is constructing a two-mile pipeline to deliver water to their facility. The cost estimate does not include the capital cost for the pipeline since it is already under construction.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Renew contract with SRA	13,440	$0.00	$508,095	$37.80	$ 0.12

See Arc View Map
Newton County

5.2.11 Orange County

The majority of the water used in Orange County comes from either the Gulf Coast Aquifer or the Sabine River, with a very small portion coming from the Neches River. The total long-term sustainable groundwater availability for Orange is estimated at 19,060 acre-feet per year (TWDB Report 320, *Evaluation of Groundwater Resources in Orange and Jefferson Counties*). This report also indicates that as much as 60,000 af/y of groundwater could be developed in the county; however, there would be substantial subsidence and salt water intrusion into the aquifer at this level of use. Current groundwater use in Orange County is just over 20,000 af/y. Because the long-term sustainable availability of the aquifer has been reached, it is recommended that any new large-scale water needs be met with surface water. It is recommended that those entities currently on groundwater be allowed to remain on groundwater to meet their future growth until such a time that potential salt water intrusion or subsidence problem are encountered.

There is a significant amount of surface water available in the Sabine River in Orange County. The SRA Canal, which is located in Orange County, has a conveyance capacity of 346,000 af/y. SRA has water rights of 147,100 af/y associated with the canal system (100,400 af/y for municipal and industrial and 46,700 acre-feet per year for irrigation). Currently, SRA has contracts for 59,532 af/y in the Canal System. SRA is in the process of contracting another 20,160 af/y to entities in Orange and Newton County for manufacturing and steam electric use. This still leaves 67,407 af/y available to be contracted (23,250 af/y for municipal and industrial and 44,157 af/y for irrigation). SRA also has a large amount of uncontracted water in Toledo Bend Reservoir that could potentially be released through the dam and carried by the Sabine River for downstream use at the canal location.

Bridge City

Although the tables do not show a shortage, the city has indicated it plans to drill an additional water well from the Gulf Coast Aquifer by 2010.

Orange

Although the tables do not show a shortage, the City has indicated it plans to drill an additional water well from the Gulf Coast Aquifer by 2010.

Rose City

Current supply is from the Sabine River. Rose City has a contract for 478 af/y with SRA for water from SRA Canal which expires after 2020. It is recommended that Rose City renew existing contract with SRA.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	697	748	795	868	953	1,039
Water Demand (ac-ft/year)	110	112	114	121	128	138
Current Supply (ac-ft/year)	478	478	478	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	368	366	364	-121	-128	-138
Recommended Strategy RC-1 (ac-ft/year): Renew contract with SRA				121	128	138

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal)
RC-1: Renew Contract with SRA	478	$0.00	$24,146	$50.51	$ 0.15

Vidor

Although the tables do not show a shortage for Vidor, the city is considering supplementing its current groundwater supply with surface water from the SRA canal.

Pine Forest

Current supply is from the Gulf Coast Aquifer. Pine Forest will need an additional backup well in 2020. The total available supply was based on the assumption that twice the historical maximum demand (97 af/y) was available. This was done because it was assumed that the historical demand was met by a single well and that there was an equivalent backup well. The existing supply (including the backup well) would be sufficient to meet the long term needs, but beginning in 2020 would need to run both wells at the same time and would then need a new backup well. It is recommended that Pine Forest drill an additional backup well in the Gulf Coast Aquifer.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal)
Drill Backup Well	50	$73,900	$8,422	$168.75	$ 0.52

County-Other

This category includes approximately 65 small water supply entities. Their current supply is from the Gulf Coast Aquifer. The Sabine portion of the county shows a 2050 shortage of 138 af/y, while the Neches portion shows a 2050 surplus of 87 af/y. This gives a total overall need of only 51 af/y. Since this is such a small amount of shortage, it is assumed that it can be taken from the Gulf Coast Aquifer with few problems. Since there are 65 entities and only a small shortage, it is assumed that only six entities (about 10% of the entities) will need a small amount of additional supply and will need one well each. The cost estimate reflects the development of six small wells.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	38,589	41,440	42,042	43,416	47,225	50,462
Water Demand (ac-ft/year)	4,462	4,508	4,287	4,227	4,434	4,675
Current Supply (ac-ft/year)	4,624	4,624	4,624	4,624	4,624	4,624
Supply(+)-Demand(-) (ac-ft/yr)	162	116	337	397	190	-51
Recommended Strategy ORC-1 (ac-ft/year): Use additional supply from Gulf Coast Aquifer						138

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ORC-1: Additional Wells	51	$425,119	$42,471	$308.51	$ 0.94

Manufacturing

Current supply is from the Gulf Coast Aquifer, the Sabine River (SRA Canal), and the Neches River. Additional water is needed from 2020-2050. There is a shortage in the Sabine portion of the county that can be met by a surplus from the Neches Basin portion of the county until year 2020. (In Table 2, approximately 4,500 af/y of manufacturing demand was incorrectly placed in the Sabine portion of the County rather than the Neches portion.) In year 2020, new supplies must be made available. Total 2050 unmet demand is 17,860 af/y.

All entities with current water contracts with SRA should renew their contracts throughout the planning period. Conoco Global, in conjunction with DuPont, is currently constructing a co-generating facility, and DuPont has increased its contract with SRA by

8 million gallons per day (8,960 af/y) from the SRA Canal to supply this facility. This demand is considered manufacturing rather than steam electric because it is integrated into DuPont's manufacturing facility. This water will be transported through DuPont's existing facilities. The remaining projected shortages (11,140 af/y) can be met using additional supply from SRA Canal, which has 20,160 af/y still uncontracted for municipal and industrial needs. It is assumed that the future facility will be located along the SRA Canal and will require minimal transmission facilities. The only cost presented here is the cost of raw water purchase. It is assumed that no treatment of the water will be necessary.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	54,349	58,286	61,862	64,872	71,425	78,309
Current Supply (ac-ft/year)	60,449	60,449	60,449	60,449	60,449	60,449
Supply(+)-Demand(-) (ac-ft/yr)	6,100	2,163	-1,413	-4,423	-10,976	-17,860
Recommended Strategy ORM-1 (ac-ft/year): Raw surface water supply from SRA Canal.			1,413	4,423	10,976	17,860
Recommended Strategy ORM-2 (ac-ft/year): Use surplus from other basin	526	4,407	6,565	6,558	6,552	6,520

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ORM-1SRA Raw Water Contract	17,860	$0.00	$675,192	$37.80	$ 0.12
ORM-2: Use surplus from other basin	6,565	$0.00	$0.00	$0.00	$0.00

Mining

Current supply from Gulf Coast Aquifer. The total unmet need in year 2050 is only one af/y. It is assumed that the existing supplies could meet this small additional demand.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	8	8	9	9	9	9
Current Supply (ac-ft/year)	8	8	8	8	8	8
Supply(+)-Demand(-) (ac-ft/yr)	0	0	-1	-1	-1	-1

Recommended Strategy ORN-1 (ac-ft/year): Expand current supplies	8	8	8	8	8	8

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
ORN-1: Expand current supplies	8	$39,448	$3,600	$450	$ 1.38

Steam Electric Power

Current supply is from the Gulf Coast Aquifer, the Sabine River (SRA Canal), and the Lower Sabine River (Sabine Lake). Table 7 currently shows a shortage in the Sabine portion of the county and a large surplus in the Neches portion. This is due to the manner in which the tables structure the "Basin for Water User Group" and "Basin where Supply is Located". In a county such as Orange that is divided into two river basins, the supply is easily interchanged from one basin to another. Assuming supply can be used in either basin, the total 2050 unmet demand is 7,023 af/y. Entergy, which currently has a water contract with SRA should renew their contract throughout the planning period. It is recommended that this need be met by purchasing additional water from SRA's Canal System.

It is assumed that any new facility will be located adjacent to the SRA Canal (along Industrial Row) and will require minimal transmission facilities. The only cost presented here is the cost of raw water purchase. It is assumed that no treatment of water will be necessary.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	6,000	10,000	15,000	20,000	25,000	30,000
Current Supply (ac-ft/year)	22,977	22,977	22,977	22,977	22,977	22,977
Supply(+)-Demand(-) (ac-ft/yr)	16,977	12,977	7,977	2,977	-2,023	-7,023
Recommended Strategy ORI-1 (ac-ft/year): SRA surface water contract					7,023	7,023
Recommended Strategy ORI-2 (ac-ft/year): Use surplus from other basin	5,037	9,037	14,037	19,055	22,014	22,014

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
OR-1SRA Surface Water Contract	7,023	$0.00	$265,503	$37.80	$ 0.12
ORI-2 (ac-ft/year): Use surplus from other basin	22,014	$0.00	$0	$0	$0.00

Irrigation

Water from the Neches Basin portion of the County has historically been used to meet irrigation needs in the Sabine portion of the County. It is assumed this will continue. The tables show a shortage in the Sabine Basin that can be adequately supplied by the Neches Basin; therefore, there is no overall shortage and no strategies are necessary.

Livestock

Water from the Sabine Basin portion of the County has historically been used to meet livestock needs in the Neches portion of the County. It is assumed this will continue. The tables show a shortage in the Neches Basin that can be adequately supplied by the Sabine Basin; therefore, there is no overall shortage and no strategies are necessary.

See Arc View Map

Orange County

5.2.12 Panola County

Both groundwater from the Carrizo-Wilcox and surface water supplies, mostly from Lake Murvaul, are used in Panola County. According to the 1997 State Water Plan, the Carrizo-Wilcox Aquifer has a long-term availability of 4,000 af/y in Panola County. Based on historical use information and well capacities from entities in the county, the groundwater supply currently available is estimated at around 6,200 af/y. Because the long-term sustainable availability of the aquifer has been reached, it is recommended that any new large-scale water needs be met with surface water. It is recommended that those entities currently on groundwater remain on groundwater to meet their future growth until such time as groundwater is no longer a reliable supply. Any entities that are willing to convert to surface water should be encouraged to do so.

Mining

Current supply is from the Carrizo-Wilcox Aquifer and Lake Murvaul. Demand is projected to increase by almost 14,000 af/y through the planning period. Approximately 9,000 af/y is available from Lake Murvaul. This use would need to be combined with other sources such as reuse from City of Carthage (~1400 af/y) and a pipeline from Toledo Bend. Since neither Lake Murvaul nor reuse from Carthage would supply the entire need, it is recommended that a pipeline from Toledo Bend be built. It is assumed that this water would not require treatment for mining purposes. Since the location of the need is unknown, a pipeline length of 20 miles from Toledo Bend was assumed for planning purposes. This length is to the approximate center of the County.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	3,245	2,645	8,697	16,912	17,179	16,912
Current Supply (ac-ft/year)	4,077	4,077	4,077	4,077	4,077	4,077
Supply(+)-Demand(-) (ac-ft/yr)	832	1,432	-4,620	-12,835	-13,102	-12,835
Recommended Strategy PLN-1 (ac-ft/year): Obtain supply from Toledo Bend			4,620	12,835	13,102	13,102

As an alternative to the selected strategy, multiple sources would be required to meet the demand. Cost for the selected and alternate strategies is presented below.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
PLN-1: Pipeline from Toledo Bend	13,102	$18,487,560	$2,335,000	$178	$ 0.54
PLN-2: Use from Lake Murvaul	9,000	$9,804,630	$1,215,000	$135	$ 0.41
PLN-3: Partial use from Toledo Bend	2,702	$8,937,400	$921,382	$341	$ 1.04
PLN-4: Reuse from Carthage	1,400	$1,244,000	$165,200	$118	$ 0.36

See Arc View Map
Panola County

5.2.13 Polk County

Supplies are largely from the Gulf Coast Aquifer.

County-Other

Supplies are from the Gulf Coast Aquifer. The selected strategy is to obtain additional supply from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	8,442	9,424	10,608	11,943	12,984	13,923
Water Demand (ac-ft/year)	1,775	1,814	1,870	1,965	2,023	2,095
Current Supply (ac-ft/year)	1,848	1,848	1,848	1,848	1,848	1,848
Supply(+)-Demand(-) (ac-ft/yr)	73	34	-22	-117	-175	-247
Recommended Strategy POC-1 (ac-ft/year): Expand existing supplies.			22	117	175	247

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
POC-1: Expand existing supplies	247	$594,772	$56,069	$227	$ 0.69

Manufacturing

Supplies are from the Gulf Coast Aquifer and Other Undifferentiated Groundwater Supply. The selected strategy is to obtain additional supply from the Gulf Coast Aquifer.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	825	879	933	986	1,039	1,090
Current Supply (ac-ft/year)	671	671	671	671	671	671
Supply(+)-Demand(-) (ac-ft/yr)	-155	-209	-263	-316	-369	-420
Recommended Strategy POM-1 (ac-ft/year): Expand existing supplies	0	324	324	405	486	486

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
POM-1: Expand existing supplies	760	$577,688	$42,525	$105	$ 0.32

See Arc View Map
Polk County

5.2.14 Rusk County

Much of the supply is groundwater taken from the Carrizo-Wilcox. However, the City of Henderson is in the process of construction of a surface water treatment plant. Surface water is also used for Steam Electric Power.

County-Other

Current supply is from Carrizo-Wilcox with the exception of surface water from Upper Neches Municipal Water Authority provided to New Salem WSC and sales to Cross Roads WSC from the City of Kilgore. Development of groundwater from Carrizo Wilcox is favorable except in areas of existing well field development appears to be at a maximum. This area is around the Henderson, New London and Mount Enterprise areas. Well fields could be developed at further distances (3-10 miles) outside these developed areas. In addition, both the City of Kilgore and the City of Henderson are currently developing new surface water systems. This may be a potential source for new water.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	27,291	29,609	34,210	38,058	41,484	43,009
Water Demand (ac-ft/year)	3,362	3,403	3,646	3,943	4,058	4,199
Current Supply (ac-ft/year)	3,219	3,219	3,219	3,219	3,219	3,219
Supply(+)-Demand(-) (ac-ft/year)	-143	-184	-427	-724	-839	-980
Recommended Strategy: RUC-1: Increase supplies from groundwater	350	350	350	500	500	640
Recommended Strategy: RUC-2: Expand services from Kilgore and Henderson	0	590	590	590	590	590

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Recommended Strategy: RUC-1: Increase supplies from groundwater	480	$718,494	$49,920	$156	$ 0.48
Recommended Strategy: RUC-2: Expand services from Kilgore and Henderson	590	$4,028,647	$698,560	$1,184	$ 3.62

City of Henderson

The City of Henderson is presently constructing a 3 mgd water treatment plant. Supply is taken from the Sabine River near Longview. The City shares a portion of the raw water supply line with the City of Kilgore. The City has a contract with the Sabine River Authority for a 4.5 mgd supply. This project will meet the demands for the City in the planning period.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	12,006	12,161	11,866	11,584	11,554	11,524
Water Demand (ac-ft/year)	2,461	2,384	2,233	2,115	2,058	2,053
Current Supply (ac-ft/year)	2,249	2,211	2,168	2,124	2,081	2,034
Supply(+)-Demand(-) (ac-ft/year)	-212	-173	-65	9	23	-19
Recommended Strategy: HE-1 Construct transfer and treatment facilities from Sabine River.	1680	1680	1680	1680	1680	1680

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Recommended Strategy HE-1 (ac-ft/year): Construct transfer and treatment facilities from Sabine River.	1680	$19,300,000	$1,653,120	$984	$ 3.01

City of New London

Current supply is from Carrizo-Wilcox. The City has an existing contract with ANRA for water from Lake Eastex if developed. The recommended strategy is for the City to continue pursuit of supplies from Lake Eastex.

	2000	2010	2020	2030	2040	2050
Population	1,039	1,069	1,079	1,127	1,191	1,256
Water Demand (ac-ft/year)	233	230	221	227	235	246
Current Supply (ac-ft/year)	242	242	242	242	242	242
Supply(+)-Demand(-) (ac-ft/yr)	9	12	21	15	7	-4
Recommended Strategy NL-1 (ac-ft/year): Obtain water from Lake Eastex		885	885	885	885	885

Alternate strategies include obtaining treated supplies from the City of Henderson or Tyler. The financially feasibility will depend on the cost of treated water from these sources.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Strategy NL-1: Obtain water from Lake Eastex	885	$5,630,000	$537,195	$607	$ 1.86
Strategy NL-2: Obtain water from City of Henderson	885	$3,857,175	$867,546	$979	$ 2.99
Strategy NL-3 Obtain water from City of Tyler	885	$7,252,954	$1,115,815	$1322	$ 4.04

City of Tatum

Current supply is from Carrizo-Wilcox. Use additional water from Carrizo-Wilcox.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	1,063	1,077	1,053	1,031	1,029	1,027
Water Demand (ac-ft/year)	141	134	123	117	112	110
Current Supply (ac-ft/year)	128	128	128	128	128	128
Supply(+)-Demand(-) (ac-ft/yr)	-13	-6	5	11	16	18
Recommended Strategy TA-1 (ac-ft/year): Increase supply from Carrizo-Wilcox	41	41	41	41	41	41

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
TA-1: Increase supply from Carrizo-Wilcox	30	$181,458	$11,820	$394	$ 1.21

Livestock

Current supply is groundwater and surface water. Use additional groundwater from Carrizo-Wilcox.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	1,237	1,253	1,271	1,292	1,317	1,345
Current Supply (ac-ft/year)	1,276	1,276	1,276	1,276	1,276	1,276
Supply(+)-Demand(-) (ac-ft/yr)	39	23	5	-16	-41	-69
Recommended Strategy RUL-1 (ac-ft/year): Increase supply from Carrizo-Wilcox				41	41	82

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
RUL-1: Increase supply from Carrizo-Wilcox	82	$37,900	$6,068	$74	$ 0.23

Steam Electric Power

Current demands are being met by Lake Martin based on historical data. Immediate future demands are related to construction of the Tanaska/Coral plant in southern Rusk County which have expected water demands of 12,900 acre-feet/year. This demand will be met with construction of raw water line from Toledo Bend. Provide surface water from Toledo Bend.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	30,000	35,000	40,000	45,000	45,000	45,000
Current Supply (ac-ft/year)	25,179	25,179	25,179	25,179	25,179	25,179
Supply(+)-Demand(-) (ac-ft/yr)	-4,821	-9,821	-14,821	-19,821	-19,821	-19,821
Recommended Strategy RUI-1 (ac-ft/year): Surface water from Toledo Bend	4,960	9,960	14,960	19,960	19,960	19,960

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Surface water from Toledo Bend	19,960	$0.00	$638,720	$32	$ 0.10

NOTE: Cost does not include transportation cost of water.

