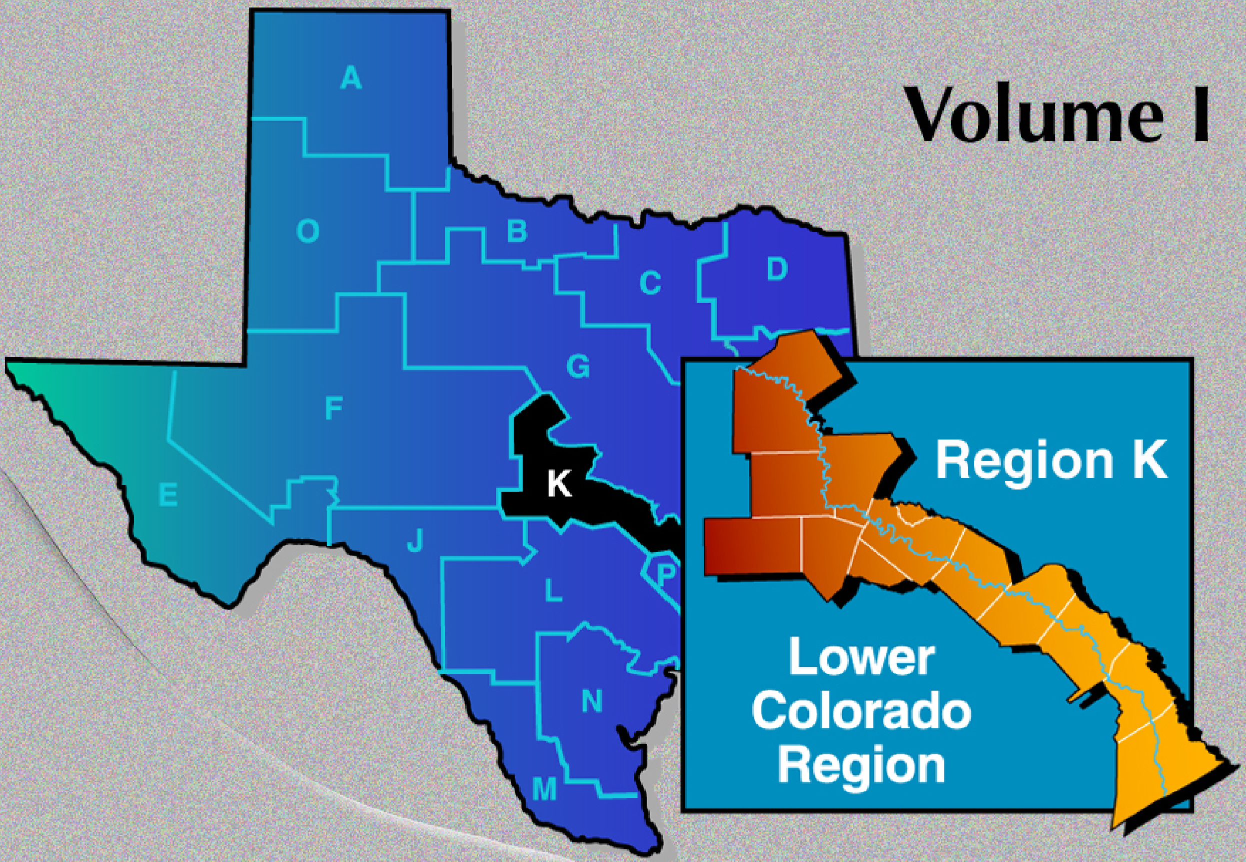
Adopted

Region "K" Water Supply Plan for the Lower Colorado Regional Water Planning Group

Volume I



prepared by
Lower Colorado Regional Water Planning Group
with funding assistance from the Texas Water Development Board

prepared for
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in association with
Alan Plummer Associates Inc.
CH2M Hill
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Strategic Communications

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A very special thanks and notice of appreciation is extended to all the Regional Planning Group Members for the thousands of volunteer hours, and their willingness to serve the Lower Colorado Region as representatives of not only the region, but also of the varied and diverse interests of citizens and residents of the region and the State of Texas.

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Counties	Commissioner Dale Henry, Mills County
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Industries	Mark Smith, Motorola
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ACRONYM KEY FOR THE LCRWPG ADOPTED PLAN	
Acronym	**Meaning**
ARP	Acreage Reduction Program
ASR	Aquifer Storage and Recovery system
BCEN	Bastrop County Environmental Network
BEG	Bureau of Economic Geology
BFZ	Balcones Fault Zone
BOD	Biochemical Oxygen Demand
BSEACD	Barton Springs/Edwards Aquifer Conservation District
CCN	Cloud Condensation Nuclei
CLWSC	Canyon Lake Water Supply Corporation
CFY	Combined Firm Yield
COA	City of Austin
CDP	Census Designated Place
CRP	Clean Rivers Program
DCP	Drought Contingency Plan
DGRA	Donald G Rauschuber and Associates
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
GBRA	Guadalupe-Blanco River Authority
GCD	Groundwater Conservation District
GIS	Geographic Information System
gpd	gallons per day
IBT	Interbasin Water Transfer
IN	Ice Nuclei
LCRA	Lower Colorado River Authority
LCRWPA	Lower Colorado Regional Water Plan Area
LCRWPG	Lower Colorado Regional Water Planning Group
mrems	millirems
MUD	Municipal Utility District
PC	Possible Concern
pCi/L	picoCuries/Liter
ppm	parts per million
ROR	Run-of-the-River
RWPG	Regional Water Planning Group
SB 1	Senate Bill 1
SCTRWPG	South Central Texas Regional Water Planning Group
SDC	State Data Center
SDWA	Safe Drinking Water Act
TAES	Texas Agriculture Experiment Station
TAC	Texas Administrative Code
TDS	Total Dissolved Solids
TNRCC	Texas Natural Resource Conservation Commission
TPWD	Texas Parks and Wildlife Department
TWC	Texas Water Code
TWDB	Texas Water Development Board
TxEMP	Texas Estuarine Mathematical Programming
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USS/RSC	Unique Stream Segments and Reservoir Sites Committee
UWCD	Underground Water Conservation District
WCID	Water Control and Improvement District
WCWWTP	Walnut Creek Wastewater Treatment Plant
WCP	Water Conservation Plan
WMA	Wildlife Management Area
WMP	Water Management Plans
WRI	Water Reclamation Initiative
WTCRWS	West Travis County Regional Water System
WUG	Water User Group

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ES.1 OVERVIEW

The main features of the *Adopted Regional Water Supply Plan* for the Lower Colorado Regional Water Planning Group (Region K) are outlined in Figure ES 1. The Plan includes:

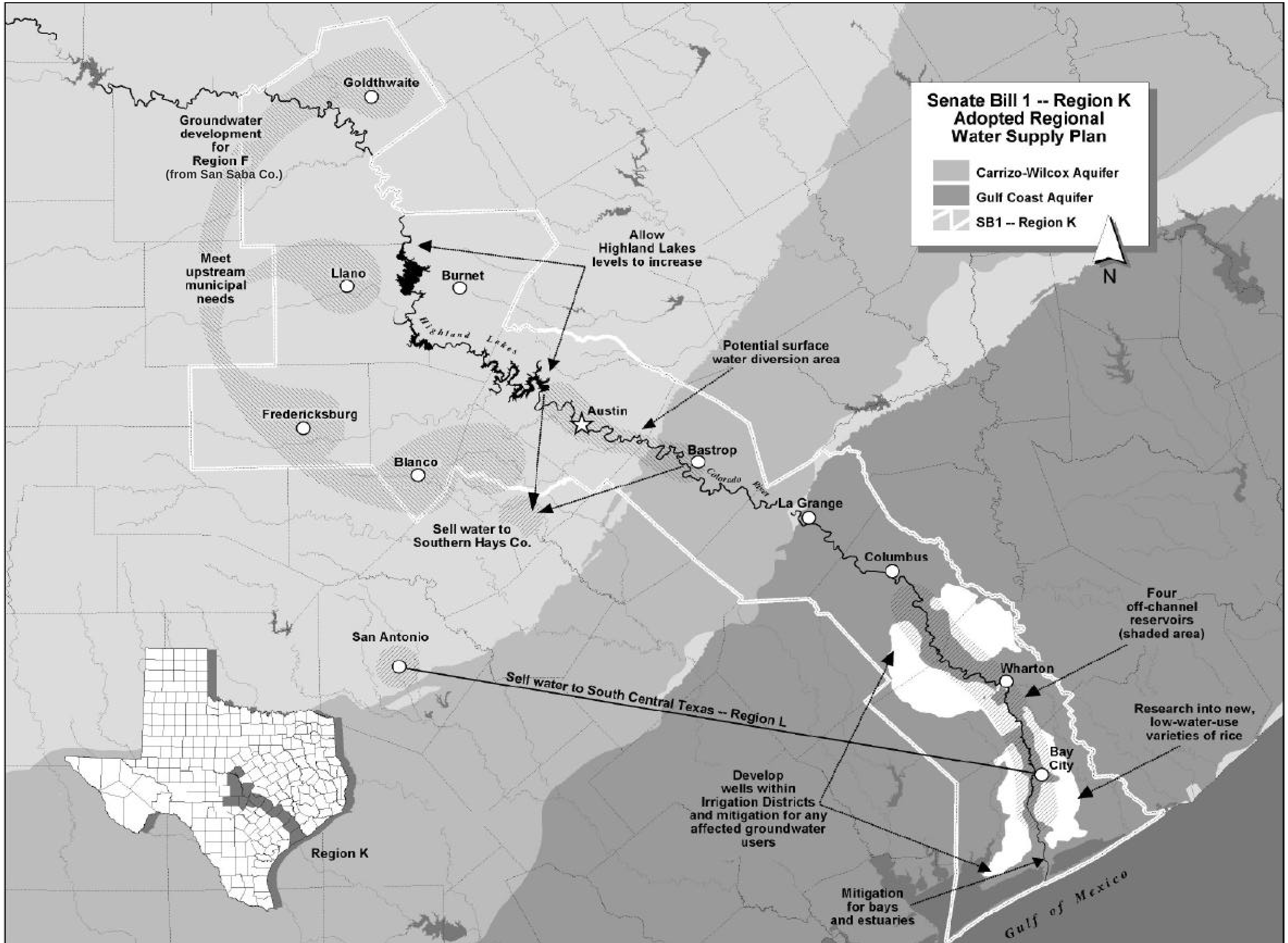
- A comprehensive approach that (a) serves Region K water users from Mills County (above the Highland Lakes) to Matagorda County on the Gulf Coast; and (b) raises funds to do so by making water available to meet a portion of the water needs on a long-term lease basis in San Antonio and southern Hays County.
- Wide-ranging policy recommendations about groundwater management, interbasin transfers, additions to the HB1437 rules on replacement of additional sales outside the Basin, farmland preservation, sustainability, ecological protection, assistance for small systems affected by proposed new USEPA radionuclide and uranium standards, clarification of some designations, and changes needed to the Senate Bill 1 planning process, among other topics.

Many of the region's water users purchase water from the Lower Colorado River Authority (LCRA) or the City of Austin (COA). These providers are expected to meet the growing needs of their existing customers.

While the Plan and its projects have been discussed with other affected regions, the implementation process will require ongoing adjustments to the projects as outlined here. The map on the following page shows Region K and solutions the Lower Colorado Regional Water Planning Group (LCRWPG) recommends to the Texas Water Development Board to meet projected water needs for the communities above the Highland Lakes; maintaining lake levels in the Highland Lakes; and irrigation in Colorado, Wharton, and Matagorda counties; including:

- Advanced on-farm water conservation and crop research projects with potential to reduce demand by about 118,000 acre-feet/year;
- Four new off-channel reservoirs at unspecified sites in the south within about five miles of the Colorado River to capture at least 131,000 acre-feet of water for use during critical drought periods. This amount may increase to 150,000 acre-feet or more depending upon permit requirements for these reservoirs, which will be based on LCRA's existing water rights;
- A pipeline beginning in the Bay City area to potentially carry up to 122,000 acre-feet per year of water to San Antonio; the water will be sold through a long-term lease at a price adequate to fund projects along the entire Lower Colorado River Basin;
  - ✓ Mitigation measures to prevent unacceptable impacts to bays and estuaries as a result of capturing this flow in the new reservoirs;
- Development of new wells within current irrigation districts in the southern counties to provide an average of up to 68,000 acre-feet per year of irrigation water during drought periods only;
  - ✓ Mitigation measures to remedy any unacceptable impacts on groundwater users caused by the new groundwater development;
- One effect of the above measures is to make it possible to maintain more water in the Highland Lakes, thereby enhancing lake levels, which helps maintain their recreational and aesthetic value;
- Long-term lease of 5,000 acre-feet initially (rising to a maximum of 9,000 acre-feet in 2050) diverted from between Lake Austin and Bastrop, plus a pipeline to carry this water to southern Hays County. The LCRWPG has approved water transfers of up to 28,000 ac-ft/yr in 2050, subject to the supply ultimately determined to be available as a result of developing the four off-channel reservoirs;

Figure ES 1: SB 1 LCRWPG Adopted Plan (Region K)

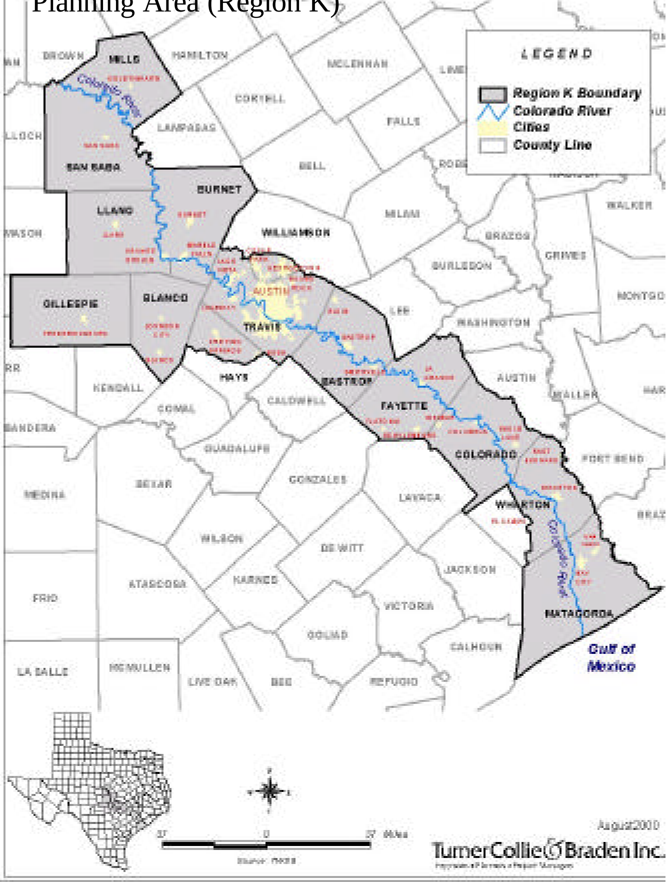


- A variety of projects recommended in the upstream communities of Goldthwaite, Blanco, Llano, Fredericksburg, and in northern Hays County to assist them in meeting their supply needs; and,
- LCRA will continue to provide supplies to Williamson County under the provisions of HB1437, which requires replacement of all water taken from the Colorado River Basin. The Region K Water Plan recommends, for transfers beyond the original 25,000 ac-ft/yr, that the legislation authorizing these additional transfers require an increased replacement ratio of at least 1.33 acre-feet of water for each 1.0 acre-foot of water transferred.
- The maximum annual water transfer to southern Hays County and San Antonio (located within SB1 Region L) in this regional water plan totals 131,000 acre-feet. However, the LCRWPG approves a maximum water transfer of up to 150,000 acre-feet annually to Region L if that amount of additional water supply ultimately is determined to be available as a result of developing the four-off channel reservoirs, subject to other permitting, mitigation and environmental protection requirements yet to be determined.

ES.2 INTRODUCTION AND BACKGROUND

Following the guidelines set forth in Senate Bill 1, the Lower Colorado Regional Water Planning Group (LCRWPG) has prepared this adopted water supply plan covering the 2000 to 2030 time period, with options outlined for water supply needs from 2030 to 2050. This plan has been submitted to the Texas Water Development Board (TWDB) for review and integration into a statewide water plan. The plan includes strategies for ensuring supplies during drought-of-record conditions and policy recommendations related to improving water management and preserving the environment. It should be noted that local plans that are not inconsistent with the regional water supply plan are also eligible to apply for TWDB financial assistance even though they have not been specifically recommended in this plan.

Figure ES 2:Lower Colorado Regional Water Planning Area (Region K)



The Lower Colorado Region—designated by the TWDB as Region K—consists of all or parts of 14 counties roughly consistent with the Lower Colorado River Basin (see Figure ES 2). This area relies primarily on the Colorado River; the Edwards, Trinity, Edwards-Trinity (Plateau), Carrizo-Wilcox, and Gulf Coast aquifers; and several minor aquifers for its water supply. Small portions of the Brazos, Guadalupe, and Lavaca River Basins also lie within the region. In total, about 23 percent of dependable yield water supplies during drought-of-record conditions come from groundwater, while the remaining 77 percent are provided by surface water.

The region stretches from arid and rocky Hill Country counties that receive an average of 24 inches of rainfall annually to the humid Coastal Plain, which receives an average of 44 inches of rain per year. Average annual stormwater runoff ranges from about 350 acre-feet per square mile near the mouth of the Colorado River to less than 50 acre-feet per square mile in the western portion of the region. During the 1950s drought - used as the drought-of-record for calculation purposes in Region K's Plan - both of these average annual runoff values declined by about 75 percent.

The system of Highland Lakes administered by the LCRA is a major hydrologic feature of the region that provides flood control, power generation, water storage, and recreational benefits.

About 75 percent of the region's population of approximately one million is currently concentrated in the rapidly growing Austin Metropolitan Area, which includes parts of Williamson and Hays counties. By 2050, the population of the region as a whole is projected to double, although the vast majority of the population growth is expected in the geographic "middle" counties (i.e., Blanco, Burnet, Hays, Travis, Williamson, Bastrop, and Fayette counties).

ES.3 WATER NEEDS AND POTENTIAL LOSSES

The region's population now consumes about 1.1 million acre-feet of water each year, with 62 percent used for agricultural and livestock purposes, 23 percent put to municipal use, 7 percent devoted to mining and manufacturing, and the remaining 8 percent to electric power generation (see Figure ES 3). As Figure ES 4 below shows, this pattern of use is expected to change over the planning period, such that the volume of irrigation use will decrease slightly, and the proportion of total use it represents will decline significantly.

Figure ES 3: Year 2000 Total Water Demand by Type of Use

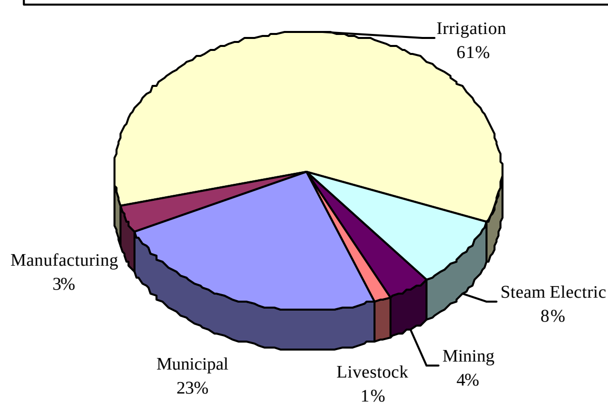
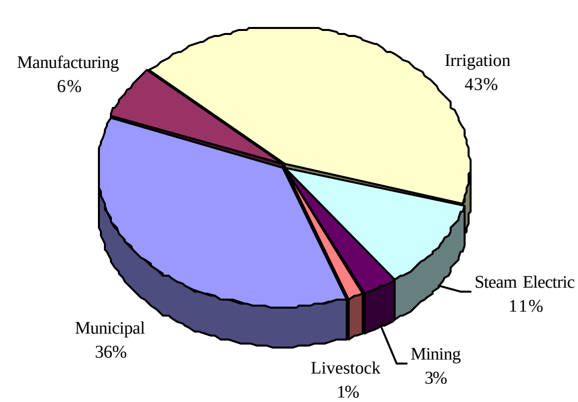


Figure ES 4: Year 2050 Total Water Demand by Type of Use



These projections include the conservation assumptions adopted by the TWDB, even though in some parts of the region about half of the water purveyors responding to Planning Group surveys indicated they had no conservation plan in place. History does show declines in total consumption as a result of improved practices, but the means to achieve further conservation savings will need to be pursued by individual water purveyors if the projections are to prove correct.

Currently developed groundwater, surface water, reclaimed water and other water supplies now provided through contractual agreements or operation of the existing system of reservoirs are not adequate to meet the projected needs in all parts of the region.

The gross economic impacts of the worst-case shortage are estimated to be losses of $162 million in terms of regional income in year 2000, rising to $1.9 billion in 2030. Employment impacts in year 2000 are 7,719 jobs, rising to 62,270 jobs in 2030.

These gross impacts have also been adjusted to reflect approximate net regional economic losses taking opportunity costs into account. The net income loss to the region is approximately $50 million per year for each year in which conditions match those of the average drought of record for Region K. Net employment declines amount to 2,100 jobs. Population loss associated with the employment loss would amount to about 4,900 persons in 2030. These losses would justify an investment of approximately $190 million today (net present value basis using a 6 percent discount rate).

The adjusted economic losses to the region from a failure to resolve shortages, while relatively small in the aggregate, would be costly to particular groups. The projected shortage in the year 2030, for example, would result in a 20 percent decline in rice production. While the net farm income loss to the region would be much less than 20 percent, the loss falls heavily on rice farmers and the economies of Colorado, Matagorda, and Wharton counties. Likewise, the economic losses from failing to solve projected municipal shortage problems would fall most heavily on communities within Mills, Llano, Blanco, Hays, and Gillespie counties.

ES.4 ISSUES AFFECTING WATER PLANNING

The issues involved in meeting these shortages are complex and inter-related. Not all issues could be resolved during this two-year planning process. The section on policy recommendations later in this summary provides an overview of some of the key concerns, and a listing of unresolved issues, related to the specifics of the Regional Plan appears below under in section ES.4.1, Unresolved Issues.

Many issues relate to the impacts of growth within the region and how to maintain a sustainable water supply system in conjunction with protecting the region's diversity of ecological communities and quality of life. Among the most prominent circumstances and concerns addressed by the LCRWPG are:

- Addressing needs of both urban growth and agricultural irrigation to maintain a sound and diverse economy and a variety of lifestyles;
- Maintaining lake levels in the Highland Lakes to support recreation and tourism, which are key elements in the region's quality of life and economic health;
- Other regions, particularly the South Central Texas Region, face major water shortages that they may not find feasible means to meet within their own boundaries. Water user groups in the areas surrounding Region K have looked to Region K for water sources to meet their needs;
- Maintaining the instream flows required for a healthy river and rich biological diversity in the bays and estuaries of the Gulf of Mexico that rely on inflows of fresh water;
- How to both respect the autonomy and local control of individual water user groups (Senate Bill 1 specifically prohibits the Regional Water Planning Groups from imposing "solutions" on individual user groups) and at the same time foster broad programs of conservation, drought management, and conjunctive use that are key elements to water management in much of the region;

- How to address water strategies (such as brush control) that cross the boundaries between public and private property, individual and community benefits, and many political jurisdictions;
- The impacts of decisions such as designation of sites for preservation or development (e.g., ecologically unique stream segments) on private property rights and the ability of cities and counties to maintain their tax base; and,
- The unintended consequences of many water strategies, such as the impacts on downstream users of upstream reservoirs and widespread dewatering of aquifers.

ES.4.1 Unresolved Issues

Although many aspects of the issues listed above continue to be debated and require additional refinement, the LCRWPG identified specific unresolved issues that will affect implementation of the proposed plan and will require the attention of future Regional Water Planning Groups.

Among the most prominent unresolved issues are those related to the uncertainties inherent in **groundwater modeling and the limited data available** regarding the region's aquifers and groundwater hydrology. This affects discussion of the water availability in the Carrizo-Wilcox aquifer, for example, which is a vital part of the strategy recommended in this Plan. In some cases, dewatering could occur across regional boundaries. The LCRWPG will continue to take an active interest in groundwater modeling efforts and other studies to better characterize the region's hydrology. In concurrence with other regions, Region K urges the TWDB to continue funding these types of studies, which are vital to the planning process.

Return flows from the City of Austin are a second area where estimating far into the future has caused uncertainty. The degree to which Austin will recycle its wastewater effluent is in part dependent on the degree to which shortages occur once the 325,000 acre-feet of water the City has provided for is fully used. The City has the right to recycle all its wastewater, but the Plan as submitted assumes a substantial amount of return flow. The planning group's approved estimates indicate that by the year 2050, Austin may be reusing approximately 31,000 ac-ft/yr (~ 16%) of its effluent and this amount is projected to increase beyond 2050.

The full impact on bays and estuaries of the combined strategies will continue to be a difficult issue to resolve. Studies are now under way regarding how the capture of water in the proposed southern-county off-channel reservoirs would affect bays and estuaries. The contribution of rice flood-culture irrigation is not well understood at present. Further study is needed to quantify stormwater runoff from open fields, irrigation water drained from fields and irrigation system leakage.

Senate Bill 1 assumes effective **conservation programs** in municipalities throughout all regions, yet many cities have not taken effective measures to achieve conservation goals. In addition, the plan proposed for Region K depends heavily on advanced farm conservation improvements, with the assumption that long-term water leases to customers outside the region can fund these improvements. If such leases do not materialize, or if the revenue is inadequate for full implementation, the goals of the plan may not be achieved.

Joint meetings and **ongoing dialog** with other regions have led to productive cooperation, but discrepancies remain with regard to regional plans involving exports of water from one region to another. It is anticipated that specific features and amounts included in these plans will be modified as individual water user groups move discussions and implementation forward. In addition, efforts to reconcile points of view on matters such as the amount of water available and diversion required from the area between

Bastrop and Lake Austin for export to Region L were not concluded at the time this report is going to press.

The line between "long-term but temporary" and "permanent" water transfers has been a concern for some due to **timeframes** of up to 80 years discussed as potential terms for water contracts.

What degree of **groundwater drawdown**, if any, is acceptable or is a desirable trade-off in a given set of circumstances? Perhaps no two people have exactly the same opinion on this controversial subject. Disagreement is often exacerbated by a lack of data about the aquifers and the interaction of groundwater and surface water hydrology.

Additional issues are sure to arise as all of the particulars of implementation, interbasin discussions and a refined Senate Bill1 planning process develop. It is incumbent on those participating in future planning and implementation efforts to explore the implications of these issues.

ES.5 IDENTIFIED SHORTAGES AND STRATEGIES TO MEET THEM

The project team compared water supplies (Chapter 3) and projected demands (Chapter 2) to determine where shortages, or "needs", are expected to occur. The comparison identified 38 water user groups (WUGs) that would have projected water deficits by the year 2030 under drought-of-record conditions. An additional 4 WUGs are shown with projected water deficits arising between 2030 and 2050.

The estimated water need under drought-of-record conditions for all of Region K is approximately 391,000 acre-feet per year (ac-ft/yr) in 2030 and 387,000 ac-ft/yr in 2050. This identified shortage is based on availability estimates, which exclude water available from LCRA on an interruptible basis and water available as a result of Austin's return flows to the Colorado River. Water needs have been identified in five of the six water use categories, as shown in Figure ES 5, which illustrates the distribution of the number of WUGs with identified water needs in the years 2030 and 2050. Figure ES 6 shows the magnitude of the identified needs by water use category for the years 2030 and 2050.

Figure ES 5: Number of LCRWPA Water User Groups With Needs

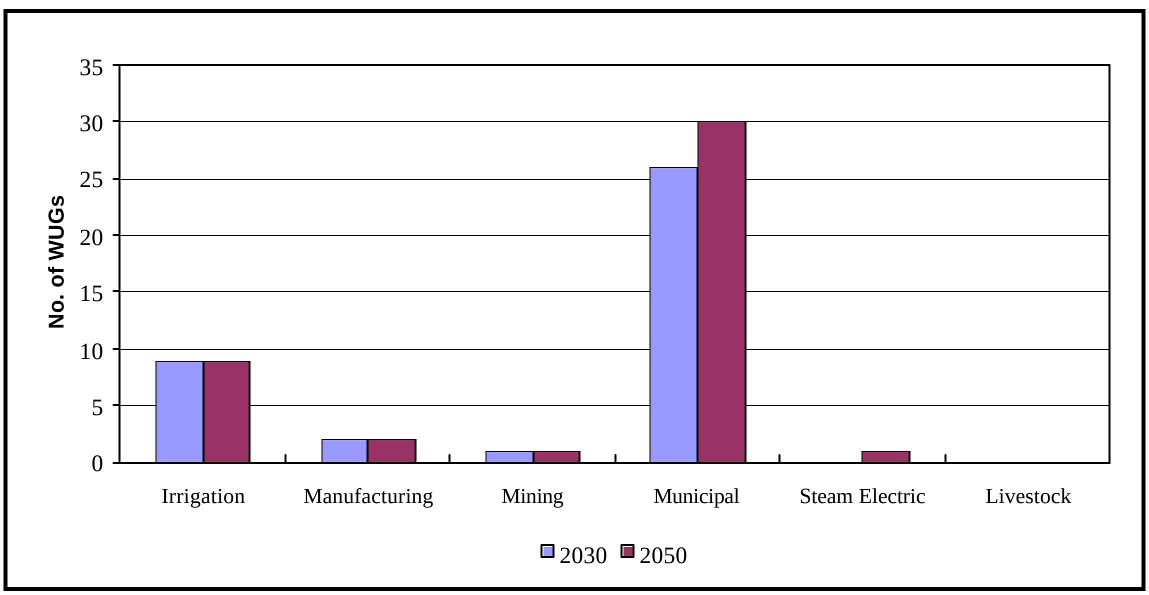
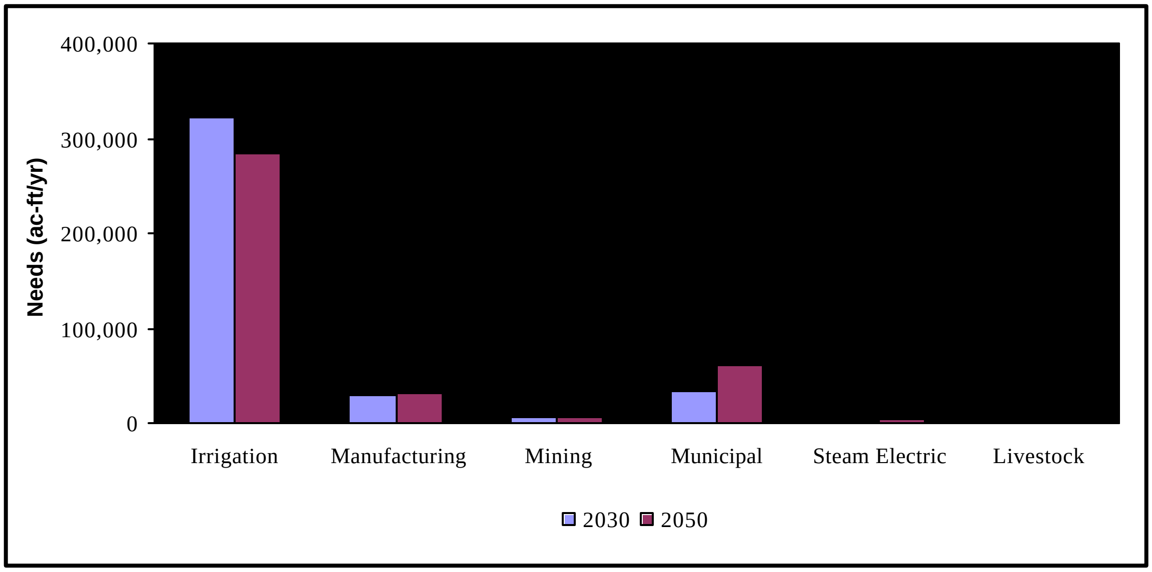


Figure ES 6: LCRWPA Identified Water Needs by WUG



Note in Figures ES 5 and ES 6 that the total regional shortage is greatest in the category of irrigation, while the largest number of user groups with potentially unmet needs are municipalities.

ES.5.1 Water Purchases from LCRA and the City of Austin

Half of the Water Users Groups (WUGs) for which the project team identified shortages hold current contracts with LCRA for the purchase of raw untreated water or with the City of Austin for the purchase of treated potable water (see Table ES 1). These contracts, almost all of which will expire during the planning period, total over 100,000 acre-feet provided by LCRA and almost 30,000 acre-feet provided by the City of Austin (including the Pflugerville contract).

Consultations with these contract holders about their future plans revealed that all of them planned to meet their future water needs by renewing their existing contracts, although almost all will need to contract for larger volumes of water to meet future needs.