Manufacturing

Supplies are from local surface water surfaces or the City of Henderson. With the construction of the new surface water plant, it would be expected that growth would occur in the Henderson area.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	344	382	425	469	512	559
Current Supply (ac-ft/year)	297	330	367	405	443	483
Supply(+)-Demand(-) (ac-ft/yr)	-47	-52	-58	-64	-69	-76
Recommended Strategy RUM-1 (ac-ft/year): Increase groundwater supply	81	81	81	81	81	81

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
RUM-1: Increase groundwater supplies	81	$51,323	$7,047	$87	$ 0.27

Irrigation

Water from the Neches Basin portion of the County has been used to meet needs in the Sabine portion of the County. It is assumed this will continue. The table shows a shortage in the Sabine Basin that can be adequately supplied by the Neches Basin. The selected strategy is to transfer surplus from the Neches to the Sabine Basin.

See Arc View Map
Rusk County

5.2.15 Sabine County

Water supply in Sabine County is comprised of water from the Carrizo-Wilcox Aquifer, the Sparta and other minor aquifers, Toledo Bend Reservoir, and other local surface supplies (irrigation and livestock). The estimated current groundwater use from the Carrizo-Wilcox is about 850 af/y, while the long-term sustainable availability from the aquifer is 3,700 af/y. Use from the Sparta is currently about 200 af/y, while the long-term sustainable availability is just over 7,000 af/y. Use from other minor ("undifferentiated") aquifers is currently about 3,400 af/y, while the long-term sustainable availability is not known. It is recommended that no water from the minor aquifers be relied upon for future additional supplies. Toledo Bend Reservoir is located along the eastern border of Sabine County. This reservoir has a very large amount of available supply (through contracts with SRA).

Hemphill

Current supply is from Toledo Bend Reservoir through a contract with SRA, which expires in 2020. It is recommended that Hemphill renew its contract with SRA. The Sabine River Authority provides treated water to the City of Hemphill at a cost of $1.0015 per thousand gallons.

	2000	2010	2020	2030	2040	2050
Population	1,345	1,512	1,683	1,966	2,235	2,527
Water Demand (ac-ft/year)	361	387	415	476	533	601
Current Supply (ac-ft/year)	1,842	1,842	1,842	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	1,481	1,455	1,427	-476	-533	-601
Recommended Strategy HH-1 (ac-ft/year): Renew contract with SRA				1842	1842	1842

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
HH-1: SRA Contract	1,842	$0.00	$601,343	$326.49	$ 1.00

County-Other

About two-thirds of the current County-Other supply is from Toledo Bend Reservoir, either directly from SRA or from City of Hemphill through ongoing contracts with no expiration). The remaining one-third is from Carrizo-Wilcox Aquifer, the Sparta and other minor aquifers. The shortage is assumed to be split in the same proportion as current use, two-thirds Toledo Bend water and one-third groundwater. For the surface water, it is assumed that 80% is Toledo Bend water based on historical use. The other 20% is assumed to be Toledo Bend water purchased as raw water from SRA. No additional treatment facilities should be needed since this is such a small amount of supply. For groundwater, it is assumed that only two out of the eleven entities on groundwater will need additional wells. All cost estimates are based on these assumptions.

	2000	2010	2020	2030	2040	2050
Population	9,052	10,537	11,972	13,300	14,563	15,888
Water Demand (ac-ft/year)	828	878	927	986	1,030	1,103
Current Supply (ac-ft/year)	676	676	676	676	676	676
Supply(+)-Demand(-) (ac-ft/yr)	-152	-202	-251	-310	-354	-427
Recommended Strategy SBC-1 (ac-ft/year): Increase supply from Carrizo-Wilcox	142	142	142	142	142	142
Recommended Strategy SBC-2: (ac-ft/year): Increase supply from Toledo Bend	55	55	55	55	55	55
Recommended Strategy SBC-3 (ac-ft/yr): Increase supply from City of Hemphill	28	67	104	148	181	314

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SBC-1: Additional Groundwater	145	$28,636	$10,140	$140.12	$ 0.43
SBC-2:Increase raw water use from Toledo Bend	55	$0.00	$8,517	$154.85	$ 0.47
SBC-3:Increase purchase from City of Hemphill (treated)	230	$0.00	$89,226	$387.94	$ 1.19

Manufacturing

In recent years, most of the supply has been from groundwater. It is assumed that will continue. Since it is not known whether this demand increase represents existing facilities or new facilities, the assumption was made that two new wells should be drilled. The cost estimate is based on two new wells.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	1,837	1,958	2,078	2,196	2,313	2,427
Current Supply (ac-ft/year)	1,849	1,849	1,849	1,849	1,849	1,849
Supply(+)-Demand(-) (ac-ft/yr)	12	-109	-229	-347	-464	-578
Recommended Strategy SBM-1 (ac-ft/year): Increase supply from Carrizo-Wilcox		578	578	578	578	578
Recommended Strategy SBM-2 (ac-ft/year): Use surplus from other basin		467	467	467	467	467

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SBM-1: Additional Groundwater Wells	578	$151,443	$38,267	$132.65	$ 0.41
SBM-2 (ac-ft/year): Use surplus from other basin	467	$0	$0	$0.00	$0.00

Livestock

Supplies are from both groundwater and local surface water.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	399	422	449	480	516	558
Current Supply (ac-ft/year)	464	464	464	464	464	464
Supply(+)-Demand(-) (ac-ft/yr)	65	42	15	-16	-52	-94
Recommended Strategy SBL-1 (ac-ft/year): Expand current supplies	27	27	27	94	94	94

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SBL-1: Expand current supplies	94	$24,650	$12,470	$132.65	$ 0.41

See Arc View Map
Sabine County

5.2.16 San Augustine County

County-Other

In addition to privately owned wells, the TNRCC lists several public water suppliers in the county that are included under this listing. They are: (1) Anthony Harbor Subdivision, Hickory Hollow Subdivision, La Playa Subdivision Water System, Powell Point Water System, Denning WSC, El Pinon Estates Water System, and USFS Townsend Recreation Area who obtain their water from the Carrizo-Wilcox Aquifer; (2) Glen Oaks, Lakewood Water System, and Parkway Water System whose wells tap the Yegua Aquifer; (3) the City of Broaddus and USCOE Jackson Hill Park whose wells tap the Jackson Group; (5) Jackson Hill Park with a single well tapping the Gulf Coast Aquifer; and (5) Sutton Hills which taps an unspecified geological unit. Entities which use wells should drill new wells. Entities that currently obtain water from public water suppliers should renew and extend their contracts in order to meet their needs.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	5,814	6,108	6,342	6,679	6,826	6,976
Water Demand (ac-ft/year)	744	733	719	726	719	727
Current Supply (ac-ft/year)	399	399	399	399	399	399
Supply(+)-Demand(-) (ac-ft/yr)	-345	-334	-320	-327	-320	-328
Recommended Strategy SAC-1 (ac-ft/year): Increase supplies from Carrizo-Wilcox	245	245	245	245	245	245
Recommended SAC-2 (ac-ft/year): Renew and expand contracts with City of San Augustine	104	100	96	98	96	98

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SAC-1: Increase supplies from Carrizo-Wilcox	245	$332,952	$35,288	$144	$ 0.44
Recommended SAC-2: Renew and expand contracts with City of San Augustine	100	$0	$31,300	$313	$ 0.96

Irrigation

Water from the Neches Basin portion of the County has been used to meet needs in the Sabine portion of the County. It is assumed this will continue. The table shows a shortage in the Sabine Basin that can be adequately supplied by the Neches Basin. The selected strategy is to transfer surplus from the Neches to the Sabine Basin.

Livestock

Supplies are from both groundwater and local surface water.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	680	729	786	852	928	1017
Current Supply (ac-ft/year)	681	681	681	681	681	681
Supply(+)-Demand(-) (ac-ft/yr)	1	-48	-105	-171	-247	-336
Recommended Strategy SAL-1 (ac-ft/year): Increase existing supplies	35	79	158	202	260	358

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SAL-1: Increase existing supplies	358	$298,352	$24,187	$112	$ 0.34

See Arc View Map
San Augustine County

5.2.17 Shelby County

Both groundwater from the Carrizo-Wilcox and surface water supplies from Toledo Bend Reservoir, Lake Pinkston, and Center Lake, are used in Shelby County. The Carrizo-Wilcox Aquifer has a long-term availability of 5,900 af/y in Shelby County. Based on historical use information and well capacities from entities in the county, the groundwater supply currently available is estimated at around 4,000 af/y. There is some groundwater available for development, but it is recommended that any new large-scale water needs be met with surface water. It is recommended that those entities currently on groundwater remain on groundwater to meet their future growth until such time as groundwater is no longer a reliable supply. Any entities that are willing to convert to surface water should be encouraged to do so.

Huxley

Huxley's current supply is from Toledo Bend Reservoir through a 147 af/y contract with Sabine River Authority which expires in 2005. It is recommended that Huxley renew its contract at that time.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Renew SRA Contract	147	$0.00	$5,990	$40.75	$ 0.12

County –Other

There is a very small shortage (3 to 6 acre-feet/year) in 2000 and 2010 in the Neches portion of the county. It is assumed that this small shortage can be met by the large surplus (over 500 acre-feet/year) in the Sabine portion of the county.

Irrigation

There is a very small shortage (6 acre-feet/year). It is assumed that the existing supply sources can produce this small amount without expansion of any facilities.

Livestock

Current supply is from Carrizo-Wilcox Aquifer and Livestock Local Supply. Some individual livestock water users may be able to drill individual wells or develop local stock ponds, but any large-scale user should obtain surface water from Toledo Bend Reservoir through a contract with SRA.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	3,142	3,830	4,669	5,692	6,938	8,458
Current Supply (ac-ft/year)	3,003	3,003	3,003	3,003	3,003	3,003
Supply(+)-Demand(-) (ac-ft/yr)	-139	-827	-1,666	-2,689	-3,935	-5,455
Recommended Strategy SHL-1 (ac-ft/year): Increase Groundwater Supplies	1,900	1,900	1,900	1,900	1,900	1,900
Long Term Scenario SHL-2 (ac-ft/year): Supplies from Toledo Bend				3,355	3,355	3,355

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SHL-1: Additional Groundwater Wells	1,900	$467,385	$125,885	$66	$ 0.20
SHL-2: Purchase Raw Water from SRA (Toledo Bend)	3,555	$5,157,280	$672,000	$189	$ 0.58

Manufacturing

Current supply from Carrizo-Wilcox Aquifer and Lake Pinkston (through retail sales from City of Center.) Only a small amount of manufacturing water has been used from the Carrizo-Wilcox. The majority of the use has been from Lake Pinkston by manufacturing customers of the City of Center, the largest of which is Tyson Foods. The City of Center has expressed its willingness to be a wholesale water supplier for Shelby County, in order to provide economic benefit to the County as a whole. It is recommended that any new manufacturing facility purchase water from the City of Center. (Center has a surplus of almost 2,500 af/y in 2050.)

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	1,535	1,892	2,249	2,605	2,962	3,319
Current Supply (ac-ft/year)	1,560	1,560	1,560	1,560	1,560	1,560
Supply(+)-Demand(-) (ac-ft/yr)	25	-332	-689	-1,045	-1,402	-1,759
Recommended Strategy SHM-1 (ac-ft/year): Purchase water from City of Center	28	385	742	1,098	1,455	1,812

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SHM-1: Purchase surface water from City of Center	1,812	$2,651,040	$958,550	$529	$ 1.62

Center

Although the tables do not indicate a need for the City of Center, the City has indicated that it is studying the feasibility of a water supply pipeline from Toledo Bend Reservoir in conjunction with the City of Nacogdoches.

See Arc View Map
Shelby County

5.2.18 Smith County

With the exception of the City of Tyler, Resort Water Service, Inc and local sources for mining and livestock, water is supplied from the Carrizo-Wilcox. The City of Tyler currently utilizes groundwater to fulfill 15% of its needs. The City of Tyler also provides approximately 75% of the manufacturing demands. The City of Tyler currently has underway a project to supply treated water from Lake Palestine. The initial phase of construction will add approximately 30 mgd capacity.

<u>County-Other</u>

Most of the supply is from Carrizo-Wilcox with the exception of surface water provided to Resort Water Services by the Upper Neches Municipal Water Authority and some sales by the City of Tyler. Demands could be provided by increasing production from Carrizo-Wilcox or through water contracts with City of Tyler.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	51,862	60,338	69,524	79,568	89,431	99,531
Water Demand (ac-ft/year)	7,757	8,645	9,624	10,719	11,921	13,145
Current Supply (ac-ft/year)	8,723	8,723	8,723	8,723	8,723	8,723
Supply(+)-Demand(-) (ac-ft/yr)	966	78	-901	-1,996	-3,198	-4,422
Recommended Strategy SMC-1 (ac-ft/year): Use additional water from Carrizo-Wilcox			160	1,120	2,400	3,520
Recommended Strategy SMC-2 (ac-ft/year): Supply from City of Tyler			885	885	885	885

Jackson WSC has a contract with ANRA for water from Lake Eastex if developed.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
SMC-1: Use additional water from Carrizo-Wilcox	3520	$5,397,060	$496,800	$207	$ 0.63
Strategy SMC-2 (ac-ft/year): Obtain water from City of Tyler.	885	$3,299,552	$489,405	$553.00	$ 1.69
Strategy SMC- 3(ac-ft/year): Obtain water from Lake Eastex.	885	$5,630,000	$525,690	$594.00	$ 1.82

City of Lindale

Supply is from Carrizo-Wilcox. Increase supply from Carrizo-Wilcox.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	1,372	1,490	1,565	1,625	1,676	1,709
Water Demand (ac-ft/year)	261	267	266	271	274	278
Current Supply (ac-ft/year)	264	264	264	264	264	264
Supply(+)-Demand(-) (ac-ft/yr)	3	-3	-2	-7	-10	-14
Recommended Strategy LI-1 (ac-ft/year): Increase supply from Carrizo-Wilcox			40	40	40	40

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
Strategy LI-1: Increase supply from Carrizo-Wilcox	40	$82,333	$8,160	$204	$ 0.62

City of Whitehouse

City of Whitehouse receives approximately 95% through City of Tyler and 5% through groundwater. Increase from City of Tyler supplies

	2000	2010	2020	2030	2040	2050
Population (number of persons)	7,230	9,535	11,289	11,724	11,806	11,889
Water Demand (ac-ft/year)	972	1,186	1,328	1,353	1,336	1,332
Current Supply (ac-ft/year)	950	950	950	950	950	950
Supply(+)-Demand(-) (ac-ft/yr)	-22	-236	-378	-403	-386	-382
Recommended Strategy WH-1 (ac-ft/year): Renew and expand contract with City of Tyler	22	236	378	403	386	382

Has a contract with ANRA for water from Lake Eastex, if developed.

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
WH-1 (ac-ft/year): Renew and expand contract with City of Tyler	382	$0	$185,270	$485	$ 1.48
WH-2 (ac-ft/year): Obtain supply from Lake Eastex	8,551	$56,306,000	$5,087,845	$595	$ 1.82

City of Tyler

The City of Tyler currently has underway a project to supply treated water from Lake Palestine. The initial phase of construction will add approximately 30 mgd capacity.

	2000	2010	2020	2030	2040	2050
Population (number of persons)	86,694	98,647	111,146	123,995	136,968	149,806
Water Demand (ac-ft/year)	17,577	19,006	20,418	20,139	22,093	23,828
Current Supply (ac-ft/year)	24,285	23,919	23,669	23,430	23,196	22,962
Supply(+)-Demand(-) (ac-ft/yr)	6,708	4,913	3,251	3,291	1,103	-866
Recommended Strategy TY-1 (ac-ft/year): Increase supply from Lake Palestine		16,800	16,800	16,800	16,800	16,800

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
TY-1: Increase supply from Lake Palestine	16,800	$60,000,000	$7,089,600	$422	$ 1.29

See Arc View Map
Smith County

5.2.19 Trinity County

No shortages

See Arc View Map
Trinity County

5.2.20 Tyler County

County Other

Current Supply from Gulf Coast Aquifer. Use additional groundwater from Gulf Coast Aquifer

	2000	2010	2020	2030	2040	2050
Population (number of persons)	14,956	16,399	18,970	20,988	21,946	22,247
Water Demand (ac-ft/year)	1,906	1,942	2,034	2,138	2,143	2,141
Current Supply (ac-ft/year)	1,959	1,959	1,959	1,959	1,959	1,959
Supply(+)-Demand(-) (ac-ft/yr)	53	17	-75	-179	-184	-182
Recommended Strategy TYC-1 (ac-ft/year): Increase supply from Gulf Coast Aquifer.			120	184	184	184

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
TYC-1: Increase supply from Gulf Coast Aquifer.	184	$445,250	$44,344	$241	$ 0.74

Steam Electric Power

A firm project has not been identified and therefore no sources are currently being used. Obtain water from BA Steinhagen or Neches River.