The City of Pflugerville (COP) has contracted for purchase of up to 10 million gallons per day (mgd) from the City of Austin to meet current and future needs. The COP has recently completed the installation of the necessary water delivery infrastructure and this water is now available for use by the COP. It should be noted however, that the COP is also continuing to evaluate other water supply options for meeting future needs (see Section 5.4.5 for details).

In addition, the City of Austin recently entered into a new contract with Mid-tex through 2030, to supply treated water to the Pfluger Ranch and Spillar Ranch developments. The details of this contract were not available when the demand projections were completed, so this demand will be included in the next planning cycle.

Table ES 1: Municipal Water User Groups with Contractual Water Supply Deficits (negative values)

WUG	County	Provider	2000 (ac-ft/yr)	2030 (ac-ft/yr)	2050 (ac-ft/yr)
Cottonwood Shores	Burnet	LCRA	-3	-168	-171
Granite Shoals	Burnet	LCRA	0	-456	-493
Marble Falls	Burnet	LCRA	0	-2,105	-2,264
County-Other	Burnet	LCRA	-880	-1,652	-1,779
County-Other	Llano	LCRA	0	-1,334	-1,653
Kingsland	Llano	LCRA	-25	-463	-493
Manufacturing	Matagorda	LCRA	1,709	-30,035	-31,019
Steam Electric	Matagorda	LCRA	0	0	-5,237
Mining	Matagorda	LCRA	-4,475	-6,249	-6,285
Anderson Mill [2]	Travis	City of Austin	0	-33	-34
Jonestown	Travis	LCRA	0	-40	-485
Lago Vista	Travis	LCRA	0	-2,995	-3,630
Lakeway	Travis	LCRA	0	-2,693	-3,287
Pflugerville [3]	Travis	City of Austin	-291	-2,323	-3,378
Rollingwood [1]	Travis	City of Austin	0	-675	-793
Wells Branch	Travis	City of Austin	0	-1,013	-1,064
West Lake Hills	Travis	City of Austin	0	-2,956	-3,682
County-Other	Travis	LCRA / COA	-60	-7,438	-8,797
Anderson Mill [2]	Williamson	City of Austin	0	-1,986	-2,106
County-Other	Williamson	City of Austin	-72	-178	-215
Regional Deficit			**-7,515**	**-64,792**	**-76,865**

[1] The City of Austin (COA) recently renewed its contract with Rollingwood for 1,120 ac-ft/yr through February 2030;
[2] The Anderson Mill MUD will become a part of the COA retail service beginning in December 2004, which will be included in the next planning cycle;
[3] Pflugerville is listed above as having water supply deficits during the planning period because they are not planning to utilize the COA contract to meet future needs and are currently evaluating alternate water supply options – this issue should be clarified in the next planning cycle;

The LCRA has two major surface water sources for its water supplies. These sources include the Highland Lakes System and run-of-river water rights in the lower portion of the basin. The LCRA has commitments to provide water to individual users and cities throughout the basin. In addition, the LCRA uses water at its electric generating facilities. Table ES 2 below contains a comparison of LCRA's dependable water supplies to its water commitments.

Table ES.2: LCRA Water Supply/Commitment Comparison (ac-ft/yr)

LCRA Water Supply/Commitments	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Dependable Water Supplies	498,166	498,166	498,166	498,166	498,166	498,166
Dependable Water Commitments	432,647	432,647	432,647	432,647	432,647	432,647
Interruptible Water Demands	379,642	353,710	334,899	318,249	301,059	284,384
Water Surplus/Deficit	**-314,123**	**-288,191**	**-269,380**	**-252,730**	**-235,540**	**-218,865**

Note: The water supply is detailed in Table 3.20. The water commitments are detailed in Table 3.21. The sum presented above represents all commitments, regardless of expiration since the LCRA plans to continue providing these services. The total water commitment includes all rice irrigation demands. Commitments also include the out-of-basin 25,000 ac-ft/yr demand from Region G in Williamson Co.

This table indicates that the LCRA does not have enough water to meet all of its water commitments, although it does have enough water to meet its dependable water commitments through the year 2050. It is important to recognize that the analysis performed for Region K's plan does not include the interruptible water supplies available through the implementation of the LCRA's Water Management Plan or the City of Austin return flows. The rice farmers at the southeastern end of the region rely on the LCRA's interruptible water supplies for irrigation, which are not considered to be available during drought of record conditions. In addition, a portion of the Colorado River's instream flow requirements are currently being met using the City's return flows. The supplies not incorporated in the analysis are the basis for the water management strategies discussed in Chapter 5.

The City of Austin (COA) has two major sources for its water. These sources include the run-of-river water rights and a contract with LCRA to receive water from the Highland Lakes during drought conditions. These rights are separated by the use of the water. The City of Austin has separate rights for municipal uses and steam electric generation. Tables ES 3 and ES 4 contain comparisons of the City of Austin's water supplies to its water commitments in these two areas.

Table ES 3: COA Municipal & Manufacturing Water Supply/Commitment Comparison (ac-ft/yr)

COA Water Supply	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Municipal Water Supply	325,000	325,000	325,000	325,000	325,000	325,000
Municipal Water Commitment	198,073	225,580	263,470	301,447	326,341	355,714
Water Surplus / Need	**126,927**	**99,420**	**61,530**	**23,553**	**-1,341**	**-30,714**

Note: Supplies are detailed in Table 3.22; commitments are detailed in Table 2.16. Above sum represents all commitments, regardless of expiration since the COA plans to continue providing these services, including 6,161 ac-ft/yr for Round Rock.

This table indicates that the City of Austin has sufficient water to meet its municipal and manufacturing needs through the year 2030. By the year 2050, it is anticipated that the City of Austin will have a deficit of approximately 31,000 ac-ft/yr, or approximately 9 percent of its demands.

Table ES 4: COA Steam Electric Water Supply/Commitment Comparison (ac-ft/yr)

COA Water Supply	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Stm. Elec. Water Supply	46,856	46,856	46,856	46,856	46,856	46,856
Stm. Elec. Water Commitment	21,500	21,500	21,500	21,500	21,500	24,500
Water Surplus	**25,356**	**25,356**	**25,356**	**25,356**	**25,356**	**22,356**

Note: Supplies are detailed in Table 3.22; commitments are detailed in Table 2.16. Above sum represents all steam electric generating needs for Travis County plus 8,000 ac-ft/yr at the Fayette Power Project.

This table indicates that the City of Austin has a surplus of water for its steam electric generating needs as a whole. The City has aggressive conservation and water reclamation programs under way and plans to recycle up to 100 percent of its wastewater flows if necessary to meet their projected demands that are in excess of 325,000 acre-feet.

ES.5.2 Region-Wide Shortages and Identified Strategies

Below is a list of the methods adopted by the LCRWPG for meeting identified water supply shortages:

Table ES 5: Summary of Adopted Methods for Meeting Identified Water Supply Shortages

Water User Group	Shortages (ac-ft/yr)	Strategies for Meeting Shortages	Estimated Unit Cost ($/ac-ft) [1]	Estimated Project Cost ($ Million) [1]
WUGs w/ expiring LCRA contracts	2050 = 102,034	Renewal of contracts for purchase of raw water from LCRA. *(Alternative C1)*	$105 [(2)]	--
WUGs w/ water expiring COA contracts	2050 = 19,308	(a) Renewal of contracts for purchase of potable water from the City of Austin *(Alternative C2)*; and/or (b) Direct use of Colorado River supply.	(a) $652 [(3)] (b) $538	-- --
City of Austin	2040 = 1,341 2050 = 30,714	(a) Water conservation -- 10% savings *(Alternative A1);* (b) Reclaimed water--up to 31,000 ac-ft/yr or recycling up to 100% of wastewater flows to meet demand in excess of 325,000 ac-ft/yr *(Alternative A2).*	(a) unknown (b) $394	-- $63.210
Hays County-Other	2010 = 162 2030 = 1,892 2050 = 3,594	Through 2030 (pending approval of the local water authorities): (a) Obtain surface water from west Travis County Regional System--up to 3,360 ac-ft *(Alternative H1)*; and/or (b) Obtain surface water from GBRA/San Marcos Regional System--up to 1,680ac-ft *(Alternative H2)*; and/or (c) Obtain potable water from the COA--up to 1,100 ac-ft/yr *(Alternative H3)*; and, (d) Build recharge-enhancing ponds along Onion Creek--up to4,000 ac-ft *(Alternative H6)*.	(a) $1,259 (b) $647 (c) $818 (d) $98	$23.610 $15.110 $2.200 $4.555
City of Dripping Springs	2030 = 22 2050 = 364	(a) Obtain surface water from west Travis County Regional System--up to 3,360 ac-ft *(also part of Alternative H1)*; and/or	(a) $1,259	Same as (a) above Hays County-Other: H1
City of Blanco	2030 = 15 2050 = 5	Purchase potable water from Canyon Lake Water Supply Corporation--up to 300 ac-ft/yr *(Alternative BL6).* (projected reduction from 2030 due to conservation)	$1,562	$4.680
Blanco County-Other	2000 = 24 2030 = 163 2050 = 215	Purchase potable water from Canyon Lake Water Supply Corporation--up to 300 ac-ft/yr *(also Alternative BL6).*	$1,562	Same as above for BL6
City of Llano	2000 = 660 2030 = 555 2050 = 602	Constraint is storage capacity (a) Dredge existing reservoirs--# of acre-foot benefit unquantified *(Alternative L1 – **annual costs only**)*; and/or (b) Add a channel dam downstream of existing reservoirs--produces 1,300ac-ft/yr *(Alternative L2).*	(a) $710 (b) $461	$0.071/yr $2.530

Water User Group	Shortages (ac-ft/yr)	Strategies for Meeting Shortages	Estimated Unit Cost ($/ac-ft) [1]	Estimated Project Cost ($ Million) [1]
City of Goldthwaite	2000 = 117 2030 = 89 2050 = 88	Constraint is storage capacity; reservoir feasibility study in progress. (a) Dredge existing reservoirs--amount unspecified *(Alternative G1)*; and/or (b) Build new off-channel reservoir--200 ac-ft *(Alt. G3)*; (c) Build new Colorado River channel dam--400 ac-ft *(Alt.G2);* (d) Build new Mills County reservoir--yield unquantified *(Alt.G4)* (Drought management plan adopted in July 2000)	(a) $1,150 (b) $1,425 (c) $750 (d) $384	$0.150 $2.890 $2.405 $4.490
Mills County-Other	Not calculated	Build Mills County reservoir--yield unquantified	$384	Same as (d) above: G4
Gillespie County	2000 = 507 2030 = 677 2050 = 1,013	Growth in Fredericksburg area creating shortages (a) Aquifer storage/recovery system--up to 1,120 ac-ft *(Alternative GL1)* (b) Develop new groundwater resources—unquantified *(Alternative GL2 – assumes 180ac-ft/yr)*	(a) $839 assumes (b) $350	$8.030 assumes $0.300
Irrigation in Matagorda, Wharton, & Colorado counties	see Sections ES.5.3.1 & ES.5.3.2	see discussion below in Sections ES.5.3.1 & ES.5.3.2	--	--

(1) Unit Costs and Project Costs obtained from Chapter 5 “Opinion of Probable Costs” tables for each alternative listed above;
(2) LCRA current water supply contract rate;
(3) City of Austin current water supply contract rate.

ES.5.3 Addressing Irrigation Shortages in the Southern Counties and the Needs of Neighboring Regions: A Comprehensive Proposal

The largest shortfall in water supply occurs in Colorado, Wharton, and Matagorda counties at the southeastern and downstream end of the region, where rice and other crops depend on reliable flows of water for irrigation. This shortfall amounts to an estimated 86,000 acre-feet per year if the drought of record were to occur in the year 2000, rising to almost 165,000 acre-feet per year in 2050, despite previously anticipated efficiencies in farm conservation.

This shortage would be even larger (about 284,000 ac-ft/yr in 2050) were it not for the interruptible water supply provided by storage in the Highland Lakes, other stormwater runoff, and run-of-the-river water LCRA is able to make available to farmers and the availability of the City of Austin’s return flows. However, the interruptible supply has hidden costs, namely the negative impacts on the economy and quality of life in the area surrounding the Highland Lakes.

Due to the seriousness of this problem, the LCRWPG formed an Irrigation Water Supply Working Group, which included outside experts familiar with irrigation needs and practices in this part of the region. The Working Group met with area farmers and others to explore the feasibility and implementability of options as they were developed, as well as working as a unit to devise a workable plan to propose to the LCRWPG as a whole.

The Working Group took a comprehensive approach, keeping in mind not only the need for an economically feasible supply of irrigation water, but also the larger picture that includes water needs in the northern portion of the region, for maintaining water levels in the Highland Lakes, and the South Central Texas Region's (Region L) proposals for importing water from Region K to meet the needs of San Antonio, Hays County, and other communities. Widespread opposition to projects to supply San Antonio from Region K (such as the potential Shaws Bend or Cummins Creek reservoir sites) motivated the working group to seek alternatives.

The adopted plan addresses all these factors. See the Overview at the beginning of this summary for a brief version of the broad-based plan. Each part is described below. The goal of the approach is to create enough new water supply to both meet irrigation and other shortages during drought periods in Region K; and to have enough to sell to Region L to fund the costs involved in addressing Region K shortages throughout the region.

ES.5.3.1 Nine Criteria for Water Sales Outside Region K

The LCRWPG members had serious concerns regarding the basis on which water exports could be discussed. They developed **the following nine-point policy as a guideline** for any talks with other regions (see Section 6.2.1 of the plan for further information). The Group communicated these guidelines to Regions L and G, which have both indicated interest in importing water supplies from Region K. The nine points are:

1. A cooperative regional water solution shall benefit each region.
2. Lower Colorado Regional Planning Area's (LCRPA) water shortages shall be substantially reduced if there is an exchange for an equitable contribution from the LCRPA to meet the municipal water shortages in the South Central Texas Region (or similar transfers to other regions of the state).
3. Proposed actions for interregional water transfers shall have minimal detrimental environmental, social, economic, and cultural impacts.
4. Regional water plans with exports of significant water resources shall provide for the improvement of lake recreation and tourism in the Colorado River Basin over what would occur without water exports.
5. Each region shall determine its own water management strategies to meet internal water shortages when those strategies involve internal water supplies and/or water demand management.
6. Cooperative regional solutions shall include consideration of alternatives to resolve conflicts over groundwater availability.
7. Any water export from the Colorado River would not be guaranteed on a permanent basis.
8. Any water export from the Colorado River shall make maximum use of inflows below Austin.
9. Any water export from the Colorado River shall comply with the LCRA's interbasin water transfer policy.

ES.5.3.2 Strategy Elements

To address the needs of irrigators in Matagorda, Colorado and Wharton counties, as well as the needs of upstream communities shown in Table ES.2 and the needs of the South Central Texas Region (Region L) several ideas were developed, which together comprise the recommended strategy. The elements are:

- Advanced farm conservation techniques such as laser-leveling of rice fields, multiple field inlets and reduced levee intervals; additional conservation savings through use of automated water delivery control systems, improvement of canal flow control structures, and flow-regulating storage reservoirs within the irrigation systems. In addition, research is planned to seek out varieties of rice that can be grown successfully with less water and alternative crops. These two measures are projected to save approximately 118,000 acre-feet of water annually within Region K, and any advances in rice varieties could contribute to conservation elsewhere on the Coastal Plain;

- Construction of four off-channel reservoirs at as yet unspecified sites in the southern end of the region within about five miles of the Colorado River to capture river flows appropriated under LCRA irrigation water rights, and unappropriated flood flows in the amount of at least 131,000 acre-feet per year of water for use during critical drought periods. This amount may increase to 150,000 acre-feet or more depending upon permit requirements for these reservoirs, which will be based on LCRA's existing water rights;
- A pipeline beginning in the area of Bay City to carry up to 122,000 acre-feet of water annually to San Antonio under a lease agreement that assures San Antonio a long-term—but not permanent—source of water. The exact amounts and forms of payment required remain open to discussion between the parties, as do many other specifics;
- Mitigation measures focused on preventing harm to the bays and estuaries due to the reduction in freshwater inflow caused by capturing water in the new off-channel reservoirs. Research into what is needed in this regard is in progress;
- Development of new wells within the boundaries of two or more of the southern irrigation districts affected by projected shortages: Lakeside, Gulf Coast, and Pierce Ranch. These wells would supplement other irrigation supplies during periods of severe drought only. This use of groundwater and surface water in combination is called "conjunctive use". Such conjunctive use systems would be staged over time to allow assessment of groundwater impacts. Average annual groundwater use during critical drought would be no more than 68,000 acre-feet per year; and,
- Mitigation measures to remedy any unacceptable impacts on groundwater users due to the development of the new wells mentioned above.

Implementing these strategies also makes it possible to preserve more water upstream in the Highland Lakes during drought periods, thereby preserving their recreational and aesthetic values for a longer period of time.

An additional strategy prompted by needs in Region L is:

- A diversion of Colorado River water from somewhere between Lake Austin and Bastrop, coupled with a pipeline to deliver this water to southern Hays County in Region L, which has identified a shortage. The LCRWPG envisions that this diversion would initially consist of about 5,000 acre-feet per year of water, with the amount rising as needs increase to an estimated maximum of 9,000 acre-feet per year. The LCRWPG has approved water transfers of up to 28,000 ac-ft/yr in 2050, subject to the supply ultimately determined to be available as a result of developing the four off-channel reservoirs. No final agreement has been reached with the potential purchasers, so no firm dollar amounts or charges are available at the time of this report.

ES.5.3.3 The Strategies in Combination

In combination, these strategies create the opportunity to develop funding through long-term water leases to the South Central Texas Region (Region L), which will pay for the measures needed to remedy shortages and mitigate impacts throughout Region K. The amount of water that can be made available is adequate to fund not only the off-channel reservoirs, but also an array of projects for the communities with shortages above the Highland Lakes, such as Goldthwaite, Llano, and Blanco (see Table ES.5 above for alternative water supply strategies for these and other upstream areas that are included for supply assistance).

At the same time, the strategies provide a significant amount of water to southern Hays County and San Antonio at prices that are expected to be competitive with other options that Region L has available. The final price, together with any surcharges or operations, maintenance or other fees, will be determined by the parties to the agreement. Initial discussions with water officials in Region L have been encouraging, but no final agreement had been reached at the time this report went to press.

ES.5.4 Region-Wide Strategies

The strategies for addressing shortages mentioned above focus on the activities of individual water user groups and jurisdictions and on actions that these entities can undertake through their own initiative. Some water management strategies, while providing major benefits, require broad public cooperation and/or require shifts in the way the public and utilities view water resources. In the Lower Colorado Region, the most important of these strategies (in order of feasibility) are:

- Municipal conservation;
- Water reclamation / recycling;
- Rainwater harvesting;
- Brush management; and,
- Weather modification.

ES.5.4.1 Municipal Conservation

TWDB projections of water demand assume an "expected" level of conservation in all municipalities throughout the state. At the same time, aggressive conservation programs have not been given the same status as other water strategies for remedying identified shortages.

Due to a lack of conservation programs in many water service areas, along with rapid growth and low rates of replacing old water fixtures, the LCRWPG questions whether the "expected" level of conservation savings is realistic for Region K as a whole. Furthermore, water user groups such as the City of Austin that have actively pursued fixture replacement and other conservation measures may well be able to reduce shortages by a substantial amount beyond the “expected” level of conservation.

ES.5.4.2 Water Reclamation and Recycling

Water reclamation and recycling is an increasingly widespread method used to reduce overall water demands. In the Lower Colorado Region, however, the form that reuse has traditionally taken has been downstream farmers using river flow augmented by treated municipal wastewater effluent for irrigation water. Because the largest shortages in the region's water supply occur providing irrigation water to farmers in the southern counties, municipal efforts to recycle water have the potential to exacerbate farm shortages while remedying shortages upstream.

For example, the City of Austin has a program under way that will substantially increase the amount of water recycled in its service area. The LCRWPG acknowledges that the City has no legal obligation to return this water to the Colorado River and recommends that future water planners take into account the changing dynamics of return flow that will occur in the lower Colorado River due to increases in municipal recycling.

ES.5.4.3 Rainwater Harvesting

The LCRWPG endorsed rainwater harvesting as a means of increasing water supplies for individuals and institutions. This practice is not yet widespread in the region, but an increasing number of demonstration projects are in operation. The City of Austin offers partial rebates for the cost of the equipment. Businesses, such as The Natural Gardner and rainwater collection tank suppliers; and organizations, such as the Lady Bird Johnson Wildflower Research Center, offer seminars on various aspects of rainwater harvesting.

ES.5.4.4 Brush Management

Juniper and mesquite trees that cover large areas of the Edwards Plateau hinder effective water management by consuming large amounts of water and preventing the amount of runoff and infiltration that would otherwise occur. Because thinning these trees only encourages expansion of the root systems of those that remain, studies have found that significant water savings are possible only when tree cover of these species is reduced to less than 15 percent.

The State is conducting field studies and modeling investigations that demonstrate the benefits of brush management, but it is often difficult to implement unless a single landowner has a large enough tract of land. Also, while substantial benefits are possible, it is often difficult to quantify the exact amount or even the location where these benefits may appear.

The LCRWPG strongly endorses pursuing programs that encourage brush management in the Hill Country where the problem is most severe and across water planning region boundaries to the north and south.

ES.5.4.5 Weather Modification

Weather modification has demonstrated the ability to provide additional water, but the results may not provide a reliable and quantifiable water supply. Moreover, concerns regarding how weather modification in one region affects weather patterns in both neighboring and remote areas remain.

The LCRWPG believes that weather modification should be dealt with as having potential as a long-term best management practice, but not as an option for meeting specific water shortages identified in this report.

ES.6 POLICY RECOMMENDATIONS

Senate Bill 1 provides for regional water planning groups to make any recommendations they see as desirable regarding regulatory, administrative or legislative changes to foster wise water planning and water use. Planning Group members deliberated at length about such changes and adopted a series of resolutions reflecting the recommendations outlined below.

ES.6.1 Groundwater Management

At present, there are six Groundwater Conservation Districts operating within the Lower Colorado Region, including two provisional Senate Bill 1911 districts. Many potential threats to groundwater sustainability now face the region. The Planning Group identified improved groundwater management as the top priority to be addressed in its policy recommendations.

Where local control is desired, The Planning Group strongly endorses the creation of Groundwater Conservation Districts (GCDs) known as "Chapter 36" GCDs. GCDs are appropriate if there is local support and the need for management of the groundwater resources. The Planning Group recommends that consideration be given to developing multi-county districts or single-county districts with shared management and costs. Priority Groundwater Management Areas in particular should be urged to consider the formation local GCDs as the preferred method for the management of groundwater resources.

Adjacent hydrological impacts should also be considered consistent with both local control and the objectives of Section 59, Article XVI of the Texas Constitution.

Wherever possible, GCD boundaries should be derived from hydrogeologic boundaries or, where only a single-county GCD is possible, adequate funding and cooperation with neighboring GCDs should be assured. The Planning Group recommends that full "Chapter 36" authority be granted to GCDs created through Senate Bill 1911 of the 76th Texas Legislature.

The Planning Group adopted a resolution stating that it opposes the mining of groundwater except during limited periods of extreme drought. The Group recognizes that GCD formation modifies the rule of capture in this regard, and believes that GCDs foster improved stewardship of groundwater resources.

This includes supporting regulation of groundwater transfers from the region by recommending that such permits be granted under guidelines that ensure beneficial and non-wasteful use, prevent unreasonable interference with previously permitted wells, protect natural resources, and require consistency with the district's management plan. The Planning Group supports amending subsections of Texas Water Code Section 36.205 to give districts more leeway and discretion in charging interregional transfer-related fees.

By the same token, the Planning Group recommends the repeal of the well permitting exemptions contained in Texas Water Code Section 36.117 by deleting the exemptions contained in Subsection (a) and the related provisions of Subsections (b) through (h). Thus, the remaining language of Section 36.227 would read: "A district may exempt wells from the requirements to obtain a drilling permit, an operating permit, or any other permit required by this chapter of the district's rules."

The recommended change would allow GCDs to adopt their own permitting exemptions through local rule-making processes. This addresses the problems presented by current exemptions of wells incapable of producing more than 25,000 gallons a day (which is far in excess of the amount needed for domestic use) and wells supplying water for activities regulated by the Texas Railroad Commission, such as for oil and gas exploration or production. The exemptions currently included in law effectively cripple efforts to better manage groundwater in many areas.

The Planning Group also supports conjunctive use of surface water and groundwater to meet the region's water needs. This is particularly cogent as regards State (or even Federal) intervention to mandate minimum spring flows. Endangered species within the Lower Colorado Region, as well as vulnerability to the demands of other regions, presents the potential for loss of highly valued local control.

Conjunctive use holds out the promise of finding solutions that protect both the region's aquifers and the environment.

ES.6.2 Interbasin Transfers of Surface Water

This controversial issue has been the topic of much debate both before and since the passage of Senate Bill 1.

The Planning Group supports the preservation of junior water rights introduced in Senate Bill 1. In addition, however, the Group believes that the junior water rights provision should be amended to clarify its full applicability to water sale contracts as well as to water rights transfers.

With regard to Region K, the Planning Group adopted a resolution stating that—while the sale of 25,000 acre-feet of water by LCRA to Williamson County already authorized by HB1437 will go ahead as planned—future sales in excess of that quantity should require replacement of at least 1.33 acre-feet of water for each 1.0 acre-foot of water transferred.

The Planning Group devised and adopted a set of nine guidelines for transporting water outside the Colorado River Basin. These guidelines have been used in discussions toward workable strategies for meeting Region K's water shortages and in talks with Regions L (South Central) and G (Brazos). See the previous heading "Developing Nine Points for Consideration of Water Sales Outside of Region K."

ES.6.3 Impacts on Return Flows and Ecological Values

The Planning Group concluded that because of increasing water reuse, conservation, water marketing, and the potential for large-scale interbasin transfers, there is a need to consider the return-flow aspects of water use in conducting water planning and in evaluating supply strategies. Diminished return flows in some cases could require more releases from LCRA reservoirs for adequate dilution to lower pollutant concentrations and maintain ecological systems.

As regards Region K in particular, the Planning Group recommends that the LCRA release water from storage as necessary to prevent degradation of human and livestock water supplies. These releases should be in amounts sufficient to protect the health of riparian, riverine, estuarine, and hardwood bottomland ecosystems.

ES.6.4 Agricultural Land Preservation and Conservation

Texas is the most rapidly urbanizing state in the country, and the Lower Colorado Region provides many examples of the advance of urban sprawl across lands that have traditionally been devoted to agricultural production. The Region K Planning Group found that a lack of reliable information about the amount and location of agricultural lands being lost to other uses has hindered the planning process.

The RWPG recommends that a farmland preservation study be undertaken. The Texas Department of Agriculture or the Agricultural Extension Service should:

- Inventory lands now devoted to agriculture;

- Analyze the amount and nature of farmlands lost to urban sprawl;
- Assess the effectiveness of current state programs for preserving farmlands;
- Consider what changes in state law or department efforts might more effectively preserve agricultural lands; and,
- Assess the economic, cultural, water quality and environmental contributions of agriculture.

Water marketing and the uncontrolled use of groundwater are of special concern in this regard. The impacts of these two factors on agriculture and people living in farm communities must be understood to gain a comprehensive view of regional water planning.

ES.6.5 Agricultural Water Conservation and Brush Control

While water users of all kinds must adopt conservation practices, funding research projects aimed at developing low-water-use varieties of rice has the potential to substantially reduce the amount of water required for the region's agriculture. The LCRWPG recommends that funds be sought for this purpose from state agency research grant programs and contributions from the rice industry, agribusiness, the LCRA, and other interested parties. Note that if a long-term lease of water from the LCRA to Region L is implemented as recommended, this long-term lease could potentially be used as a funding source.

The LCRWPG also endorses studies of brush control on a voluntary basis, especially in the area west of Interstate Highway 35. In addition, the Planning Group recommends that state and/or federal funds be made available to landowners requesting assistance with brush control efforts.

ES.6.6 Sustainability

The LCRWPG supports State action to develop forecasts of each region's growth limits assuming current technology. This forecast should estimate the number of people, industries, and agricultural systems a Regional Water Plan will support, regardless of whether these water user groups reside within or outside of the region's boundaries. The forecast should take into account the need to preserve cultural resources, economic opportunity, farmlands and rural communities.

ES.6.7 Relief for Small Systems Affected by New Radionuclides and Uranium Standards

The U.S. Environmental Protection Agency (USEPA) is planning to issue new drinking water standards for radionuclides and uranium. Small water systems in Region K that use groundwater from the Hickory and Marble Falls aquifers (as well as utilities in Region F) could be severely affected.

The LCRWPG recommends that the State request the USEPA to provide thorough scientific data showing that health risks are indeed present, since there have been no known radiation-related health problems in the communities served by these utilities.

Furthermore, if compliance with the new standards is required, the LCRWPG recommends that the State provide adequate funding for both treatment and radioactive waste disposal, in addition to establishing procedures for disposal. These small rural water systems may be unable to bear the financial burden of compliance, endangering the water supply of rural communities.

ES.6.8 Recommended Improvements to the Regional Planning Process

The shift to a grassroots/interest-group focused approach has fostered a great deal of positive citizen interaction and dialog within the Lower Colorado Region and with neighboring regions. At the same time, the first cycle through the new Senate Bill 1 planning process led the LCRWPG to suggest the following changes, all of which are designed to fine-tune the planning process as currently outlined in the law:

- Integrate water quality as well as water supply (quantity) considerations into the planning process;
- Establish a consistent policy statewide regarding the water conservation assumptions and the degree to which conservation might be used as a strategy to help ensure adequate supplies during drought;
- Provide continuous funding for improving the quality and quantity of water resources data available and information dissemination;
- Provide centralized administrative support and public information materials support to prevent each region from "reinventing the wheel" and duplicating efforts;
- Provide for the continuity of Regional Water Planning Groups between planning cycles;
- Improve representation of women and minorities in the membership of Regional Water Planning Groups; and,
- Improve the estimation of economic losses from failing to supply water demand by conducting industry studies throughout economic regions (such as the Gulf Coast area for rice production and processing, for example), rather than considering impacts within individual regions only.

ES.7 ECOLOGICALLY UNIQUE STREAM SEGMENTS AND RESERVOIR SITES

The potential for designating ecologically unique stream segments and potential reservoir sites surfaced many questions, concerns and recommendations from the members of the public attending Planning Group meetings and four special public comment meetings held by the Planning Group's committee devoted to this topic.

As an adjunct to the policy recommendations outlined above, the LCRWPG recommends legislative clarification be provided regarding Texas Water Code Section 16.051, which addresses this designation. Many participants requested that the terms be spelled out relative to how property rights and taxation might be affected.

No sites are recommended for designation due to the need for clarification of this section, but some sites have been identified as needing further study or meriting comment.

ES.7.1 Ecologically Unique Stream Segments

While the LCRWPG did not recommend any site for designation as an ecologically unique stream segment, the nine stream segments shown in Table ES 6 were identified as meriting further study and future consideration for such designation.

Table ES 6: Stream Segments Identified for Further Study

Stream Segment	Location	Criteria Used
Barton Springs segment of the Edwards Aquifer	Recharge stretches of Barton, Bear, Little Bear, Onion, Slaughter, and Williamson Creeks in Travis and Hays counties.	*Riparian*: lower end is in a city park *Quality*: designated an "ecoregion" stream *Species:* only known population of the endangered *Eurycea sosrum,* salamander
Bull Creek	From the confluence with Lake Austin upstream to its headwaters in Travis County.	*Biologic:* nearly pristine *Hydrologic:* reduces flooding *Riparian:* in Bull Creek Preserve *Quality*: high aesthetic value *Species:* endangered salamander (Eurycea sp.)
Colorado River	Within TNRCC classified segments 1409 and 1410 including Gorman Creek in Burnet, Lampasas, and Mills counties.	*Biologic:* white bass spawning area *Riparian:* in Colorado Bend State Park *Quality:* high aesthetic value *Species:* endangered Concho water snake; rare mollusks
Colorado River	TNRCC classified segments 1428 and 1434 in Travis, Bastrop, and Fayette counties.	*Biologic:* riverine habitat on Central Flyway *Hydrologic:* reduces flooding, filters water, connected to aquifers *Riparian:* in McKinney Roughs Environmental Learning Center *Quality:* aquatic life use *Species:* endangered blue sucker and Houston toad
Colorado River	TNRCC classified segment 1402 including Shaws Bend in Fayette, Colorado, Wharton, and Matagorda counties.	*Biologic:* riverine habitat on Central Flyway *Species:* endangered blue sucker
Cummins Creek	From the confluence with the Colorado River upstream to FM 159 in Fayette County.	*Quality:* designated an "ecoregion" stream
Llano River	TNRCC classified segment 1415 from the confluence with Johnson Creek to CR 2768 near Castell in Llano County.	*Quality:* exceptional aesthetic value
Pedernales River	TNRCC classified segment 1414 in Kimball, Gillespie, Blanco, and Travis counties.	*Biologic:* significant nature area *Riparian:* in 2 state parks, 1 national park , 1 city park *Quality:* exceptional aesthetic value

Stream Segment	Location	Criteria Used
Rocky Creek	From the confluence with the Lampasas River upstream to the union of North Rocky Creek and South Rocky Creek in Burnet County.	*Quality:* designated an "ecoregion" stream

ES.7.2 Unique Reservoir Sites

Eight specific reservoir sites, one reservoir enhancement project and several non-specific reservoir sites were considered as possible candidates for this designation. Table ES 7 summarizes the sites considered and the corresponding recommendations.

As with stream segments, the LCRWPG recommends clarification of the Texas Water Code regarding the effects that designation might have on property rights and city and/or county taxation.

Table ES 7: Potential Reservoir Sites Identified for LCRWPG Evaluation

Potential Site Location	LCRWPG Recommendation
Mills County: Off-channel reservoir alternatives for Blanket, Pompey, Browns, and Bennett Creeks, plus an in-channel alternative on the Colorado River	Support residents' efforts to construct reservoirs and pipelines for water supply.
Fayette & Colorado counties: Shaws Bend site	Oppose potential designation; would inundate 12,400 acres, and directly impact an additional 12,913 acres; would exacerbate flooding, adversely impact cultural and historic resources, bottomland forests, riverine habitat, and archaeological sites.
Colorado County: Cummins Creek site	Oppose potential designation; local community voiced strong opposition; would adversely affect 7,200 acres of bottomland forest, stream segments designated as "ecologically significant"; 15 dams already exist on the creek.
Llano County: Small in-channel check dams	Support further study and potential development of small in-channel check dams within existing flood plains; no specific sites yet identified; public support not determined; need has not been verified.
Llano County: Llano River diversion to Lake Buchanan	Support further study of this reservoir enhancement project; past studies and new technology indicate that this may be a desirable project; potential benefits would be an increase in Highland Lakes lake levels and improved Llano County flood control; cost-effectiveness and public support remain in question.
Fayette County: Clear Creek site	Oppose potential designation; local community voiced strong opposition, no potential projects officially under consideration for Clear

Potential Site Location	LCRWPG Recommendation
	Creek
Unspecified Locations: LCRA off-channel flood storage facilities	Support "no action" on LCRA permits for unspecified numbers and locations of facilities until more information is supplied; LCRA may have new information regarding storage options
Unspecified Locations: Study of LCRA off-channel flood storage facilities	Support further study and potential development for priority use within the Lower Colorado River Basin; specific locations not yet identified, potential impacts on recommended upstream reservoir projects undefined

ES.8 PUBLIC OUTREACH ACTIVITIES

Regional Planning Group members put forth a major effort to reach out to interest groups, civic leaders, small water utilities, and the public at large. The Group held 15 of their regular monthly meetings in locations throughout the region, which were publicized through invitations, news releases, and posters in order to provide the opportunity for the public to participate in the planning process. Each of the 15 meetings was sponsored by a local host who arranged for lunch to be served to all those attending.

The Group also maintained a web page and provided fact sheets about the process and proposed solutions. Individual planning group members made presentations to well over 100 civic and special-interest groups. In this way, the LCRWPG succeeded in providing important information to thousands of regional stakeholders.

In addition to generating extensive print media coverage throughout regarding the planning process and for the *Initially Prepared Plan*, several RWPG members were guests on radio talk shows. Two television appearances on PBS' the *Austin At Issue* public affairs program also encouraged awareness and participation.

All of these efforts made information and updates on the regional water planning process available to thousands of people throughout the entire region.

ES.9 FOR MORE INFORMATION

For information regarding opportunities to obtain additional information about the Region K planning process and how you can participate, please refer to the LCRA web page at: www.lcra.org and click on the LCRWPG Senate Bill 1) heading.

Full text of the sixteen RWPG Adopted Plans are available on the Texas Water Development Board web page at: www.twdb.state.tx.us/ and scroll down to find and click on the "Regional Water Planning Groups" heading.

Copies of this Executive Summary, videos, and other information materials may also be obtained by calling Dr. Quentin Martin at the LCRA, (512) 473-3200.

Please refer to the body of the Plan for detailed information regarding methodology, projections, and issue discussions.

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CHAPTER 1.0: INTRODUCTION AND DESCRIPTION OF THE LOWER COLORADO REGIONAL WATER PLANNING AREA

1.1 INTRODUCTION TO THE PLANNING PROCESS

Sections 16.051 and 16.055 of the Texas Water Code direct the Executive Administrator of the Texas Water Development Board (TWDB) to prepare and maintain a comprehensive State water plan as a flexible guide for the development and management of all water resources in Texas in order to ensure that sufficient supplies of water will be available at a reasonable cost to further the state's economic growth. Section 16.056 requires the TWDB to amend the plan as needed in response to increased knowledge and changing conditions.

In February 1998, the TWDB adopted rules establishing 16 regional water planning areas and designated the initial members of the regional water planning groups representing 11 interests (Figure 1.1). Each Regional Water Planning Group (RWPG) has the option to add interest group categories and members. With technical and financial assistance from the TWDB, and in accordance with planning guidelines it set forth, the regional water planning groups are to prepare a consensus-based regional water plan by 5 January 2001. Once completed, the TWDB will assemble the regional water plans into a new state water plan by 5 January 2002. Once organized, the regional water planning groups have proceeded with a two-phase planning process. The first phase, which was completed on 1 August 1998, was to develop a detailed scope-of-work and budget for the development of the regional water plans. The second phase, which began during the fall of 1998, is to develop the regional water plans. The "initially prepared" regional water plan was submitted to the TWDB 2 October 2000 and is to be finalized and adopted by 5 January 2001. Subsequently, by January 2002, the TWDB will prepare a new state water plan, which incorporates the adopted regional water plans. This plan will then be updated every five years.

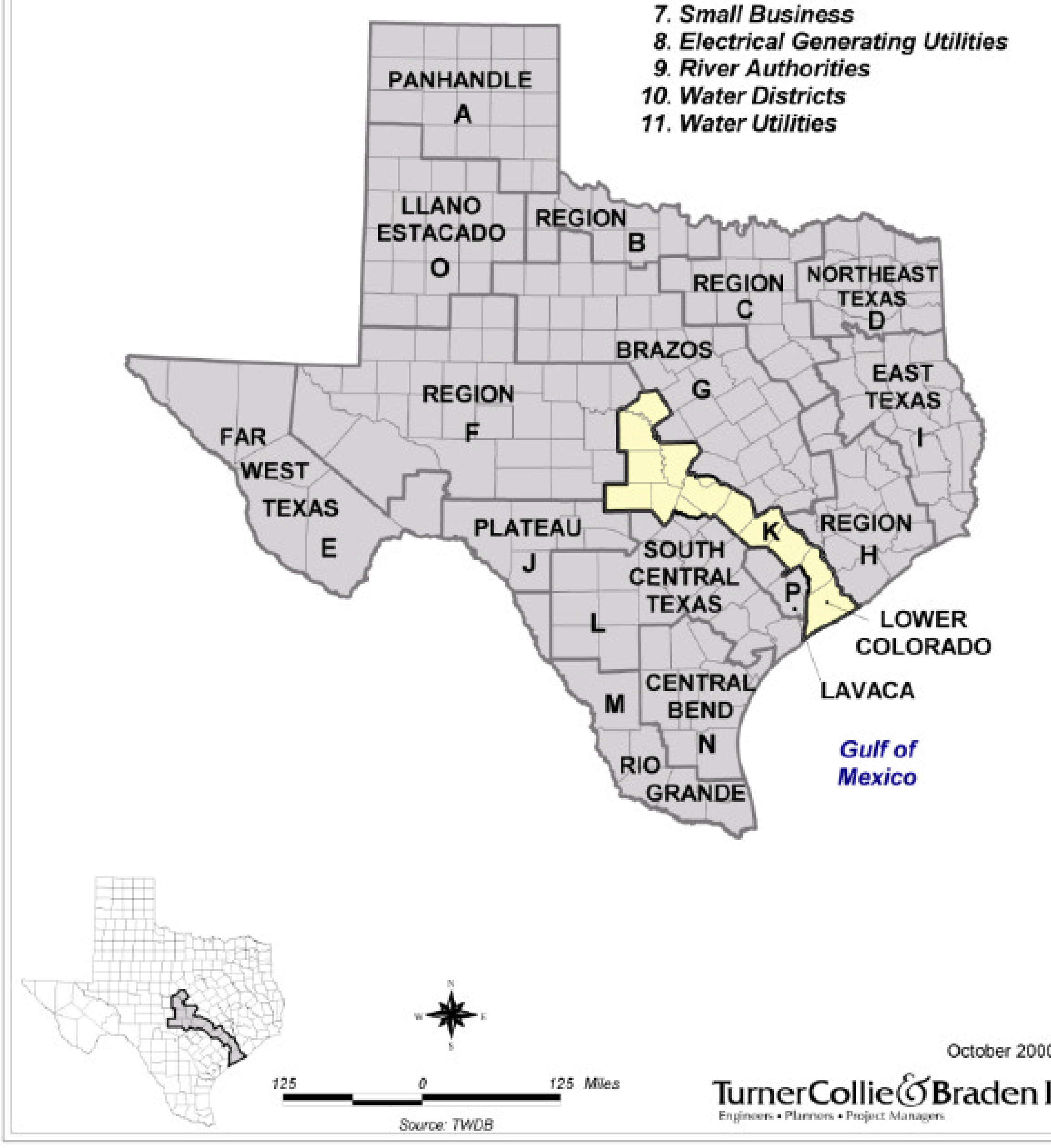
The Lower Colorado Regional Water Planning Area, initially designated by the TWDB as "Region K," encompasses all or part of 14 counties mostly within the Lower Colorado River Basin from the Hill Country to the Gulf of Mexico (Figure 1.2). The Lower Colorado Regional Water Planning Group (LCRWPG), representing the 11 TWDB-required interest groups and two additional regional interest groups, is responsible for the development of the Lower Colorado Regional Water Plan (Table 1.1). The TWDB's guidelines require the LCRWPG's regional water plan to complete the following tasks (items d through g are discretionary and may be included by the RWPG):

- Population and water demand projections (Chapter 2);
- Estimates of currently available water supplies (Chapter 3);
- Comparison of currently available water supplies and projected water demands to determine the future water supply needs of the region (Chapter 4);
- Evaluation of alternative water management strategies meeting identified needs (Chapter 5); and,
- Develop a plan containing (Chapter 5):
  a. specific strategies to meet water needs in the thirty-year period (2000-2030);
  b. options to consider for meeting long-term needs (2030-2050);
  c. identification of needs that have no feasible solutions;
  d. identification of ecologically unique stream segments;
  e. identification of sites uniquely suited for reservoir construction;
  f. coordination with adjacent RWPGs concerning mutual interests and shared resources; and,
  g. regulatory, administrative, and/or legislative recommendations to improve water resources management in the state as a whole.

Figure 1.1 : TWDB Designated Regional Water Planning Areas

TWDB - Required Interest Groups:

1. Public
2. Counties
3. Municipalities
4. Industries
5. Agriculture
6. Environmental
7. Small Business
8. Electrical Generating Utilities
9. River Authorities
10. Water Districts
11. Water Utilities



October 2000

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Figure 1.2 : Lower Colorado Regional Water Planning Area (Region K)

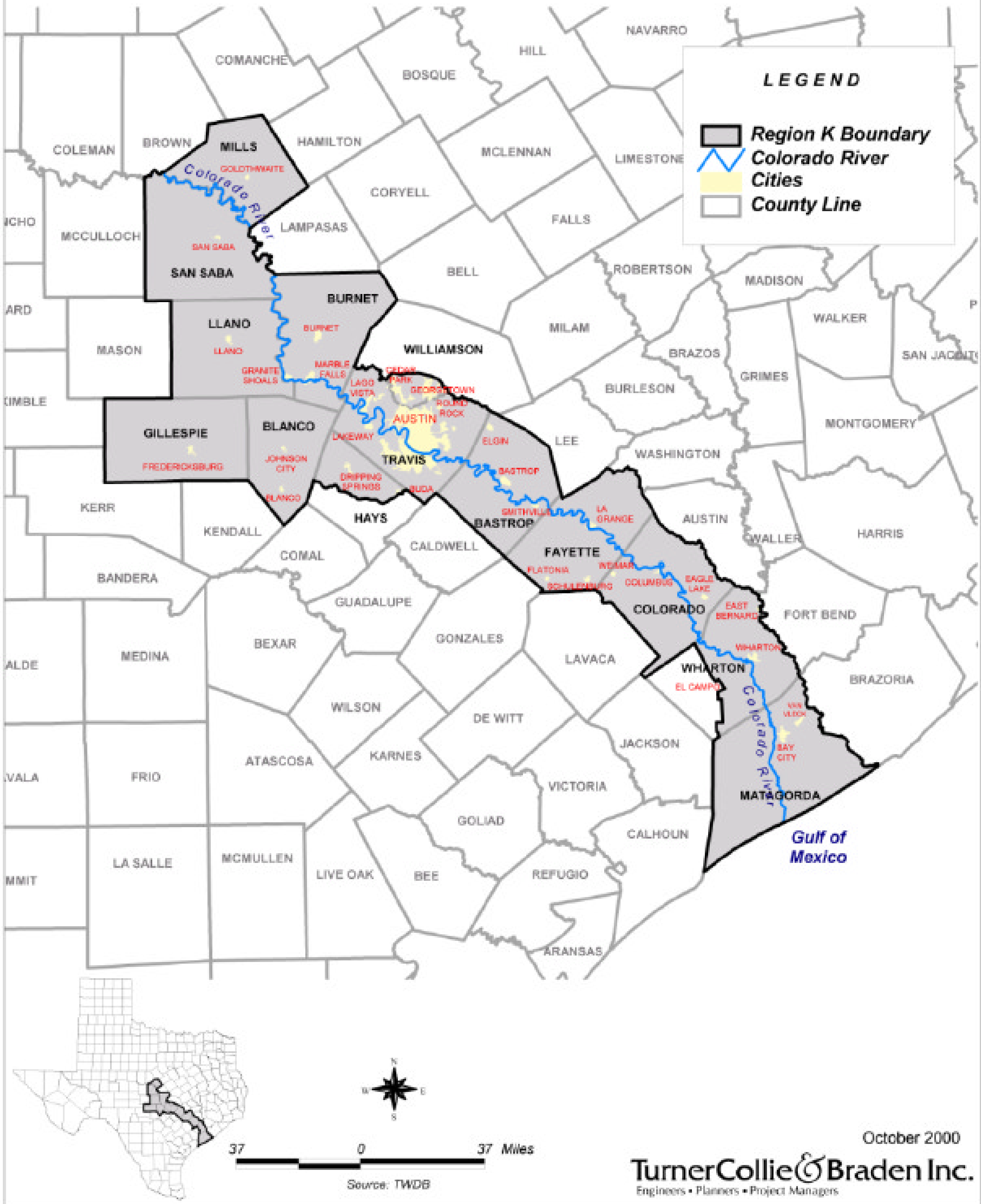


Table 1.1a: The Lower Colorado River Water Planning Group Voting Board Members

Interest	Name	Entity	County (Location of Interest)
Public	Julia Marsden	League of Women Voters	Travis
Counties	Dale Henry	Mills Co. Commissioners Court	Mills
Municipalities	Teresa Lutes	City of Austin	Travis & Williamson
	Mayor Charlie Martinez	City of Bay City	Matagorda
Industries	Mark Smith	Motorola	Travis
Agricultural	Haskell Simon	Rice industry rep. & farmer	Matagorda
	Steve Balas	Rice industry rep.	Colorado
Environmental	Dede Armentrout	Sierra Club, Lone Star Chapter	Blanco
	Jim Barho	Protect Lakes Inks, Buchanan	Burnet
Small Businesses	Robert Dickerson	Hurst Harbor Marina	Travis
	Ronald Gertson		Wharton
	Richard Macaulay		Fayette
Elec. Generating Utilities	Rick Gangluff	South Texas Nuclear Project	Matagorda (service in entire region)
River Authorities	Quentin Martin	LCRA	Travis (service in entire region)
Water Districts	Stovy Bowlin	Barton Springs/Edwards Aquifer Conservation District	Hays & Travis
	Stan Reinhard	Hickory UWCD No.1	San Saba
	Paul Tybor	Hill Country UWCD	Gillespie
Water Utilities	John Burke, Gen. Mgr.	Aqua WSC	Bastrop & 5 other counties
Other(s)	Bill Stewart		Llano
Recreation	Cole Rowland	Highland Lakes Group	Burnet, Llano, & Travis

Table 1.1b: The Lower Colorado River Water Planning Group Non-Voting Members and Adjacent Region Liaisons

David Bradsby	Texas Parks & Wildlife
Randy Goss	Lower Colorado River Authority
Joe McCarley	Texas Dept. of Agriculture
David Meesey	Texas Water Development Board
Dexter Svetlik	Natural Resource Conservation Service
John Dodds	Texas Assn. Of Nurserymen, Inc.
Carole Baker	Region H RWPG Representative
Stuart Coleman	Region F RWPG Representative
Josephine Miller	Region N RWPG Representative
James Nuse	Region G RWPG Representative
L.G. Raun	Region P RWPG Representative
John Wendele	Region J RWPG Representative
Bill West	Region L RWPG Representative

Table 1.1c: Alternates and Former Members of the Lower Colorado Regional Water Planning Group

W.R.(Bob) Pickens	Judge Geroge Byars	Gerard Hajovsky
James Holbrook	Dr. Jobaid Kabir	Barbara Johnson
Ron Fieseler	Clark Young	Bob Ficken
Sandy Dannhardt	Peggy Walicek	Billy Mann
Laurance Armour, III	Craig Bell	Harold Sohner
John Grant	Ron Neighbors	Roy Roberts
Bill McPherson	Jonathon Letz	Jock Davis
Bill Couch	Bennie Fuelberg	W. Owen Parks

Texas is an extremely diverse state both in climate and economics, and these differences were considered in the creation of the sixteen Regional Water Planning Groups. This diversity requires the use of a variety of water management strategies, the combination of which will be unique for each Region. The types of strategies that may be considered include:

- expected/advanced water conservation;
- water reuse;
- expanded use of existing supplies;
- reallocation of reservoir storage;
- water marketing and interbasin transfers;
- subordination of water rights;
- yield enhancement measures;
- chloride control measures; and/or,
- new supply development.

Water availability, economics, environmental concerns, and public acceptance were considered during the process of developing water management strategies within each region. The final regional water plan must comply with all existing state and federal regulations including the protection of existing water rights, instream flows, bay/estuary freshwater inflows, water quality, threatened/endangered species, critical habitats, and sites of historical importance.

The overall goal of the State Water Plan is to address water supply needs at the local level with the consideration of balancing affordable water supply availability across the entire state and conserving the State’s natural resources.

1.2 DESCRIPTION OF THE LOWER COLORADO REGIONAL WATER PLANNING AREA

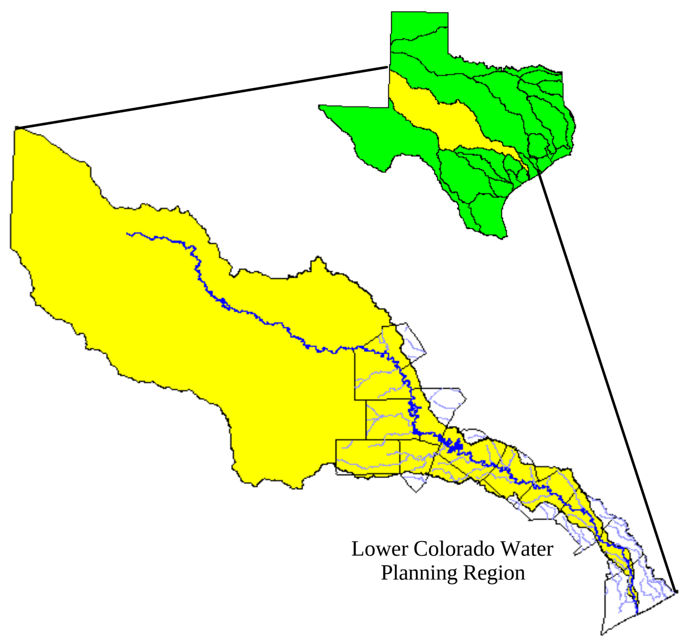
The Lower Colorado Regional Water Planning Area (Region K) encompasses all or part of the following counties:

Bastrop	Llano
Blanco	Matagorda
Burnet	Mills
Colorado	San Saba
Fayette	Travis
Gillespie	Wharton (partial)
Hays (partial)	Williamson (partial)

Most of the Lower Colorado Region lies within the Colorado River Basin and crosses the Great Plains and the Coastal Plains physiographic provinces. The following sections provide a general description of the area's physical and socioeconomic characteristics, as well as water quality and natural resource issues of importance to the region.

1.2.1 Physical Characteristics of the Lower Colorado Regional Water Planning Area [1]

Figure 1.3: The Colorado River Basin



The Colorado River Basin extends well beyond the boundaries of the Lower Colorado Region northwest into eastern New Mexico (Figure 1.3). From these headwaters, the river travels 900 miles to the Gulf of Mexico. The Colorado River basin is bordered by the Brazos River basin to the north and east, and by the Guadalupe River, and Lavaca River basins to the south and west. The total drainage area of the Colorado River is 42,318 square miles, 11,403 sq.mi. of which is considered non-contributory to the river's water supply. There are six major tributaries with drainage areas greater than 1000 sq.mi., that contribute to the Colorado River: Beall's Creek and the Concho River, above the LCRWPG boundary; and the San Saba, Llano, and Pedernales Rivers, as well as Pecan Bayou, which occur in San Saba, Llano, Travis, and Mills counties, respectively. All of these major tributaries and approximately 90 percent of the entire contributing drainage for the river occur upstream of Mansfield Dam near Austin. This dam is the primary regulator of water flow, from its location south to the Gulf of Mexico. Downstream of Austin, there are only two

[1] Lower Colorado River Authority (LCRA), June 1992. "Instream Flows for the Lower Colorado River, Final Report"

tributaries with drainage areas greater than 300 square miles: Onion Creek in Travis County and Cummins Creek in Colorado County.

1.2.1.1 Geology of the Lower Colorado River Basin [2,3]

The northern most boundary of the Lower Colorado Region lies in the Central Texas section of the Great Plains physiographic province (Figure 1.4). It is here that the Colorado River intersects the broad, low structural zone exposing early Paleozoic and Precambrian igneous and metamorphic formations, called the Llano Uplift. In the northwestern portion of the region, the major southern tributaries and the Colorado River drain the Edwards Plateau section of the Great Plains province, which is characterized by Cretaceous-aged limestone formations overlain by Tertiary-aged sediments. The Colorado River meanders through these limestone deposits in relatively steep narrow canyons in this area; however, there are also flat-topped remnants of the once more extensive Edwards Plateau. At the eastern edge of the Edwards Plateau, the Edwards aquifer outcrops at several locations along the Balcones Fault Zone, creating aquifer recharge zones and associated natural discharge points or springs, such as Barton Springs in Travis County. Typical soils (Figure 1.5) of the Llano Uplift are reddish-brown to brown, neutral to slightly acidic, calcareous, sandy loams. Soils mapped on the Edwards Plateau section typically consist of dark, deep to shallow, stony, calcareous clays.

The Western Gulf Coast section of the Coastal Plains province contains the remaining 300 miles of the Colorado River south of the Balcones Fault Zone in Travis County to the Gulf of Mexico. The Western Gulf Coast section is characterized as an elevated sea bottom with low topographic relief ranging from low hills in the west to coastal flats. Surface geologic units mapped along the next portion of the Colorado River include a relatively narrow band of Upper Cretaceous formations just southeast of the Balcones Fault Zone, followed by a belt of Tertiary deposits that outcrop from Bastrop County southeast to Colorado County. The remaining geologic units, from Colorado County to the Gulf of Mexico, are mapped as Quaternary-aged deposits. Sediments in the Western Gulf Coast section are composed primarily of marine deposits such as limestones, marls, and shales; however, the river valley also contains significant fluvial (river) terrace deposits of granitic assemblage, quartz and quartzite, chert, limestone, sandstone, siltstone, hornblende schist, silicified wood, and rip-up clasts. Colorado Basin soils in the Western Gulf Coast section are typically dark, neutral to slightly acidic, clay loams, and clays. Near the coast, soils become light, acidic sands, and darker, loamy to clayey soils.

1.2.1.2 Climate [4,5,6]

The climate across the state of Texas varies considerably, however there are no natural boundaries, and changes occur gradually from east to west. In general, average temperatures, rainfall, and the length of the growing season decrease from the east to the north and west. The upper atmospheric winds, or

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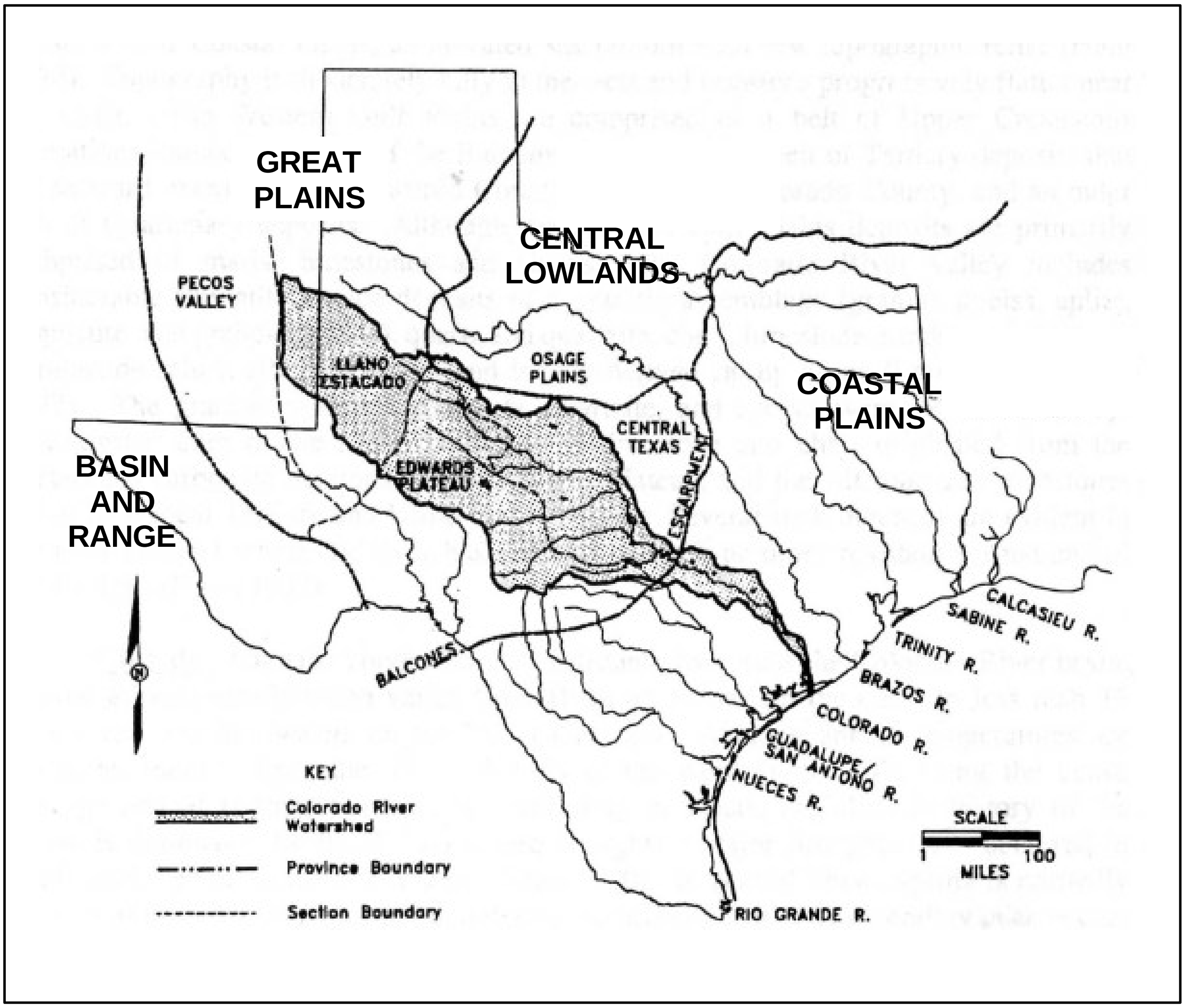
[2] LCRA, Op. Cit., June 1992.
[3] Texas Water Development Board (TWDB), May 1977. "Continuing Water Resource Planning and Development for Texas, Volume II"
[4] TWDB, Op. Cit., May 1977.
[5] Hatch, S.L., et al, July 1990. "Checklist of the Vascular Plants of Texas", Texas Agricultural Experiment Station, College Station, Texas.
[6] Jones, B.D., 1990. "Texas Floods and Droughts. *In* National Water Summary 1988-1989". U.S. Geological Survey, pp.513-520.

jetstreams, affect the large-scale weather patterns in the state. The polar jetstream affects the movement of cold artic airmasses from December through February. The moist warm airmasses are brought to

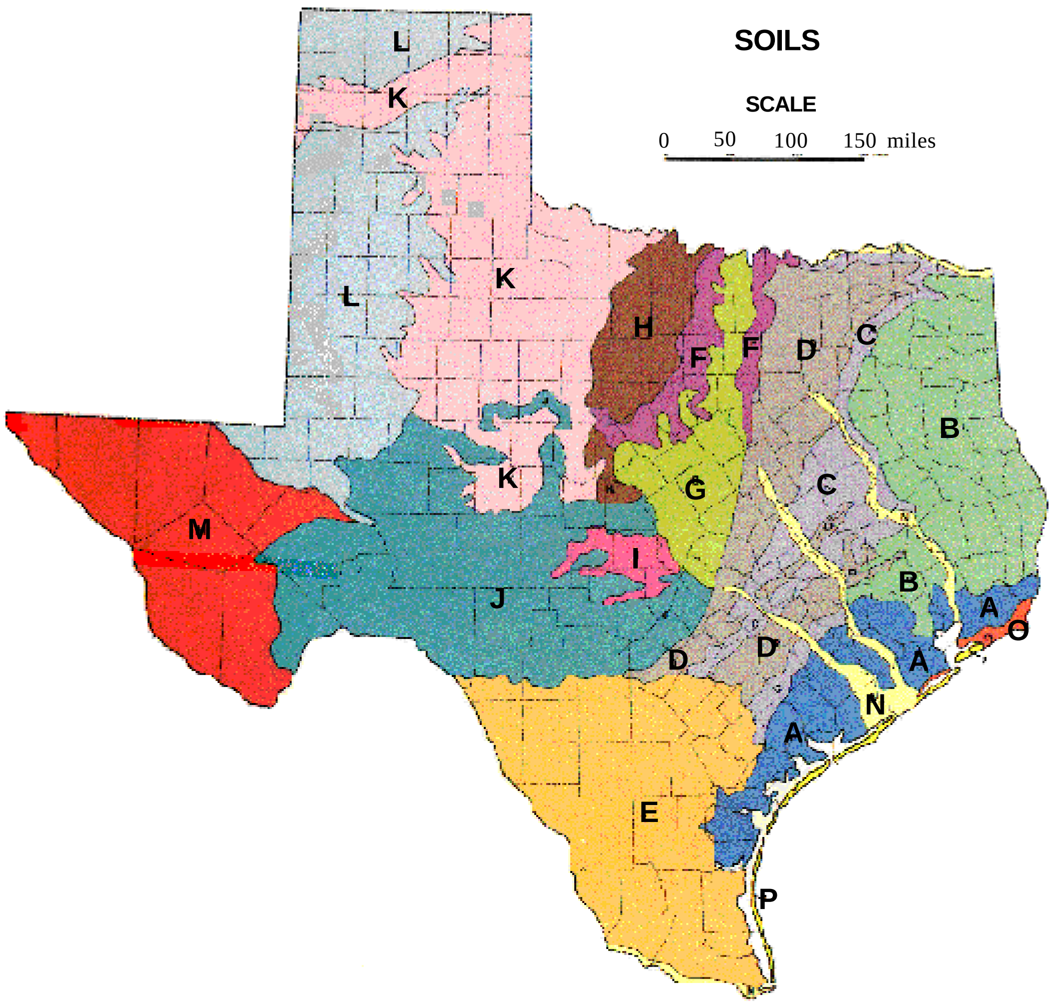
Figure l.4: Physiographic Provinces and Major Drainage Basins of the Western Gulf Slope (Modified from Conner and Suttkus, 1977)



Texas from the Pacific Ocean by the subtropical jetstream, whose influence is most prevalent during the spring and fall.

The Lower Colorado Region lies entirely within the warm-temperate/subtropical zone. The constant flow of warm tropical maritime air from the Gulf of Mexico produces a humid subtropical climate with hot summers across the lower third of the region. This maritime air combines with cooler and drier continental air further inland, which results in a subtropical climate with dry winters and humid summers in the remainder of the region. Winters in the Lower Colorado Region typically are mild with frequent, short duration surges of colder continental air masses and strong northerly winds. Average annual net evaporation in the Lower Colorado Planning Region varies from 20-24 inches at the coast to approximately 44 inches in the uppermost portion of the Region (Figure 1.6).