	2000	2010	2020	2030	2040	2050
Water Demand (ac-ft/year)	0	5,000	10,000	15,000	20,000	25,000
Current Supply (ac-ft/year)	0	0	0	0	0	0
Supply(+)-Demand(-) (ac-ft/yr)	0	-5,000	-10,000	-15,000	-20,000	-25,000
Recommended Strategy TYI-1 (ac-ft/year): Obtain supply from BA Steinhagen or Neches River		5,000	10,000	15,000	20,000	25,000

Strategy	Firm Yield (AF/Y)	Total Capital Cost	Total Annualized Cost	Unit Cost ($/AF)	Unit Cost ($/Thou. Gal.)
TYI-1: Obtain supply from BA Steinhagen or Neches River	25,000	$0	$702,844	$28.11	$ 0.09

See Arc View Map
Tyler County

5.3 Strategies by Major Water Provider

The water management strategies for water user groups, as presented in the previous section, is categorized by Major Water Provider in TWDB Table 13. The Major Water Provider named for each strategy is the ultimate Provider which is responsible for the raw water supply. The quantity of supply for the selected strategies by Major Water Provider is provided in the following table.

Major Water Provider	Quantity Provided (ac-ft/yr)
Angelina Neches River Authority	70,690
City of Beaumont	12,450
City of Center	1,812
City of Jacksonville	1,130
City of Lufkin	14,000
City of Nacogdoches	12,802
City of Port Arthur	10,826
City of Tyler	1,267
Houston County WCID No. 1	2,165
Lower Neches Valley Authority	587,528
Sabine River Authority	79,899
Upper Neches River Municipal River Authority	28,009
Motiva	14882
Huntsman Chemical	62761

The supply for each Major Water Provider is discussed below.

Angelina Neches River Authority

The shortages shown in TWDB Table 8 are to supply all of the current participants and to meet Steam Electric Power demand in Cherokee County. Not all of the current participants were shown to have a need in the 50 year planning period. These participants include Jacksonville, Whitehouse, Smith County-Other, Tyler, Troup and Arp. Supply would be provided from the proposed Lake Eastex. The expected firm yield of Lake Eastex is 85,000 acre-feet/year.

City of Beaumont

The shortages for the City of Beaumont are related to meeting demands in the Neches-Trinity Basin. There is sufficient supply in the Neches Basin to meet the demands. No additional physical work is required to meet the demands.

<u>City of Center</u>

Supply from the City of Center to fill the water needs is from Lake Pinkston, which has a firm yield of 3,000 acre-feet/year.

<u>City of Jacksonville</u>

The City of Jacksonville obtains water supply from Lake Acker, Lake Jacksonville and the Carrizo-Wilcox Aquifer. TWDB Table 8 does not indicate a need for Jacksonville to increase its water supply. However, there is a need for Jacksonville to increase supply to County-Other users which rely on the City of Jacksonville for water.

<u>City of Lufkin</u>

The City of Lufkin is currently in the planning process to construct transport and treatment facilities for water from Sam Rayburn Reservoir.

<u>City of Nacogodoches</u>

The City currently obtains water from the Carrizo-Wilcox aquifer and Lake Nacogdoches. The City is currently improving its facilities to increase its supply from Lake Nacogdoches. The City will need to begin evaluating alternate sources of water as a shortage is indicated in the last decade of the 50 year planning period. The City is a current participant in the Lake Eastex project and is included as a part of its strategy

<u>City of Port Arthur</u>

Shortages are related to short term contracts with the Lower Neches Valley Authority. Renewal of contracts will eliminate shortages.

<u>City of Tyler</u>

The City of Tyler currently obtains water supply from Lake Tyler and Tyler East and the Carrizo-Wilcox. The City is currently constructing facilities to obtain a portion of its rights from Lake Palestine. Although TWDB Table 8 does not indicate a need to increase water supply, water management strategies indicate the need for the City to increase supplies to the City of Whitehouse and County-Other users.

<u>Houston County WCID No. 1</u>

Houston County WCID No. 1 currently has water rights of 3,500 acre-feet/year from Houston County Lake. An additional 3,500 acre-feet/year in water rights could be obtained through application for the rights as part of the strategy.

Lower Neches Valley Authority

The Lower Neches Valley Authority (LNVA) obtains supply from the Sam Rayburn/B.A. Steinhagen Reservoirs and has water rights in the Neches River. The firm yield available from the reservoirs is 820,000 acre-feet/year. A study is currently underway by the River Authority to evaluate the yield, taking into account the proposed Salt Water Barrier and operation of power generation from the reservoir. Strategies related to the LNVA are largely related to renewal of short term contracts. New demands, not presently supplied by the LNVA, include the City of Lufkin and power demands in Tyler and Nacogdoches Coounties.

Sabine River Authority

The Sabine River Authority (SRA) provides supply for the region from Toledo Bend and run-of-the river rights in the Sabine River. SRA holds water rights of 750,00 acre-feet/year from Toledo Bend Reservoir and 147,000 acre-feet/year from the Sabine River. A portion of the strategies are related to renewal of contracts. New demands, not presently supplied by the SRA, include City of Henderson and power demands for Newton, Panola and Rusk Counties.

Upper Neches River Municipal River Authority

The UNRMWA operates Lake Palestine. Of the 238,000 acre-feet/year rights in the Lake, 120,354 acre-feet/year is the report firm yield currently available to entities with the East Texas Regional Water Planning Group Area. The UNRMWA has also developed a strategy for developing groundwater to effectively increase yield of surface water supplies and to provide readily available supplies. A copy of the strategy is included in Appendix A.

Motiva

Shortages are related to short term contract with the Lower Neches Valley Authority (LNVA). Renewal of contracts is required. These demands are also included under manufacturing for the LNVA strategies.

Huntsman Chemical

Shortages are related to short term contract with the Lower Neches Valley Authority (LNVA). Renewal of contracts is required. These demands are also included under manufacturing for the LNVA strategies.

5.4 Impact on Groundwater

The quantity of water from the major aquifers, the Carrizo-Wilcox and Gulf Coast, required to fill the needs identified by the water management strategies were added to the existing supplies to evaluate the utilization of the total aquifer supply as outlined in TWDB Table 4. The results of the comparison are provided in the following table:

Aquifer	County	Utilization
Carrizo-Wilcox	Anderson	Fully
	Angelina	62%
	Cherokee	Fully
	Henderson	56%
	Houston	42%
	Nacogdoches	63%
	Panola	Fully
	Rusk	Fully
	Sabine	26%
	San Augustine	45%
	Shelby	Fully
	Smith	57%
Gulf Coast	Hardin	Fully
	Jasper	Fully
	Jefferson	Fully
	Newton	16%
	Orange	Fully
	Polk	24%
	Trinity	Fully
	Tyler	16%

The supply quantities in Table 4 were based on models which performed analysis to evaluate whether the aquifer could meet certain maximum historical usage and do not reflect an estimation as to the quantity of water which can be produced from the aquifer. Therefore, more water may be available than that which is indicated in the above Table.

It is critical that groundwater availability models be performed which provide a more accurate reflection of groundwater availability. Such models should be used to provide an opinion as to expected production rates and outline areas which may experience difficulties due to local conditions such as salt domes and heavy concentrations of oil and gas well production.

5.5 Environmental Considerations

An evaluation of environmental issues for the various water management strategies is provided in Appendix B. Flow demands to sustain the Sabine-Neches Estuary is a concern to the East Texas Regional Water Planning Group. Official studies are not currently available, although a review of the issue was presented. Appendix C provides a review of the concerns regarding environmental flow demand for the Region.

Evaluation of environmental impacts, for the various water management strategies, is limited to the purpose of determining the general types and relative severity of the impact. This information is used to evaluate and select the water management strategies. The evaluation of environmental issues for the various water management strategies is provided in Appendix B. The scope and time frame for this planning study does not lend itself to providing a detailed environmental impact for each strategy. Any project developing from the strategies will be required to comply with current regulations concerning environmental impacts. Availability of water for environmental flows (such as groundwater availability for springs and surface water for instream flows) required evaluation through the use of models, which is beyond the scope of this planning process. The ETRWPG has noted in this report its concern over the lack of information on groundwater modeling and its concerns with the results of surface water models.

The selected strategy having the most significant environmental impact to the Region is the Lake Eastex project. The ETRWPG recognizes the environmental impact of the project but also recognizes the need for additional surface water in the areas represented by the current entities which have contracts with ANRA. The current permit process provides for a thorough check and balance of the environmental impacts and economic benefits of all the selected management strategies.

In addition to the requirements for evaluating the environmental impacts of the selected strategies, an area of concern to the ETRWPG is the flow demand to sustain the Sabine-Neches Estuary. Official studies are not currently available, although Appendix C provides a review of the concerns regarding environmental flow demand for the Region. None of the strategies, with the exception of Lake Eastex, would be expected to change the existing environmental flows. The environmental flows on Lake Eastex will have to be addressed as a part of the permit process for the reservoir.

5.6 Water Conservation and Drought Response

Water conservation is a potentially feasible water savings strategy that can be used to preserve the supplies of existing water resources. For municipalities and manufacturers, advanced drought planning and conservation can be used to protect their water supplies and increase reliability during drought conditions. The demand projections for SB1 Planning have already incorporated a significant level of conservation to be implemented over the planning period. For municipal use, assumed reductions in per capita use is the result of implementation of the State Water-Efficiency Plumbing Act, water conservation programs promoted by the state and federal regulation, and the increasing cost of water. Manufacturing projections assume that manufacturing use per unit of output will be reduced over time due to improvements in technology and other water conservation efforts. Allowance for water conservation was also provided in the irrigation demands. Reductions in demands due to conservation were not considered for mining, steam electric power and livestock.

SB1 requires each region's water plan to address drought management and conservation for each supply source within the region. This includes both groundwater and surface water.

The ETRWPG believes that utilizing advanced water conservation measures (i.e. savings beyond those incorporated into project demands for municipal, agricultural and industrial uses) will be implemented by local governing entities as conditions arise. The ETRWPG feels that water conservation is not a widely recognized effective strategy in East Texas at the present time and should not be relied upon in meeting future needs. This opinion may change as economics and water supply conditions change in East Texas.

Ninety-five drought contingency plans were received. The majority of the plans use trigger conditions based on the demands placed on the water distribution system. Of the plans reviewed 6 users based trigger actions well levels, 3 based actions on reservoir levels (2 of which were tied to the Sabine River Authority) and 2 based actions on climate or weather conditions. A summary of the submitted plans is provided in Table 5.6.1.

Table 5.6.1

	Type Trigger Condition	
Entity	Demand	Supply
Anderson County		
BBS WSC	X	
Dogwood Water System	X	
Walton Springs WSC	X	
Palestine	X	
Brushy Creek	X	
Angelina County		
Sun n Fun	X	
Pollock Redtown WSC	X	
Walnut Ridge Water System	X	
Angelina WSC	X	
Four Way WSC	X	
FSA Water Utility	X	
Cherokee County		
Eagles Bluff	X	
Gum Creek	X	
Reklaw WSC	X	
North Cherokee	X	
Stryker Lake WSC	X	

Dialville-Oakland WSC	X	
Rusk Rural WSC	X	
Gallatin WSC	X	
City of Jacksonville	X	
Hardin County		
Medina Utilities	X	
Little Big Horn Services	X	
North Hardin WSC	X	
Wildwood	X	
Henderson County		
Bluewater Key Water Co.	X	
Carrizo Water Co.	X	
Poynor Community WSC	X	
Tecon Water Companies	X	
Houston County		
Houston Cty. WCID 1	X	X
Jasper County		
Evadale Water System		X
Jefferson County		
Newton & Co.	X	
Bevil Oaks MUD	X	
City of Groves	X	
Sunchase Water Co.	X	
Moore Water Service		X
Nacogdoches County		
East Texas Water Supply	X	
Appleby WSC	X	
Melrose WSC	X	
Swift WSC	X	
City of Cushing	X	
City of Nacogdoches	X	
Orange County		
North Orange W&S		X
River Bend Water Svcs.	X	
Cypress Bayou, Inc.	X	

PCS Water System		X
Kelly Brewer		X
Larry Brewer		X
Community Water	X	
Panola County		
Deadwood Water Supply Corp.	X	
Rehobeth WSC	X	
Panola-Bethany WSC	X	
Deberry WSC	X	
Hollands Quarter WSC	X	
Polk County		
City of Corrigan	X	
Tecon Water Cos.	X	
Moscow WSC	X	
Damascus-Stryker WS	X	
Rusk County		
Shan-D Water Works	X	
New Prospect WSC	X	
Cross Roads	X	
South Rusk County WSC	X	
Ebenezer WSC	X	
Sabine County		
Frontier Park Resort and Marina	X	
Timberlane Estates	X	
G-M WSC	X	
South Sabine WSC	X	
El Camino Water System		X
Timberlane Water System		
San Augustine County		
Sam Rayburn Water		X
City of San Augustine		X
Shelby County		
City of Tenaha		X
On-Site Water Works	X	
City of Center	X	
City of Timpson	X	
City of Huxley	X	

Smith County		
Pine Ridge WSC	X	
Southern Utilities, Inc.	X	
Lindale Rural WSC	X	
Jackson WSC	X	
Tecon	X	
Community Water Co.	X	
Dogwood Estates	X	
City of Troup	X	
City of Tyler	X	
Trinity County		
Tecon Water Cos.	X	
Woodlake-Josserand WSC	X	
Nogalus Centralia WSC	X	
City of Groveton	X	
TRA	X	
Tyler County		
Doucette Water System	X	
Lakeside Water Supply	X	
City of Woodville	X	
Warren WSC	X	
Tecon	X	
River Authorities		
Sabine		X
LNVA		X
UNRMWA	X	

Drought trigger conditions for surface water supply are customarily related to reservoir levels. The East Texas Regional Water Planning Group will be working with the regional operators of reservoirs to establish the trigger conditions. Trigger conditions which have been ascertained for the region's reservoirs follows:

Sam Rayburn/B.A.Steinhagen

The LNVA operates storage in Sam Rayburn Reservoir in accordance with guidelines from the U.S. Army Corps of Engineers. The conservation storage space is divided into four zones, which vary on a seasonal basis. These four zones are shown in Figure 6 taken from the operating guidelines. The trigger conditions established by the LNVA are as follows:

- Mild: Water surface below 160.0 MSL
- Moderate: Level remaining in Zone 3 for a continuous 30-day period.
- Severe: Level reaches Zone 4.

Toledo Bend

The Sabine River Authority's trigger conditions are based on percent of capacity levels in Lake Fork, Lake Tawakoni, Toledo Bend and/or flow measurements of U.S. Geological Survey gage on the Sabine River near Ruliff, Texas. The trigger condition for the Ruliff gage is dependent on the amount of water the Authority is contracted to deliver. The trigger conditions for the various conditions are summarized in the following table.

Gulf Coast Division Drought Trigger Conditions

Contracted Diversion	Contracted Division	Minimum Ruliff Flows for Diversion	Trigger Flow at Ruliff Gage		
			Mild Conditions	Moderate Conditions	Severe Conditions
(ac-ft/yr)	(cfs)	(cfs)	(cfs)		
50,000	69	173	260	216	173
60,000	83	208	312	260	208
70,000	97	243	365	304	243
80,000	111	278	417	348	278
90,000	124	310	465	388	310
100,000	138	345	518	431	345
110,000	152	380	570	475	380
120,000	166	415	623	519	415
130,000	180	450	675	563	450
140,000	193	483	725	604	483
147,100	203	508	762	635	508

NOTE: The minimum flow required at Ruliff to allow the contracted division was calculated by multiplying the contracted diversion (in cfs) by 2.5. The following assumptions were used in determining the multiplication factor.

i. Only half the flow downstream of the gage flows on the Texas side.
ii. At least 20% of the flow on the Texas side flows past the canal intake structure.
iii. The mild drought trigger flow is 1.5 times the minimum; the moderate drought trigger flow is 1.25 times the minimum; the severe drought trigger flow is the minimum flow required to allow the contracted division.

See Figure 6
From the U.S. Army Corps of Engineers guidelines

Reservoirs

Condition	Reservoir Capacity		Gage at Ruliff
	Lake Fork & Tawakoni	Toledo Bend	
Mild	75%	75%	See Table Above
Moderate	66%	66%	See Table Above
Severe	50%	50%	See Table Above

Lake Palestine

The trigger conditions established by the Upper Neches River Municipal Authority's Water Conservation and Emergency Demand Management Plan is measured by the level at which the individual water utility is operating. The trigger conditions are as follows:

Mild: Daily water demand reaches the level of 90% of the water utility system capacity for three consecutive days or distribution pressure remains below normal for more than six consecutive days.

Moderate: Daily water demand reaches 100% of system capacity for three consecutive days, supply of water is continually decreasing on a daily basis and water supply utility is advised to conserve by UNRMWA, TNRCC or TDH, or decrease in water pressure in distribution system as measured by pressure gauges and customer complaints.

Severe: Water demand exceeding 100% of system capacity for three consecutive days, full allotment of raw water is being pumped from the system's supply source or imminent or actual failure of a major component of the system which would cause an immediate health or safety hazard.

Houston County Lake

Trigger conditions for drought response implementation by the Houston County WCID No. 1 is based on demand and water levels in Houston County Lake. The trigger conditions are as follows:

Mild: Demand reaches 90% of the system for 3 consecutive days with plant operating at 100% of rated production, weather conditions will result in reduced supply available from Houston County Lake for an extended period of time or water level drops below 275 feet above MSL.

Moderate: Demand reaches 100% of the system for 3 consecutive days with plant operating at 100% of rated production, weather conditions result in Lake levels falling to a point that mild operational problems occur or water supply storage facilities are not maintaining a constant level with plant operating at 100% of rated production.

Severe: Treatment plant is non-operational due to a malfunctions at the site or water levels drop at the reservoir to a point where pumping equipment will not function properly.

Lake Jacksonville/Acker

The City of Jacksonville relies on both surface water from Lake Jacksonville and Acker and groundwater. The Drought Contingency Plan for the City of Jacksonville contain numerous trigger conditions. The conditions related to system capacity are summarized below by the various condition levels.