Figure 1.5: Soils of Texas
(Source: Bureau of Economic Geology, 1977)



A Dark-colored, neutral to slightly acid clay loams & clays; some lighter colored sandy loams; acid soils mostly east of Trinity River.

B Light-colored, acid sandy loams, clay loams, & sands; some red soils & clays.

C Light-brown to dark-gray, acid sandy loams, clay loams, & clays.

D Dark-colored calcareous clays; some grayish-brown, acid sandy loams & clay loams along eastern edge of the major prairie & interspersed in minor prairies.

E Dark calcareous to neutral clays & clay loams; reddish-brown, neutral to slightly acid sandy loams; grayish-brown, neutral sandy loams & clay loams; some saline soils near coast.

F Light-colored, acid loamy sands & sandy loams.

G Dark-colored, deep to shallow clay loams, clays, & stony calcareous clays over limestone.

H Reddish-brown to grayish-brown, neutral to slightly acid sandy loams & clay loams; some stony soils.

I Reddish-brown to brown, neutral to slightly acid, gravelly & stony sandy loams.

J Dark, calcareous stony clays & clay loams.

K Dark-brown to reddish-brown, neutral to slightly calcareous sandy loams, clay loams, & clays.

L Dark-brown to reddish-brown neutral sands, sandy loams, & clay loams; some very shallow calcareous clay loams.

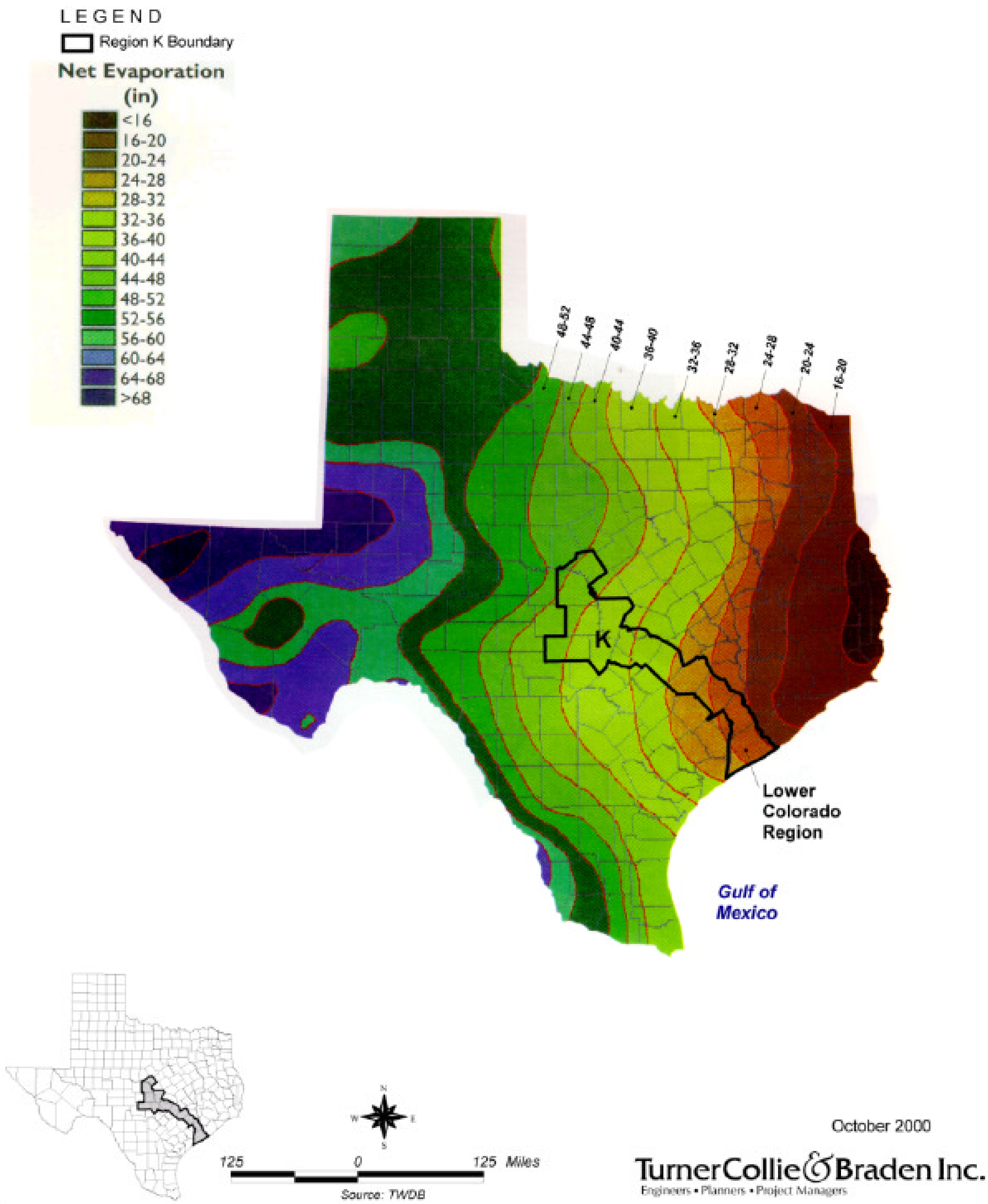
M Light reddish-brown to brown sands; clay loams & clays (mostly calcareous, some saline) & rough stony lands.

N Light-brown to reddish-brown, acid sandy loams; acid & calcareous clay loams & clays.

O Light- & dark-colored, acid sands, sandy loams, & clays.

P Tan, loose sand & shell material.

Figure 1.6 : Lower Colorado Regional Water Planning Area (Region K) Average Annual Net Evaporation

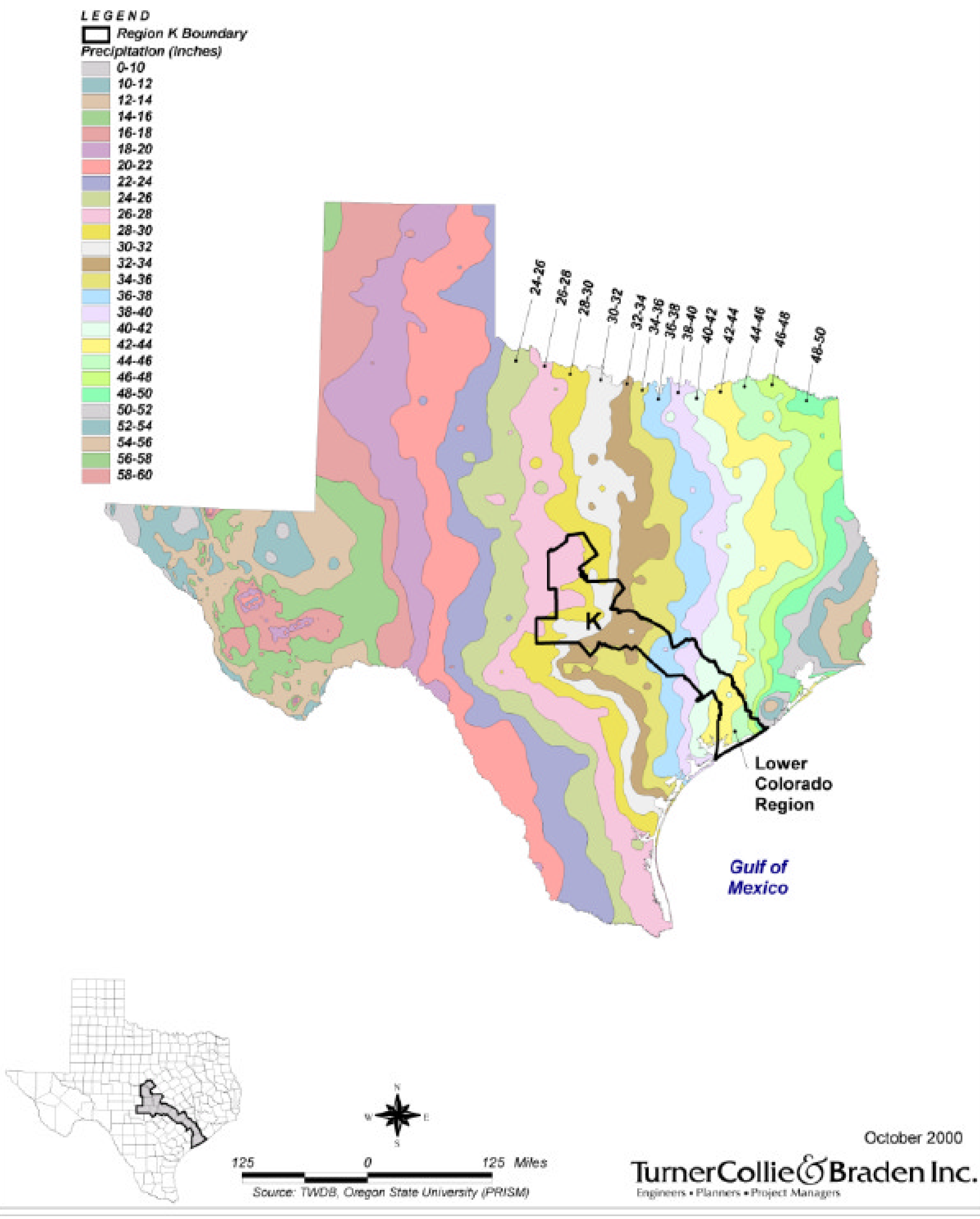


The amount of rainfall varies across the Lower Colorado Planning Region from an average of 44 inches at the coast to 24 inches in the northwest portion of the Region (Figure 1.7). The rainfall distribution pattern in this region has two peaks: spring is typically the wettest season with a peak in May, and a second peak usually occurs in September, coinciding with the tropical cyclone season in the late summer/early fall. The spring rains are typified by convective thunderstorms that produce high intensity, short duration precipitation events with rapid runoff. These thunderstorms are generally caused by successive frontal systems that move through the state. These weak cold airmasses are overrun by warm Gulf moisture and the line of instability that develops where the two airmasses come in contact produces thunderstorms. The fall seasonal rains are primarily governed by tropical storms and hurricanes that originate in the Caribbean Sea or the Gulf of Mexico and make landfall on the coast from Louisiana to Mexico. As the storm moves inland, the coverage area for a single tropical cyclone event can be quite large and the storm severe, with wind and flood damage common.

The hydrologic characteristics of the Colorado River are closely linked to the precipitation patterns that occur in the river basin, especially the cycles of floods and droughts, which are common in Texas. Major flood and drought events are those with statistical recurrence intervals greater than 25 years and 10 years, respectively. Streamflow gaging data collection began in the early 1900's and the data shows that there has been a major drought in almost every decade of this century. Droughts in Texas are primarily the result of the presence of a strong subtropical high-pressure cell, called a Bermuda High, which becomes stationary over the state and prevents low-pressure fronts from passing through the state. Major droughts can cause stock ponds and small reservoirs to go dry and large reservoirs, such as Lake Travis, can drop their storage levels to less than one-third their capacity. The average annual runoff during the period from 1941-1970 ranges from 350 acre-feet per square mile near the mouth of the Colorado River to less than 50 ac-ft/sq.mi. in the western-most portion of the basin's contributing zone, which translates to an overall basin average of 81 ac-ft/sq.mi. During this 30-year time period there have been three major statewide droughts: 1947-48, 1950-57, and 1960-67. These periods of drought saw average annual runoff values decrease 72-80 percent, to 16-23 ac-ft/sq.mi., which resulted in record low flows in the Colorado River. The most severe of these droughts occurred from 1950 to 1957, where 94 percent of the counties in the state were declared disaster areas. The drought of record for the Lower Colorado Region is the period 1948-1957 and these drought-of-record conditions have been used in this regional water planning effort.

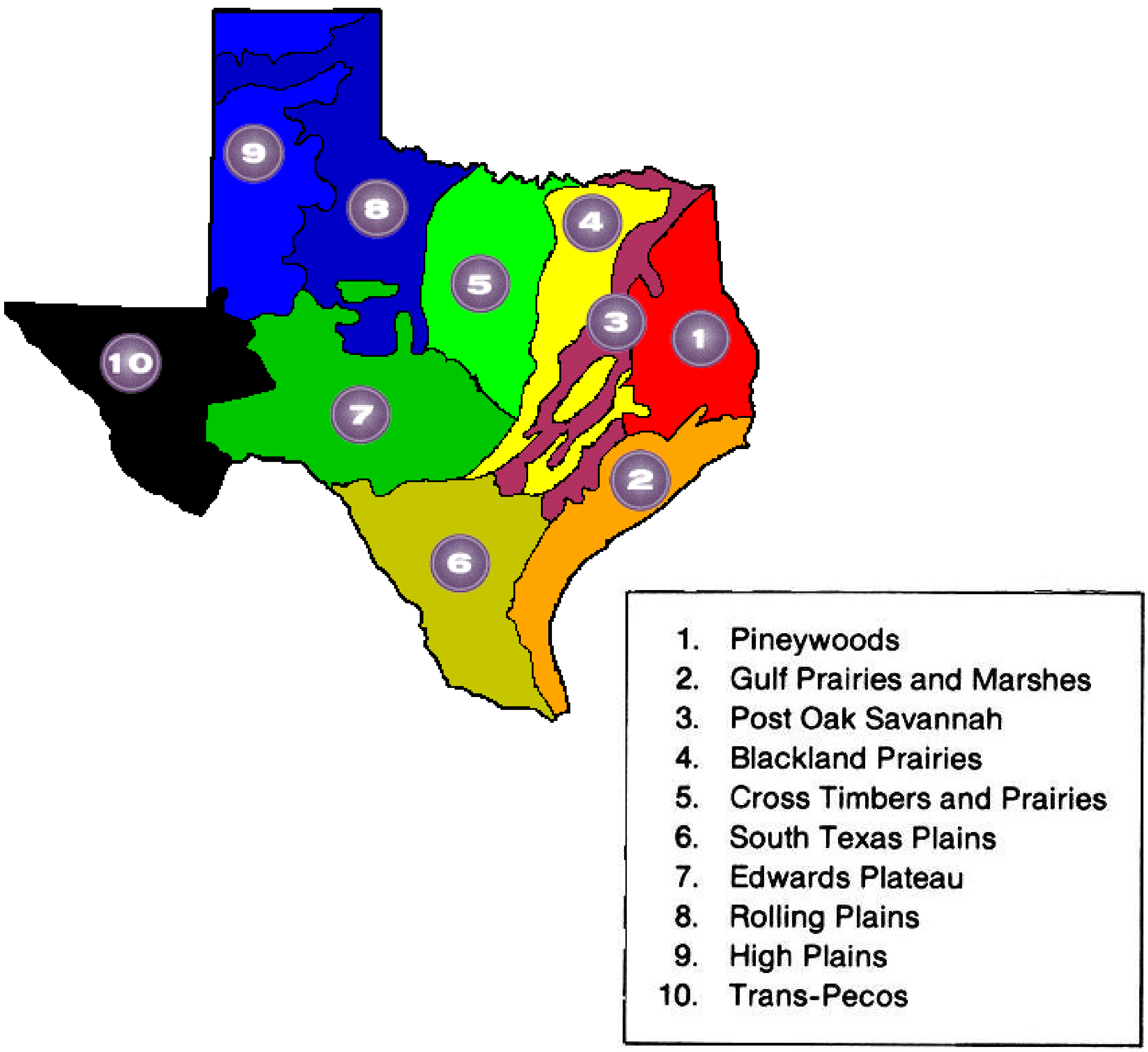
The end of a drought cycle is often marked by one or more flooding events, allowing aquifers and man-made water storage facilities to recharge. The floodplains of the upper Colorado River and its tributaries are typically steep narrow channels with rocky soils and sparse vegetative cover. During intense rain events this allows for rapid runoff, resulting in sharp-crested floods with high peak discharges and velocities. Downstream, the floodplains become wider with denser vegetation, which decrease these streamflow velocities, however the massive volumes of water moving down the river basin can still cause a great deal of flood damage. Areas expected to be most prone to flood damage in the Lower Colorado Planning Region are along Lake Travis and Lake Austin, and the cities of Austin, La Grange, Columbus, Wharton, and Matagorda. Historically, the coastal portion of the river basin is affected by hurricanes two of every five years. The Hill Country in Central Texas has experienced more severe flood events than in any other region of the country. In fact, the continental United States record for the most intense 18-hour rainfall occurred in Williamson County in the Brazos River Basin in 1921, with 36 inches of rain. From 1843 to 1938, there have been 22 major floods along the Colorado River. The most intense localized flash flood in the Lower Colorado Planning Region in recent history occurred 24 May 1981 in Austin. This storm produced a flood with a recurrence level greater than 100 years, caused $40 million in damage, and was responsible for 13 deaths.

Figure 1.7 : Lower Colorado Regional Water Planning Area (Region K) Average Annual Precipitation



1.2.1.3 Vegetational Areas [7]
Natural regions, or vegetation areas, are based on the interaction of geology, soils, physiography, and climate. There are ten vegetational areas that cross the state of Texas and five of these intersect the Lower Colorado Region (Figure 1.8). These are the Cross Timbers and Prairies, the Edwards Plateau, the Blackland Prairies, the Post Oak Savannah, and the Gulf Prairies, and Marshes. Each of these vegetation areas is described below. Figure 1.9 shows the dominant plant species that occur in the Lower Colorado Region.

Figure 1.8: Vegetational Areas of Texas
(Source: Dr. Stephen L. Hatch, Texas Agricultural Experiment Station)



[7] Hatch, et al, Op. Cit., July 1990.

The **Cross Timbers and Prairies** vegetational area includes all of Mills County, most of Burnet County, the north portions of San Saba and Travis counties, and the section of Williamson County within the Lower Colorado Planning Region. This region falls within the southern extension of the Central Lowlands and the western edge of the Coastal Plains physiographic provinces. There are sharp contrasts in topography, soils, and vegetation in this region due to the wide variety of geologic formations in the area. Elevations range from 500 feet to 1,500 feet above mean sea level. Cross Timber soils are typically of the orders Mollisol and Alfisol. In the East and West Cross Timbers subregions, soils range from light, slightly acid loamy sands and sandy loams with yellowish brown to red clayey subsoils in the upland areas to dark, neutral to calcareous clayey bottomland soils, and loamy alluvial soils along minor streambeds. The North Central Prairies subregion is interspersed with sandstone and shaley ridges and hills. Uplands are brown sandy loam to silt loam, slightly acid soils that overlay red to gray, neutral to alkaline clayey subsoils. The bottomlands have brown to dark gray, loamy, and clayey, neutral to calcareous, and alluvial soils.

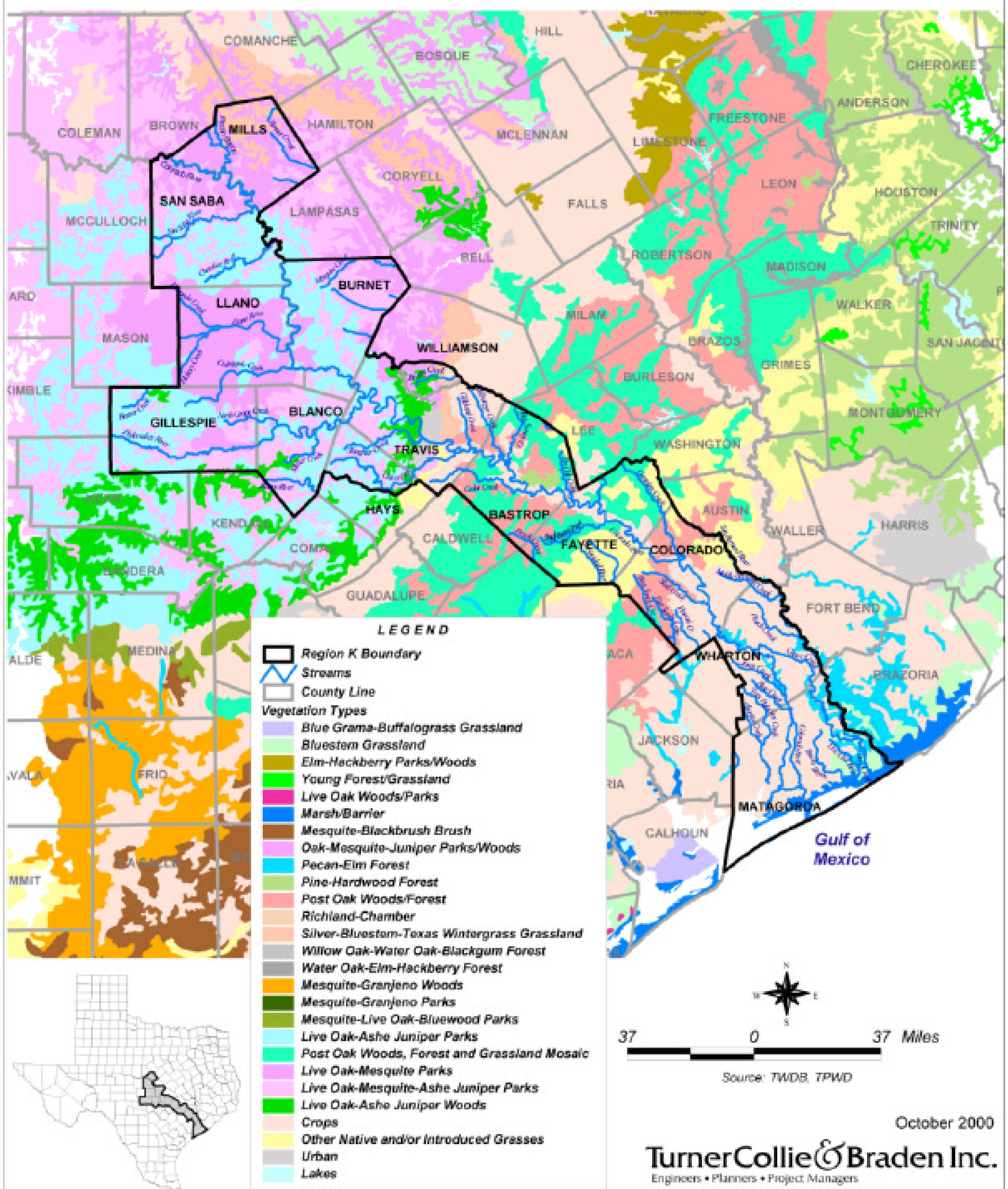
The Cross Timbers and Prairies support tallgrasses such as big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and Canada wildrye (*Elymus canadensis*), with minor populations of midgrasses and shortgrasses such as sideoats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), hairy grama (*B. hirsuta*), Texas wintergrass (*Stipa leucotricha*), and buffalograss (*Buchloe dactyloides*). Overgrazing has allowed the midgrasses and shortgrasses to increase their range and has allowed the invasion of scrub oak (*Quercus turbinella*), honey mesquite (*Prosopis glandulosa*), and Ashe juniper (*Juniperus ashei*) in upland areas, as well as hairy tridens (*Erioneuron pilosum*), Texas grama (*Bouteloua rigidiseta*), red lovegrass (*Eragrostis secundiflora*), wild barleys (*Hordeum*), threeawns (*Aristida*), fringed-leaf paspalum (*Paspalum setaceum*), and tumble windmillgrass (*Chloris verticillata*). Bottomland trees include pecan (*Carya illinoensis*), oak (*Quercus*), and elm (*Ulmus*), with invasion of mesquite. Typical shrubs and vines include skunkbush (*Rhus aromatica*), saw greenbriar (*Smilax bona-nox*), bumelia (*Bumelia lanuginosa*), and poison-ivy (*Rhus toxicodendron*).

Today, approximately 75 percent of the Cross Timbers and Prairies natural region is rangeland and pastureland. White-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), squirrel (*Sciurus* spp.), bob white quail (*Colinus virginianus*), and mourning dove (*Zenaida macroura*) are plentiful.

The **Edwards Plateau** vegetational area consists of an area of West Central Texas commonly known as the “hill country” and includes the entire portion of Hays County within the Lower Colorado Planning Region, all of Llano, Gillespie, and Blanco counties, most of San Saba County, southern Burnet County, and western Travis County. The geologic formation known as the Balcones Escarpment forms the eastern and southern boundary of this region. Elevations range from 1,200 feet to over 3,000 feet above mean sea level, and the landscape is deeply dissected, hilly, rough, and well drained. Edwards Plateau soils are typically shallow Entisols, Mollisols, or Alfisols that have a variety of surface textures and are underlain by limestone.

Historically, the natural vegetation of the Edwards Plateau was grassland or open savannah-type plains with tree or brush along rocky slopes and streambeds. Tall grasses such as cane bluestem (*Bothriochloa barbinodis*), big bluestem, little bluestem, indiangrass, and switchgrass, are still common today along rocky outcrops and protected areas with good soil moisture. In areas with more shallow soils, tall grasses have been replaced by midgrasses and shortgrasses such as sideoats grama, Texas grama, and buffalograss. Typical wildflowers are Engelmann daisy (*Engelmannia pinnatifida*), orange zexmania (*Wedelia hispida*), western ragweed (*Ambrosia psilostachya*), and sneezeweed (*Helenium*

Figure 1.9 : Lower Colorado Regional Water Planning Area (Region K) Vegetation Distribution



quadridentatum). Areas disturbed by over-grazing have been invaded by pricklypear (*Opuntia*), bitterweed (*Hymenoxys odorata*), broadleaf milkweed (*Asclepias latifolia*), smallhead sneezeweed (*H. microcephalum*), broomweeds (*Amphiachyris* and *Gutierrezia*), prairie coneflower (*Ratibida columnifera*), mealycup sage (*Salvia farinacea*), and tasajillo (*Opuntia leptocaulis*). Common woody species are live oak (*Quercus virginiana*), sand shin oak (*Quercus havardii*), post oak (*Quercus stellata*), mesquite, and juniper.

Land suitable for cultivation occurs only along narrow streams and divides within the Edwards Plateau region and in these areas tree orchards are common. The majority of the region is utilized as rangeland for the production of livestock and wildlife. This area was once one of the major wool and mohair producers in the country, providing up to 98 percent of the nation's mohair; however the loss of federal mohair subsidies has caused a decline in this industry over the past decade. The Edwards Plateau also supports the largest deer population in North America and exotic big game ranches are increasing across the region.

Within the Lower Colorado Region, the **Blackland Prairies** vegetational area occurs in eastern Travis County, several small sections of Bastrop County, western and eastern portions of Fayette County, and a minor portion of Colorado County. The characteristic topography is gently rolling hills to nearly level with well-defined contours for rapid surface drainage. Elevation varies from 250 to 700 feet above mean sea level. Major soil orders include Vertisols and Alfisols, which are naturally very productive and fertile. Upland soils are dark, calcareous, and clayey. Bottomland soils are typically reddish-brown to dark gray, slightly acid to calcareous, loamy to clayey to alluvial.

The Blackland Prairie once supported a tall-grass prairie dominated by big bluestem, little bluestem, indiangrass, tall dropseed (*Sporobolus asper*), and Silveus dropseed (*S. silveanus*). Minor species including sideoats grama, hairy grama, Mead's sedge (*Carex meadii*), Texas wintergrass, and buffalograss have increased due to grazing pressure. Erosion and agricultural activities have decreased the productivity of these soils. Common wildflowers include asters (*Aster*), prairie bluet (*Hedyotis nigricans*), prairie-clover (*Petalostemon*), and late coneflower (*Rudbeckia serotina*). Typical legumes are snoutbeans (*Rhynchosia*), and vetch (*Vicia*). Areas disturbed by grazing and agriculture have been invaded by mesquite, huisache (*Acacia smallii*), oak, and elm trees. Oak, elm, cottonwood (*Populus deltoides*), and native pecan can be found in moist drainage areas. Isolated areas of Blackland Prairies are intermingled within the Post Oak Savannah vegetation area.

In the latter 19th and early 20th centuries, approximately 98 percent of the Blackland Prairies vegetational area had been converted to cropland. Pastureland and livestock forage cropland began to increase in the 1950s and today only 50 percent of the area is used for cropland. Cultivated pastures make up 25 percent of the land area, and the rest is used as rangeland. Significant game species include dove, bobwhite quail, and squirrel.

The **Post Oak Savannah** vegetational area within the Lower Colorado Region occurs in most of Bastrop and Colorado counties, and central Fayette County. The region is characterized by gently rolling, moderately dissected wooded plains with elevations between 300 feet and 800 feet above mean sea level. There are several areas of Blackland Prairie intermingled in the southern portion of the Post Oak Savannah. Typically shallow upland soils are gray, slightly acid sandy loams that overlay gray, mottled, or red, firm clayey subsoils. Infiltration-resistant claypan layers occur at varying soil depths, which impedes the percolation of moisture. Bottomland soils are reddish-brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial.

Typically, short oak trees, such as post oak and blackjack oak (*Q. marilandica*), are interspersed among the tallgrass species of little bluestem, silver bluestem (*Bothriochloa saccharoides*), indiangrass, switchgrass, and midgrass and shortgrass species of, Texas wintergrass (*Stipa leucotricha*), purpletop (*Tridens flavus*), narrowleaf woodoats (*Chasmanthium sessiliflorum*), and beaked panicum (*Panicum anceps*). Elms, junipers, hickories (*Carya*), and hackberries (*Celtis*) are also common trees here. Shrubs and vines such as yaupon (*Ilex vomitoria*), American beautyberry (*Callicarpa americana*), coralberry (*Symphoricarpos orbiculatus*), greenbriar (*Smilax*), and grapes (*Vitis*) are typical. Historically, periodic wildfires have suppressed the overgrowth of brush and trees, and in their absence thickets tend to form. Wildflowers characteristic of the true prairie species include wild indigo (*Babtisia*), indigobush (*Amorpha fruticosa*), senna (*Cassia*), tickleclover (*Desmodium*), lespedezas (*Lespedeza*), prairie-clovers, western ragweed, crotons (*Croton*), and sneezeweeds.

The Post Oak Savannah was extensively cultivated through the 1940s, however, today many acres have been returned to native habitat or tame pastureland, which have been seeded with non-native species such as bermudagrass, bahiagrass, weeping lovegrass, and clover. The region supports game species such as deer, squirrel, and quail.

The **Gulf Prairies and Marshes** vegetational area encompasses all of Matagorda County, the entire portion of Wharton County within the Lower Colorado Region, and the eastern tip of Colorado County. This is a 30- to 80-mile wide strip of lowlands adjacent to the Texas coast from the Louisiana border to the Mexico border. The landscape consists of low, wet coastal marshes, and nearly flat, undissected plains with elevations from sea level to 250 feet. Marsh soils are typically dark, poorly drained, saline and sodic, sandy loams, and clays, and light neutral sands. Prairie soils are characterized by dark, neutral to slightly acid clay loams, and clays, with a narrow belt of light acid sands and darker loamy to clayey soils along the coast. Bottomland and delta soils are typically reddish-brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial.

Original Gulf Prairie vegetation consisted of tallgrasses and post oak savannah. Today, however, trees and shrubs such as honey mesquite, oaks, acacia, and bushy sea-ox-eye (*Borrichia frutescens*) have formed thickets in many areas. Characteristic tallgrasses include gulf cordgrass (*Spartina spartinae*), big bluestem, little bluestem, indiangrass, eastern gamagrass (*Tripsacum dactyloides*), gulf muhly (*Muhlenbergia capillaris*), tanglehead (*Heteropogon contortus*), as well as *Panicum* and *Paspalum* species. Typical wildflowers include asters, Indian paintbrush (*Castilleja indivisa*), poppy mallows (*Callirhoe*), phloxs (*Phlox*), bluebonnets (*Lupinus*), and evening primroses (*Oenothera*). Common invaders such as yankeeweed (*Eupatorium compositifolium*), broomsedge bluestem (*Andropogon virginicus*), smutgrass (*Sporobolus indicus*), western ragweed, tumblegrass (*Schedonnardus paniculatus*), threeawns (*Aristida*), pricklypear, and many annual wildflowers and grasses have increased their ranges. Saline Gulf Marsh areas support species of sedges (*Carex* and *Cyperus*), rushes (*Juncus*), bulrushes (*Scirpus*), cordgrasses (*Spartina*), seashore saltgrass (*Distichlis spicata*), common reed (*Phragmites australis*), marshmillet (*Zizaniopsis miliacea*), longtom (*Paspalum lividum*), seashore dropseed (*Sporobolus virginicus*), and knotroot bristlegrass (*Setaria geniculata*). Marshmillet and maidencane (*Panicum hemitomon*) are two important freshwater grass species found in the upper coast. Typical aquatic forbs include pepperweeds (*Lepidium*), smartweeds (*Polygonum*), docks (*Rumex*), bushy seedbox (*Ludwigia alternifolia*), green parrotfeather (*Myriophyllum pinnatum*), pennyworts (*Hydrocotyle*), water lilies (*Nymphaea*), narrowleaf cattail (*Typha domingensis*), spiderworts (*Tradescantia*), and duckweeds

(*Lemna*). Common halophytic herbs and shrubs found on the salty sands of the coast include spikesedges (*Eleocharis*), fimbries (*Fimbrystalis*), glassworts (*Salicornia*), sea-rockets (*Cakile*), maritime saltwort (*Batis maritima*), morningglories (*Ipomoea*), and bushy sea-ox-eye.