Mild: Demand of 7.04 mgd for five consecutive days or water levels in tanks are consistently below ¾ fill for five consecutive days.

Moderate: Demand reaches limit of 8.38 mgd for any two days within a 30-day period or water level in tanks are consistently below half full for three consecutive days.

Severe: Demand exceeds limit of 8.38 mgd for more than five consecutive days and water levels in tanks are too low to provide adequate fire protection (generally less than ¼ full).

Lake Kurth

Lake Nacogdoches

The City of Nacogdoches currently uses both ground and surface water. The surface water treatment plant, which takes water from Lake Nacogdoches, limits surface water delivery to 6 million gallons per day. The trigger conditions for initiation of a drought response is based on system demand and not levels in Lake Nacogdoches. The current trigger conditions are as follows:

Mild: Daily water demand equals or exceed 14 million gallons per day for 7 consecutive days or 14.49 million gallons in a single day.

Moderate: Daily water demand equals or exceeds 14.49 million gallons per day for 7 consecutive days or 15.35 million gallons in a single day.

Severe: Daily water demand equals or exceeds 15.35 million gallons per day for 5 consecutive days or 15.75 million gallons in a single day.

Lake Tyler/Lake Tyler East/Bellwood Lake

The City of Tyler currently obtains water groundwater sources in addition to surface water from Lake Tyler/Tyler East. In addition it also has water rights to Bellwood Lake and Lake Palestine. The trigger conditions for initiation of drought response is based on water demand and is as follows:

Mild: Demand equals or exceeds 34 million gallons per day for 7 consecutive days or 37 million gallons on a single day.

Moderate: Demand equals or exceeds 36 million gallons per day for 7 consecutive days or 38 million gallons on a single day.

Severe: Demand equals or exceeds 38 million gallons per day for 5 consecutive days or 39 million gallons on a single day.

Lake Pinkston/Lake Center

The City of Center currently obtains its water supply from Lakes Pinkston and Center. The combined firm production capacity of its two treatment plants is 4.7 MGD. Trigger conditions are based on production capacity and are summarized below:

Mild: Demand reaches 90% of firm production capacity, disruption in operations which would limit capacity of water system below 85% of capacity or demand usage patterns that exceed distribution systems capabilities causing same affect as first two criteria.

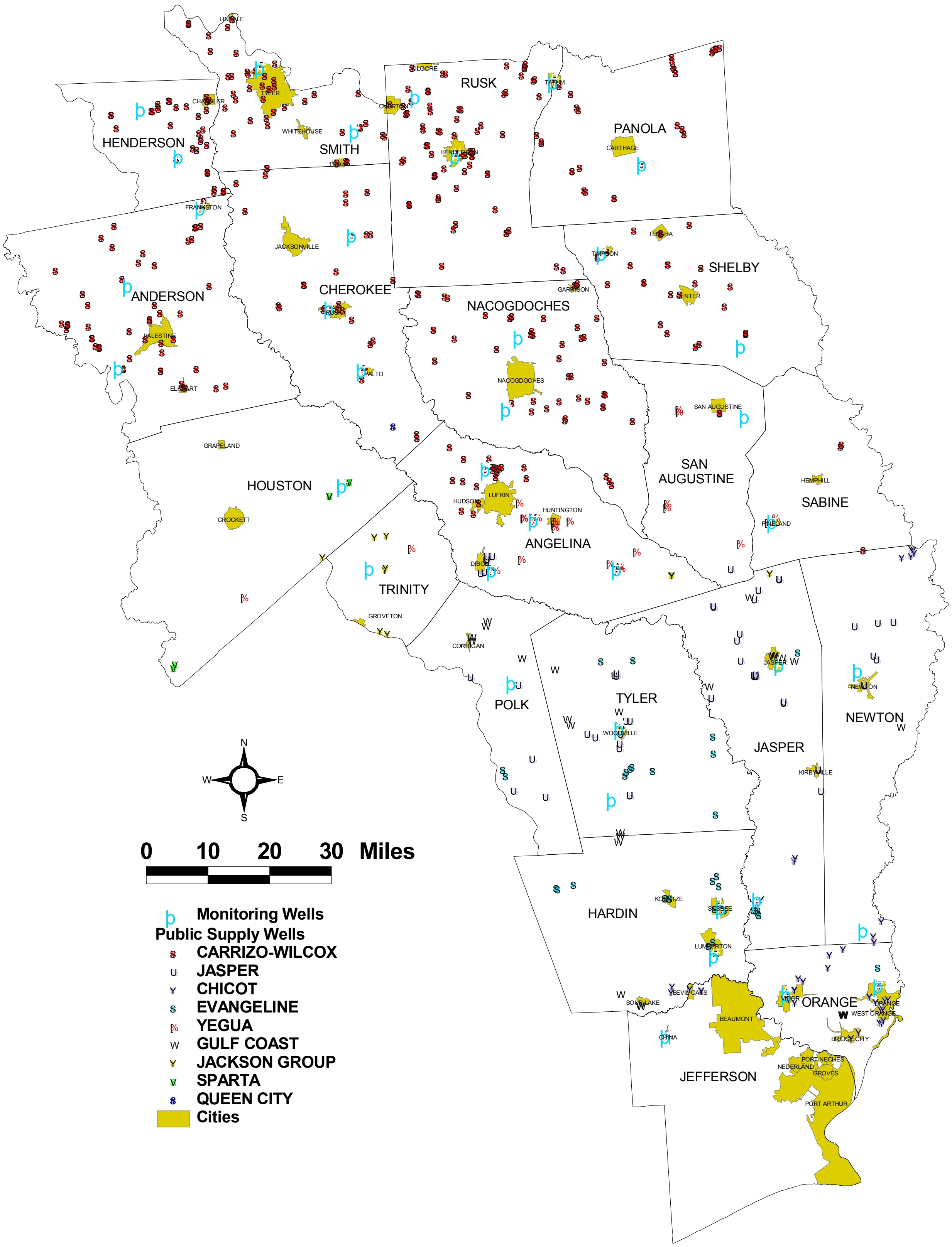
Moderate: Demand reaches 95% of firm production capacity, disruption in operations which would limit capacity of water system below 75% of capacity or demand usage patterns that exceed distribution systems capabilities causing same affect as first two criteria.

Severe: Demand reaches 100% of firm production capacity, disruption in operations which would limit capacity of water system below 70% of capacity or demand usage patterns that exceed distribution systems capabilities causing same affect at first two criteria.

Establishment of a regional trigger condition for groundwater sources is difficult due to the variability within the aquifers. However, a series of wells have been identified for monitoring. Public water supply wells were not selected because of the cyclical nature of pumping in these wells, which could cause difficulty for interpretation of water level trends as used for drought contingency planning. Instead, wells were selected that are relatively close to public water supply wells and/or well fields. At least one monitoring well was selected in each county, but in some cases, up to four wells were selected to ensure that areas dependent on groundwater are well monitored. The selected wells are monitoring in the same hydrostratigraphic unit as the closest public water supply wells to ensure that the most representative water levels are monitored. Wells with a longer monitoring history were selected over wells that had very little monitoring data. The earliest monitoring year for the group of wells ranges from 1929 to 1981 and the average is 1963. All but two of the wells have been monitored through the 1990's. The average duration of monitoring is 33 years and an average of 25 water level measurements have been collected from each well. Therefore, each well has a relatively long historical record that can be compared to future monitoring data to help determine the nature and severity of any water level fluctuations. The list of wells is provided in the following Table. A map showing the general location of the monitoring wells is also included.

GROUNDWATER MONITORING WELLS FOR EAST TEXAS REGIONAL WATER PLANNING AREA

State Well Number	Longitude	Latitude	County	Aquifer	First Year Monitored	Most Recent Year Monitored	Water Levels Collected	Years Monitored
3819404	95.74861	31.68583	Anderson	Wilcox Group	1939	1998	25	59
3803703	95.71417	31.87944	Anderson	Carrizo Sand And Wilcox Group	1976	1993	16	17
3460602	95.50556	32.05528	Anderson	Carrizo Sand	1949	1998	10	49
3743902	94.62611	31.28528	Angelina	Yegua Formation	1967	1998	27	31
3734902	94.75139	31.41028	Angelina	Carrizo Sand	1967	1998	27	31
3751403	94.74722	31.17222	Angelina	Yegua Formation	1967	1997	21	30
3753904	94.40500	31.16083	Angelina	Yegua Formation	1971	1995	17	24
3808105	95.09028	31.97611	Cherokee	Wilcox Group	1968	1998	22	30
3815607	95.16111	31.80667	Cherokee	Carrizo Sand	1969	1995	21	26
3824802	95.07917	31.65722	Cherokee	Carrizo Sand	1929	1989	16	60
6147208	94.16833	30.34806	Hardin	Evangeline Aquifer	1962	1996	26	34
6155206	94.19472	30.23639	Hardin	Evangeline Aquifer	1977	1998	19	21
3443603	95.65972	32.29389	Henderson	Wilcox Group	1970	1998	23	28
3452507	95.55972	32.17889	Henderson	Queen City Sand Of Claiborne Group	1973	1998	21	25
3839901	95.14778	31.38694	Houston	Spiller Sand Member Of Cook Mountain	1961	1998	21	37
6148214	94.06917	30.36333	Jasper	Chicot Aquifer	1941	1994	29	53
6201701	93.97417	30.91389	Jasper	Lagarto Clay And Oakville Sandstone	1964	1998	28	34
6162415	94.33667	30.05278	Jefferson	Chicot Aquifer	1965	1998	12	33
3719301	94.64306	31.71722	Nacogdoches	Carrizo Sand	1945	1998	30	53
3727506	94.68778	31.54861	Nacogdoches	Carrizo Sand	1968	1998	27	30
6202901	93.76000	30.89083	Newton	Evangeline Aquifer	1964	1998	29	34
6242904	93.78528	30.27778	Newton	Chicot Aquifer	1964	1991	27	27
6156919	94.00361	30.13694	Orange	Chicot Aquifer,Lower	1967	1996	42	29
6250911	93.75389	30.14500	Orange	Gulf Coast Aquifer	1982	1996	11	14
3562301	94.27889	32.11139	Panola	Wilcox Group	1977	1998	20	21
6103706	94.70917	30.90417	Polk	Jasper Aquifer	1966	1998	29	32
3541601	94.89694	32.29583	Rusk	Carrizo Sand	1972	1997	26	25
3544601	94.51278	32.31417	Rusk	Wilcox Group	1939	1996	22	57
3550801	94.79333	32.15083	Rusk	Wilcox Group	1947	1997	22	50
3641707	93.97222	31.25194	Sabine	Yegua Formation	1968	1997	19	29
3732901	94.03194	31.50306	San Augustine	Cane River Formation	1971	1998	26	27
3705902	94.40333	31.90556	Shelby	Wilcox Group	1972	1981	92	9
3724601	94.03194	31.66972	Shelby	Wilcox Group	1972	1998	27	26
3438805	95.32500	32.38111	Smith	Wilcox Group	1964	1998	23	34
3456207	95.07000	32.22028	Smith	Carrizo Sand And Wilcox Group	1965	1998	19	33
3856501	95.08194	31.18917	Trinity	Yegua Formation	1960	1996	24	36
6113802	94.42000	30.78306	Tyler	Jasper Aquifer	1953	1998	30	45
6129203	94.45056	30.61694	Tyler	Chicot Aquifer	1953	1998	29	45


HENDERSON
SMITH
RUSK
PANOLA
ANDERSON
CHEROKEE
NACOGDOCHES
SHELBY
HOUSTON
SAN AUGUSTINE
SABINE
ANGELINA
TRINITY
POLK
TYLER
JASPER
NEWTON
HARDIN
ORANGE
JEFFERSON
TYLER
JACKSONVILLE
PALESTINE
LUFKIN
NACOGDOCHES
CROCKETT
CARTHAGE
BEAUMONT
PORT ARTHUR
N
S
E
W
0
10
20
30
Miles
Monitoring Wells
Public Supply Wells
CARRIZO-WILCOX
JASPER
CHICOT
EVANGELINE
YEGUA
GULF COAST
JACKSON GROUP
SPARTA
QUEEN CITY
Cities

5.7 Recreational Considerations

The ETRWPG had discussion concerning the recreational benefits from reservoir construction and the need to sustain this economic benefit. The general consensus of the ETRWPG is that since there are no major changes to the reservoir demands during this planning cycle and there is no readily available information on the impact of the low water levels on the recreational industry, the issue does not need to be addressed in this planning cycle.

Upper Neches River Municipal Water Authority
Strategy for Developing Groundwater to
Effectively Increase Yield of Surface Water
Supplies, Promote Conjunctive Use of Ground and
Surface Water and to Have Water Resources Quickly
Available for Delivery to Public Water Supply During
Times of System Failures or Capacity Shortfall

The statute creating the Upper Neches River Municipal Water Authority (Article 8280-157) in Section 13. Added Powers states that in addition to powers granted otherwise the Authority is empowered:

"To acquire and develop underground sources of water in such instances and to such extent as the Districts Board of Directors may consider necessary and feasible in the conduct of its business and affairs, but only within Smith, Cherokee, Anderson, and Henderson Counties."

The Upper Neches River Municipal Water Authority (UNRMWA) own Lake Palestine and adjoining land amounting to about 50 square miles. Using a typical spacing of one mile for large wells, a field of about 20 wells could be placed on each side of the lake for a total of 40 to 60 million gallons of water per day. This based on use for intermittent demands and for peaking only.

The approach for developing a conjunctive use plan would proceed as follows:

Phase 1:

- Study available reports and data to define groundwater characteristics in the vicinity of Lake Palestine,
- Estimate the availability of groundwater for conjunctive use operations development potential in the vicinity of Lake Palestine,
- Develop a preliminary design and cost estimate.

Phase 2:

- Develop a groundwater model in the area of influence,
- Develop conceptual operational models using the groundwater model and available surface water availability model,
- Formulate alternative conjunctive use operations, including ASR operations,
- Test the potential operations of combined sources, and
- Optimize operations considering
  - a maximum supply,
  - a more assured firm surface water supply,
  - additional potable water supply in the four-county area, and/or
  - additional raw water supply.

Phase 3:

- Conduct field tests and studies to obtain site-specific data. These tests and studies may include:
  - drilling test wells
  - channel loss studies, and
  - systems operations studies to incorporate customers' operations plans to support a preliminary engineering design report or reports

- Determine the appropriate phasing of the project.

Phase 4

- Implement the plan with construction of wells, pipelines, pump stations and other needed appurtenances.

Appendix B

Environmental Evaluation

This appendix addresses environmental issues associated with East Texas Regional Water Planning Group water management strategies. Categories of environmental issues evaluated include:

- Instream flows;
- Bay and estuary flows;
- Wildlife habitat
- Cultural resources;
- Wetlands; and
- Water quality.

ENVIRONMENTAL ASSESSMENT TABLES

Table 1 lists the general strategies that are defined in Senate Bill 1. These strategies range from fully adoptable to impracticable for implementation in East Texas Regional Water Planning Group. Table 1 has been structured to display those strategies that have been recommended in East Texas Regional Water Planning Group. In some cases the strategy involves a major construction component that has environmental issues in itself. For example, pipelines and pump stations are necessary to implement several of the strategies. Table 1 includes these components and provides an assessment for them as well as the strategy itself. Table 2 lists water management strategies associated with regional water suppliers and the associated environmental issues. Table 3 lists the environmental issues for water management strategies associated with each water user group in East Texas Regional Water Planning Group. Rankings are provided in each table, shown as low, moderate, high, or a combination of low, moderate or high. This ranking system is based on the degree of difficulty necessary to either avoid the specific environmental issue or to mitigate it. Where appropriate a narrative explanation has been provided in the tables to provide additional information

The tables do not include any discussion of effects that can logically be considered as low or non-existent. An example of a low effect is an administrative action such as renewal of existing water supply contracts. Another example is installation of a new well when sufficient groundwater supply exists.

GENERAL STRATEGIES

Table 1 contains environmental impacts of general strategies that are feasible for East Texas Regional Water Planning Group. Only one type of strategy, Reservoir

Construction, is identified as having the potential for significant environmental concerns. Discussion of environmental concerns is expanded in this area. The other strategy areas may apply to multiple projects and the severity of environmental concerns are summarized by specific strategy in Table 3.

- New Water Supply Development
  - Reservoir Construction
  - Adding a New Well
  - Pipeline and Pump Station Construction;
- Connecting to Existing Sources
- Interbasin Transfers
- Reservoir System Operations
  - Overdrafting Reservoirs
  - Temporary Aquifer Overdrafting;
- Reuse of Wastewater
- Desalination
- Water Conservation
- Emergency Management and Drought Response
- Reallocation to New Uses
- Water Management Strategies in Current State Water Plan
- Brush Control

The following strategies were not adopted as having specific project identification or applicability at this time.

Voluntary Transfer of Water Rights
Voluntary Subordination of Water Rights
Control of Naturally Occurring Chlorides
Precipitation Enhancement
Water Right Cancellation
Aquifer Storage and Recovery
Desalination

GENERAL STRATEGIES

An assessment of the various General Strategies, or their individual components, is provided below

NEW SUPPLY DEVELOPMENT

Reservoir Construction

In general, reservoir construction results in changes in the following environmental conditions.

Instream Flows: Construction of a reservoir will result in a change in downstream flow conditions. The environmental effect, both positive and negative, will be assessed during the reservoir permitting process. Mitigation of negative effects, such as maintaining instream flow conditions, will be a component of the permit(s) provisions.

Bay - Estuary Flows: Construction of a reservoir may change the flow pattern that enters downstream bays and estuaries. The projections for bay and estuary needs are subject to refinement as site-specific data is gathered regarding water quality conditions and fishery production. Sources of inflow to bays and estuaries include gaged and ungaged streams within contributing basins.

Wildlife Habitat: Construction of a reservoir creates a new wildlife habitat for fisheries and other aquatic animals. The inundation of lowland stream channels and riparian corridors will result in changing the nature of the aquatic and terrestrial habitat.

Cultural Resources A reservoir may impact cultural resources by the construction of the dam and spillway or inundation of certain areas. Impacts on cultural resources will be minimized during the design and construction process and will be mitigated during the permitting process

Wetlands Wetlands may be impacted both within the impoundment area and downstream of the dam. Oftentimes significant areas are altered. Effects of impoundments can increase wetlands in the upper arms of the reservoir in some cases.

Water Quality Reservoirs can affect the quality of water by changing from a riverine environment of varying flow regimes to a pool environment. The resulting water quality depends to a large degree on the characteristics of the upstream drainage area (i.e., non-point discharge sources and wastewater return flows.) Additionally, the physical characteristics and hydrology of the reservoir have an effect on water quality conditions. A reservoir can serve to improve water quality by removing and reducing pollutants such as sediments with their attached chemical constituents. Ponded water within the reservoir can also result in an increase in algae and macrophyte levels, a naturally occurring process that can be stimulated by nutrients (i.e., phosphorus and nitrogen). Water quality within reservoirs can be managed to a large degree by watershed management programs. Actions for controlling the water quality conditions to ensure that quality is suitable for its intended use will be dictated by the Texas Natural Resource Conservation Commission Water Quality Standards.

Adding New Wells.

The addition of new wells is recommended in those cases where sustainable groundwater is available within the aquifers that underlie the region. Environmental impacts of groundwater wells are minor and are usually limited to the construction of pipelines and pump stations. However, the location and yield of wells must be accurately determined so as to avoid impacts to springs, base flow and yields of existing, nearby wells. Since groundwater wells are an alternative to surface water use, the strategy of adding wells represents an avoidance of environmental conflicts with developing surface water resources.

Pipeline and Pump Station Construction (A major component of Reservoir Construction, Interbasin Transfers, Reuse projects and Groundwater projects).

Careful selection of pipeline routes and construction methodology for stream crossings can limit the environmental issues associated with pipelines and pump stations. The preferred route for pipelines is along existing road right-of-ways or in existing rights-of ways for other utility systems. Whereas this does not obviate the need for consideration of environmental study of the proposed route, it does locate the construction in areas where other construction has already taken place. Where pipelines are planned for areas where no other utilities or roadways exist, or where economics favor other alignments, there are usually a choice of possible alignments, such that the pipeline can be routed around areas where known cultural resources exist, or where a critical wildlife habitat is known. Stream crossings can be selected based on careful investigation of habitat and aquatic environment within the reach. If conflicts exist that cannot be resolved by relocating the crossing, other construction techniques, such as tunneling can be used to limit intrusion into the streambed and riparian corridor.

CONNECTING TO EXISTING SOURCES

The principal component of connecting to existing sources is pipeline and pump station construction. The strategy provides for the use of reserves that are currently available. In the case of reservoirs the use will have some effect on the stage-frequency of the lake level and the number of spills from the reservoir.

INTERBASIN TRANSFER

Depending on location, interbasin transfer and interstate transfer of water can affect instream flows, bays and estuary flows, wildlife habitat and cultural resources and water quality. In general there is a decrease in flows in the basin of origin while the flows in the receiving basin are increased, by at least the amount the return flows are released to the streams. Water quality concerns could exist for transporting organisms from one basin to another. In the case of East Texas Regional Water Planning Group all proposed interbasin transfers are from basins from which water is currently being imported. Other issues include the regulatory difficulty in completing the interbasin transfers.

RESERVOIR SYSTEMS OPERATIONS

Overdrafting Reservoirs

Operating a series of reservoirs as a system can maximize the yield from the reservoirs. Often this is accomplished by overdrafting reservoirs at the lowest portion of the basin, or overdrafting the reservoirs that are in areas of higher annual rainfall. Overdrafting a reservoir increases available storage and results in a decrease in downstream spills. Lower lake levels associated with overdrafting could have an effect on wildlife habitat by changing the littoral zone of the lake. Finally, lower lake volumes could have a water quality impact on the lake.

Temporary Aquifer Overdrafting

Overdrafting aquifers as a strategy can only be contemplated for short-term duration until alternate supplies can be obtained. Overdrafting can have adverse effects, such as localized surface subsidence, loss of flows to springs, permanent loss of reservoir capacity, and impact on yields of neighboring wells. The actual impact may have only minimal effect on the above factors and must be determined on a case-by-case basis. In those cases where resolution of additional supplies might be a lengthy process, establishment of groundwater conservation districts may be considered for managing groundwater supplies on a district-wide basis.

WATER RECLAMATION AND REUSE

The reuse of reclaimed water (i.e., treated wastewater) is a water management strategy that can be a significant supply source for meeting water demands. Reclaimed water has historically been used for irrigation and certain industrial purposes. The use of reclaimed water for supplementing water supplies is currently being pursued within East Texas Regional Water Planning Group as well as across the country. The practice of water reclamation and reuse serves as an effective water conservation measure.

The quality of reclaimed water has to satisfy the Texas Natural Resource Conservation Commission (TNRCC) rules and regulations for it to be suitable for irrigation purposes. Additionally, the water quality of reclaimed water for supplementing water supplies must result in the quality of a blend of reclaimed water and natural water meeting Safe Drinking Water Standards for potable use.

In addition to the water quality issues sited above, the potential effect on instream flows has to be assessed. The use of reclaimed water may alter the instream flows. However, this effect on instream flow may be offset by population growth and resulting wastewater return flows to a water body. The environmental issue will be addressed during the water reuse permitting process.

WATER CONSERVATION

Water Conservation has been made part of all strategies. Water User Group demand figures reflect the decreased per capita consumption. Actual per capita usage must be evaluated over the years to determine whether conservation goals are being achieved and whether more active public awareness/information programs or other strategies should be instituted.

REALLOCATION OF RESERVOIR STORAGE TO NEW USES

Reallocation of Groundwater

In some counties where the available groundwater is fully allocated to meet current water demands, the implementation of surface water strategies is expected to free up groundwater at various times during the planning period. The groundwater made available can be reallocated to other uses with no attendant environmental impacts.

CONTRACT RENEWAL

The strategies selected follow the projects in the current Water Plan. "Contract Renewal" has been identified with that strategy. There are no direct environmental impacts due to water user groups renewing contracts with a water supplier. In general, the individual contract user demands are aggregated into a single demand on the part of the supplier. The environmental impacts are associated with the total project. In the case of a surface water supplier, the project will have been permitted by the state. Conditions established for operations, such as releases to sustain instream flows, will be part of the permit.

BRUSH CONTROL

Brush control is not adopted as a regional strategy, however, it is recognized that brush control has local application, particularly in livestock operations. Brush control will serve to improve the amount of instream flow by increasing the amount of rainfall runoff that reaches the stream; however, it will result in a loss of habitat for wildlife. Brush control projects will require assessments on a site-specific basis.

SUMMARY

The greatest potential for environmental changes are generally associated with water management strategies that might be adopted by the major water providers (Sabine River Authority (SRA), Lower Neches River Authority (LNVA), Angelina Neches River Authority (ANRA) and major cities. Water management strategies by such entities include:

- Construction of new water supply reservoirs;
- Construction of pump stations and cross-country water lines;
- Water reclamation and reuse;
- Interbasin transfer of water;

Regional strategies are shown in Table 2

SUBREGIONAL STRATEGIES

A number of water management strategies for East Texas Regional Water Planning Group involve local entities acting individually or in cooperation with the regional water suppliers. The specific local strategies are summarized in Table 3.

The environmental issues associated with the local strategies are generally presented in the Tables 1 or 2 for General Strategies and Regional Strategies. If that is the case the assessments are not repeated in Table 3. Only assessments unique to a specific local strategy are presented in Table 3. Other than typical water supply projects the local strategies also include:

- Reuse of reclaimed wastewater for cooling at steam electric power plants;
- Increased diversions from local reservoirs;
- Overdrafting of local reservoirs;
- Reuse of reclaimed wastewater for golf course irrigation; and
- Conversion of water from one type of use to another (i.e. Mining to Manufacturing).

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LIST OF ABBREVIATIONS

cfs	cubic feet per second
LCRA	Lower Colorado River Authority
MinQ	the minimum inflow that satisfies the TxEMP model constraints
MaxH	the inflow that maximizes the predicted fisheries harvest
MaxQ	the maximum inflow that satisfies the TxEMP model constraints
TDWR	Texas Department of Water Resources
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
TxEMP	Texas Estuarine Mathematical Programming Model
USGS	U.S. Geological Survey
WAM	Water Availability Modeling

EAST TEXAS REGION
REGIONAL WATER PLAN
ENVIRONMENTAL FLOW REQUIREMENTS
REVIEW DRAFT

The legislation establishing the regional water planning process requires that regional water plans include “appropriate provision for environmental water needs.” The environmental water needs to be provided for are the flows in streams and the freshwater inflows to estuaries that sustain specified habitat characteristics for aquatic life and preserve other desirable environmental characteristics. Environmental water needs vary seasonally and between ecological regions. The environmental water needs discussed in this report are instream flows and freshwater inflows to the Sabine-Neches Estuary.

INSTREAM FLOWS

Instream flows are provided to sustain specified habitat characteristics for aquatic life and other desirable environmental characteristics of streams. In this section, instream flows provided by required environmental releases from reservoirs and historical flows, site-specific instream flow studies, the Environmental Planning Criteria for instream flows, and planned future instream flow studies will be reviewed.

Environmental Releases from Reservoirs

The concept of an environmental water demand is relatively new and has generally not been provided for when issuing Texas water right permits. The four largest reservoirs in the East Texas Region (Toledo Bend Reservoir, Sam Rayburn Reservoir, Lake Palestine, and B.A. Steinhagen Reservoir) were surveyed to determine whether there are required releases from these reservoirs for environmental flow needs. These reservoirs comprise approximately 95% of the reservoir storage volume in the East Texas Region.

Of these reservoirs, only Lake Palestine is required by permit to release water for instream flow needs (5 cfs). This requirement is based on an evaluation of instream flow needs below Lake Palestine, which was performed when the permit was developed in 1984[2]. The other three reservoirs make voluntary releases or releases for other purposes, such as hydropower generation and prevention of salt water intrusion.

Historical Flows

Historical flows in the Neches and Sabine River Basins are reviewed in this section. Information in this section will be important to an understanding of the Environmental Planning Criteria discussed in a later section. Historical flows can be characterized based on average values, frequency of occurrence, naturalized flow estimates, and the seven-day average low flow with a recurrence interval of two years (7Q2). Each of these approaches is discussed below.

Average Flows and Frequency of Occurrence

The U.S. Geological Survey (USGS) maintains stream gages on the Neches, Sabine and Trinity Rivers and some of their tributaries. Daily average discharge values at various stream stations have been computed by the USGS[3]. Table 1 is a summary of average flows at gage stations in the Neches River Basin, the Sabine River Basin, and that portion of the Trinity River Basin in the East Texas Region. The USGS also has determined percent exceedance statistics for each gage station, which are presented in Table 1. For example, 90 percent of the time the flow in the Neches River at Evadale has exceeded 641 cfs.

Naturalized Flow

Naturalized flow is the flow that would be present in a stream in the absence of human influences such as reservoir storage and wastewater treatment plant return flows. As part of a Water Availability Modeling (WAM) study in progress, estimates of naturalized flows in the Neches River Basin are being updated.

Table 1

Median monthly naturalized flows have been estimated at the Evadale gage on the Neches River[4]. The median monthly naturalized flows are similar to or slightly higher than median monthly historical flows in winter and spring but are much lower than median monthly historical flows in summer and fall (Figure 1). This pattern is also seen in the comparison of median monthly historical flows before and after the impoundment of Sam Rayburn Reservoir (Figure 2). This indicates that water is being captured in the reservoirs in the winter and spring and released from reservoirs in the summer and fall.

Naturalized flows have not been calculated for the Sabine River Basin. At the Ruliff gage on the Sabine River, median monthly historical flows before the impoundment of Toledo Bend Reservoir are similar to median monthly historical flows after the impoundment of Toledo Bend Reservoir[4] in the winter and spring and lower in the summer and fall (Figure 3). Since a study has not been performed to compute naturalized flows, historical flows during the period before the impoundment of Toledo Bend Reservoir provide the best estimate of naturalized flow.

<u>7Q2 Flow</u>

In the Texas Surface Water Quality Standards[5], the Texas Natural Resource Conservation Commission (TNRCC) has defined the low-flow value below which water quality criteria do not apply as the 7Q2 flow. The 7Q2 flow is not intended for use in regulating flows or defining minimum flow requirements for streams[5].

Measurements at USGS gages are used to compute 7Q2 values, when available. If there is not a suitable gage on a stream, the 7Q2 flow may be determined from an adjacent gage or gage on a comparable watershed. Table 2 lists the 7Q2 flows for gages in the East Texas Region.

The 7Q2 flows do not characterize natural conditions in rivers where the flow is controlled by upstream reservoir operations. For example, during what would otherwise be low-flow months, approximately 2,500 cfs is released from Sam Rayburn Reservoir to control salinity at downstream water intakes. Therefore, the 7Q2 flow in the Neches River at Evadale (1,780 cfs) is much higher than what would naturally occur.

Site-Specific Instream Flow Studies

With the exception of the evaluation of instream flow needs during the permitting of Lake Palestine, no site-specific studies that estimated instream flow needs at locations in the East Texas Region

Figure 1

Figure 2

Figure 3

Table 2

have been identified.

Environmental Planning Criteria for Instream Flows

During the development of the 1997 Texas Water Plan, the TWDB, TPWD, and TNRCC jointly developed instream flow Environmental Planning Criteria that are to be used for evaluating proposed on-channel reservoirs and direct diversions, when site-specific criteria are not available[1]. The objectives of the Environmental Planning Criteria are to mimic natural hydrology, maintain streamflow, prevent rapid changes in streamflow, maintain channels, maintain water quality standards, provide drought relief measures, and allow for regional climatic and hydrologic differences. The Criteria also endeavor to strike a balance between meeting high priority human needs and meeting environmental needs. The purpose of these Criteria is to allow for "rapid assessment of instream environmental flow needs" and to "assist in the assessment of potential project feasibility.[1]"

The Environmental Planning Criteria are intended for use in the planning process only in the absence of site-specific criteria. They apply only to new reservoirs or diversions and not to existing projects.

The Criteria are comprised of a hierarchy of reservoir or diversion project pass-through requirements that depend on the amount of water stored in a reservoir or the actual streamflow near a diversion point[1]. The storage volume/streamflow condition identified as Zone 1 represents a relatively high volume of storage in a reservoir or a relatively high streamflow past a diversion point. Zone 2 represents an intermediate condition, and Zone 3 represents a low volume of storage in a reservoir or a low streamflow past a diversion point. The maximum amount of flow that will be required to be passed through new projects is the median naturalized flow. This pass-through requirement applies when the storage volume or streamflow is in Zone 1. An intermediate flow, the 25th percentile naturalized flow, is to be passed through new projects when the storage volume/streamflow is in Zone 2. For Zone 3, the amount of flow to be passed for new projects is the 7Q2 flow; this requirement is for the purpose of maintaining water quality standards. For a complete description of the Environmental Planning Criteria, see the 1997 TWDB publication Water for Texas[1], page 2-23.

One potential problem with the application of the Environmental Planning Criteria in the East Texas Region is that the Zones 1 and 2 flows are calculated from naturalized flows, while the Zone 3 (7Q2) flows are calculated from actual historical flows (that have been influenced by reservoir operations). An example of this potential problem is provided by the flow data for the Neches River at Evadale. The Zone 1 flow at the Neches River at Evadale ranges from 679 cfs in September to 7,900 cfs in March. The Zone 3 flow (7Q2) is 1,780 cfs. The 7Q2 flow exceeds the median naturalized streamflow from July through October.

Consider the hypothetical example of a new water supply project built on the Neches River at Evadale. Under the Environmental Planning Criteria, if this new reservoir was greater than 80% full in September, it would be required to pass 679 cfs (the median naturalized streamflow) through the reservoir. However, if the new reservoir were less than 50% full, it would be required to pass 1,780 cfs through the reservoir. This is contrary to the spirit of the Environmental Planning Criteria, which are supposed to decrease the pass-through requirements as reservoir storage decreases.

The Environmental Planning Criteria do not require the release of “makeup” flows from reservoir storage in order to meet the pass-through requirements. In other words, if the pass-through requirement is the median naturalized flow, but the flow entering the reservoir is less than the median naturalized flow, the reservoir operator would only have to pass through the reservoir the amount of flow actually entering the reservoir.

Table 3 shows the monthly pass-through flows required by the Environmental Planning Criteria for the Neches River at Evadale. Similar tables can be generated for each gaged location in the Neches River Basin. Naturalized flows in the Sabine River Basin will not be available until completion of the Sabine River Basin WAM project.

Future Instream Flow Studies

No planned site-specific instream flow studies have been identified. However, before granting a new water right permit or a water right permit amendment, the TNRCC will require an evaluation of impacts on instream flows[1] for the following types of water resource projects:

- Construction of a new reservoir or new direct diversion
- Significant change in a point of diversion from downstream to upstream
- Moving a point of diversion to an adjoining tributary
- Moving a point of diversion to an area with endangered species habitat
- Increase in the amount and/or rate of diversion
- Change in consumptive use.

The “evaluation of impacts” may require a site-specific instream flow study.

Table 3

FRESHWATER INFLOWS TO THE SABINE-NECHES ESTUARY

The Sabine-Neches Estuary consists of Sabine Lake and the tidal portions of the Sabine and Neches Rivers. Sabine Lake covers approximately 100 square miles and is typically less than 10 feet deep. Sabine Pass, a seven-mile long channel, separates Sabine Lake from the Gulf of Mexico. Sabine Lake has a total drainage area of approximately 20,531 square miles.