The low coastal marshes of the Gulf Prairies and Marshes vegetational area provide excellent habitat for upland game and waterfowl. Higher elevations of the marshes are used for livestock and wildlife production. These coastal marshes and barrier islands contain most of the state's National Seashore parks. Urban, industrial, and recreational developments have been increasing in this region and cultivation has never been of much importance due to the saline soils and recurrent flooding of the area. However, approximately one-third of the inland prairies region is cultivated. This is also the major area of irrigated crop production, consisting primarily of rice cultivation, for the entire Lower Colorado Region. Bermudagrass and several bluestem species are common in tamed pasturelands. The Gulf Prairies and Marshes region has seen more industrialization than anywhere in Texas since World War II.

1.2.1.4 Water Resources [8,9]

Two percent, or 3,432,320 acres, of the total area in Texas is covered with water. Once these surface waters become channelized they belong to the state, and individuals, municipalities, and industries are granted water rights permits for the use of "Waters of the State." In addition to the issuance of water rights permits, individual landowners have the legal right to use the surface water generated on their property without a permit and are allowed to construct storage facilities with a maximum unit capacity of 200 acre-feet for agricultural purposes. Regulation of the state's surface water is the responsibility of the Texas Natural Resource Conservation Commission (TNRCC). Surface water resource development and facility financing is the responsibility of the Texas Water Development Board (TWDB). Determination of available water supply for planning purposes is based on the concept of "firm yield", which is the amount of water that is available from a water source during a repeat of the drought of record.

The primary surface water feature of the Lower Colorado Region is the Colorado River. Figure 1.10 displays the surface water hydrology characteristics of the Region. The major sources of dependable surface water supplies in the region are the Highland Lakes reservoir system and the "run-of-the-river" (ROR) water from the Colorado River below Austin. Run-of-the-river water rights entitle permit holders to divert water directly from a channelized river. Tributary run-of-the-river and off-channel storage are also utilized by several water user groups. And a small portion of the planning region's surface water supply comes from local supplies within adjacent river basins. There are 11 water supply reservoirs within the LCRWPG boundaries: Goldthwaite, Blanco, Llano, and Cedar Creek reservoirs, Lake Walter E. Long, and the Highland Lakes System (Lakes Buchanan, Inks, Lyndon B. Johnson, Marble Falls, Travis, and Austin). Lake Georgetown is located outside the boundaries of the Lower Colorado Region in Williamson County, however a small portion of this water supply is utilized within the region. The City of Austin (COA), with approximately 47 percent, is the largest run-of-the-river water rights holder (based on firm yield) for the Colorado River in the region. The COA is followed by the Lower Colorado River Authority (LCRA) (35%), Houston Power & Light (10%), City of Corpus Christi (7%) and Lacy Armour (1%) for the remaining Colorado River ROR water rights in the Lower Colorado Region.

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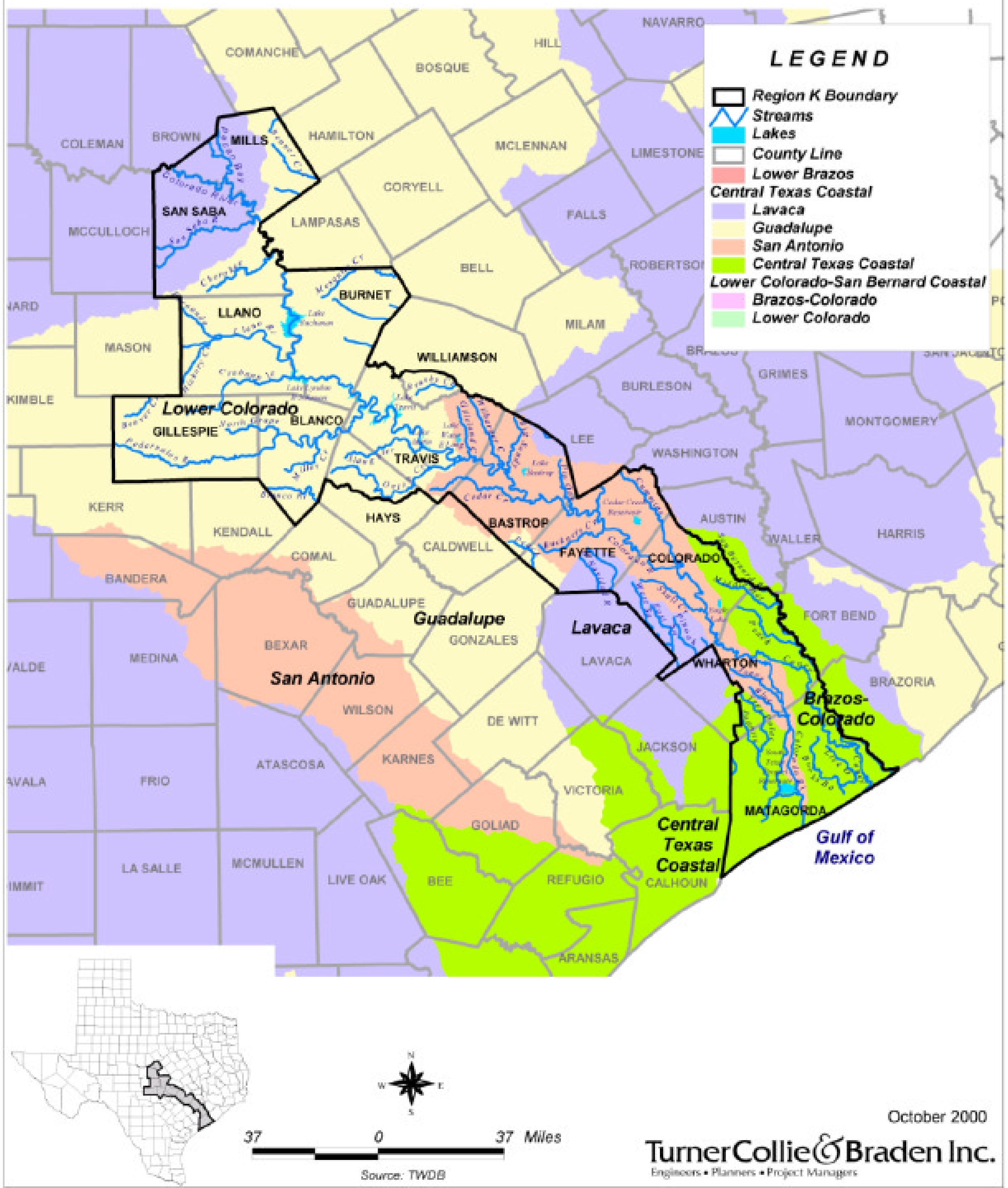
[8] Dallas Morning News, 1999. "Texas Almanac 2000-2001, 60th Edition," Texas A&M Press.
[9] Texas Water Development Board (TWDB), November 1995. "Aquifers of Texas, Report 345."

Figure 1.10 : Lower Colorado Regional Water Planning Area (Region K) Surface Water Hydrology



Large quantities of fresh to slightly saline groundwater underlie more than 81 percent of the land in Texas. There are nine "major" aquifers that can produce large quantities of water over a large area, and 20 "minor" aquifers that yield smaller amounts of water over smaller geographic areas. At present, fifty-six percent of the state's annual water consumption is derived from the state's major and minor aquifers, 75 percent of which is used for agriculture. Of these 29 aquifers, five major and five minor aquifers occur within the Lower Colorado Region.

The five major aquifers are the Carrizo-Wilcox, Edwards (BFZ), Edwards-Trinity (Plateau), Gulf Coast, and Trinity (Figure 1.11). These aquifers tend to run in curved belts northeast to southwest across the state. The northern-most major aquifer in the Lower Colorado Region is the Trinity, which has both unconfined water-table and pressurized artesian zones, and covers portions of Mills, Burnet, Gillespie, Blanco, Travis, Hays, and Bastrop counties. Within the region, the Trinity aquifer contains two major early Cretaceous age formations: the Antlers Formation, which consists of a maximum of 900 feet of sand and gravel, with clay beds in the middle section; and the Travis Peak Formation, which contains calcareous sands and silts, conglomerates, and limestones. West of the Trinity aquifer in Gillespie County is a small eastern water-table portion of the Edwards-Trinity (Plateau) aquifer. Within the planning region, the Edwards-Trinity (Plateau) aquifer contains saturated sediments of lower Cretaceous age formations and overlying limestones and dolomites. Maximum saturated thickness of the aquifer is 800 feet, however the eastern portion of the aquifer in Gillespie County is thinner. Overlying a portion of the Trinity artesian zone is the Edwards (BFZ) aquifer, which covers portions of Hays, Travis, and Williamson counties within the Lower Colorado Region. In this area, the aquifer contains both unconfined and artesian zones and feeds the well-known recreational Barton Springs, which contributes an estimated average of 50 cubic feet per second (cfs) of flow to the Colorado River. The Edwards (BFZ) is primarily composed of early Cretaceous age limestone deposits that have a thickness ranging between 200 feet and 600 feet. This aquifer has a high permeability and transmissivity, making it heavily dependent on consistent recharge and extremely sensitive to environmental stresses. Southeast of the Trinity is the Carrizo-Wilcox aquifer in portions of Bastrop and Fayette counties. This aquifer contains both water-table and artesian zones and consists of two hydrologically connected formations, the Wilcox Group and the overlying Carrizo Formation, which are predominantly composed of Tertiary age sand that is imbedded with gravel, silt, clay, and lignite. The thickness of the artesian zone ranges from 200 feet to 3,000 feet. The southernmost and largest major aquifer within the Lower Colorado Region is the Gulf Coast aquifer, which stretches continuously from southeastern Fayette County through Matagorda County. This portion of the aquifer is described as a leaky artesian system, which is composed of Cenozoic age complex interbedded clays, silts, sands, and gravel. In some areas near the Gulf Coast heavy pumping has also caused the intrusion of saltwater into aquifer layers that previously had good water quality. The physical characteristics of this aquifer make it susceptible to dewatering, or a permanent compaction of the clay layer and loss of water storage capacity, as a result of overuse of the aquifer. This compaction can also cause subsidence of surface land overlying the aquifer, which can contribute to flood and structural damage in the area.

The minor aquifers occurring within the Lower Colorado Region are the Ellenburger-San Saba, Hickory, Marble Falls, Queen City, and Sparta (Figure 1.12). All five of these aquifers contain unconfined zones and pressurized artesian zones. The Ellenburger-San Saba, Hickory, and Marble Falls aquifers occur in the northwestern portion of the planning region, have discontinuous circular coverage areas, and overlap one another. The Hickory aquifer is composed of the Hickory Sandstone Member of the Cambrian Riley Formation, which contains some of the oldest sedimentary rocks found in Texas. This aquifer has a maximum thickness of 480 feet. The Ellenburger-San Saba aquifer has the same general shape as the Hickory, and is composed of late Cambrian age limestone and dolomite. San Saba Springs is thought to

Figure 1.11 : Lower Colorado Regional Water Planning Area (Region K) Major Aquifers

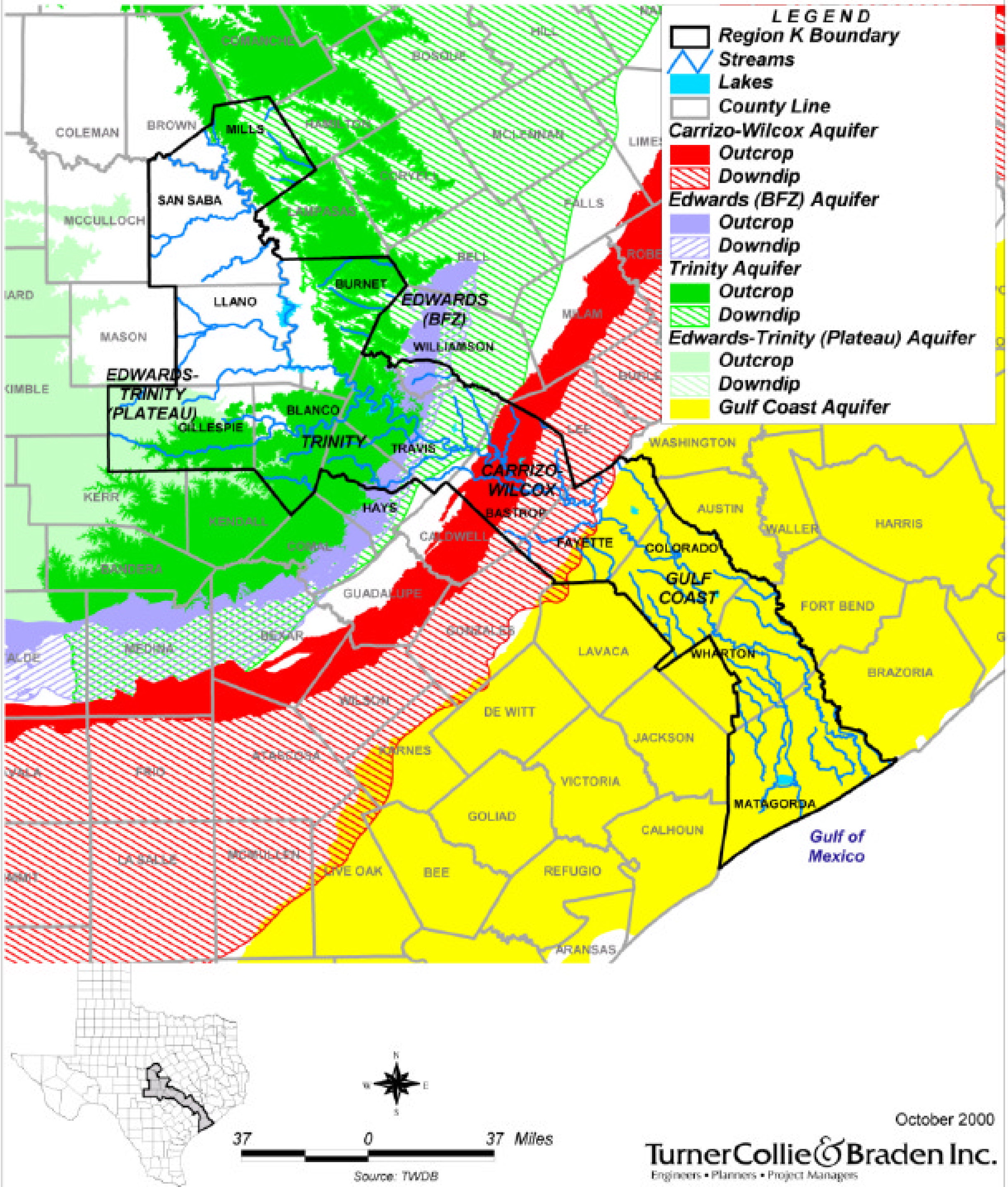
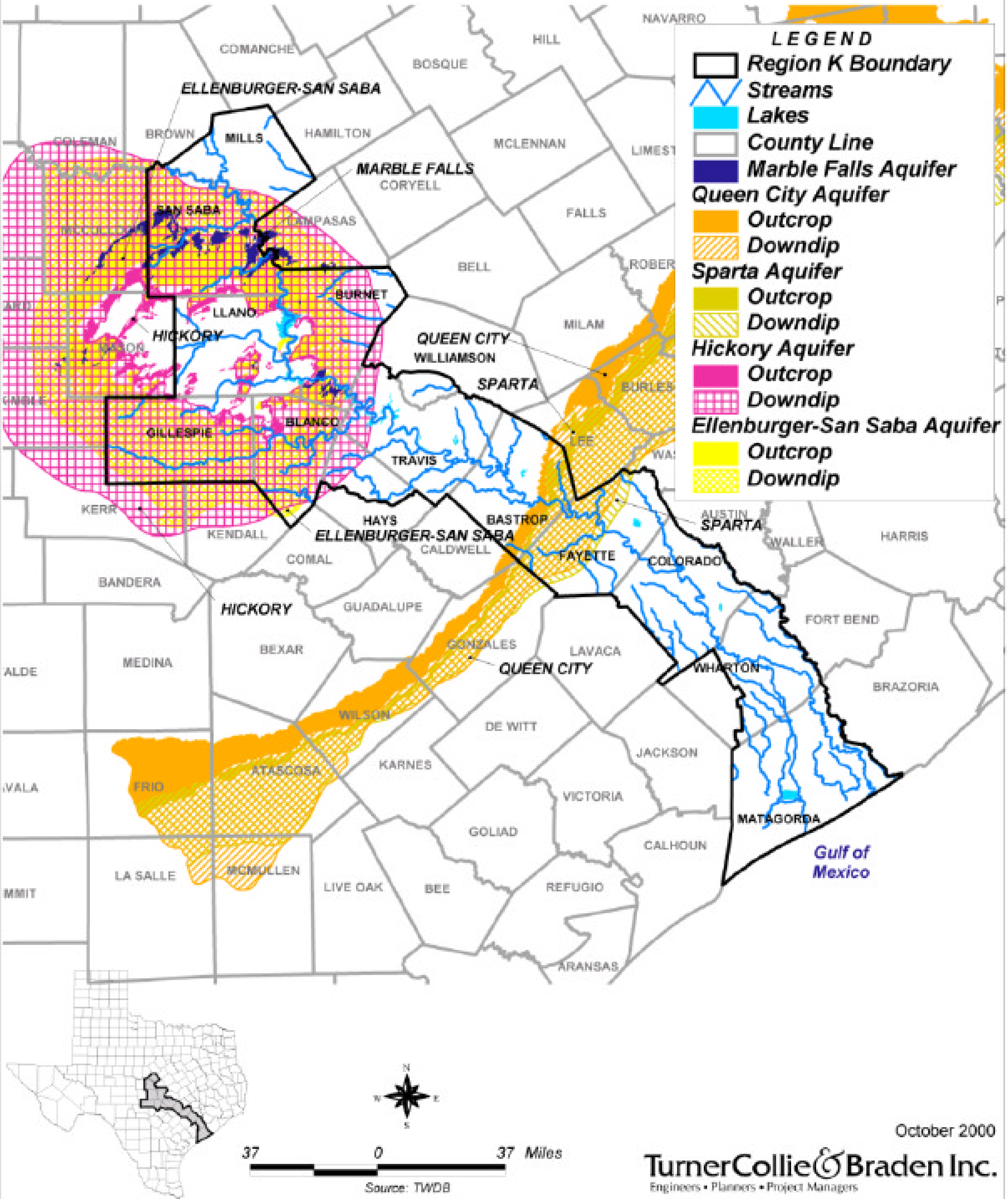


Figure 1.12 : Lower Colorado Regional Water Planning Area (Region K) Minor Aquifers



be supplied primarily by the Ellenburger-San Saba and Marble Falls aquifers, which may be hydrologically connected in some areas. The Marble Falls aquifer occurs in several disconnected outcrops of Pennsylvanian age limestone that form fractures, solution cavities, and channels. The maximum thickness of this aquifer is 600 feet. Numerous large springs are fed by the Marble Falls aquifer, which provide a substantial portion of baseflow to the San Saba and Colorado rivers in San Saba County. The Queen City and Sparta aquifers overlap one another across southeastern Bastrop and northwestern Fayette counties. The Queen City aquifer is composed of Tertiary age sand, loosely cemented sandstone, and interbedded clay. The maximum thickness of this aquifer is less than 500 feet. The Sparta aquifer overlies the downdip portion of the Queen City aquifer and consists of Tertiary age sand and interbedded clay.

The total water supply currently available to the Lower Colorado Region during a repeat of the drought-of-record is estimated to be 1,203,111 acre-feet, of which approximately 65 percent is from Colorado River (Table 1.2). Groundwater accounts for about 28 percent of the region's water supply. Surface water and groundwater supply availabilities for the Lower Colorado Region are detailed in Chapter 3.

Table 1.2: Currently Available Water Supplies Within the Lower Colorado

Type of Surface Water (SW) Supply	Firm Yield[1, 2] (ac-ft)	% SW Supply
Colorado River reservoirs	449,966	37.4%
Colorado River run-of-the-river	336,061	27.9%
Colorado River Basin local supplies	60,536	5.0%
Brazos River Basin local supplies	566	0.0%
Brazos-Colorado Coastal Basin local supplies	8,049	0.7%
Colorado-Lavaca Coastal Basin local supplies	4,228	0.4%
Lavaca River Basin local supplies	4,671	0.4%
Guadalupe River Basin (local & reservoirs)	648	0.1%
Total SW Supply	***864,725***	***71.9%***
Type of Ground Water (GW) Supply	Available GW Supply[1, 3] (ac-ft)	% GW Supply
Gulf Coast Aquifer	198,425	16.5%
Carrizo-Wilcox Aquifer	22,350	1.9%
Edwards Aquifer BFZ	20,995	1.7%
Trinity Aquifer	11,821	1.0%
Edwards-Trinity Plateau Aquifer	1,657	0.1%
Hickory Aquifer	27,380	2.3%
Queen City Aquifer	3,991	0.3%
Sparta Aquifer	9,889	0.8%
Ellenburger-San Saba Aquifer	23,574	2.0%
Marble Falls Aquifer	18,304	1.5%
Total GW Supply	***338,386***	***28.1%***
Total LCRWPG Available Water Supply	**1,203,111**	**100.0%**

[1] Year 2000 water available during drought of record conditions.

[2] Excludes City of Austin return flow.

[3] The supply amounts provided in the groundwater table are current TWDB estimates of availability. They do not reflect model results associated with a maximum drawdown adopted by the LCRWPG and are subject to change.

1.2.1.5 Land Resources [10]

The majority of the Lower Colorado Region's land area falls within the Colorado River Basin and 92 percent of the region's population resides in this portion of the basin. Land use (Figure 1.13) in the Lower Colorado Region consists primarily of agricultural land in Matagorda, Wharton, Colorado, Fayette, and eastern Travis counties. Forest land runs through the middle of Colorado and Fayette counties; western Travis and Burnet counties; southeastern Llano County; and a significant portion of Gillespie and Hays counties. Rangeland predominates in Mills, San Saba, northwestern Llano, and eastern Burnet counties. Blanco County is primarily a mixture of forest land and range land. Bastrop County is a mixture of forest land, agricultural land, and rangeland. A significant concentration of urban land only occurs in the Austin metropolitan area.

The state of Texas has 123 state parks and 14 of these, with a total of 28,223 acres, occur within the counties of the Lower Colorado Region (Table 1.3). The Texas state park system offers a variety of recreational and educational opportunities, including camping, hiking, fishing, boating, water skiing, swimming, wildlife viewing, picnicking, and tours of nature exhibits and historical sites.

1.2.1.6 Wildlife Resources [11]

There are 17 national wildlife refuges in Texas, comprising over 463,000 acres, and four of these occur within the Lower Colorado Region (83,338 acres). Refuges function to preserve and protect critical wildlife habitat for unique, rare, threatened, and/or endangered species. Many refuges allow bird and wildlife viewing, hunting, and fishing during specific times of the year. In addition, the Texas Parks and Wildlife Department (TPWD) currently manages 50 Wildlife Management Areas (WMA) in the state with a total of 750,000 acres. Two WMA's lie within the Lower Colorado Region and encompass approximately 7,500 acres. These areas preserve and manage quality wildlife habitat and can allow compatible activities such as research, hunting, fishing, hiking, camping, bicycling, and horseback riding. Table 1.4 lists the wildlife refuges and management areas within the Lower Colorado Region.

Each county within the Lower Colorado Planning Region provides habitat for several threatened or endangered animal and plant species. Endangered species are those at risk of extinction. Threatened species are those likely to become endangered in the future. These designations are made at the state and federal level by the Texas Parks and Wildlife Department (TPWD) and the U. S. Fish and Wildlife Service (USFWS). State and federal Threatened and Endangered species listings for each county in the Lower Colorado Region are presented in Appendix A. Rare species that are not listed as threatened or endangered are also included.

[10] Dallas Morning News (Texas Almanac 2000-2001), Op. Cit., 1999.
[11] Dallas Morning News (Texas Almanac 2000-2001), Op. Cit., 1999.

Figure 1.13 : Lower Colorado Regional Water Planning Area (Region K) Landuse Distribution

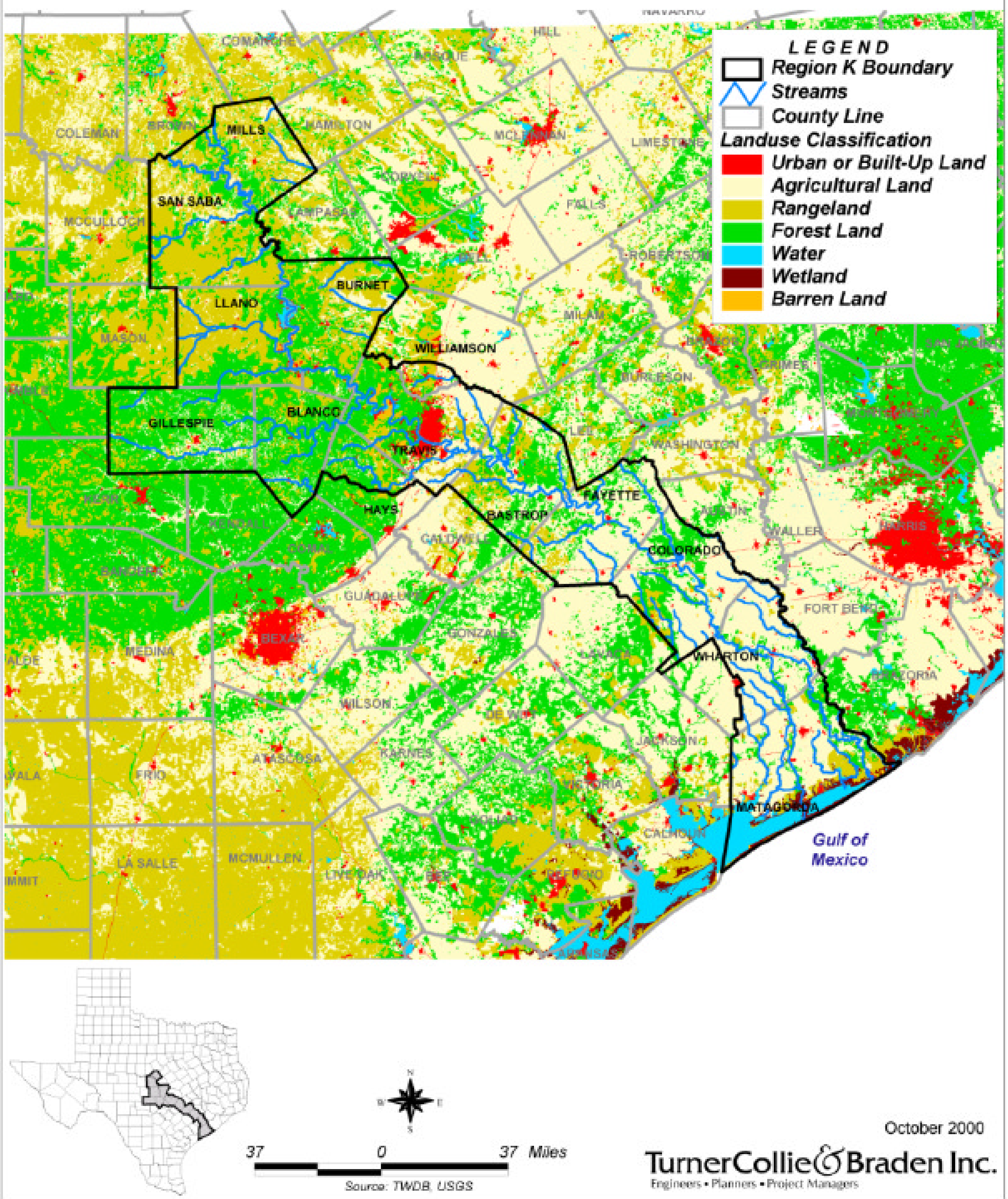


Table 1.3: State Parks Within the Lower Colorado Region

Name	County	Acreage	Description
Admiral Nimitz Museum & Historical Center	Gillespie	7	Established in 1969 and contains special exhibits from World War II
Bastrop State Park	Bastrop	3,504	Established between 1933 and 1935 and contains the "Lost Pines" isolated region of loblolly pine and hardwoods.
Blanco State Park	Blanco	105	Established in 1933 along the Blanco River and has fishing for winter rainbow trout, perch, catfish, and bass.
Buescher State Park	Bastrop	1,017	Established between 1933 and 1936 and was part of Stephen F. Austin's colonial grant; an estimated 250 species of birds can be found in the park.
Colorado Bend State Park	San Saba	5,328	Established in 1984 and part is in Lampasas Co.; contains scenic Gorman Falls and is home to rare and endangered species including the bald eagle, golden-cheeked warbler, and black-capped vireo.
Enchanted Rock State Park	Gillespie & Llano	1,644	Established in 1978 along Big Sandy Creek and contains a large granite outcrop that is the second largest batholith in the U.S. Enchanted Rock is also a National Natural Landmark and a National Historic Site.
Inks Lake State Park	Burnet	1,202	Established in 1940 along Inks Lake.
Lake Bastop S. Shore Park	Bastrop	773	Established in 1989.
Longhorn Cavern State Park	Burnet	639	Established between 1932 and 1937 and was dedicated as an natural landmark in 1971. The cave has been used as a shelter since prehistoric times.
LBJ State Historical Park	Gillespie	718	Established in 1965 along the banks of the Pedernales River; contains LBJ's home and a portion of the official Texas longhorn herd, as well as bison, deer, and wild turkey; living-history demonstrations at the restored Sauer-Beckmann house.
Matagorda Island State Park	Matagorda	7,325	A natural accreting barrier island located offshore between Port O'Conner and Fulton and is home to a variety of migratory and resident wildlife, including 18 state or federally listed endangered species.
McKinney Falls State Park	Travis	744	Established in 1970.
Monument Hill State Historical Park/Kreische Brewery State Historical Pk.	Fayette	5	Established in 1907/1977. Memorial to the Salado Creek Battle in 1842 and the "black bean lottery" of the Mier Expedition; and one of the 1st breweries in the state.
Pedernales State Park	Blanco	5,212	Established in 1970 and has typical Edwards Plateau terrain, with live oaks, deer, turkey, and stone hills.

Table 1.4: Wildlife Refuges/Management Areas Located Within the Lower Colorado Region

Name	County	Acreage	Description
National Wildlife Refuges			
Attwater Prairie Chicken	Colorado	8,000	Established in 1972 to preserve habitat for the endangered Attwater Prairie Chicken, which includes native tallgrass prairie, potholes, sandy knolls, marshes, and some wooded areas.
Balcones Canyonlands	Travis	14,144	Established in 1992 northwest of Austin to protect the nesting habitat of two endangered bird species: golden-cheeked warbler and the black-capped vireo. The refuge will eventually encompass 46,000 acres of oak-juniper woodlands and other habitats.
Big Boggy	Matagorda	4,526	Coastal prairie and salt marsh along East Matagorda Bay for the benefit of wintering waterfowl.
Matagorda Island	Matagorda	56,668	A natural accreting barrier island located offshore between Port O'Conner and Fulton and is home to a variety of migratory and resident wildlife, including 18 state or federally listed endangered species.
Wildlife Management Areas			
Mad Island	Matagorda	7,281	This area allows hunting and wildlife viewing.
D.R. Wintermann	Wharton	246	This area has restricted access.

1.2.2 Socioeconomic Characteristics of the Lower Colorado Regional Water Planning Area

1.2.2.1 Historic and Current Population Trends [12, 13]

The Lower Colorado Region has had a steady increase in population from 1950 to the present. As Figure 1.14 shows, in 1950 there were approximately 316,573 people, which has increased to an estimated 939,811 people in 1996. This corresponds to an overall 197 percent increase in the number of people living in the region. The average compound annual growth rate for the 1950 to 1996 period was an estimated 2.4 percent. The period from 1970 to 1980 had the largest percent increase of almost 36 percent, or an addition of 160,878 people. The time period of smallest population growth occurred between 1950 and 1960, with an increase of 45,830 persons (14.5%). As discussed in Chapter 2, this growth trend is expected to continue for the entire state of Texas, as well as the Lower Colorado Region. For the period 1990 to 2050, a projected compound annual growth rate of 1.6 percent is projected resulting in a total regional population of 2,107,106 in 2050.