Human activities have altered the amount and patterns of inflow to the Sabine-Neches Estuary. Impoundment and diversion of water, some water conservation practices, and reuse of existing treated wastewater discharges reduce inflows. Reservoir releases during dry seasons, treated wastewater discharges, and return flows from groundwater used for irrigation increase inflows.

Twenty-six man-made reservoirs store water in the Sabine Lake drainage area. The reservoirs have a combined conservation capacity of approximately 10 million acre-feet[4]. The largest reservoirs are Toledo Bend Reservoir on the Sabine River and Sam Rayburn Reservoir on the Angelina River.

In this section, the role of freshwater inflows will be reviewed. In addition, the Environmental Planning Criteria for bay and estuary inflows, historical freshwater inflows to the Sabine-Neches Estuary, previous freshwater inflow studies, current freshwater inflow studies, and freshwater inflow studies of other estuaries will be summarized.

Role of Freshwater Inflows

The role of freshwater inflows to bays and estuaries in maintaining aquatic ecosystems includes the following:

- Dilution of seawater
- Transport and dilution of contaminants
- Creation of low-salinity nursery habitats
- Moderation of bay temperatures
- Reduction of metabolic stresses
- Transport of sediment and nutrients
- Modification of chemical reactions
- Partitioning of resources to estuarine plants and animals
- Distribution and vertical movement of organisms in water column
- Cutting and filling of channels
- Migration of species

- Prevention of salt-wedge formation farther upstream

Environmental Planning Criteria for Bay and Estuary Inflows

It has been assumed that, for most environmental planning purposes, the Zone 1 release requirements for instream flows will also "provide a 'fair-share' of the total targeted freshwater inflows to the bays and estuaries.[1]"No other bay and estuary inflow provisions were made in the Environmental Planning Criteria. Where site-specific bay and estuary freshwater inflow studies have been completed, however, the inflow requirements from these studies will be used to determine pass-through requirements for new reservoirs or direct diversions located within 200 river miles of the coast[1].

Historical Freshwater Inflows to the Sabine-Neches Estuary

In this report, two types of freshwater inflow quantities are discussed: gaged freshwater flows and combined freshwater inflows. Gaged freshwater flows are the sum of flow measurements at the USGS gaging stations. Combined freshwater inflows are estimates of the total inflow to the estuary.

The TWDB has calculated monthly combined freshwater inflows to the Sabine-Neches Estuary[6] using gaged streamflows, estimated return flows, estimated diversions, and modeling of ungaged areas. The combined freshwater inflow values illustrate the variability of inflows to the estuary. Over the period 1941 to 1987, the minimum annual combined inflow to Sabine Lake was 3,183,000 acre-feet in 1967; the maximum annual combined inflow was 29,017,000 acre-feet in 1946; the average annual combined inflow was 13,038,000 acre-feet per year; and the median annual combined inflow was 11,838,000 acre-feet per year. The minimum flow, which occurred in 1967, may have been influenced by impoundment in upstream reservoirs. Deliberate impoundment in Sam Rayburn Reservoir took place from March 1965 to April 1968, and deliberate impoundment in Toledo Bend Reservoir took place from October 1966 to June 1968.

Monthly inflows to the Sabine-Neches Estuary vary seasonally, with greater inflows in the winter and spring (December through May) than in the summer and fall. The median monthly combined inflow is lowest in October (259,000 acre-feet) and highest in February (1,453,000 acre-feet). The median and 10^{th} percentile monthly combined inflows to the Sabine-Neches Estuary are shown in Figure 4.

Figure 4

Note that the *sum* of the median *monthly* combined inflows is 10,055,000 acre-feet per year, which is less than the median *annual* combined inflow of 11,838,000 acre-feet per year. This is due to the fact that a large inflow event is more likely to occur sometime during a year than it is to occur in any given month.

Previous Freshwater Inflow Studies

In 1981[7] and 1984[8], the Texas Department of Water Resources (TDWR) published recommended freshwater inflows to the Sabine-Neches Estuary. These recommendations are best characterized as preliminary estimates based on limited data. Due to the data limitations and differences in methodology between this study and the current freshwater inflow study, the TWDB does not propose to use the previous results in the regional planning process[9].

Current Freshwater Inflow Studies

The TWDB, TNRCC, and TPWD are conducting a study of freshwater inflow needs for the Sabine-Neches Estuary. The study is currently in the data collection phase. The estimated completion date for this study is January 2001.

The following data are being collected/calculated:

- Salinity data are being collected using TWDB's *in-situ* Hydrolab Water Quality Monitoring Network and from historical records of other agencies.
- Biological data are being compiled from commercial fish harvest records and TPWD's Coastal Fisheries Monitoring Program.
- Information on salinity limits for survival, growth, and reproduction of estuarine plants and animals is being developed.
- Historical freshwater inflows to the estuary are being calculated from gaged streamflow records, rainfall runoff modeling of ungaged areas, permitted diversions, and records of return flows.

Upon completion of the data collection phase, statistical regression models will be developed to investigate relationships between freshwater inflows, estuarine salinities, and the occurrence of coastal fisheries species. A nutrient budget for the estuary will be developed using a STELLA compartment model, and sedimentation in the estuary will be analyzed using the SED5 accretion model.

Using the results of these analyses, an optimization model (Texas Estuarine Mathematical Programming Model, or TxEMP) will be developed to forecast a range of monthly estuary inflows that are believed to maintain biological productivity and overall ecological health. The monthly inflows recommended by the TxEMP model are constrained to being between the 10^{th} percentile and 50^{th} percentile (or median) historical flows (Figure 4). Using the TxBLEND hydrodynamic model, the circulation and salinity patterns associated with the potential range of inflows are calculated. If the circulation and salinity patterns match the actual ecological zonation of fresh, brackish, and marine habitats, the model is considered to be verified.

In particular, three flow quantities will be identified:

- MinQ, the minimum inflow that satisfies the TxEMP model constraints,
- MaxH, the inflow that maximizes the predicted fisheries harvest, and
- MaxQ, the maximum inflow that satisfies the TxEMP model constraints.

In general, MaxQ is greater than MaxH, and MaxH is greater than MinQ.

Freshwater Inflow Studies of Other Estuaries

The results of the current TWDB-TPWD Sabine-Neches Estuary study will not be available until January 2001. However, studies of other Texas estuaries have been completed. These studies provide some indication of the types of results that may come from the Sabine-Neches Estuary study.

The TWDB, TNRCC, and TPWD have completed freshwater inflow studies for the Galveston Bay/Trinity and San Jacinto Estuaries[10] and the San Antonio Bay/Guadalupe Estuary[11], and the Lower Colorado River Authority (LCRA) has completed a study of Matagorda Bay/Lavaca and Colorado Estuaries[12]. Each of these studies identifies freshwater inflow targets.

Trinity-San Jacinto Estuary

For the Trinity-San Jacinto Estuary study[10], TPWD recommended the MaxH flows as the "lowest freshwater inflow target value which generally fulfills the biological needs of the Galveston Estuary on a seasonal basis.[10]" TPWD preferred the "conservative" MaxH flows over the MinQ flows because the MaxH flows provide "conditions closer to the salinity preferences of the target species" and “protect the oyster fisheries from disease.[10]”

Table 4 compares historical inflows, MinQ, and MaxH values for the Trinity-San Jacinto Estuary.[10] In several months (February, July, August, September, and October), MinQ is greater than MaxH. This is possible on a monthly basis but not on an annual basis.[13] The annual MaxH (5.22 million acre-feet per year) is greater than MinQ (4.16 million acre-feet per year).

Table 4

Figure 5 shows the predicted annual fisheries harvest in the Trinity-San Jacinto Estuary as a function of freshwater inflow. The 25% increase in flow from MinQ to MaxH produces an estimated 9% increase in fisheries harvest.

Figure 6 is a comparison of the MinQ and MaxH flows to the historical combined freshwater inflows to the Trinity-San Jacinto Estuary. The MinQ flow is always greater than or equal to the 10th percentile historical inflow; is greater than the 25th percentile historical inflow in nine months; and equals the median historical inflow for September through December. The MaxH flow is almost always equal to the 10th percentile, 25th percentile, or median historical inflow amount. In September and October, the two months when this does not occur, the MinQ flow is equal to the median historical inflow. The physical explanation for this phenomenon is that during months when MaxH equals the median historical inflow (March through June, November, and December), the estuarine species require as much freshwater flow as the model will allow. The model is constrained not to allow more than the median historical inflow. Conversely, in months when MaxH is close to the 10th percentile historical inflow (January, February, September, and October), the estuarine species seem to want as little freshwater inflow as possible. The model is constrained not to allow less than the 10th percentile historical inflow. The months when MaxH is approximately equal to the 25th percentile historical inflow (July and August) are coincidental.

Figure 7 presents annual flow values that have been determined by computing the sums of the monthly flows for different statistics and recommended flows. The sum of the monthly recommended freshwater inflows gives a recommended annual flow. It should be remembered, however, that the sum of the monthly nth percentile freshwater inflows is not the same as the annual nth percentile freshwater inflow. For the Trinity-San Jacinto Estuary, the annual MinQ and MaxH flows are greater than the sum of the monthly 25th percentile freshwater inflows and less than the sum of the monthly median freshwater inflows.

If the annual MinQ flow is greater than the sum of the monthly 25th percentile freshwater inflows and less than the sum of the monthly median (50th percentile) freshwater inflows, then what percentile does the annual MinQ flow correspond to? An analysis of the data indicates that, for the Trinity-San Jacinto Estuary, the annual MinQ flow approximately equals the sum of the monthly 32nd percentile freshwater inflows, and the annual MaxH flow approximately equals the sum of the monthly 39th percentile freshwater inflows. Put another way, the annual MinQ flow is approximately 58% of the sum of the monthly median freshwater inflows, and the annual MaxH flow is approximately 73% of the sum of the monthly median freshwater inflows.

Figure 5

Figure 6

Figure 7

Guadalupe Estuary

For the Guadalupe Estuary study[11], as for the Trinity-San Jacinto Estuary, TPWD recommended requiring the MaxH flows. Table 5 shows the values for MinQ and MaxH, that were developed by the Guadalupe Estuary study[11] and estimated historical inflows. Figure 8 shows the predicted annual fisheries harvest as a function of freshwater inflow. The 12% increase in flow from MinQ to MaxH produces an estimated 15% increase in fisheries harvest.

Figure 9 is a comparison of MinQ and MaxH flows with the historical combined freshwater inflows to the Guadalupe Estuary. The MinQ flow is always greater than the 10th percentile historical inflow; is greater than the 25th percentile historical inflow in six months (January, February, and May through August); and equals the median historical freshwater inflow in January and February. The MaxH flow is always greater than the 10th percentile historical inflow and is equal to or slightly less than the median historical inflow in six months (January, February, and May through August). The MaxH and the MinQ values are equivalent except for May through August.

Figure 10 shows the annual flow values that are determined by computing sums of the monthly flows for different statistics and recommended flows (MinQ and MaxH) for the Guadalupe Estuary. The annual MinQ and MaxH flows are greater than the sum of the monthly 25th percentile freshwater inflows and less than the sum of the monthly median freshwater inflows.

As for the Trinity-San Jacinto Estuary, the relationship between some of the flow statistics and the combined freshwater inflow values were computed for the Guadalupe Estuary. The annual MinQ flow approximately equals the sum of the monthly 32nd percentile inflows, and the annual MaxH flow approximately equals the sum of the monthly 37th percentile inflows. In addition, the annual MinQ flow is approximately 69% of the sum of the monthly median inflows, and the annual MaxH flow is approximately 76% of the sum of the monthly median inflows.

Lavaca-Colorado Estuary

LCRA performed a study of the Lavaca-Colorado Estuary[12] and recommended two flow regimes: “target” flows and “critical” flows. The target flows are intended to represent the monthly and seasonal inflows that achieve the following conditions:

Table 5

Figure 8

Figure 9

Figure 10

- Produce 98% of the maximum total normalized biomass for nine key finfish and shellfish species.

- Cause the salinity to fall within the predetermined monthly ranges preferred by most species.
- Result in productivity for each species that was at least 80% of the historical average.
- Replace at least 100% of the natural nutrient losses from the system.

The critical flows were determined by calculating the minimum total annual inflow required to maintain the salinity near the mouths of the Colorado and Lavaca Rivers at 25 parts per thousand or less[12]. The critical flows are intended to provide for a drought condition. The objective of this flow regime is to “allow the finfish and shellfish to recover and repopulate the bay” when more normal weather conditions return[12].

The recommended target annual inflow to the Lavaca-Colorado Estuary is 2.0 million acre-feet per year[12]. The recommended critical annual inflow is 287,400 acre-feet per year[12]. Monthly target values were not reported[12].

Figure 11 shows the sums of the historical monthly combined freshwater inflows for different statistics and the recommended target and critical inflows for the Lavaca-Colorado Estuary. The target flow is greater than the sum of the monthly median combined freshwater inflows and less than the sum of the monthly 75th percentile inflows. The target flow approximately equals the sum of the monthly 55th percentile inflows and is approximately 111% of the sum of the median monthly inflows. The critical flow is less than the sum of the minimum monthly flows for the period of record (306,250 acre-feet). The critical flow for the Lavaca-Colorado Estuary is approximately 16% of the sum of the monthly median inflows to the Lavaca-Colorado Estuary.

The methodology used for the Lavaca-Colorado Estuary study was different than the methodology used by the TWDB for the Trinity-San Jacinto and Guadalupe Estuaries. In the TWDB studies, the recommended monthly inflows were constrained to be greater than the 10th percentile combined freshwater inflow and less than the 50th percentile inflow. Therefore, the recommended annual inflows would be greater than the sum of the monthly 10th percentile inflows and less than the sum of the monthly 50th percentile inflows. However, neither the target flow nor the critical flow recommended by the LCRA methodology is in this range of values.

Figure 11

INFLOWS CONSIDERATIONS FOR THE SABINE-NECHES ESTUARY

The results of the current TWDB-TPWD study of the Sabine-Neches Estuary will not be available until 2001. Therefore, this current Regional Plan can neither make provision for, nor assess whether there are, potential impacts on water supply availability from proposed projects as a result of providing inflows to bays and estuaries. These components of the plan should be addressed in the first update to the Regional Plan.

It may be helpful, however, to those preparing the current Regional Plan to have some idea of the range of values that may be recommended for inflows to bays and estuaries. The constraints associated with the study methodology and the relationships between historical inflow and recommended inflow for other estuaries can be used to provide a gross approximation of what the recommended inflows may be for the Sabine-Neches Estuary. This method of estimating what the inflow recommendation may be, clearly, does not account for the variability in habitats and ecosystems that exists from one estuary to another; and, thus, the following approximation of potential inflow requirements can be expected to vary from the final recommendations produced by the TWDB-TPWD Study.

Table 6 presents the method and the results of using the relationships between historical inflows and recommended inflows in the Trinity-San Jacinto and the Guadalupe Estuaries to estimate what potential inflows would be required for the Sabine-Neches Estuary, if it were similar to the two estuaries studied previously. The first three columns in Table 6 summarize the relationships between historical inflows and the MinQ and MaxH inflow recommendations that have been determined in previous sections of this report. The last two columns provide approximations of the MinQ and MaxH inflows that would be recommended for the Sabine-Neches Estuary, if similar relationships to historical inflows are concluded to be appropriate for this estuary.

The calculation indicates that the MinQ annual flow for the Sabine-Neches Estuary may range from 5.8 to 6.9 million acre-feet per year. The MaxH annual flow for the Sabine-Neches Estuary may range from 7.3 to 7.6 million acre-feet per year.

The percentages of the historical annual combined freshwater inflows to the Sabine-Neches Estuary (1941-1987) that are greater than the MinQ and MaxH values in Table 6 have been determined. The historical inflow has exceeded both the MinQ and MaxH values in 77% of the years from 1941 to 1987.

Table 6

The approximations of inflow requirements can be apportioned between the Sabine and Neches Basins using historical flow data. Table 7 shows the average historical inflow from the gaged and ungaged watersheds that comprise the Sabine-Neches Estuary drainage basin. The data are for the period 1941-1976. As shown in Table 7, an average of 45% of the combined inflow to the Sabine-Neches Estuary has come from the Neches River Basin, 49% has come from the Sabine River Basin, 5% has come from the Neches-Trinity Coastal Basin, and 1% has come from the Black and Johnson Bayou ungaged area in Louisiana.

Using these percentages, the inflow from each drainage basin that would provide the projected freshwater inflow requirement for the Sabine-Neches Estuary is as follows: 2.6 to 3.4 million acre-feet per year from the Neches River Basin, 2.8 to 3.7 million acre-feet per year from the Sabine River Basin, and 0.3 to 0.4 million acre-feet per year from the Neches-Trinity Coastal Basin.

SUMMARY AND CONCLUSIONS

Available information that can be used to identify requirements for environmental flows (instream flows and freshwater inflows to the Sabine-Neches Estuary) was reviewed. Very little information has been developed on these subjects. As site-specific information on environmental flow requirements in the East Texas Region is developed in the future, the plan will need to be revised. Following is a summary of the information that is currently available.

Instream Flow Requirements

No site-specific studies that identify instream flow requirements for streams in the East Texas Region have been identified. One permit that requires a release from a reservoir (Lake Palestine) for environmental flow needs was identified. Therefore, the following conclusions and recommendations are provided regarding instream flows:

- An instream flow requirement in the Neches River below Lake Palestine has been set at 5 cfs.
- For the purposes of this plan, for any other stream, the Environmental Planning Criteria should be used to estimate the instream flow requirements associated with new reservoirs or new direct diversions.
- As future, site-specific, instream flow studies are performed, the results from these studies should be incorporated into the regional water supply plan.

Table 7

Inflows for Bays and Estuaries

The TWDB guidance for the development of regional water supply plans provides that, where site-specific bay and estuary inflow studies are not available, it can be assumed that compliance with the Environmental Planning Criteria requirements for maintaining instream flows will provide adequate inflows for bays and estuaries. Since the site-specific inflow study has not been completed for the Sabine-Neches Estuary, in this initial regional water supply plan, inflow requirements for new reservoirs or diversions will be assumed to be met by compliance with the Environmental Planning Criteria for instream flows. The Sabine-Neches Estuary study is scheduled for completion in January 2001. Therefore, it will be available for the first update to the regional plan.

However, to provide a gross approximation of what future inflow requirements may be for the Sabine-Neches Estuary, the results of comparable studies in other estuaries have been reviewed and extrapolated to the Sabine-Neches Estuary. It should be recognized that future recommendations for the Sabine-Neches Estuary will vary from the existing recommendations for the other estuaries because the aquatic community, habitat, and flow regime in the Sabine-Neches Estuary vary from those in the other estuaries. Therefore, the actual study results for the Sabine-Neches Estuary will vary from the approximations presented below.

The Sabine-Neches Estuary study will identify values for MinQ, MaxH, and MaxQ. MinQ is the minimum inflow that satisfies salinity, sedimentation, and biological constraints; MaxH is the inflow that maximizes the predicted fisheries harvest; and MaxQ is the maximum inflow that satisfies the above constraints. The study methodology requires that these values be between the 10^{th} and 50^{th} percentile historical combined freshwater inflows[9]. Further, the methodology requires flows that approximate MinQ in some months and MaxH in other months.

An analysis of completed estuary inflow studies was performed that developed relationships between historical inflows and recommended inflows. These relationships were then applied to historical inflow data for the Sabine-Neches Estuary to determine what the approximate inflow requirements would be if the Sabine-Neches Estuary were comparable to the other estuaries studied. The resultant extrapolated values for freshwater inflow requirements for the Sabine-Neches Estuary are 5.8 to 7.6 million acre-feet per year. This inflow requirement could be distributed among the major contributing watersheds, based on historical inflow patterns, as follows:

- 2.6 to 3.4 million acre-feet per year from the Neches River Basin,
- 2.8 to 3.7 million acre-feet per year from the Sabine River Basin, and

- 0.3 to 0.4 million acre-feet per year from the Neches-Trinity Coastal Basin.

The annual flows recommended by the Sabine-Neches Estuary Study will be distributed to establish monthly inflow requirements. Flows approximating the median historical inflow may be required in the spring; early summer; and, possibly, in November and December. During the other months, inflow requirements may range from the 10^{th} percentile to the 25^{th} percentile historical inflow.

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Task 6

Task 6

Additional Recommendations

6.1 Introduction

This section describes additional recommendations discussed by the East Texas Regional Water Planning Group. Consideration was given to reservoir sites and legislative and regional policy issues.

6.2 Reservoir Sites

The four River Authorities located within the East Texas Planning Area presented, to the ETRWPG, locations they have evaluated as being hydrologically and topographically unique for construction of reservoir sites. The ETRWPG recognizes that reservoirs can have major impacts on the environment and that the protection of the environment is already afforded through a process which is more thorough the planning process established under Senate Bill 1. The ETRWPG has elected to designate the 13 reservoir sites, as presented by the four River Authorities, as containing features which make them desirable for reservoir construction. It should be recognized that only 1 of the 13 sites has been recommended as a strategy within the 50 year planning cycle. The ETRWPG believes that the lengthy and thorough economic and environmental review process for the reservoirs will in themselves determine if reservoirs are constructed as opposed to any decision by the ETRWPG.

Major Water Provider	**Reservoir Site**
Angelina Neches River Authority	Lake Eastex
Lower Neches Valley Authority	Rockland Reservoir
Sabine River Authority	Big Cow Creek
	Bon Weir
	Carthage Reservoir
	Kilgore Reservoir
	Rabbit Creek
	State Hwy. 322, Stage I
	State Hwy. 322, Stage II
	Stateline
	Socogee
Upper Neches River Municipal Water Authority	Fastrill Reservoir
	Ponta

In addition to the above sites, Lake Naconiche, located in northeast Nacogdoches County may also be another potential reservoir site. Lake Naconiche has a main purpose of flood control. However, it impoundment area may serve to provide a water source. Discussion of Lake Naconiche is not provided as physical details are not known at this time.

A brief description of each of the above reservoir sites is provided below. The description of the Sabine River Authority sites are excerpted from "Comprehensive Sabine Watershed Management Report". Figures 6.1 thru 6.4 show the approximate location of the reservoir sites.

Lake Eastex

The reservoir site is located predominately in Cherokee County but extends into the southern portion of Smith County. The reservoir will be formed by construction of a dam on Mud Creek approximately 2.5 miles downstream of the U. S. Highway 79 crossing. The dam is expected to impound water approximately 14 miles upstream with an estimated surface of 10,000 acres. The firm yield for the reservoir site is 85,000 acre-feet with a total storage volume at normal pool elevation, 315 feet msl, of 187,839 acre-feet. Developmental concerns include bottomland hardwood area.

Rockland Reservoir

The Rockland Reservoir site is located on the Neches River at River Mile 160.4. The top of the flood pool would be at elevation 174 feet, msl with top of conservation pool of 165 feet, msl. It is estimated the reservoir site would affect 99,524 acres of wildlife habitat (Frye, 1990).

Rockland Reservoir was authorized for construction, as a federal facility, in 1945 along with Sam Rayburn, B. A. Steinhagen and Dam A lakes. A report in 1947 recommended construction of Sam Rayburn and B. A. Steinhagen with deferral of Rockland Reservoir and Dam A until such time the need develops. Rockland and Dam A were classified as inactive in 1954. A reevaluation study performed in 1987 identified the potential for significant benefits in the areas of flood control, water supply, hydropower and recreation.

Development concerns include Priority 1 bottomland hardwood site.

Big Cow Reservoir

The Big Cow Reservoir is a proposed local water supply project on Big Cow Creek in Newton County. The Big Cow Creek dam site is located about one-half mile upstream from U.S. Hwy 190, west-northwest of the Town of Newton. It is in the Lower Sabine Basin. The expected yield of the reservoir is 61,700 acre-feet per year with a storage capacity of 79,852 acre-feet and area of 4,618 acres. The conservation level would be 212 ft msl.

No environmental assessment has been conducted for this site. It appears that this site is located outside priority bottomland hardwoods and known lignite deposits. CRP Water Quality assessments reported possible concerns for fecal coliform and dissolved aluminum.

The perennial streams that feed Big Cow Creek and abundant rainfall should provide sufficient inflow for considerable yield for a reservoir of this size. Nevertheless, for this planning period (through 2050), there are no identified needs in the Lower Basin that cannot be met with existing supplies.

Bon Wier Reservoir

The Bon Wier dam site is located on the state line reach of the Sabine River in Newton County, Texas and Beauregard Parish, Louisiana. The reservoir will extend from about 5 miles upstream of U.S. Hwy 190 to approximately Highway 63. It was originally proposed for re-regulation of the hydropower discharges from Toledo Bend Reservoir and for the generation of hydropower. The reservoir, if constructed, would yield 440,000 acre-feet per year at a normal operating elevation of 90 feet above mean sea level. The area and capacity would be 34,540 acres and 353,960 acre-feet, respectively.

It is estimated that the Bon Wier Reservoir would affect 35,000 acres of wildlife habitat (Frye, 1990). This includes several acid bogs/baygalls, which are unique and sensitive areas of the region. Several threatened and endangered species are known to occur in this area. No cultural resource survey has been conducted, but the site is expected to impact numerous archeological and historical sites in both Texas and Louisiana. The CRP Water Quality data reported possible concerns for elevated TDS and low dissolved oxygen during the summer months. The site also requires congressional approval for construction of a dam, because it is on interstate navigable water of the U.S.

The advantages to this site is the large reservoir yield and potential for hydropower; however, it is located in the Lower Basin which has sufficient existing water supply for the planning period.

Carthage Reservoir

The Carthage Reservoir is a proposed main stem project on the Sabine River in Panola, Harrison, Rusk and Gregg counties. It is located immediately upstream from the U.S. Highway 59 crossing and downstream from the City of Longview. The yield of this reservoir, if constructed, would be approximately 537,000 acre-feet per year at a conservation pool elevation of 244 feet msl. The area and capacity would be 41,200 acres and 651,914 acre-feet, respectively.

Developmental concerns for Carthage Reservoir include bottomland hardwoods, aquatic life, lignite deposits and cultural resources. The downstream half of the site encompasses a USFWS Priority 1 bottomland hardwood area. This portion of the Sabine River is designated a significant stream segment and is home to several protected aquatic species (Bauer, 1991). Other potential conflicts with this site include oil and gas wells. Permitting for this reservoir will require an act of Congress since the dam is located on navigable interstate waters of the U.S. There is one active lignite mine, South Hallisville Mine No. 1, near the reservoir boundary.

The water quality assessment of the Sabine River (SRA, 1996a) indicates this segment of the river has possible concerns for nutrients, but the water quality is improving. The advantage of this reservoir is its large yield. The estimated yield of 537,000 acre-feet per year would provide for all projected needs well beyond the year 2050

Kilgore Reservoir

The Kilgore Reservoir is a proposed local water supply project located on the Upper Wilds Creek in Rusk, Gregg and Smith counties. It was originally proposed to supplement the City of Kilgore's water supply. The project would provide a yield of 5,500 acre-feet per year at the normal operating elevation of 398 feet msl. At that level, the area and capacity would be 817 acres and 16,270 acre-feet, respectively.

Construction of this reservoir has never been initiated, and the City of Kilgore is using diversions from the Sabine (purchased from SRA and released from Lake Fork) and ground water for its water supply. However, this project still has the potential as a local water supply source in the Kilgore area should other proposed projects not be developed. Only preliminary studies have been performed for the Kilgore Reservoir and no environmental impacts have been assessed. Based on preliminary screening data, the site is not located within a priority bottomland hardwood area; there are no known water quality issues and no active mines within the reservoir site.

Rabbit Creek Reservoir

Several reservoir projects have been proposed on Rabbit Creek for local water supply. The latest proposal for the City of Overton and surrounding communities was completed in 1998 (Burton, 1998). The proposed reservoir project is located on Rabbit Creek in Smith and Rusk counties, and would have a firm yield of 3,500 acre-feet per year. This is considerably less yield than the previous studies, which is due in part to the smaller storage capacity and conservative inflows that were assumed for the study. In the latest study, the area would be 520 acres and the capacity would be 8,000 acre-feet at a conservation level of 406 ft msl. However, this yield is considered satisfactory to meet the regional demands of the area. Environmental review of the site reports no significant concerns that would preclude development. There are also no significant cultural resources in the area, no known water quality issues, and no active mining within the reservoir area.

The advantages of this reservoir site are the few developmental concerns. However, it was rejected as a water supply alternative in the 1998 study due to costs. A large percentage of the total costs were associated with a water treatment and distribution system. Due to the relatively low yield of Rabbit Reservoir, this project could only be considered for local water supply.

State Highway 322 Stage I

The Highway 322 Reservoir is a proposed local water supply project in Rusk County, upstream of Lake Cherokee. The project, as originally proposed, was to be developed in two stages: 1) a dam and reservoir on Tiawichi Creek (Stage 1 and 2) a separate dam and reservoir on Mill Creek (Stage II). The reservoirs were to be joined by a connecting channel that would allow one spillway to serve both dams.

The proposed Stage I dam is located on Tiawichi Creek, approximately one mile upstream of its confluence with the Upper end of Lake Cherokee. The reservoir, at its normal operating elevation of 330 ft msl, would provide a net yield of 22,000 acre-feet per year. Its area and capacity would be 4,450 acres and 82,450 acre-feet, respectively. If Stage I is operated independently from Lake Cherokee, the firm yield of the reservoir would be reduced due to Lake Cherokee's superior water rights.

The primary developmental concern for the Stage I reservoir is active lignite mining. In 1995, the Oak Hill Mine expanded its current permit area to include approximately one third of the proposed Stage I reservoir area. There have been no environmental studies conducted for this site. Based on preliminary screening, the site is located outside priority bottomland hardwood areas, and there are no known water quality issues.

The advantage to this reservoir site is its location near Harrison County, which has the greatest projected need. If operated with Lake Cherokee, there is existing infrastructure for distribution of water to the City of Longview and local industry.

State Highway 322 Stage II

The State Highway 322 - Stage II reservoir is the second phase of the State Highway 322 water supply project in Rusk County. The Stage II dam would be located on Mill Creek, approximately one mile upstream of the existing Lake Cherokee. Operated at the same level as Stage I (330 feet msl), this project would provide an increased yield to the Cherokee Lake system of 13,000 acre-feet per year with added storage capacity of 112,000 acre-feet. Stage II surface area would be 2,060 acres. The State Highway 322 project (Stages I and II) and Lake Cherokee could be operated as a system to provide a total yield of 53,000 acre-feet per year and maintain the recreational and aesthetic benefits currently provided by Lake Cherokee. If State Highway 322 project is operated independently from Lake Cherokee, the firm yield would be reduced due to Lake Cherokee's superior water rights.

The primary developmental concern for Stage II is the active lignite mining. Surface mining records indicate that the Oak Hill Mine permit encompasses much of the Stage II reservoir. Preliminary screening indicates no priority bottomland hardwoods in the reservoir area, and there are no known water quality issues. The advantages to this reservoir site is its location near the areas with projected water needs and the possibility that when mining is completed, the site will already be cleared and ready for reservoir development.

Stateline Reservoir

The Stateline Reservoir is a proposed main stem project on the Sabine River, approximately eight miles upstream of Logansport, Louisiana and about four miles upstream from the headwaters of Toledo Bend Reservoir. The project site is located in the southeastern section of Panola County and would have an estimated yield of 280,000 acre-feet per year. At the conservation level of 187 feet msl, the area and capacity would be 24,100 acres and 268,330 acre-feet, respectively.

Developmental concerns for this site include bottomland hardwoods, oil and gas wells, water quality, and permitting issues. The northern half of the site lies in a USFWS designated Priority 1 hardwood area. The southern half is a high quality wetland area and currently being considered for a wetland mitigation bank by the SRA. The mineral rights associated with the Carthage Oilfield significantly affect land acquisition for the reservoir. The CRP Water Quality data indicated possible concerns for elevated nutrient levels, metals, low dissolved oxygen and fecal coliform. This segment of the stream is also a known habitat for several protected aquatic species. Permitting for this reservoir will require an act of Congress since the dam is located on navigable interstate waters of the U.S. (Rivers and Harbors Act, 1899). Construction of the dam and reservoir may also require consent of Louisiana for the part that will impact the state of Louisiana (Sabine River Compact). As currently proposed, the dam site is located immediately upstream of the stateline reach and there is minimal impact to Louisiana lands. However, due to the close proximity of Toledo Bend Reservoir, it is unlikely that Stateline Reservoir would be more economical than Toledo Bend in meeting the needs of the Upper Basin.

Socogee Reservoir

The Socagee Reservoir site is located in the eastern portion of Panola County on Socagee Creek, approximately six miles upstream of its mouth. The reservoir, at normal pool elevation, would have a yield of 39,131 acre-feet per year. The reservoir area would be approximately 9,100 acres and the capacity would be about 160,000 acres.

Approximately 40 percent of the site overlies existing lignite deposits. As of 1986, there was no known exploitation of the lignite deposits, and there currently are no active mines within the area. One cultural resource site is reported in the reservoir boundary. There are no known water quality issues or priority bottomland hardwoods that affect this reservoir site. Socogee Reservoir could be used to meet the local needs of Panola County; however, Lake Murvaul, which has been designated for Panola County use only, has adequate yield to meet the future needs of Panola County

Fastrill Reservoir

The Fastrill Reservoir would be located in Anderson and Cherokee Counties. The dam would be located at River Mile 288. Normal pool elevation would be at Elevation 274 and would have an area of 25,900 acres. Storage capacity at normal pool elevation would be 495,000 acre-feet. Water supply would provide a dependable yield of 166.8 million gallons per day.

Ponta Reservoir

The Ponta Reservoir would be located on Mud Creek in Cherokee County east of Jacksonville, Texas. The dam site is located approximately one mile upsteram from the Southern Pacific Railroad crossing over Mud Creek. The normal pool elevation would be about Elevation 302 feet and would have an area of 11,000 acres. Storage capacity at normal pool elevation would be 200,000 acre-feet. Water supply storage would provide a dependable yield of 94.6 million gallons per day.

See Arc View Map

Rockland Reservoir

See Arc View Map
Lower Sabine Reservoir

See Arc View Map

Upper Sabine Reservoir

See Arc View Map

Fastill, Ponta, Eastex and Naconiche

6.3 Legislative and Regional Policy Issues

Section 357.7 (a)(9) of the Texas Water Development Board (TWDB) regional water planning guidelines requires that a regional water plan include recommendations for regulatory, administrative, and legislative changes.

"357.7 (a) Regional water plan development shall include the following…. (9) regulatory, administrative, or legislative recommendations that the regional water planning group believes are needed and desirable to: facilitate the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of the state and regional water planning area. The regional water planning group may develop information as to the potential impact once proposed changes in law are enacted."

This memorandum presents the regulatory, administrative, and legislative recommendations of the East Texas Regional Water Planning Group Water Planning Group and the reasons for the recommendations. The memorandum is divided into the following sections:

- Summary of recommendations
- Legislative Policy Issues
- Suggestions for state and federal programs to address water supply issues

<u>Summary of Recommendations</u>

The East Texas Regional Water Planning Group Water Planning Group makes the following recommendations for regulatory, administrative and legislative changes:

<u>Legislative Policy Issues</u>

- Provide clarification of the impacts of designating a stream as a unique stream segment.
- Use of appropriate criteria for planning purposes.
- Allow more than one water strategy to be designated as recommended strategy.
- Continued funding by the State of the Regional Water Planning process, including funds for interim planning required prior to the next cycle.
- Support of the Texas Water Conservation Association **Legislative Recommendations Regarding the Management of Groundwater** as adopted by its Board of Directors on June 8, 2000.
- Changes to Junior Water Rights regulations not be amended until all of the Regional Plans are consolidated into a Statewide Plan and the Statewide Plan be reviewed by the Regional Planning Groups.
- Availability of Water for Agricultural Use

- Water Availability Models

Suggestions for state and federal programs to address water supply issues

- Accelerate State-sponsored studies of ground-water availability modeling in the Carrizo-Wilcox and Gulf Coast Aquifers in the East Texas Region.
- Investigate a regional or statewide environmental mitigation system that would make available environmental projects to satisfy mitigation required by large scale projects such as reservoirs.