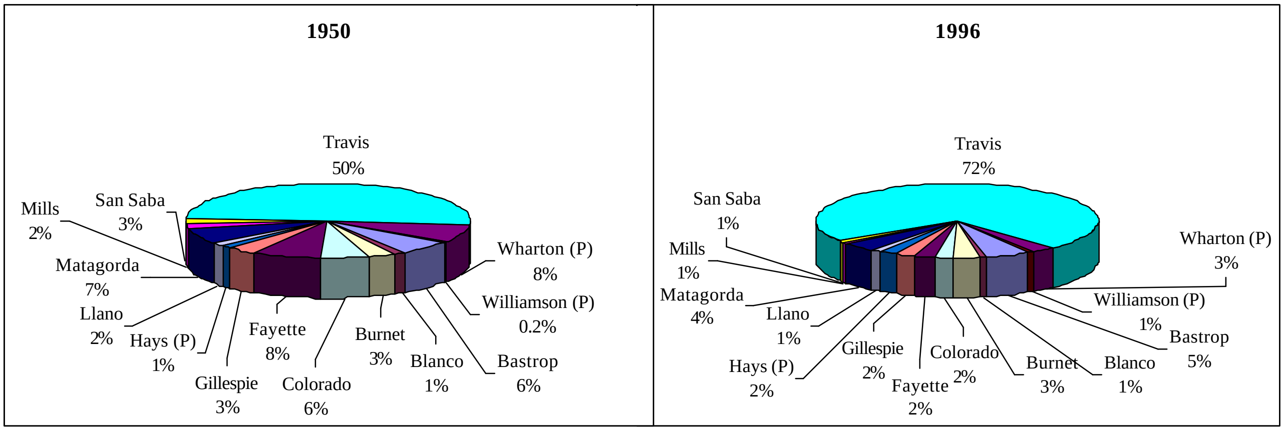
Comparison of the region's county population distribution between 1950 and 1996 (Figure 1.15) shows that Travis County still contains the majority of the region's population. However, this proportion has increased from 50 percent in 1950 to 72 percent in 1996 due to the rapid growth of the Austin area. Travis County's population has more than quadrupled between 1950 and 1996, with the addition of over half a million people. Hays County has also seen a large population increase with almost five times as

[12] Bureau of the Census, Decadal Censuses of 1950, 1960, 1970, 1980, and 1990; and Region K historic population data supplied by the Texas Water Development Board for 1980 – 1996. Populations for the Partial Region K counties of Hays, Williamson, & Wharton were estimated by determining the % decreases observed in projections from the US Census and the TWDB for 1980 and 1990; these percent decreases were then averaged & applied to the 1950, 1960, and 1970 US Census partial-county populations.

[13] There is a difference in historic regional population between Chapter 1 & Chapter 2 that is due to the use of slightly different TWDB data sources. Chapter 1 used the original TWDB CDRom data provided to the LCRWPG and Chapter 2 used later updated TWDB Template information. The original data only included communities with at least 1,000 residents and the new updated version included all communities with at least 500 residents (8 more towns for Region K: Anderson Mill, Bertram, Boling-lago, Cottonwood Shores, Kingsland, Markham, Wells Branch, and Meadowlakes). See Chapter 2 for the updated information used in the water planning analyses.

many people living in the county in 1996 as in 1950. Other counties in the region have experienced much smaller growth rates.

Figure 1.15: Lower Colorado Region County Population Distribution



1.2.2.2 Primary Economic Activities [14,15]

Economic activities in the Lower Colorado Region include agriculture, government/services, manufacturing, mining, and trades. Table 1.5 lists the primary economic base of each county as well as the breakdown of mining and agricultural activities.

Agriculture plays a major role in most of the counties in the Lower Colorado Region. Livestock accounts for more than 60 percent of the planning region's agricultural cash receipts and important crops include rice, hay, wheat, and cotton. The counties located in the northwestern portion of the planning region depend heavily on livestock production. Rice is the major crop produced in the southern most counties of Colorado, Wharton, and Matagorda.

The manufacturing sector consists primarily of the technology and semiconductor industries, in the mid-region counties of Bastrop, Travis, and Williamson, have experienced a healthy economic growth. The largest single manufacturing industry in the coastal counties is petroleum refining and petrochemicals, and the price fluctuations in oil prices resulted in a slight decline in the economic growth rate during this period. At the same time there has been significant economic growth in food processing, lumber, wood products, and construction supplies for the coastal counties. Textile and apparel industries are found throughout the Lower Colorado Region, however the economic growth rate has been on the decline over the past decade. The construction sector economic trend was productive throughout the planning region due to increases in residential markets, prison facilities, and shopping malls.

In the decade between 1984 and 1994, almost every sector of the regional economy experienced growth, except construction and mining. During this time, average annual employment growth rates for the Lower Colorado Region were 2.7 percent for the far northern portion of the region, 3.5 percent for the middle portion, and 1.3 percent for the lower portion of the region.

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[14] Dallas Morning News (Texas Almanac 2000-2001), Op. Cit., 1999.
[15] Texas Comptroller of Public Accounts, Texas Economy, www.window.state.tx.us/ecodata/regional/

More than 70 percent of the jobs in the Lower Colorado Region are in the trade, government/services, and manufacturing sectors. Table 1.6 breaks down the employment distribution between the major employment sectors in the region. The three largest employment sectors in the region each provide jobs for over 100,000 people. These are state/local governments, the wholesale/retail trade, and business/social services, with a combined 1995 job total of 491,102 jobs, which is approximately 58 percent of the total regional employment. These categories have a combined estimated economic value of $14.27 billion per year, which is approximately 43 percent of the region's total estimated economic value. The agricultural sector accounts for almost 4 percent, construction is approximately 8 percent, and manufacturing is 10 percent of the region's employment. These correspond to 1.4 percent, 6.4 percent, and 18.1 percent of the region's total estimated economic value, respectively.

Table 1.5: Lower Colorado Region Primary Economic Activities, by County

County	Primary Economic Base	Mineral Deposits	Agriculture
Bastrop	government/services, tourism, agribusiness, computer equipment	clay, oil, gas	hay, beef cattle, turfgrasses, horses, goats, pecans, pine
Blanco	tourism, agribusiness, ranch supplies & equipment manufacturing, hunting	insignificant	cattle, sheep, goats, hay, vegetables, wheat, peaches, pecans, greenhouse nurseries
Burnet	stone processing, manufacturing, agribusiness, tourism, hunting	granite, limestone	cattle, goats, sheep, hay, hunting, pecans
Colorado	agribusiness, oilfield services/ equipment, manufacturing, mineral processing	gas, oil, uranium	rice, cattle, nursery, corn, poultry, hay, sorghum, cedar, pine
Fayette	agribusiness, tourism, electrical power generation, mineral production, small manufacturing	oil, gas, sand, gravel	poultry, beef cattle, dairies, corn, sorghum, peanuts, hay, pecans
Gillespie	agribusiness, tourism, government/ services, food processing, hunting, small manufacturing, granite processing	sand, gravel, gypsum, limestone	beef cattle, turkeys, sheep, goats, peaches, hay, sorghum, oats, wheat, grapes
Hays (p)	tourism, retirement, some manufacturing, hunting	sand, gravel, cement	beef cattle, goats, exotic wildlife, greenhouse nurseries, hay, corn, sorghum, wheat, cotton
Llano	tourism, retirement, ranch commerce center, vineyards, granite mining, hunting	granite, vermiculite, llanite	beef cattle, turkeys, hogs, sheep, goats, hay, peanuts, oats
Matagorda	petroleum operations, petrochemicals, agribusiness, varied manufacturing, significant tourism	gas, oil, salt	major rice-growing area, cotton, turfgrass, grains, soybeans, cattle
Mills	agribusiness, hunting	insignificant	beef cattle, sheep, goats, sorghum, hay, dairies, pecans
San Saba	agribusiness, stone processing, tourism, hunting, government/ services	stone	cattle, poultry, sheep, goats, pecans, wheat, hay, peanuts
Travis	education, state government, tourism, research, industries, conventions	limestone, sand, gravel, oil, gas	cattle, nursery crops, hogs, sorghum, corn, cotton, small grains, pecans
Wharton (p)	oil, sulphur, & other minerals, agribusiness, hunting, varied manufacturing	oil, gas	leading rice producing county, cotton, milo, corn, sorghum, soybeans, turfgrass, eggs, beef cattle
Williamson (p)	agribusiness, varied manufacturing, government/services	stone, sand, gravel	beef cattle, sorghum, cotton, corn, wheat

(p) - a portion of the county lies within the LCRWPG boundaries

Table 1.6: Lower Colorado Region Industry Economic Value Estimates (1995)

Industry	Employment (# of Jobs)	Millions of Dollars					
		Industry Output	Employment Compensation	Proprietor Income	Other Property Income	Indirect Business Tax	Total Value Added
Dairy Farm Products	186	12.166	1.56	3.132	0.98	0.048	5.72
Poultry and Eggs	972	79.549	8.592	5.979	13.211	0.432	28.214
Ranch Cattle	4,927	121.17	12.346	25.113	10.499	5.002	52.96
Feed Lot Livestock	98	10.28	0.813	6.443	1.379	0.7	9.336
Other Livestock	2,853	34.174	5.655	3.627	5.786	0.996	16.063
Cotton	783	57.063	6.974	7.615	16.775	2.602	33.965
Food Grains	1,963	47.955	1.884	7.794	15.608	2.773	28.058
Feed Grains	1,878	68.19	1.999	18.282	18.836	5.441	44.558
Other Field Crops	5,380	67.547	8.674	9.646	22.405	3.691	44.417
Forestry, Fisheries, Greenhouses	8,773	322.909	96.233	37.736	59.821	9.292	203.082
Mining	4,997	980.762	196.945	48.27	241.452	65.041	551.708
Construction	59,129	4,575.45	1,477.45	397.586	179.263	44.892	2,099.19
Food and Fiber Processing	4,288	724.045	96.663	3.298	59.631	5.819	165.412
Wood and Paper Processing	4,056	350.559	93.633	14.646	26.255	3.57	138.104
Printing & Publishing	6,367	718.901	193.468	21.949	55.717	14.621	285.755
Chemicals	2,365	849.083	108.546	128.783	133.987	22.569	393.885
Petroleum, Rubber, Leather	1,920	277.645	56.337	1.142	18.379	2.857	78.714
Non-metallic Mineral Products	2,874	331.02	100.786	4.873	23.371	7.209	136.239
Primary & Fabricated Metal Products	2,612	374.583	84.57	6.088	36.075	5.352	132.086
Comm. Machinery, Electronics, Transportation	41,393	10,106.35	2,404.71	137.278	1,614.98	149.261	4,306.23
Other Manufacturing	6,532	908.834	252.332	20.048	42.53	15.05	329.96
Transport., Communication, Non-Water Utilities	18,650	2,686.68	619.754	208.263	581.303	181.337	1,590.66
Water Supply, Sewerage, Sanitary Services	440	71.831	14.462	11.37	9.575	9.242	44.649
Wholesale & Retail Trade	140,030	6,629.08	2,623.89	237.429	699.068	962.74	4,523.13
Finance, Insurance, Real Estate	50,993	8,355.72	1,225.65	152.936	3,558.65	925.516	5,862.75
Business & Social Services	162,574	8,853.94	3,547.54	975.538	529.057	169.596	5,221.73
Business & Professional Orgs	44,613	2,145.58	930.855	181.749	76.575	14.643	1,203.82
State and Local Government	116,498	4,989.30	3,812.96	0	712.245	0	4,525.21
Federal Government	15,851	953.058	671.989	0	212.36	0	884.348
Private Households	6,989	61.889	59.378	0	2.511	0	61.889
Miscellaneous	0	-106.78	-11.291	0	-95.489	0	-106.78
Totals	720,984	55,658.53	18,705.35	2,676.62	8,882.80	2,630.29	32,895.05

*Source: Texas Water Development Board - the TWDB excluded Hays County (partial county) from the Lower Colorado Region (K) data

The economic outlook for 2000 is projected to vary across the Lower Colorado Region, but overall the average annual employment growth rate is expected to moderate. The upper, middle, and lower portions of the region are projecting economic growth rates of 1.2 percent, 2.4 percent, and 1.6 percent, respectively. The economic growth rate in the middle portion of the region is expected to remain among the strongest in the state. Most new jobs for the year 2000 have been projected to occur in the service sector, which includes business services, healthcare, state/local government, transportation, communications, and public utilities.

Personal income averages in the Lower Colorado Region counties ranges from $17,563 in Mills County to $27,610 in Travis County (Table 1.7). The regional average is $24,821, which is 4.69 percent higher than the state average. Total personal income of the region accounts for approximately 6.7 percent of the state total. Matagorda, Mills, San Saba, and Wharton counties have the four highest poverty rates in the region and are higher than the state average by 10.7, 12.4, 60.5, and 8.5 percent, respectively. The regional unemployment rate is 2.9 percent, which is significantly less than the state average. Only Matagorda and Wharton counties have unemployment rates higher than the state average.

Table 1.7: Lower Colorado Region County Population and Economic Estimates

County Name	July 1997 Resident Population (1)	CY 1997 Personal Income (2)		CY1995	CY 1995 Poverty (3)		CY 1998 Average Labor Force Employment and Unemployment (4)			
		Per Capita ($)	Total (millions $)	Median Household Income ($) (3)	Persons in Poverty	Poverty Rate (%)	Labor Force	Persons Employed	Persons Unemployed	Unemployment Rate (%)
Bastrop	48,178	$18,530	$905	$31,457	6,832	14.7	27,086	26,270	816	3
Blanco	7,645	$20,952	$172	$28,727	912	11.7	3,677	3,593	84	2.3
Burnet	30,272	$19,877	$612	$28,845	4,501	15.4	13,406	12,923	483	3.6
Colorado	19,600	$20,551	$390	$26,852	3,394	18.2	8,135	7,820	315	3.9
Fayette	21,759	$21,859	$462	$27,269	3,019	14.4	10,398	10,108	290	2.8
Gillespie	20,160	$21,640	$430	$29,494	2,230	11.6	10,267	10,078	189	1.8
Hays	84,800	$19,846	$1,695	$35,119	10,728	14.1	50,488	49,119	1,369	2.7
Llano	13,129	$21,018	$277	$24,810	1,862	14.4	5,282	5,104	178	3.4
Matagorda	38,304	$17,740	$672	$29,970	7,517	19.6	16,997	15,009	1,988	11.7
Mills	5,223	$17,563	$83	$21,811	924	19.9	2,299	2,226	73	3.2
San Saba	5,608	$18,836	$108	$19,918	1,546	28.4	2,531	2,423	108	4.3
Travis	693,517	$27,610	$19,136	$38,368	87,177	12.9	454,920	442,400	12,520	2.8
Wharton	41,309	$20,194	$809	$29,075	7,705	19.2	18,966	17,908	1,058	5.6
Williamson	207,123	$23,453	$4,943	$49,542	14,647	7.4	133,173	130,578	2,595	1.9
LCRWPG (5)	1,236,627	$24,821	$30,694		152,994	-	757,625	735,559	22,066	2.9
Texas	19,439,337	$23,707	$459,585	$31,488	3,500,334	17.7	10,118,326	9,631,443	486,883	4.8

Full Appendix Table A11 downloaded from Window on State Government, February 17, 2000

(1) Texas State Data Center at Texas A&M University (URL: http://www-txsdc.tamu.edu/tpepp/1997_txpopest_county.html)

(2) U.S. Bureau of Economic Analysis (URL: http://www.bea.doc.gov/bea/regional/reis/scb/svy_tx.htm)

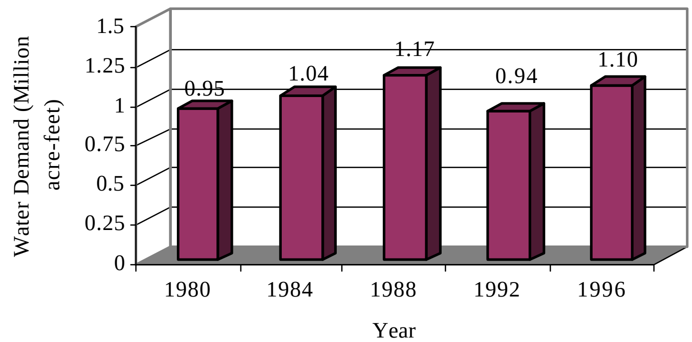
(3) U.S. Bureau of the Census (URL: http://www.census.gov/hhes/www/saipe/saipe93/estimate.html) (website has since been changed)

(4) Texas Workforce Commission (URL: http://www.twc.state.tx.us/lmi/fastfacts/fastfactshome.html)

(5) Includes all of Hays, Wharton and Williamson counties.

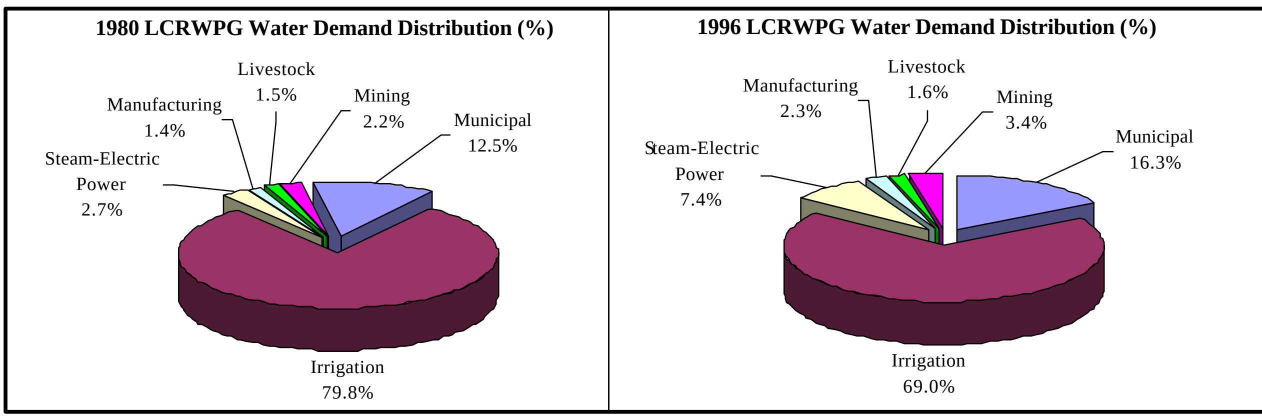
1.2.2.3 Historical Water Uses [16,17]

Figure 1.16: Lower Colorado Regional Water Planning Area Historical Water Demand



Total annual water use in the Lower Colorado Regional Planning Area has increased approximately 16 percent from 1980 to 1996 (Figure 1.16). A peak water use of 1.17 million acre-feet occurred in 1988. By 1992 the region's water use had decreased almost 20 percent to 0.94 million acre-feet. The period from 1980 to 1996 has seen a relatively moderate fluctuation of +/-17 percent as compared to the 16-year annual water demand average of almost one million acre-feet. When compared to the region's consistently increasing population and industry, the effect of improvements in water-use efficiencies is evident. Relative water use distribution, by water use category, has remained relative similar between 1980 and 1996 (Figure 1.17). Irrigation is the largest water use in the Lower Colorado Region, which accounted for almost 80 percent of water use in 1980 and 69 percent in 1996. Municipal has consistently been the second largest water use since 1980, followed by steam-electric power, mining, manufacturing, and livestock water uses.

Figure 1.17: Lower Colorado Region User Group Water Demand Distribution



Actual irrigation water demand has remained virtually the same over this 16-year period, with an actual increase of less than one percent. Municipal experienced a 52 percent increase in actual water demand between 1980-1996, livestock 25 percent, mining 77 percent, manufacturing 97 percent, and steam electric power generation saw the largest actual water demand increase of 223 percent.

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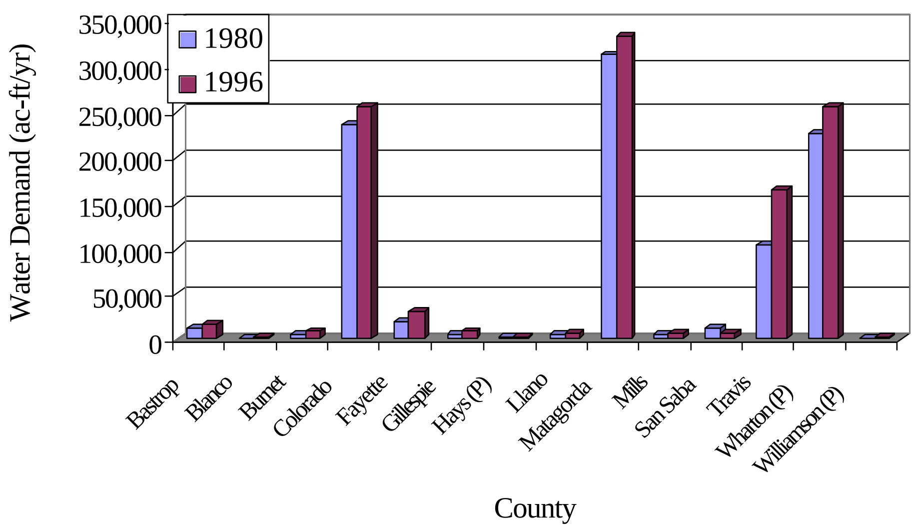
[16] LCRA, Op. Cit., June 1992.
[17] Lower Colorado River Authority (LCRA), December 1997. "Freshwater Inflow Needs of the Matagorda Bay System".

The water demand distribution between the 14 counties in the Lower Colorado Region shows that demand has consistently been greatest during the period from 1980 to 1996 in Matagorda County, which accounted for approximately 33 percent of the region's total water demand in 1980, and 30 percent in 1996 (Figure 1.18). The major water use in Matagorda County is rice irrigation. Colorado and Wharton counties are among the largest water users in the region, which is also attributed to the extensive rice irrigation in these counties. Travis County contains the region's only major demand center and its water use ranks second overall in 1980 and fourth in 1996. Overall, these four counties account for approximately 93 and 92 percent of the region's total water demand, respectively for 1980 and 1996. Details of the Lower Colorado Region's water demand are presented in Chapter 2.

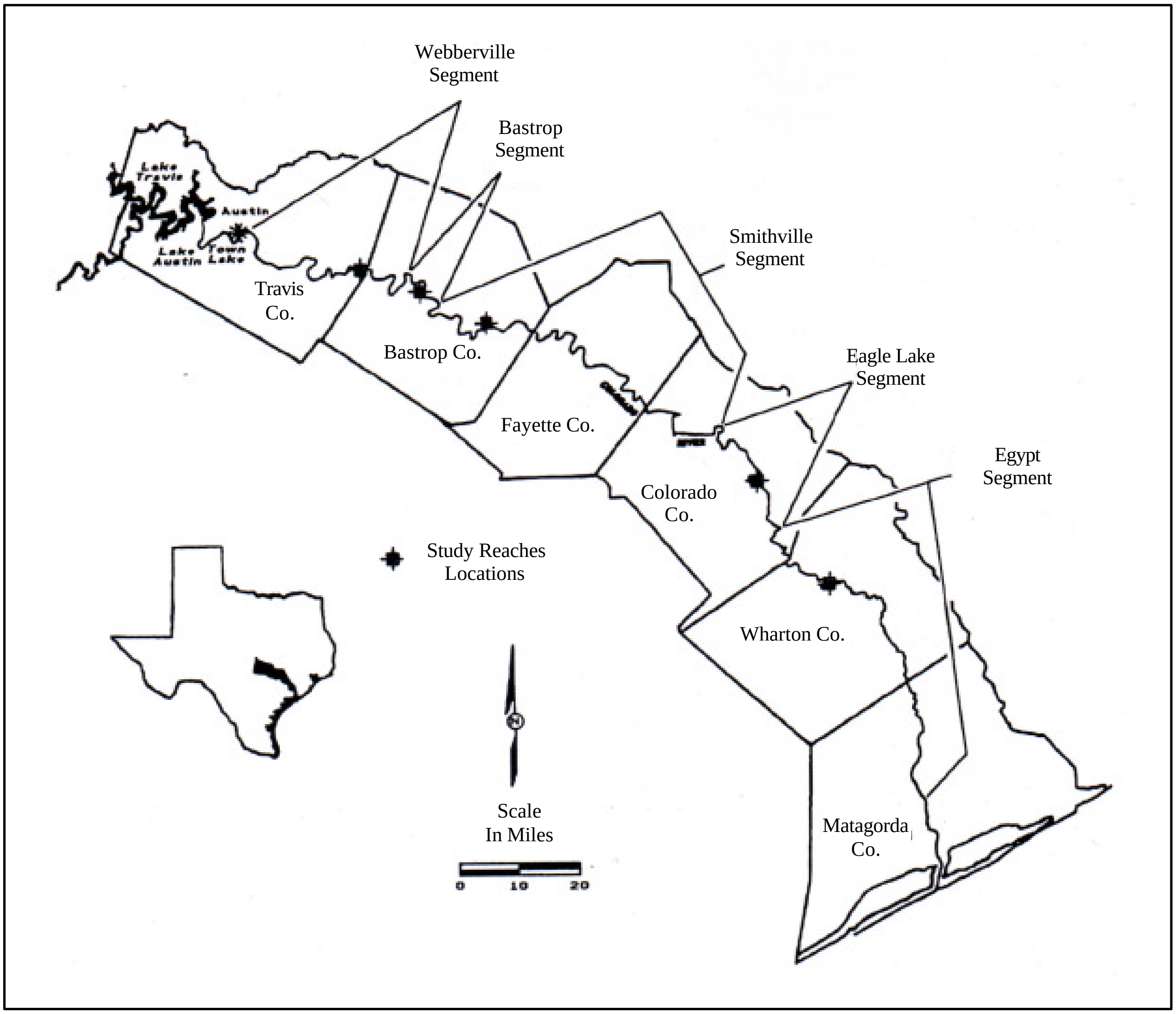
Figure 1.18: Lower Colorado Regional Water Planning Area County Water Demand Distribution



Flows for the maintenance of important environmental resources are also a significant water use within the free-flowing reaches of streams in the Lower Colorado Region. Free-flowing reaches above the Highland Lakes System in San Saba and Mills counties are dependent on water releases from Stacy Dam at Owen Ivy Reservoir, which is outside the Lower Colorado Region and is under the control of the Colorado River Municipal Water District. A management plan has been implemented in this area, between Owen Ivy Reservoir and Lake Buchanan, to protect the federally endangered Conchos River Watersnake. The minimum continuous instream flow releases from Stacy Dam are 11 cubic feet per second (cfs) from April through September and 2.5 cfs from October through March. These flow regimes are designed to preserve and protect the aquatic foodbase of the Conchos River Watersnake. These instream flows were required by the U.S. Fish and Wildlife Service (USFWS) as a mitigation component to obtain a Section 404 permit from the U.S. Army Corps of Engineers (USACE) in order to build Stacy Dam. The water management plan also specifies that once every two years Stacy Dam will release a two-day 2,500 cfs instream flow to provide channel maintenance for the watersnake habitat.

The free-flowing reaches below the Highland Lakes System downstream to the mouth of the Colorado River are under the control of the Lower Colorado River Authority (LCRA). A 1992 instream flow study was performed by the LCRA for five consecutive study reaches, which start downstream of Austin at river mile 290 (from the mouth of the Colorado River) to river mile 34 near Bay City (Figure 1.19).

Figure 1.19: Lower Colorado River Instream Study Reaches (LCRA)



Subsistence or critical instream flows are classified as a non-interruptible demand on water resources, and instream flows should be constantly maintained at or above the minimum critical flow at all times. Table 1.8 gives the minimal critical flow requirements recommended by the LCRA for two gage stations along the Lower Colorado River.

Table 1.8: Critical Flow Requirements for the Lower Colorado River

USGS Gage Station	Subsistence Flow (cfs)
Austin (near Mansfield Dam)[1]	> 46
Bastrop (June-February)[2]	> 120
Bastrop (March-May)[3]	> 500

[1]Minimum Austin gage flow is based on the 7Q10 flow (a 7-day low flow period w/ a 10-year recurrence period).

[2]Minimum Bastrop gage flow is based on maintaining adequate dissolved oxygen levels (TNRCC requires 5mg/l).

[3]Minimum Bastrop gage flow is based on critical flow requirements during target fish species spawning season.

Target instream flows are designed to provide an optimal range of habitat complexity to support a well-balanced, native aquatic community within a stream reach. Table 1.9 provides a schedule of flows recommended by the LCRA for the five Colorado River study stream reaches to meet the physical habitat requirements of the native fish communities and other critical aquatic habitats. Target flows were adjusted monthly to incorporate the normal seasonal variations in flows for which native fish species are adapted. These flow regimes are to be maintained whenever water resources are adequate, but are classified as interruptible demands that can be reduced during drought conditions.

Table 1.9: Target Flows Schedule For The Colorado River Downstream Of Austin

Month	Study Reach Target Flows (cfs)[1,2]					Mean Target Flow (cfs)
	Webberville	Bastrop	Smithville	Eagle Lake	Egypt	
January	214	369	457	295	240	315
February	247	426	529	341	277	364
March	322	555	688	444	361	474
April	351	605	750	484	393	517
May	596	1028	1275	822	668	878
June	480	827	1026	662	538	707
July	214	369	457	295	240	315
August	141	244	302	195	158	208
September	233	402	498	321	261	343
October	274	473	586	378	307	404
November	213	366	454	293	238	313
December	195	337	417	269	219	287

[1]target flows were determined for 5 study reaches during an inflow study performed by the LCRA, June 1992.

[2]schedule of flows is designed to optimize community diversity under normal rainfall. Under drought conditions, target flows should be curtailed in accordance to the severity of the drought and flows should be maintained at or above subsistence levels based on water quality considerations.

Maintenance flows are classified as short periods of higher than normal flows, which are needed to remove the buildup of silt and overgrowth of macrophytic vegetation. These flows should occur naturally during rainfall events, but may occasionally require periodic dam releases to accomplish this task.

Freshwater instream flow is also essential for healthy coastal estuarine ecosystems along the Texas Coast. Ninety-seven percent of the fishery species (shellfish and finfish) in the Gulf of Mexico spend all or a portion of the lifecycle in estuaries. The lifecycles of estuarine-dependent species vary seasonally and have different migratory patterns between the estuary and the Gulf. The Matagorda Bay system is the second largest estuary in the state and this system receives freshwater inflow from the Colorado River, the Lavaca River, and surface runoff from the contributing drainage basin areas. On average, Matagorda Bay annually receives approximately 560 billion gallons (more than 1.7 million acre-feet) of freshwater from the Colorado River and basin. This corresponds to about 69 percent of the river's available water supply from surface runoff inflow. The LCRA performed an instream flow study on the bay system in 1997 and determined the critical inflow that would keep salinity near the mouth of the river less than 25 parts per million (ppm) for protection of fishery sanctuary habitat during droughts. Target inflows were also determined that would result in producing 98 percent of the maximum total normalized biomass for key estuarine fishery species, while maintaining a certain salinity, population density, and nutrient inflow conditions. Modeling efforts determined that the optimal total critical flows and target flows for the Matagorda Bay system are 287,400 ac-ft/yr and 2,000,000 ac-ft/yr, respectively. Table 1.10 provides the monthly flows required exclusively from the Colorado River's contribution to the bay system. The Colorado River provides almost 52 percent of the bay system's target freshwater inflows and almost 60 percent of the critical inflows.