Legislative Policy Issues

Provide clarification of the impacts of designating a stream as a unique stream segment.

As part of the Senate Bill One planning process, regional water planning groups are asked to consider recommendations for designation of unique streams segments. It is difficult to make such recommendations at this time because of the uncertainty of the implications of this designation. The legislature is requested to clarify the intent and impact of the unique stream segment designation. Specific questions that should be answered include the following:

- What is the objective of designating a unique stream segment; i.e., what activities are expected to be managed differently?
- How would existing and future uses of adjacent private properties be affected by the designation?
- How will future water rights be affected? For example, would in stream flow requirements be different in, or upstream of, these segments?
- How will the designation affect regulatory programs for protecting water quality (water quality standards and total maximum daily load (TMDL) development, for example)?
- What types of activities could be restricted as a result of the designation?
    - Reservoir on the segment
    - Upstream reservoirs
    - Wastewater treatment plant discharge permits
    - Power line rights-of-way
    - Municipal separate storm sewer system permits
    - Pipeline rights-of-way
    - Road rights-of-way and/or bridges
    - Landfill siting
    - Septic system permitting
    - Non-point source use of herbicide, pesticides and fertilizers
    - Other activities

- What area is affected by the designation? Does it include the stream , an area immediately adjacent to the stream, the watershed, and/or upstream watershed?

Use of appropriate criteria for planning purposes

The present planning process does not allow for an adequate factor of safety. Development of planning criteria for future planning cycles should include consideration of the following:

- The supplies which result from water conservation strategies should be indicated separately, as opposed to being incorporated into the calculation of demand as is presently being done.
- During the initial stages of a drought of record water users will be unaware that a drought has begun. Water models should be adjusted to reflect these demands.
- The drought we should be planning for is outside the current domain of information available for our use. The drought of record being used currently probably has a recurrence frequency of about 50 years. The drought condition we are planning for should have a recurrence frequency several periods longer than our planning period.
- Using the guidelines of this planning effort, water conservation should be considered an unstated water management strategy for all water user groups nearing their available water supplies. Use of drought response as a water management strategy for those user groups should be anticipated for implementation about every 10 years for a summer season or longer.

Allow more than one water strategy to be designated as recommended strategy.

Section 357.7(a)(8) of the TWDB Regional Water Planning guidelines requires "specific recommendations of water management strategies to meet near term needs…". As we understand the TWDB interpretation of this requirement:

- Needs through 2030 are near-term needs
- Listing of a number of alternative strategies among which a water supplier can choose is not allowed for near-term needs.

We are concerned that this requirement decreases the local control and flexibility that have been an important part of the successful efforts to meet water needs in East Texas Regional Water Planning Group and throughout the state. Water suppliers need to have a full range of options as they seek to provide new water supplies for Texas' future. It is impossible to foresee all the possibilities for new water supplies in a planning process such as this, and changing circumstances can change the preferred alternative for new supplies very quickly. New laws, court decisions, regulatory changes, permitting decisions, changes in growth patterns, and other factors may make a recommended strategy impossible and require a supplier to develop other alternatives. We are also concerned that limiting the options of water suppliers will make negotiations to obtain needed land or water more difficult and drive up the cost of new water supplies. We recommend that the following steps be taken to address these concerns.

- The TWDB and the Texas Natural Resource Conservation Commission (TNRCC) should interpret existing legislation to give the maximum possible flexibility to water suppliers as they seek to serve the public and provide new supplies. Changes in the timing of supply development, the order in which strategies are implemented, the amount of supply from a management strategy, or the details of a project should <u>not</u> be interpreted as making that project inconsistent with the regional plan.

- Willing buyer/willing seller transactions of water rights and treated water should not be controlled by this regulation. Such transactions may be beneficial to all concerned and may simply not have been foreseen in the planning process.
- The TWDB and TNRCC should make liberal use of their ability to waive consistency requirements if local water suppliers elect strategies that differ from those in the regional plan.
- Legislative and regulatory changes should be made to remove this requirement for specificity from the Senate Bill One planning guidelines and allow plans to present alternative sources of supply where appropriate.

<u>Continued funding by the State of the Regional Water Planning process, including funds for interim planning required prior to the next cycle.</u>

- The East Texas Regional Water Planning Group believes the grassroots planning effort created by Senate Bill 1 is important to the state of Texas and should be continued.
- We also believe the most fair and efficient method of financing continuation of this effort for future planning cycles is to continue funding of this effort by the state with administrative expenses for the region being provided from sources within the region.
- There are important tasks that need to continue. Improvement of data for the next planning cycle is very important. State funding of those efforts needs to made available.

<u>Support of the Texas Water Conservation Association **Legislative Recommendations Regarding the Management of Groundwater** as adopted by its Board of Directors on June 8, 2000.</u>

The East Texas Regional Water Planning Group Water Planning Group supports the attached recommendations prepared by the Texas Water Conservation Association.

<u>Any proposed change to Junior Water Rights in the Water Code should not be considered until all Regional Plans are consolidated into a Statewide Plan and the Statewide Plan be reviewed by the Regional Planning Groups.</u>

<u>Availability of Water for Agricultural Use.</u>

Agriculture in East Texas is an important link in our nation's food chain and critical to our national security. The Eas Texas Regional Water Planning Group believes water must always be made available for agriculture, even in the face of adverse economic conditions or competing demands.

Water Availability Models

The final conclusions as to reservoir yields should include input from Regional Planning Groups. Water Availability Models often include conclusions on water supply amounts based on a series of runs with variations in assumptions. The Regional Water Planning Groups and regional major water providers should be included in the process for determining which of the runs should be adopted as the final product of the model.

Suggestions for State and Federal Programs to Address Water Supply Issues

Accelerate State-sponsored studies of ground-water availability modeling in the Carrizo-Wilcox and Gulf Coast Aquifers in the East Texas Region.

We encourage TWDB to continue its program of developing new groundwater availability models for major aquifers in Texas. If possible, we request that TWDB accelerate development of the model and of new availability estimates for the Carrizo-Wilcox & Gulf Coast Aquifers in the East Texas Region.

- Availability must identify allowable, sustaianable withdrawal rates per unit area of an aquifer. This characteristic varies within an aquifer.
- Water quality issues must also be identified especially as it affects the acceptability of groundwater for municipal water supply.

Investigate a regional or statewide environmental mitigation system that would make available environmental projects to satisfy mitigation required by large scale projects such as reservoirs.

- Conservation of our environmental resources is important to the East Texas Regional Planning Group and those we represent.
- Meeting the spirit of environmental mitigation requirements may best be accomplished within a system that would allow development of large mitigation projects, all or a portion of which could be banked for a future named or unnamed project in a similar environmental area.
- Liberal interpretation of environmental regulations would be necessary and would have to be agreed to by both state and federal regulators for this to occur. Legislation at the state and federal level is needed to assure development of such a system.

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Task 7
Plan Adoption

Task 7

Plan Adoption

This section describes the plan approval process for the East Texas Regional Water Planning Group Water Plan and the efforts made to inform the public and encourage public participation in the planning process. Special efforts were made to inform the general public and water suppliers and others with special interest in the planning process and to seek their input.

7.1 Regional Water Planning Group

The original legislation for Senate Bill One and the Texas Water Development Board planning guidelines establish regional water planning groups to control the planning process. The regional water planning groups were to include representatives of eleven specific interests:

- General Public
- Counties
- Municipalities
- Industrial
- Agricultural
- Environmental
- Small Businesses
- Electric Generating Utilities
- River Authorities
- Water Districts
- Water Utilities

Table 7.1 lists the members of the East Texas Regional Water Planning Group, the interests they represent, their organizations, and their counties. The East Texas Regional Water Planning Group held regular meetings during the development of the plan, receiving information from the region's consultants and making decisions on planning efforts. These meetings were open to the public, and proper notice was made under Senate Bill One guidelines. All of the East Texas Regional Water Planning Group meetings were held in Nacogdoches, a central location in the region. The water planning group generally met monthly and held more frequent meetings when the intensity of the planning effort required. The committee held 7 meetings in 1998, 7 meetings in 1999, and 12 meetings in 2000.

Table 7.1

Executive Committee	
Chair	Mr. Nick Carter
Vice Chair	Mr. George P. Campbell
2nd Vice Chair	Mr. Tom Mallory
Secretary	Ms. LaNell Larsen
Asst. Secretary	Mr. Edward McCoy, Jr.
At-Large	Judge Carl R. Griffith, Jr.
At-Large	Mr. David Alders

Table 7.1 (cont)

Voting Members		
Interest	Name	County (Location of Interest)
Public	Glenda Kindle	Henderson
	LaNell Larsen	Jasper
Counties	Judge Chris von Doenhoff	Houston
	Judge Carl R. Griffith	Jefferson
Municipalities	Dick Nugent	Jefferson
	Monty Shank	Smith
Industries	Michael Harbordt	Angelina
	Melvin Swoboda	Orange
Agricultural	David Alders	Nacogdoches
	Hermon E. Reed, Jr.	Panola
Environmental	Dr. J. Leon Young	Nacogdoches

Small Business	Ernest Mosby	San Augustine
	Edward McCoy, Jr.	Anderson
Electric Generating Utilities	Ken Deshotel, CPA	Hardin & Tyler
River Authorities	Jerry Clark	Orange (Service in Sabine portion of region)
	John Robinson	Jefferson (Service in Lower Neches portion of region)
	Tom Mallory	Anderson (Service in Upper Neches portion of region)
Water Districts	Nick Carter	Hardin
Water Utilities	Kelley Holcomb	Angelina
Other	Bill Kimbrough	Jefferson
	George P. Campbell	Nacogdoches
	Bart Bauer	Rusk

Table 7.1 (cont.)

Non Voting Members	
James Alford	County of Trinity
J. D. Allen	Imperial-Calcasieu Regional Planning & Development Commission of Louisiana
J. D. Beffort	Texas Water Development Board
Leroy Burch	Region C Water Planning Group
Cynthia Duet	Louisiana Governor's Office of Coastal Activities
William R. Heugel	County of Sabine
Jim Hughes	County of Newton
Steve Tyler	Region H Water Planning Group
Robert McCarthy	City of Dallas
Jerry Mambretti	Texas Department of Parks & Wildlife
Mendy Rabicoff	Region D Water Planning Group
Cliff Todd	Texas Department of Agriculture
Judge Floyd "Dock" Watson	County of Shelby

Judge Sandra Hodges	County of Rusk

Table 7.1 (cont.)

Consultants	
Schaumburg & Polk, Inc.	Gary Graham, P.E.
	Rick Bourque, P.E.
Freese & Nichols	Amy Kaarlela
Everett Griffith & Associates	Wayne Stolz, P.E.
Alan Plummer & Associates	Brian McDonald, P.E.
	Alan Plummer, P.E.
	Peggy Glass
LBG-Guyton	James Beach
Bob Bowman & Associates	Bob Bowman
Texas Agricultural Experiment Station	Dr. James W. Stansel

Table 7.1 (cont.)

Deep East Texas Council of Governments	
Van Bush	Regional Services Planner
Walter G. Diggles	Executive Director

7.2 Outreach to Water Suppliers and Regional Planning Groups

The East Texas Regional Water Planning Group made special efforts to contact water suppliers in the region and obtain their input in the planning process. The major water providers in the region (Angelina and Neches River Authority, City of Beaumont, City of Center, City of Jacksonville, City of Lufkin, City of Nacogdoches, City of Port Arthur, City of Tyler, Houston County WCID No. 1, Huntsman Chemical, Lower Neches Valley Authority, Motiva Enterprises, Panola County FWSD, Sabine River Authority, Upper Neches River Municipal Water Authority). The planning group encouraged the East Texas Regional Water Planning Group consultants to keep in close touch with the major water providers and other water suppliers as planning proceeded. Water suppliers were included on the mailing list for East Texas Region newsletters (discussed below under outreach to the public). Joint meetings with members of the Region H Water Planning Group and Region D Water Planning Group were held separately. The Region H joint meeting was held in San Jacinto County at the Waterwood National Resort, and Region D joint meeting was held in Longview. Members were appointed for representation on adjacent water planning groups. These people were: David Alders to Region H, Monty Shank to Region C, and Glenda Kindle to Region D. Other specific measures to obtain input from water suppliers and from other regional water planning groups are discussed below.

Questionnaires

Questionnaires were sent out early in the East Texas Region planning process to all East Texas Region counties, cities with populations over 1,000, regional water suppliers, retail water suppliers (supplying over 0.2 mgd), and large industries. The questionnaires sought information on population and water use projections and other water supply issues.

Technical Review Committee

As part of the development of population and water use projections for East Texas Region, the water planning group appointed a technical review committee composed of experienced water resource planners. This committee worked with the East Texas Region consultants to develop recommended Scope of Services. Members of the Technical Review Committee included:

- Dr. Leon Young (Chairman) – Environmental
- Michael Harbordt – Industries
- George Campbell – Other
- Melvin Swoboda – Municipalities
- Tom Mallory – River Authorities
- Monty Shank – Municipalities

7.3 Outreach to the Public

The East Texas Regional Water Planning Group published newsletters as needed to inform the public of the progress of the planning process. The newsletters were sent to:

- Water right holders
- County Judges
- Mayors and Officials of cities in the region
- Other water planning regions
- Texas Water Development Board staff
- Approximately 75 media

- Any person who requested to be on the mailing list

A total of seven newsletters have been distributed as of November 2000. An additional newsletter may be distributed in late December 2000. Copies of the East Texas Regional Water Planning Group newsletters published before November 2000 are included.

Public Awareness Presentations

Members of the East Texas Regional Water Planning Group Water Planning Group have made a number of presentations on the planning process to interested groups throughout the region. Table 7.2 is a partial list of the presentations made by planning group members.

Table 7.2

Public Awareness Presentations Made during the East Texas Regional Water Planning Group Planning Process

Date	Location	Speaker	Audience
May 13, 1999	Beaumont	Gary Graham	Municipal
May 18, 1999	Nacogdoches	Gary Graham	Manufacturing
May 19, 1999	Tyler	Gary Graham	Manufacturing
May 20, 1999	Nacogdoches	Gary Graham	Municipal
May 25, 1999	Beaumont	Gary Graham	Irrigation
May 26, 1999	Beaumont	Gary Graham	Manufacturing
June 2, 1999	Beaumont	Gary Graham	Ecological
June 9, 1999	Beaumont	Gary Graham	Power Generation
June 10, 1999	Nacogdoches	Gary Graham	Livestock
June 15, 1999	Lufkin	Gary Graham	Recreation
June 16, 1999	Tyler	Gary Graham	Mining
May 17, 2000	Beaumont	Gary Graham	Southeast Texas Regional Planning Commission
October 18, 2000	Sour Lake	Gary Graham	Leadership of Southeast Texas

Media Outreach

The media outreach plan for East Texas Region called for using a number of communication vehicles to keep the media, and hence the public, informed of the progress and activities of the East Texas Regional Water Planning Group.

- Newsletters – Newsletters were sent to approximately 75 media as well as to members of the general public on the mailing list.

- Public Meetings – The media were invited via a printed Public Meeting Notice to attend public hearings on September 26, September 27, and/or September 28, 2000.

- Ongoing media relations – Reporters form the Tyler County Booster, The Orange Leader, and Beaumont Enterprise have diligently covered the issues and activities surrounding the Region's water planning efforts.

The East Texas Regional Water Planning Group and its efforts have netted a significant of press coverage since August 1999. Copies of the press clippings for East Texas Region are included. During the planning process, articles on the East Texas Regional Water Planning Group and its efforts have been published in the following:

- *Beaumont Enterprise*
- *Tyler County Booster*
- *The Orange Leader*

Publication on the Web

In order to make the draft of the Initially Prepared East Texas Region Water Plan more accessible to the public, the Texas Water Development Board maintained a web site with information on the East Texas Region planning process as planning proceeded.

7.4 Public Meetings and Public Hearings

Initial Public Meeting

As required by Senate Bill One, the East Texas Regional Water Planning Group Water Planning Group held an initial public meeting to discuss the planning process and the scope of work for the region on March 25, 1998.

Public Meetings on Water Needs and Potential Strategies

In September of 2000, the water planning group held a set of public meetings to discuss the planning effort, present population and water use projections, discuss possible water management strategies for each county, and encourage public feedback. These meetings were held throughout the region.

Public Meetings and Public Hearing on Draft Initially Prepared Plans

In September of 2000, the East Texas Regional Water Planning Group held a series of public meetings around the region to present the draft *East Texas Regional Water Plan* and seek public input. The public hearing on the draft *East Texas Region Water Plan* were held as follows:

- September 26, 2000, 6:00 pm, Holiday Inn – Southeast Crossing, Tyler, Texas
- September 27, 2000, 6:00 pm, Holiday Inn, Nacogdoches, Texas
- September 28, 2000, 6:00 pm, Beaumont Hilton, Beaumont, Texas

Public comments were to be sent prior to October 3, 2000 to:

Van Bush
Deep East Texas Council of Governments
274 East Lamar Street
Jasper, Texas 75951-4108
(409) 384-5704

Response to Public Comments

A summary of the comments received as a result of the Public Hearings is provided as an appended section entitled "Summary of Public Comments." This section also provides a listing of where the Initially Prepared Plan was modified in response to these comments. In addition to addressing the public comments, these modifications also address the ETRWPG's position in response to comments made by the Texas Parks and Wildlife, by letter dated November 27, 2000.