Table 1.10: Critical and Target Flows Schedule For Matagorda Bay System from the Colorado River

Month	Freshwater Inflows (1000 ac-ft)[1]	
	Critical	Target
January	14.26	44.1
February	14.26	45.3
March	14.26	129.1
April	14.26	150.7
May	14.26	162.2
June	14.26	159.3
July	14.26	107
August	14.26	59.4
September	14.26	38.8
October	14.26	47.4
November	14.26	44.4
December	14.26	45.2
Annual Totals	171.1	1033.1

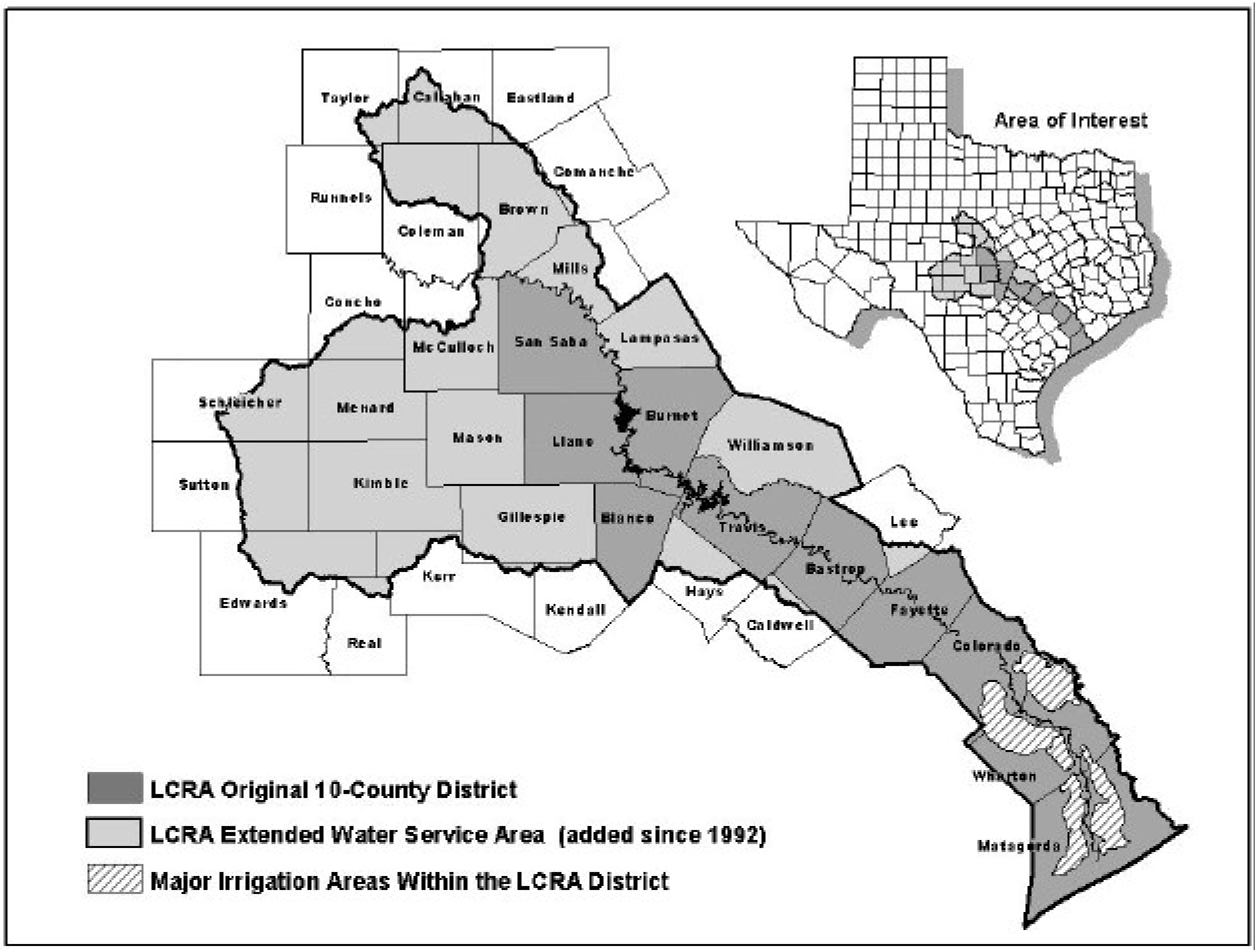
[1]schedule of flows is designed to optimize biodiversity/productivity under normal rainfall. Under drought conditions, target flows should be curtailed in accordance to the severity of the drought and flows should be maintained at or above critical levels based on water quality considerations.

1.2.2.4 Major Water Providers

The Texas Water Development Board guidelines allow each RWPG to identify and designate "major water provider(s)" for each region. These guidelines define a major water provider as an entity "…which delivers and sells a significant amount of raw or treated water for municipal and/or manufacturing use on a wholesale basis." The intent of these TWDB guidelines is to ensure that there is an adequate future supply of water for each entity that receives all or a significant portion of its current water supply from another entity.

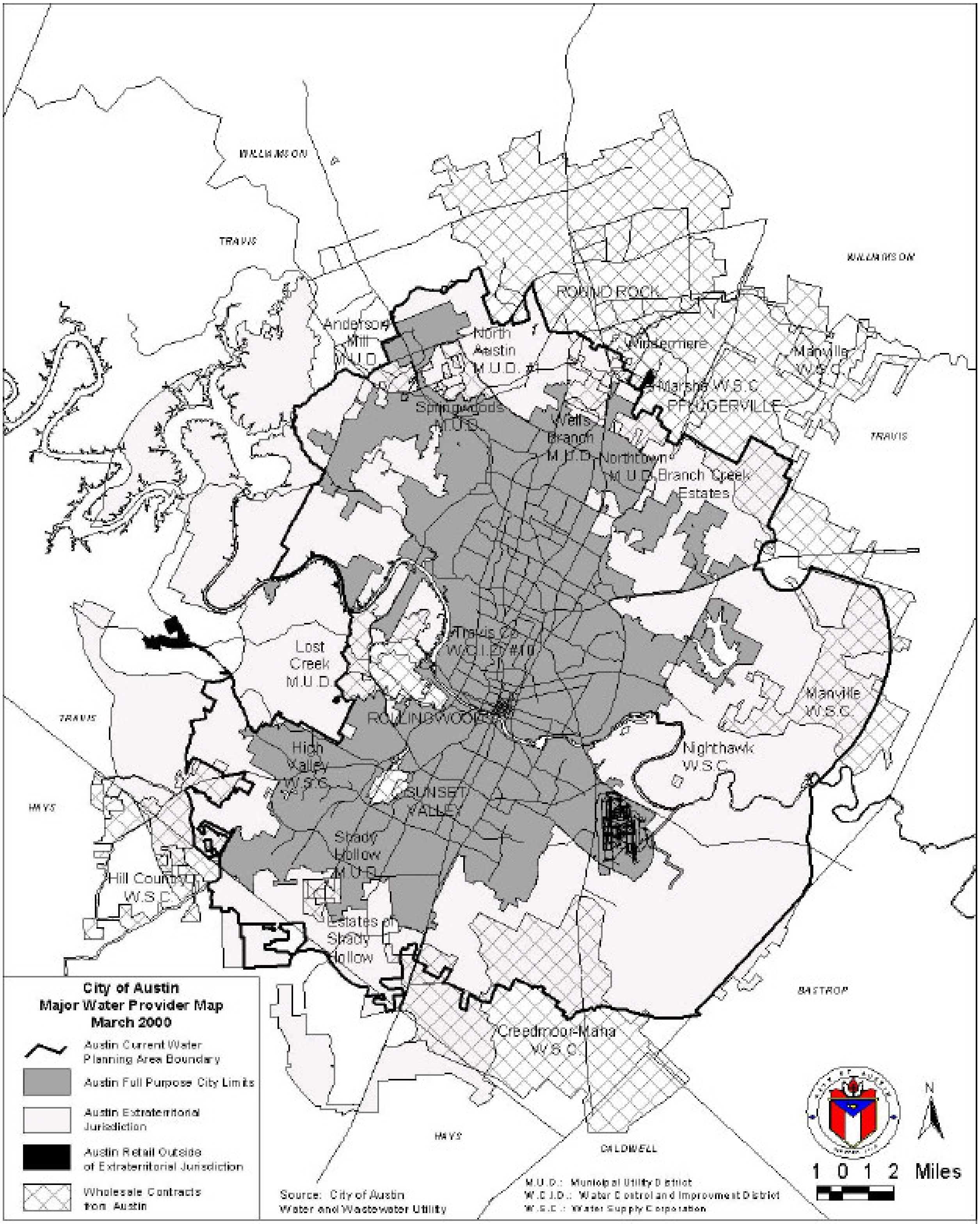
As discussed in Chapter 2, the Lower Colorado Regional Water Planning Group has officially designated the Lower Colorado River Authority (LCRA) and the City of Austin as major water providers. The Lower Colorado River Authority provides water for municipal, manufacturing, steam electric, and mining uses within a 33-county service area. The LCRA currently provides water to entities in each of the 14 counties within the Lower Colorado Regional Planning Area (Figure 1.20). The City of Austin supplies water for municipal, manufacturing, and steam electric uses. The City's water planning area encompasses portions of Travis and Williamson counties (Figure 1.21).

Figure 1.20: Lower Colorado River Authority Water Supply Service Area



Source: The Lower Colorado River Authority (March 2000)

Figure 1.21: City of Austin Water Supply Service Area



1.2.3 Water Quality in the Colorado River Basin [18,19,20]

The chemical characteristics of and the State Water Quality Criteria assigned to the Colorado River vary along its length (900 river miles) from the upper basin that is mainly within the West Texas Regional Water Planning Area (Region F) to the mouth of the river at Matagorda Bay in the Lower Colorado Regional Planning Area (Region K) (Table 1.11, bolded segments occur within Region K). The water quality differences of the various stream segments of the Colorado River are due to variations in both natural and man-made influences affecting each segment's drainage area. In addition, water flowing from upstream segments of the Colorado River and its tributaries also contribute to each downstream segment's water quality characteristics.

The Colorado River is divided into 18 mainstem classified stream segments, which are defined by the Texas Natural Resource Conservation Commission (TNRCC) as:

> *"Surface waters of an approved planning area exhibiting common biological, chemical, hydrological, natural, and physical characteristics and processes. Segments will normally exhibit common reactions to external stresses (e.g., discharge or pollutants). Segmented waters include most rivers and their major tributaries, major reservoirs and lakes, and marine waters, which have designated physical boundaries, specific uses, and specific numerical physicochemical criteria. Segments are classified in the water identification system utilized by the TNRCC Office of Water Resources Management (OWRM) and are the management unit to which water quality standards and regulations are applicable under the Clean Water Act."*

Approximately 70 percent of these mainstem segments are within the Lower Colorado Region. There are also 16 classified stream segments that are tributaries of the Colorado River, and almost 40 percent of these are within the Lower Colorado Region.

The TNRCC initiated the Texas Clean Rivers Program (CRP) in 1991 to address the Texas Clean Rivers Act. The state legislature passed this act in response to concerns within the state that water quality issues were being addressed in an uncoordinated fashion. The CRP established a watershed management approach to identify and evaluate water quality issues, as well as to set priorities for the improvement of water quality throughout the state. The CRP set up a partnership in each river basin that consisted of the TNRCC, other state agencies, river authorities, local governments, and private citizens. Each river basin is to provide the TNRCC with updated regional water quality data and the TNRCC is required to summarize these basin-wide assessments into a statewide report every two years.

In 1996, the TNRCC published two reports that updated water quality information for each river basin and stream segment in the state: *The State of Texas Water Quality Inventory* and *Texas Water Quality: A Summary of River Basin Assessments.* The CRP's Colorado River Basin regional assessment technical report defines the "Upper Basin" of the Colorado River as the classified mainstem segments 1411-1413 and 1426; and classified tributary segments 1421-1425. These segments fall within the SB 1 Regions F and G. The "Middle Basin" contains mainstem segments 1403-1410, 1429, and 1433; and tributary segments 1414-1417, 1427, 1431, and 1432. These segments fall within SB 1 Region F and the Lower

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[18] TWDB, Op. Cit., May 1977.

[19] Texas Natural Resource Conservation Commission (TNRCC), December 1996. "Texas Water Quality: A Summary of River Basin Assessments," Texas Clean Rivers Program Report SFR-46.

[20] TNRCC, October 1996. "Regional Assessment of Water Quality: Colorado River Basin & Colorado/Lavaca Coastal Basin," Texas Clean Rivers Program Technical Report.

Table 1.11: Classified Stream Segment Uses and Water Quality Criteria in the Colorado River Basin

COLORADO RIVER BASIN			USES[1]			STATE STREAM STANDARDS CRITERIA[2]						
Stream Segment #	Stream Segment Name	SB 1 Planning Region	Recreation	Aquatic Life	Water Supply	Chloride Annual Avg. (mg/L)	Sulfate Annual Avg (mg/L)	TDS Annual Avg (mg/L)	D.O. (mg/L)	pH Range	Fecal Coliform (30-day geometric mean, CFU/100ml)	Temp (*F)
1401	Colorado River - Tidal	K	CR	H	PS				4.0	6.5-9.0	200	95
1402	Colorado River below Smithville	K	CR	H	PS	90	60	450	5.0	6.5-9.0	200	95
1403	Lake Austin	K	CR	H	PS	85	60	375	5.0	6.5-9.0	200	90
1404	Lake Travis	K	CR	E	PS	85	60	375	6.0	6.5-9.0	200	90
1405	Marble Falls Lake	K	CR	H	PS	115	70	450	5.0	6.5-9.0	200	94
1406	Lake LBJ	K	CR	H	PS	115	70	450	5.0	6.5-9.0	200	94
1407	Inks Lake	K	CR	H	PS	135	95	525	5.0	6.5-9.0	200	90
1408	Lake Buchanan	K	CR	H	PS	145	95	525	5.0	6.5-9.0	200	90
1409	Colorado River above Lake Buchanan	K	CR	H	PS	200	155	875	5.0	6.5-9.0	200	91
1410	Colorado River below Ivie Reservoir	K	CR	H	PS	500	455	1,475	5.0	6.5-9.0	200	91
1411	E.V. Spence Reservoir	F	CR	H	PS	950	450	1,500	5.0	6.5-9.0	200	93
1412	Colorado River below Lake J.B. Thomas	F	CR	H		11,000	2,500	20,000	5.0	6.5-9.0	200	93
1413	Lake J.B. Thomas	F	CR	H	PS	80	110	500	5.0	6.5-9.0	200	90
1414	Pedernales River	K	CR	H	PS	105	50	525	5.0	6.5-9.0	200	91
1415	Llano River	K	CR	H	PS	45	25	300	5.0	6.5-9.0	200	91
1416	San Saba River	K/G	CR	H	PS	40	30	425	5.0	6.5-9.0	200	90
1417	Lower Pecan Bayou	K	CR	H		310	120	1,025	5.0	6.5-9.0	200	90
1418	Lake Brownwood	F	CR	H	PS	150	100	500	5.0	6.5-9.0	200	90
1419	Lake Coleman	F	CR	H	PS	150	100	500	5.0	6.5-9.0	200	93
1420	Pecan Bayou above Lake Brownwood	F	CR	H	PS	500	500	1,500	5.0	6.5-9.0	200	90
1421	Concho River	F	CR	H		775	425	1,600	5.0	6.5-9.0	200	90
1422	Lake Nasworthy	F	CR	H	PS	450	400	1,500	5.0	6.5-9.0	200	93
1423	Twin Buttes Reservoir	F	CR	H	PS	200	100	700	5.0	6.5-9.0	200	90
1424	Middle Concho/S.Concho River	F	CR	H	PS	150	150	700	5.0	6.5-9.0	200	90
1425	O.C. Fisher Lake	F	CR	H	PS	150	150	700	5.0	6.5-9.0	200	90
1426	Colorado River blw E.V. Spence Reservoir	F	CR	H	PS	610	980	2,000	5.0	6.5-9.0	200	91
1427	Onion Creek	K	CR	H	PS/AP	50	50	300	5.0	6.5-9.0	200	90
1428	Colorado River below Town Lake[3]	K	CR	H	PS	90	60	425	6.0	6.5-9.0	200	95
1429	Town Lake[4]	K	CR	H	PS	75	60	375	5.0	6.5-9.0	200	90
1430	Barton Creek	K	CR	H	AP	40	40	500	5.0	6.5-9.0	200	90
1431	Middle Pecan Bayou	F	CR			410	120	1,100	2.0	6.5-9.0	200	90
1432	Upper Pecan Bayou	F	CR	H	PS	190	140	760	5.0	6.5-9.0	200	90
1433	O.H. Ivie Reservoir[5]	F	CR	H	PS	*n/a*	*n/a*	*n/a*	5.0	6.5-9.0	200	93
1434	Colorado River above La Grange	K	CR	H	PS	90	60	45	6.0	6.5-9.0	200	95

Source: TNRCC, October 1996. "Regional Assessment of Water Quality: Colorado River Basin & Colorado/Lavaca Coastal Basin, Technical Report".

[1] Uses: CR = Contact Recreation; H = High Aquatic Life; E = Exceptional Aquatic Life; PS = Public Water Supply; AP = Aquifer Protection

[2] Criteria: Standards set by the TNRCC do not guarantee the water to be usable for municipal, domestic, irrigation, livestock, &/or industrial uses, such as segment # 1412 & others; this causes the above screening process to be misleading for certain segments, especially for salinity.

[3] Dissolved Oxygen (D.O.) criteria of 6.0 mg/L only applies at stream flows >= 150 cfs as measured at USGS gage # 8158000 located in Travis County upstream from U.S. Hwy 183.

[4] While segment # 1429 may exhibit quality characteristics which would make it suitable for contact recreation, the use is prohibited by local regulation for reasons unrelated to water quality.

[5] Numerical criteria for Total Dissolved Solids (TDS), chlorides, and sulfates have not yet been established for this new reservoir.

Colorado Regional Water Planning Area (Region K). The Colorado River's "Lower Basin" lies wholly within the Lower Colorado Region and includes the mainstem segments 1401, 1402, 1428, and 1434; as well as several unclassified tributary segments.

Upstream of the Lower Colorado Region high salinity concentrations are the primary concern in the CRP's "Upper Basin" stream segments. This is caused both by the natural characteristics of the geologic formations in the watershed as well as pollution from oil and gas activities. As Table 1.11 shows, some of these stream segments have very high water quality criteria for salinity, or total dissolved solids (TDS), which is an aggregate measurement of various mineral concentrations including chlorides, carbonates, and sulfates. The designated uses of a stream segment, such as recreation, aquatic life, and water supply, are based on the Texas Surface Water Quality Standards, which are criteria with the force of law. Potential uses for water in segments with very high salinity criteria, such as segment 1412 below Lake J.B. Thomas, are limited by the high TDS concentrations that exist despite the fact that the criteria is rarely exceeded. For example, the secondary drinking water standard for TDS is 1,000 milligrams per liter (mg/l).

The water quality of the "Middle Basin" and "Lower Basin" improves significantly due in large part to the dilution of the upstream base flow by inflow of higher quality tributary waters. Major tributaries between the headwaters of O.H. Ivie Reservoir and the Highland Lakes System, namely the Concho River, Pecan Bayou, and the San Saba River, have TDS concentrations that are generally less than 500 mg/l at their confluence with the Colorado River. The major tributaries that join the Colorado River within the Highland Lakes System, including the Llano and Pedernales Rivers, have TDS concentrations less than 400 mg/l.

1.2.4 Agricultural and Natural Resources Issues Within the Lower Colorado Region [21,22,23,24,25]

The primary agricultural issue in the Lower Colorado Region is the availability of sufficient quantities of irrigation water for rice farming under drought of record conditions. Natural resources, on the other hand, have impacts from both water quantity and water quality issues. Classified stream segments in the Colorado River Basin are shown in Figure 1.22 and those with water quality concerns are listed. The stream segments that have water quality concerns within the Lower Colorado Region are discussed below.

1.2.4.1 Threats Within the Lower Colorado Region Due to Water Quality Issues

The primary water quality issue for all of the surface water stream segments and the major groundwater aquifers in the Lower Colorado Region is the increasing potential for water contamination due to nonpoint source pollution. Nonpoint source pollution is precipitation runoff that, as it flows over the

[21] TNRCC, Op. Cit., December 1996.
[22] TNRCC, Op. Cit., October 1996.
[23] Lower Colorado River Authority (LCRA), 29 June 1993. "Water Management Plan for the Lower Colorado River Basin".
[24] Texas Water Development Board (TWDB), February 2000. "A Numerical Groundwater Flow Model of the Upper and Middle Trinity aquifer, Hill Country Area", Open-file report 00-02.
[25] TWDB, et. al., April 1999. "Assessment of Groundwater Availability in the Carrizo-Wilcox aquifer in Central Texas – Results of Numerical Simulations of Six Groundwater-Withdrawal Projections (2000-2050)", Draft Final Contract Report.

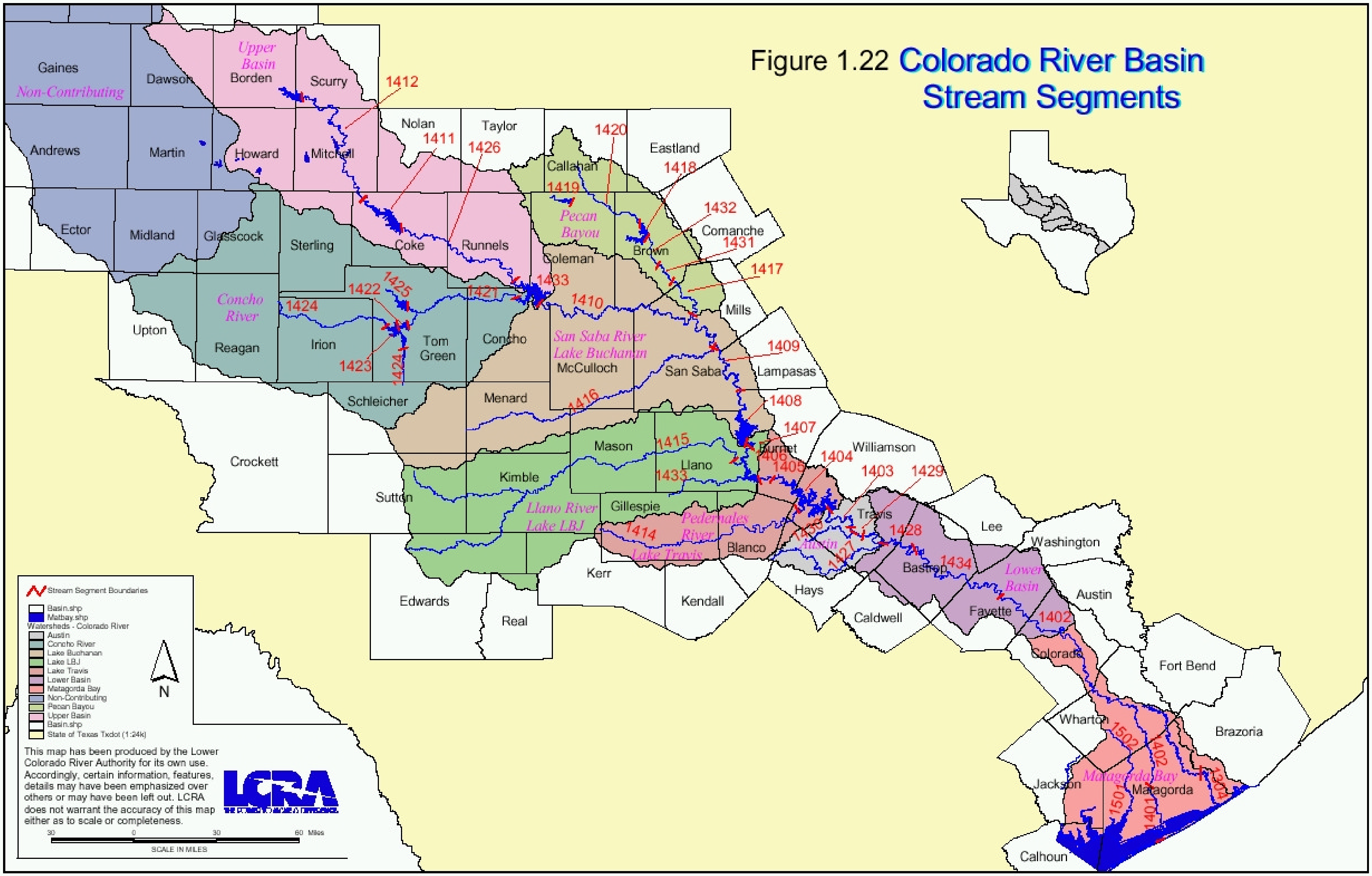
Figure 1.22 Colorado River Basin
Stream Segments
Upper Basin
Non-Contributing
Concho River
Pecan Bayou
San Saba River
Lake Buchanan
Llano River
Lake LBJ
Pedernales River
Lake Travis
Austin
Lower Basin
Matagorda Bay
Gaines
Dawson
Borden
Scurry
Andrews
Martin
Howard
Mitchell
Nolan
Taylor
Callahan
Eastland
Ector
Midland
Glasscock
Sterling
Coke
Runnels
Coleman
Brown
Comanche
Mills
Upton
Reagan
Irion
Tom Green
Concho
McCulloch
San Saba
Lampasas
Schleicher
Menard
Crockett
Sutton
Kimble
Mason
Llano
Burnet
Williamson
Gillespie
Blanco
Travis
Lee
Washington
Kerr
Edwards
Real
Kendall
Hays
Caldwell
Bastrop
Fayette
Austin
Colorado
Fort Bend
Wharton
Brazoria
Jackson
Matagorda
Calhoun
1412
1411
1426
1420
1418
1419
1432
1431
1417
1433
1410
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1425
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1423
1424
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1416
1408
1407
1415
1433
1404
1406
1405
1403
1429
1414
1428
1434
1402
1502
1401
1501
1304
Stream Segment Boundaries
Basin.shp
Matbay.shp
Watersheds - Colorado River
Austin
Concho River
Lake Buchanan
Lake LBJ
Lake Travis
Lower Basin
Matagorda Bay
Non-Contributing
Pecan Bayou
Upper Basin
Basin.shp
State of Texas Txdot (1:24k)
N
This map has been produced by the Lower Colorado River Authority for its own use. Accordingly, certain information, features, details may have been emphasized over others or may have been left out. LCRA does not warrant the accuracy of this map either as to scale or completeness.
LCRA
30 0 30 60 Miles
SCALE IN MILES

land, picks up various pollutants that adhere to plants, soils, and man-made objects and, which eventually infiltrates into the groundwater table or flows into a surface water stream. As more and more land in the Colorado River watershed and aquifer recharge zones is developed, the runoff from precipitation events will pick up increasing amounts of pollution. Another nonpoint source of pollution is the accidental spill of toxic chemicals near streams or over recharge zones that will send a concentrated pulse of contaminated water through stream segments and/or aquifers. Public water supply groundwater wells that currently only use chlorination water treatment and domestic groundwater wells that may not treat the water before consumption, are especially vulnerable to nonpoint source pollution, as are the habitats of threatened and endangered species that live in and near springs and certain stream segments. Nonpoint sources of pollution are difficult to control and there has been increased awareness and research of this issue as well as interest in the initiation of abatement programs.

There are concerns throughout the entire Colorado River Basin regarding surface water quality degradation due to increases of salinity, or total dissolved solids, during drought conditions due to increased water evaporation and decreased dilution. However, under normal hydrologic conditions, there are 15 classified stream segments with a possible concern (PC) and 2 with a concern (C), based on data reported for 1996, for exceedence of the State Water Quality Criteria for TDS in the Lower Colorado Region (Table 1.11 and Table 1.12). The "Concern" parameter is assigned to a classified stream segment when more than 25 percent of the readings taken for a particular water quality indicator exceed the State Water Quality Criteria. The "Possible Concern" parameter is assigned when between 10 and 25 percent of the readings exceed the State Water Quality Criteria.

Table 1.12: Stream Segment Water Quality Concerns and Possible Concerns in the Lower Colorado Region [1]

Stream Segment #	Stream Segment Name	Total Dissolved Solids	Dissolved Oxygen	Fecal Coliform	Nutrients	Metals
1401	Colorado River - Tidal			PC	C	
1402	Colorado River below Smithville	PC		PC	C	PC
1403	Lake Austin	PC	PC		PC	
1404	Lake Travis	PC			PC	
1405	Marble Falls Lake	PC			PC	
1406	Lake LBJ	PC			PC	
1407	Inks Lake	PC				
1408	Lake Buchanan	PC			PC	
1409	Colorado River above Lake Buchanan	C		PC	PC	PC
1410	Colorado River below Ivie Reservoir	PC		PC	C	
1414	Pedernales River	PC		PC	C	
1415	Llano River	PC			PC	PC
1416	San Saba River	PC		PC	PC	
1417	Lower Pecan Bayou	PC	PC	PC	PC	
1427	Onion Creek	C		PC	PC	PC
1428	Colorado River below Town Lake	PC		PC	C	PC
1429	Town Lake	PC		PC	PC	PC
1430	Barton Creek			PC	PC	PC
1434	Colorado River above La Grange	PC		PC	PC	PC

Source: TNRCC, Oct.1996. "Regional Assessment of Water Quality: Colorado River Basin & Colorado/Lavaca Coastal Basin, Technical Rprt"

[1] The "Concern" parameter (C) is assigned to a classified stream segment when > 25 % of the readings taken for a water quality indicator exceed the State Water Quality Criteria. The "Possible Concern" parameter (PC) is assigned when 10-25 % of the readings exceed the criteria.

Another surface water quality indicator is dissolved oxygen (DO) and the associated biochemical oxygen demand (BOD). The basin-wide concentrations of DO that have existed in the past were indicative of relatively unpolluted waters; however, these have been changing and have become a concern in some segments of the Colorado River and its tributaries, as populations and urban development continue to increase. DO is a measure of the amount of oxygen that is available in the water for metabolism by microbes, fish, and other aquatic organisms. BOD is a measure of the amount of organic material, containing carbon and/or nitrogen, in a body of water that is available as a food source to microbial and other aquatic organisms, which require the consumption of dissolved oxygen from the water to metabolize the organic material. The primary manmade sources of BOD in bodies of water are the discharge of municipal and industrial waste, as well as nonpoint source pollution from urban and agricultural runoff. Thus, the presence of excess amounts of BOD allows increased rates of microbial and algal metabolism, which in turn depletes the dissolved oxygen concentrations in the water. Without sufficient levels of DO in the water, other aquatic organisms, such as fish, cannot survive. 1996 data indicates that there are 2 classified stream segments with a possible concern (PC) for dissolved oxygen, based on the state Water Quality Criteria in the Lower Colorado Regional Water Planning Area (Table 1.11 and Table 1.12).

Another set of surface water quality indicators that can deplete dissolved oxygen levels in surface water bodies are termed “nutrients” and includes nitrogen (Kjeldahl nitrogen, nitrite+nitrate, and ammonia nitrogen), phosphorus (phosphates, orthophosphates, and total phosphorus), sulfur, potassium, calcium, magnesium, iron, and sodium. Nutrients are monitored by the TNRCC as a part of the Texas Clean Rivers Program; however, there are no state or federal standards for screening nutrients. Currently, naturally occurring background levels reported by the U.S. Geological Service (USGS) or historical data collected by the TNRCC is used to determine the level of concern for nutrients. Nutrients have the same primary manmade sources as the BOD sources described above. Based on 1996 data, there are 13 classified stream segments with a possible concern (PC) for nutrients and 5 with a concern (C), in the Lower Colorado Regional Water Planning Area (Table 1.11 and Table 1.12).

Fecal coliform are harmless bacteria that are present in human and/or animal waste. However, the presence of this organism is an indicator for the presence of disease-causing bacteria and viruses that are also found in human/animal wastes. Municipal waste is treated to remove most of the bacterial and viral contaminants so that safe levels will exist in the surface water body upon discharge from the point source. Therefore, when fecal coliform is detected, the most likely source of contamination is nonpoint source pollution, which can include agricultural runoff as well as runoff from failed septic systems. A wastewater treatment plant point source could also be the source of contamination if the system is not functioning properly. Data, reported for 1996, indicates that there are 12 classified stream segments with a possible concern (PC) for fecal coliform, based on the state Water Quality Criteria in the Lower Colorado Region (Table 1.11 and Table 1.12). There have also been bans on the contact recreation water use due to levels of fecal coliform present in four classified stream segments within the planning area.

The presence of toxic dissolved metals, such as aluminum, barium, arsenic, chromium, cadmium, copper, lead, nickel, mercury, selenium, silver, and zinc, in surface water are a possible concern (PC) in 7 classified stream segments in the Lower Colorado Regional Water Planning Area (Table 1.11 and Table 1.12).

1.2.4.2 Threats Due to Water Quantity Issues

As mentioned previously, the primary threat to agriculture in the Lower Colorado Region are the water shortages for irrigation that are anticipated to occur in Matagorda, Wharton, and Colorado counties during a repeat of the drought of record. The water supply available for irrigation is from two sources: “Run-of-the-river” supplies and stored water from the Highland Lakes System. Whenever the Colorado River’s natural instream flows are insufficient to meet irrigation demands, the LCRA releases from upstream storage reservoirs to supplement the instream flows. The water supplied from the Highland Lakes storage is considered an interruptible supply and is subject to curtailment in accordance with policies and procedures specified in LCRA's Water Management Plan and Drought Management Plan. Consequently, under drought of record conditions, there are substantial shortages of water for irrigation in Matagorda, Wharton, and Colorado counties. The magnitude and implications of these shortages are further discussed in Chapter 4. Potential strategies for meeting these irrigation needs are presented in Chapter 5.

Water quantity is also a concern during drought conditions in terms of instream flows and freshwater inflows to Matagorda Bay. As discussed in Section 1.2.2.3, the free-flowing reaches below the Highland Lakes System downstream to the mouth of the Colorado River have been studied by the LCRA and critical flows have been determined as the non-interruptible demand on water resources. Instream flows are to be constantly maintained at or above the minimum critical flow at all times. Target instream flows, also determined by the LCRA study, are to provide an optimal range of habitat complexity to support a well-balanced, native aquatic community within a stream reach. These target flow regimes are to be maintained whenever water resources are adequate, but are classified as interruptible demands that can be reduced during drought conditions.

The Highland Lakes provide the primary surface water storage and flood control capabilities for the Lower Colorado Region. The issue of providing maintenance to retain the maximum water storage capacity will become increasingly important as natural sedimentation processes decrease the volume of water each reservoir can hold. Currently, there are no programs in place to address this issue.

With regard to flood control, Lake Travis is the only reservoir in the Highland Lake System specifically designated for this purpose. Currently, the LCRA must regulate the release of flood flows from Mansfield dam so as to minimize and balance the impacts of floodwaters upstream and downstream of the dam without compromising the safety of the dam. Because development continues to encroach upon and alter the floodplain of the Lower Colorado River, the LCRA in cooperation with the U.S. Army Corps of Engineers (USACE) is currently studying alternative flood control measures, such as modifying current flood control operations and the possible addition of new off-channel flood control structures.

One of the major groundwater quantity concerns involves the Barton Springs segments of the Edwards aquifer (Balcones Fault Zone [BFZ]), which is a karst formation that responds quickly to changes in the environment due its highly permeable and transmissive characteristics. South of the artesian zone of the Edwards aquifer there exists an interface, or "bad water line", that separates the good quality groundwater from a layer of water that is not usable for human consumption due to the high total dissolved solids content. This line, which is also referred to as the saline-water line or fresh-water/saline-water interface, marks the interface where the groundwater reaches a total dissolved-solids concentration of 1,000 mg/l. Little is actually known about this interface and research is currently being conducted to delineate the "bad water line" and to determine the effects that pumping large quantities of aquifer water will have on its location. At present, there is a great deal of concern and uncertainty regarding the intrusion of poor quality water into the freshwater zone. The current lack of factual information makes the formulation of management strategies extremely difficult.

The second major issue in the Barton Springs segments of the Edwards aquifer (Balcones Fault Zone [BFZ]) is the minimum required environmental flows discharged from the artesian zone through Barton Springs. Increased groundwater pumping from the aquifer during drought conditions decreases all spring discharges, which can potentially impact the state and federally listed threatened and endangered species that depend on the springs for habitat, such as the Barton Springs salamander.

The primary water quantity issue in the Gulf Coast aquifer is subsidence, which is the dewatering of the interlayers of clay within the aquifer as a result of over-pumping. This compaction of the clay causes a loss of water storage capacity in the aquifer, which in turn causes the land surface to sink, or subside. Once the ability of the clay to store water is gone it can never be restored. The implementation of water conservation practices and conversion to surface water sources are currently the only remedies for this situation. Saltwater intrusion from the Gulf of Mexico into the Gulf Coast aquifer is also a potential concern due to groundwater pumping rates that are greater than the recharge rates of the aquifer.

The Trinity aquifer's primary water quantity concern is the anticipated water-level declines during drought conditions due to increased demand that will be placed on the aquifer's resources. Recently, a computer model has been developed to simulate the flow of groundwater within Trinity aquifer and results, for the portion of the aquifer that lies within the Lower Colorado Region, suggest that water levels in the Dripping Springs area of Hays County could decline more than 100 feet by the year 2040. Other portions of Hays County as well as Blanco and Travis counties may experience moderate water-level declines between 50-100 feet by the year 2010. Most of the rivers gain water from the Trinity aquifer as they pass over the aquifer. Increased pumping during drought conditions will decrease the baseflow of the rivers that cross the Trinity aquifer, however the groundwater flow model suggests that these rivers will continue to flow seasonally.

The Carrizo-Wilcox aquifer's primary water quantity concern is the water-level declines anticipated through the year 2050 due to increased pumping. Groundwater withdrawals have increased an estimated 270 percent between 1988 and 1996, from 10,100 acre-feet/year to 37,200 acre-feet/year, from the mostly porous and permeable sandstone aquifer. The area in and around the Carrizo-Wilcox aquifer is expected to see continued population growth and increases in water demand. The TWDB co-sponsored a study of the Central Texas portion of the Carrizo-Wilcox aquifer using a computer model to assess the availability of groundwater in the area. Six water demand scenarios were simulated in the model, which ranged from considering only the current 1999 demand, to analyzing all projected future water demands through the year 2050. On the basis of the calibrated model, all withdrawal scenario water demands appear to be met by groundwater from the Carrizo-Wilcox aquifer through the year 2050. The simulations indicate that the aquifer units remain fully saturated over most of the study area. The simulated water-level declines in the Carrizo-Wilcox aquifer mainly reflect a pressure reduction within the aquifer's artesian zone. Some dewatering takes place in the center of certain pumping areas. In addition, simulations indicate that drawdown within the confined portion of the aquifer will significantly increase the movement of groundwater out of the shallow, unconfined portions to the deeper artesian portions of the aquifer. The relationships that currently exist between surface and groundwater may also change. Simulations indicate that the Colorado River, which currently gains water from the Carrizo-Wilcox aquifer, may begin to lose water to the aquifer by the year 2050.

The LCRWPG passed a resolution regarding the "mining of groundwater" on 9 February 2000, which strongly opposes the over-utilization of groundwater, including the mining of groundwater, within its region at rates that could lead to eventual harm to the groundwater resources, except during limited periods of extreme drought. They define groundwater mining as *"the withdrawal of groundwater from an aquifer at an annualized rate, which exceeds the average annualized recharge rate to an aquifer where the recharge rate can be scientifically derived with reasonable accuracy."* This resolution addresses the concerns listed above for the Barton Springs segments of the Edwards (Balcones Fault Zone), Gulf Coast, Trinity, and Carrizo-Wilcox aquifers that are located within the Lower Colorado Region. Based on the projected future groundwater demand in the Lower Colorado Region, the LCRWPG's position on groundwater mining restricts the water supply strategies that can be considered for the Lower Colorado Regional Water Plan, which are further discussed in Chapter 5.

1.2.5 Existing Water Planning in the Lower Colorado Regional Water Planning Area

In 1997, the 75th Texas Legislature enacted Senate Bill 1 (also referred to as SB 1 or the Brown-Lewis Water Plan), which provides a major overhaul of many long-standing state water laws and policies. Among its many provisions, SB 1 legislation amends Chapter 36 of the Texas Water Code to require certain water supply entities to develop water management plans (WMPs), water conservation plans (WCPs), and/or drought contingency plans (DCPs). WCPs and DCPs must be submitted to the Texas Natural Resource Conservation Commission (TNRCC) for review and certification. The TNRCC receives the plans, reviews them for minimum criteria according to the TNRCC's Chapter 288 Rules, which reflect SB 1 rules. Finally, the TNRCC sends the water supply entity a letter of certification that its plan contains the necessary minimum criteria components. It should be noted that the TNRCC does not subjectively critique the quality of the water management, water conservation, or drought contingency plans; it only determines whether or not minimum criteria have been met. Each water supply entity is required to update the respective plan every five years, so that the plan will improve as the water supply entity gains experience in managing its water resources. The TWDB also receives copies of each certified WCPs and DCPs for review with respect to TWDB's water planning efforts. However, there are no rules requiring action by the TWDB.

One category of SB 1 required plan is the Water Management Plan (WMP), which is to be developed by Groundwater Conservation Districts (GCDs) in the state. The intent of a Water Management Plan (WMP) is to conserve, preserve, prevent waste, protect, and recharge water supplies within a water conservation district. These WMPs were submitted to the TWDB for review and administrative certification by 1 September 1998. Surface water conservation districts, primarily river authorities, are also required to submit water management plans as a provision of the final adjudication of the river authority's water rights and receive administrative certification from the TNRCC. Table 1.13 lists the water conservation districts in the Lower Colorado Region and the status of certification of their WMPs. In the Lower Colorado Region there were initially four designated GCDs and one surface water conservation district (LCRA), and all have received certification from the TWDB or the TNRCC for their WMPs. In 1999, the 76th Legislature created two new Groundwater Conservation Districts in the Lower Colorado Region, as provisions of Senate Bill 1911 (SB 1911). However, these two districts, Lost Pines GCD and Hays-Trinity GCD, were not granted full authorization and cannot participate in groundwater resource planning efforts at present. These SB 1911 GCDs are currently petitioning the TNRCC for planning authority as an alternative to waiting for the state legislature's future ratification to grant full authority. Water management plans are also submitted to the regional water planning groups for inclusion in the regional water plan.

The SB 1 State Water Plan also requires each entity that possesses major surface water and/or groundwater rights to develop a water conservation plan (Table 1.14). These include irrigation water rights of at least 10,000 acre-feet/year and non-irrigation (municipal, industrial, mining, recreational) water rights of at least 1,000 acre-feet/year. The intent of the Water Conservation Plan is to develop and implement programs that will reduce water use within each of the major water user groups listed above, primarily through utilizing advances in technology, reducing distribution system water losses, and educating customers and encouraging voluntary participation in water use efficiency efforts. Approximately 90 percent of the Lower Colorado Region's water use occurs in the agricultural irrigation and municipal sectors, and the majority of the water conservation programs have targeted these two water use groups. There are currently fifteen entities in the Lower Colorado Regional Water Planning Area required to develop Water Conservation Plans and these are currently in the submittal/review/certification process with the TNRCC. The remainder of entities holding water rights are not required to develop or submit a WCP unless they petition the TNRCC for an amendment to their water right or apply for a capital improvement loan with the TWDB. In addition, Chapter 288 of the TNRCC Rules requires wholesale water supply customers to submit water conservation plans to the wholesale supplier.

Table 1.13: Lower Colorado Region SB 1-Required Water Management Plans

Entity[1]	**Lower Colorado Region County**	**Water System Managed[2]**	**Water Management Plan**
Barton Springs / Edwards Aquifer Conservation District (BSEACD)	Hays, Travis	Edwards (BFZ) & Trinity Aquifers, & Alluvial Deposits	complete
Fox Crossing UWCD	Mills	Trinity Aquifer	complete
Hays-Trinity GCD[3]	Hays	Trinity Aquifer	--
Hickory UWCD #1	Llano, San Saba	Hickory Aquifer	complete
Hill Country UWCD	Gillespie	Edwards-Trinity, Ellenberger-San Saba, & Hickory Aquifers	complete
Lost Pines GCD[3]	Bastrop	Carrizo-Wilcox Aquifer	--
Lower Colorado River Authority (LCRA)	Region K	Lower Colorado River	complete

Source: TWDB

[1] UWCD = Underground Water Conservation District; GCD = Groundwater Conservation District.

[2] Water systems managed: only portions of the indicated aquifer system is located within a GCD's jurisdiction.

[3] New GCD created under SB 1911- currently has limited authorization, which does not include planning; currently awaiting review by the state legislature for consideration of obtaining water planning authorization.

Table 1.14: Lower Colorado Region SB 1-Required Water Conservation Plans

Entity	**County**	**Water Uses[1]**	**Water Conservation Plan**
City of Llano	Llano	MUN, IRR	not received
Lake LBJ Municipal Utility District	Llano	MUN	received
Don A. Culwell/Leslie L. Appelt	Matagorda	IND, REC	received
Farmers Canal Company	Matagorda	IRR	received
Houston Lighting & Power	Matagorda	IND	received
Texas Brine Co. LLC	Matagorda	IND	not received
City of Goldthwaite	Mills	MUN, IND, IRR	not received
Lower Colorado River Authority (LCRA)	Region K	MUN, IND, MIN, IRR, HYD	complete
Capitol Aggregates, Ltd.	Travis	MIN, IRR	complete
City of Austin	Travis	MUN, IND, IRR, REC, HYD	received
City of Cedar Park	Travis/Williamson	MUN, IND	received
H & L New Gulf, Inc.	Wharton	MUN, MIN, IND	received
Lacy Withers Armour Trust et al.	Wharton	MUN, IND, IRR, REC	received
Leonard Wittig	Wharton	MUN, MIN, IND, IRR	received
New Gulf Power Ventures	Wharton	MUN, MIN, IND	received

Source: TNRCC List of SB1-Required WCPs, dated 3-27-00.

[1] water uses: IRR = irrigation; MUN = municipal; IND = industrial; MIN = mining; REC = recreation; HYD = hydroelectric.

The third category of water resource planning effort required by Senate Bill 1 is the Drought Contingency Plan (DCP). The intent of the DCP is to specify how a water supply entity will contract and supply dependable stored water supplies to its customers during a repeat of the drought of record, which is the period 1948-1957 for the Lower Colorado Region. Triggering conditions for water shortages during a drought must be defined, and the actions that will be taken by the water supplier to mitigate the adverse of effects of these water shortages must be specified. The DCP's major goals are extending the supplies of dependable water, preserving essential water uses, protecting public health and safety, and establishing equitable distributions of water among the water supplier's customers.

The 527 water supply entities required to develop a Drought Contingency Plan within the Lower Colorado Region are listed in Table 1.15 below. All wholesale water suppliers (Table 1.15a) and those retail water suppliers with at least 3,300 water supply connections (Table 1.15b) were to submit DCPs to the TNRCC by 1 September 1999, and all are currently in the review/certification process. The LCRA's Drought Contingency Plan was incorporated into its 1993 Water Management Plan; however, this plan was lacking a DCP component for retail irrigation suppliers. The LCRA has recently updated its certified Water Conservation Plan to include the DCP for irrigation supplies, has submitted the plan to the TNRCC as an amendment, and is currently awaiting certification. Retail entities with fewer than 3,300 connections (Table 1.15c) are required to submit DCPs to the Regional Water Planning Groups (RWPGs) by 1 September 2000. However, the RWPGs do not review or certify drought contingency plans.

Table 1.15a: Lower Colorado Region SB 1-Required Drought Contingency Plans (Wholesale Water Suppliers)

Wholesale Public Water Supplier[1]	County	Water Source[2]	Water Conservation Plan	# Connections
AUSTIN CITY OF -WATER & WASTEWATER*	TRAVIS	S	received	156,054
AUSTIN'S COLONY	TRAVIS	G	received	449
BRUSHY CREEK MUNICIPAL UTILITY DIST	WILLIAMSON	G	received	2,760
CEDAR PARK CITY OF*	WILLIAMSON	S	received	7,920
CHISHOLM TRAIL S U D	WILLIAMSON	G	received	2,240
EAGLE LAKE CITY OF	COLORADO	G	received	1,600
EL CAMPO CITY OF*	WHARTON	G	received	4,250
KYLE CITY OF	HAYS	G	received	1,180
LCRA-BUCHANAN DAM	LLANO	S	complete	2
MANVILLE WATER SUPPLY CORPORATION*	TRAVIS	G	received	3,846
NOACK WATER SUPPLY CORPORATION	WILLIAMSON	P	received	221
ROUND ROCK CITY OF*	WILLIAMSON	S	received	15,918
SAN MARCOS CITY OF*	HAYS	Y	received	6,317
TAYLOR CITY OF*	WILLIAMSON	S	received	4,727
TRAVIS CO MUD 4	TRAVIS	S	received	31
TRAVIS CO WCID NO 17*	TRAVIS	S	received	2,485
WEST TRAVIS COUNTY REGIONAL W S	TRAVIS	S	received	2

Sources: TNRCC List of SB1-Required Drought Contingency Plans, updated 3-23-00; and the Public Drinking Water Public Water Supply System database, updated 3-23-00.

[1] MUD = Municipal Utility District; WCID = Water Control & Improvement District; WS = Water System or Water Supply.

[2] water source: G = groundwater; S = surface water; P = surface water purchased; W = groundwater purchased; Y = gw (under the influence of surface water); Z = gw (under the influence of surface water purchased)

*Wholesaler also supplies retail water service with more than 3,300 connections.

Table 1.15b: Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With > 3,300 Connections)

Retail Public Water Supplier (> 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
ANDERSON MILL MUD	WILLIAMSON	P	complete	4,161
AQUA WATER SUPPLY CORPORATION	BASTROP	W	received	10,120
AUSTIN CITY OF -WATER & WASTEWATER*	TRAVIS	S	received	156,054
BAY CITY CITY OF	MATAGORDA	G	received	8,738
CEDAR PARK CITY OF*	WILLIAMSON	S	received	7,920
EL CAMPO CITY OF*	WHARTON	G	received	4,250
FREDERICKSBURG CITY OF	GILLESPIE	G	received	4,200
GEORGETOWN CITY OF	WILLIAMSON	G	received	9,996
MANVILLE WATER SUPPLY CORPORATION*	TRAVIS	G	received	3,846
PFLUGERVILLE CITY OF	TRAVIS	G	received	3,419
ROUND ROCK CITY OF*	WILLIAMSON	S	received	15,918
SAN MARCOS CITY OF*	HAYS	Y	received	6,317
TAYLOR CITY OF*	WILLIAMSON	S	received	4,727
TRAVIS CO WCID NO 17*	TRAVIS	S	received	2,485
WHARTON CITY OF	WHARTON	G	received	3,743

Sources: TNRCC List of SB1-Required Drought Contingency Plans, updated 3-23-00; and the Public Drinking Water Public Water Supply System database, updated 3-23-00.

[1] MUD = Municipal Utility District; WCID = Water Control & Improvement District; WS = Water System or Water Supply.

[2] water source: G = groundwater; S = surface water; P = surface water purchased; W = groundwater purchased; Y = gw (under the influence of surface water); Z = gw (under the influence of surface water purchased)

*Retailer also supplies wholesale water service.

Table 1.15c: Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
ACME BRICK COMPANY	BASTROP	G	due 9-1-00	16
BASTROP CITY OF	BASTROP	G	due 9-1-00	2,001
BASTROP COUNTY WCID NO 1	BASTROP	W	due 9-1-00	192
BASTROP COUNTY WCID NO 2	BASTROP	G	due 9-1-00	614
BASTROP WEST WATER SUPPLY	BASTROP	G	due 9-1-00	52
ELGIN CITY OF	BASTROP	G	due 9-1-00	2,036
K & K WATER COMPANY	BASTROP	G	due 9-1-00	66
SMITHVILLE CITY OF	BASTROP	G	due 9-1-00	1,924
UT - MD ANDERSON CANCER CENTER	BASTROP	G	due 9-1-00	9
BLANCO CITY OF	BLANCO	S	due 9-1-00	691

Source: Public Drinking Water Public Water Supply System database, updated 3-23-00. (continued next page)

[1] MUD = Municipal Utility District; WCID = Water Control & Improvement District; WS = Water System or Water Supply.

[2] water source: G = groundwater; S = surface water; P = surface water purchased; W = groundwater purchased; Y = gw (under the influence of surface water); Z = gw (under the influence of surface water purchased)

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
DOUBLE R RESORT	BLANCO	G	due 9-1-00	11
JOHNSON CITY CITY OF	BLANCO	G	due 9-1-00	660
OAK RIDGE HOME OWNERS ASSN	BLANCO	G	due 9-1-00	16
OAKS MOBILE HOME PARK	BLANCO	G	due 9-1-00	20
RUST RANCH WATER SUPPLY	BLANCO	G	due 9-1-00	40
SOUTHWEST CENTER	BLANCO	G	due 9-1-00	3
TPWD PEDERNALES FALLS STATE PARK	BLANCO	S	due 9-1-00	78
BERTRAM CITY OF	BURNET	G	due 9-1-00	540
BONANZA BEACH WATER ASSOCIATION	BURNET	G	due 9-1-00	56
BUCKNER CHILDREN'S RANCH	BURNET	G	due 9-1-00	10
BUENA VISTA SUBDIVISION	BURNET	S	due 9-1-00	98
BURNET CITY OF	BURNET	S	due 9-1-00	1,714
BURNET HILLS MOBILE HOME PARK	BURNET	G	due 9-1-00	26
CAMP BALCONES SPRINGS	BURNET	G	due 9-1-00	40
CAMP BUCKNER	BURNET	G	due 9-1-00	17
CAMP CHAMPIONS	BURNET	G	due 9-1-00	30
CAMP LONGHORN - INDIAN SPRINGS	BURNET	G	due 9-1-00	0
CAMP OF THE HILLS	BURNET	G	due 9-1-00	13
CAMP PENIEL	BURNET	G	due 9-1-00	13
CASSIE WATER SYSTEM	BURNET	G	due 9-1-00	42
CHANNEL OAKS WATER SYSTEM	BURNET	G	due 9-1-00	38
COTTONWOOD SHORES CITY OF	BURNET	S	due 9-1-00	374
COUNCIL CREEK VILLAGE	BURNET	G	due 9-1-00	112
CRACKER BARREL GROCERY	BURNET	G	due 9-1-00	3
DEER SPRINGS WATER COMPANY	BURNET	G	due 9-1-00	78
EAGLE BLUFF SUBDIVISION	BURNET	Y	due 9-1-00	28
GRANITE SHOALS CAMPGROUND	BURNET	G	due 9-1-00	26
GRANITE SHOALS CITY OF	BURNET	S	due 9-1-00	1,438
GRANITE SHOALS-KINGSWOOD	BURNET	G	due 9-1-00	203
GRANITE SHOALS-SHERWOOD SHORES III	BURNET	G	due 9-1-00	138
H2O ON TAP WATER HAULER	BURNET	P	due 9-1-00	120
HIGH SIERRA WATER SYSTEM	BURNET	G	due 9-1-00	19
HIGHLAND UTILITIES	BURNET	G	due 9-1-00	171
HOLLINGSWORTH CORNER	BURNET	G	due 9-1-00	7
KINGSLAND LODGE	BURNET	G	due 9-1-00	29
LACO MOBILE HOME PARK	BURNET	G	due 9-1-00	39
LAKESIDE BEACH CIVIC ASSOCIATION	BURNET	S	due 9-1-00	92
LA-Z-L RV PARK	BURNET	G	due 9-1-00	14
LITTLE LODGE ON THE LAKE	BURNET	G	due 9-1-00	12
MARBLE FALLS CITY OF	BURNET	S	due 9-1-00	2,273
MEADOWLAKES MUD	BURNET	S	due 9-1-00	541
NORTH SILVER CREEK VILLAGE WSC	BURNET	G	due 9-1-00	84
NR WATER SUPPLY CORPORATION	BURNET	G	due 9-1-00	6
PIONEER CONCRETE OF TEXAS INC	BURNET	G	due 9-1-00	2
QUAIL CREEK SUBDIVISION	BURNET	G	due 9-1-00	37
RIDGE HARBOR	BURNET	S	due 9-1-00	78

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
RIVER OAKS SUBD WATER SYSTEM	BURNET	G	due 9-1-00	99
SKYLINE TERRACE SUBDIVISION	BURNET	G	due 9-1-00	50
SMITHWICK MILLS COMMUNITY	BURNET	G	due 9-1-00	60
SONNYS TRADITION RESTAURANT & CLUB	BURNET	G	due 9-1-00	1
SOUTH COUNCIL CREEK NO 2	BURNET	G	due 9-1-00	32
SOUTH ROAD WSC	BURNET	S	due 9-1-00	41
SOUTH SILVER CREEK I,II,III	BURNET	G	due 9-1-00	100
SPICEWOOD BEACH WATER SUPPLY CORP	BURNET	G	due 9-1-00	206
SUNSET HILLS SUBDIVISION	BURNET	G	due 9-1-00	82
SUNSET WOODS WATER SYSTEM	BURNET	G	due 9-1-00	45
TEXAS GRANITE CORPORATION	BURNET	G	due 9-1-00	9
THUNDERBIRD RESORT	BURNET	G	due 9-1-00	21
TPWD INKS LAKE STATE PARK	BURNET	P	due 9-1-00	220
TPWD LONGHORN CAVERNS STATE PARK	BURNET	G	due 9-1-00	2
VISTA DEL RIO	BURNET	G	due 9-1-00	18
WILLOWS WATER SYSTEM	BURNET	S	due 9-1-00	27
WINDERMERE OAKS SUBDIVISION	BURNET	S	due 9-1-00	126
WINDY HILLS ESTATES	BURNET	G	due 9-1-00	26
ATTWATER PRAIRIE CHICKEN WILDLIFE	COLORADO	G	due 9-1-00	8
BARTEN SUBDIVISION	COLORADO	G	due 9-1-00	27
BAYOU HOLDINGS LLC	COLORADO	G	due 9-1-00	3
BURCHFIELD MINISTRIES/COUNTRY CAM	COLORADO	G	due 9-1-00	13
CARDON VILLA MOBILE HOME PARK	COLORADO	G	due 9-1-00	17
COLORADO COUNTY WCID NO 2	COLORADO	G	due 9-1-00	210
COLUMBUS CITY OF	COLORADO	G	due 9-1-00	1,617
COLUMBUS MOTEL	COLORADO	G	due 9-1-00	15
COLUMBUS OAKS APARTMENTS	COLORADO	G	due 9-1-00	32
DIVERSITECH CORPORATION	COLORADO	G	due 9-1-00	3
FALLS MUD THE	COLORADO	G	due 9-1-00	31
GLIDDEN FWSD NO 1	COLORADO	G	due 9-1-00	208
GULF COAST CHRISTIAN YOUTH CAMP	COLORADO	G	due 9-1-00	5
HACKEMACK'S HOFBRAUHAUS	COLORADO	G	due 9-1-00	2
HANOVER SMITH INC	COLORADO	G	due 9-1-00	1
HAPPY OAKS R V PARK	COLORADO	G	due 9-1-00	44
HICKORY HILL DRIVE IN	COLORADO	G	due 9-1-00	1
JERRY MIKESKA BAR-B-QUE	COLORADO	G	due 9-1-00	1
LAKE SHERIDAN ESTATES	COLORADO	G	due 9-1-00	148
NEW TOWN WATER CORPORATION	COLORADO	W	due 9-1-00	45
PILSNER STORE	COLORADO	G	due 9-1-00	2
PIONEER CONCRETE - ARENA PLANT	COLORADO	G	due 9-1-00	1
RICE CONSOLIDATED ISD	COLORADO	G	due 9-1-00	7
ROCK ISLAND WATER SUPPLY CORP	COLORADO	G	due 9-1-00	110
SANDY CREEK DRIVE INN GROCERY	COLORADO	G	due 9-1-00	2
SHELL OIL CO-HOUSTON CENTRAL PLANT	COLORADO	G	due 9-1-00	6
SHERIDAN WATER SUPPLY CORPORATION	COLORADO	G	due 9-1-00	96
ST MARYS PARISH	COLORADO	G	due 9-1-00	5

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
TEXAS TRAVEL STOP	COLORADO	G	due 9-1-00	5
THOUSAND TRAILS INCORPORATED	COLORADO	G	due 9-1-00	128
TXDOT - I10 REST AREA - NORTH	COLORADO	G	due 9-1-00	2
TXDOT - I10 REST AREA SOUTH	COLORADO	G	due 9-1-00	2
WEIMAR CITY OF	COLORADO	G	due 9-1-00	997
CAMP LONE STAR	FAYETTE	G	due 9-1-00	24
CAMP LUTHERHILL	FAYETTE	G	due 9-1-00	28
CARMINE CITY OF	FAYETTE	G	due 9-1-00	160
CISTERN WATER COMPANY	FAYETTE	G	due 9-1-00	29
ELLINGER WATER SUPPLY CORPORATION	FAYETTE	G	due 9-1-00	145
FAYETTE CO WCID - MONUMENT HILL	FAYETTE	G	due 9-1-00	222
FAYETTE POWER PROJECT - LCRA	FAYETTE	S	due 9-1-00	40
FAYETTE W S C - EAST	FAYETTE	G	due 9-1-00	288
FAYETTE W S C - WEST	FAYETTE	G	due 9-1-00	990
FAYETTEVILLE CITY OF	FAYETTE	G	due 9-1-00	210
FLATONIA CITY OF	FAYETTE	G	due 9-1-00	717
LA GRANGE CITY OF	FAYETTE	G	due 9-1-00	2,096
LEDBETTER WATER SUPPLY CORPORATION	FAYETTE	G	due 9-1-00	156
OUTPOST	FAYETTE	G	due 9-1-00	4
SCHULENBURG CITY OF	FAYETTE	G	due 9-1-00	1,240
BIRTHPLACE - LBJ NATL HIS	GILLESPIE	G	due 9-1-00	0
CHAPARRAL WATER SYSTEM	GILLESPIE	G	due 9-1-00	50
DEERWOOD SUBDIVISION	GILLESPIE	G	due 9-1-00	102
DOSS CONSOLIDATED SCHOOL DISTRICT	GILLESPIE	G	due 9-1-00	4
EBERT RANCH CAMP	GILLESPIE	G	due 9-1-00	1
EL GALLO MEXICAN RESTAURANT	GILLESPIE	G	due 9-1-00	1
ENCHANTED INN RESTAURANT	GILLESPIE	G	due 9-1-00	2
FREDERICKSBURG KOA	GILLESPIE	G	due 9-1-00	76
HARPER INDEPENDENT SCHOOL DIST	GILLESPIE	G	due 9-1-00	1
HARPER ROAD ESTATES	GILLESPIE	G	due 9-1-00	83
LBJ NATL HIST PARK-MAIN HOUSE	GILLESPIE	G	due 9-1-00	6
LIVEOAKS MOBILE HOME PARK THE	GILLESPIE	G	due 9-1-00	88
LONGHORN CAFE	GILLESPIE	G	due 9-1-00	1
LOS COMPADRES RESTAURANT	GILLESPIE	G	due 9-1-00	2
MAPUS RENTALS - TEXANA CORP	GILLESPIE	G	due 9-1-00	16
NORTHWEST HILLS WATER SUPPLY	GILLESPIE	G	due 9-1-00	74
OAKWOOD R V PARK	GILLESPIE	G	due 9-1-00	83
STONEWALL WCID	GILLESPIE	G	due 9-1-00	72
TPWD LYNDON B JOHNSON SHP	GILLESPIE	G	due 9-1-00	200
TRINITY LUTHERAN - STONEWALL	GILLESPIE	G	due 9-1-00	8
WEST OAK HEIGHTS	GILLESPIE	G	due 9-1-00	43
WHISPERING OAKS	GILLESPIE	G	due 9-1-00	43
AQUA TRIO MOBILE HOME PARK	HAYS	G	due 9-1-00	15
AZTEC VILLAGE MHP	HAYS	G	due 9-1-00	128
BLANCO RIVER RANCH	HAYS	G	due 9-1-00	25
BROWN KARHAN HEALTH CARE INC	HAYS	G	due 9-1-00	3

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
BUDA CITY OF	HAYS	G	due 9-1-00	584
CAMP BEN MCCULLOCH WS	HAYS	S	due 9-1-00	40
CAMP YOUNG JUDAEA INC	HAYS	G	due 9-1-00	13
CARDINAL VALLEY WATER COMPANY INC	HAYS	G	due 9-1-00	36
CEDAR OAK MESA WSC	HAYS	G	due 9-1-00	173
CHAPARRAL WATER COMPANY	HAYS	G	due 9-1-00	147
CHATLEFF CONTROLS WATER SYSTEM	HAYS	G	due 9-1-00	1
CHURCH OF CHRIST AT BUDA-KYLE	HAYS	G	due 9-1-00	1
CIELO AZUL RANCH	HAYS	G	due 9-1-00	24
CIMARRON PARK WATER COMPANY INC	HAYS	G	due 9-1-00	584
CITY OF HAYS	HAYS	G	due 9-1-00	86
COPPER HILLS WATER SYSTEM	HAYS	G	due 9-1-00	28
COUNTY LINE WATER SUPPLY CORP	HAYS	G	due 9-1-00	420
CRESTVIEW RV CENTER	HAYS	G	due 9-1-00	80
CRESTWOOD CENTER	HAYS	G	due 9-1-00	9
DIAMOND PURE WATER COMPANY	HAYS	G	due 9-1-00	79
DON CARR'S JUNCTION	HAYS	G	due 9-1-00	4
DRIPPING SPRINGS WATER SUPPLY CORP	HAYS	G	due 9-1-00	904
EL RANCHO CIMA	HAYS	G	due 9-1-00	0
GATEWAY ESTATES II	HAYS	G	due 9-1-00	17
GATEWAY ESTATES III	HAYS	G	due 9-1-00	11
GOFORTH WATER SUPPLY CORPORATION	HAYS	G	due 9-1-00	1,866
GOLDENWOOD WEST WATER SYSTEM	HAYS	G	due 9-1-00	111
GRANITE CREEK WSC	HAYS	G	due 9-1-00	40
HAYS CITY STORE	HAYS	G	due 9-1-00	1
HAYS CONSOLIDATED ISD	HAYS	G	due 9-1-00	1
HAYS CONSOLIDATED ISD	HAYS	G	due 9-1-00	1
HAYS HILLS BAPTIST CHURCH	HAYS	G	due 9-1-00	1
HAYS YOUTH SPORTS COMPLEX	HAYS	G	due 9-1-00	2
HILL COUNTRY WATER SUPPLY CORP	HAYS	P	due 9-1-00	431
HUNTINGTON ESTATES	HAYS	G	due 9-1-00	92
LEISUREWOODS WATER COMPANY	HAYS	G	due 9-1-00	427
MEADOW WOODS WATER SUPPLY INCORP	HAYS	G	due 9-1-00	299
MOCKINGBIRD MOBILE HOME PARK	HAYS	G	due 9-1-00	39
MOUNTAIN CITY OAKS	HAYS	G	due 9-1-00	212
MOUNTAIN VIEW MOTEL	HAYS	G	due 9-1-00	18
OAK MEADOWS	HAYS	G	due 9-1-00	122
PLUM CREEK WATER COMPANY	HAYS	G	due 9-1-00	996
RADIANCE WATER SUPPLY CORPORATION	HAYS	G	due 9-1-00	30
RIVER OAKS RANCH	HAYS	G	due 9-1-00	87
SAC AND PAC NO 109	HAYS	G	due 9-1-00	2
SALT LICK BAR B Q	HAYS	G	due 9-1-00	1
SAN MARCOS BAPTIST ACADEMY	HAYS	G	due 9-1-00	41
SIGNAL HILLS 24 COOPERATIVE	HAYS	G	due 9-1-00	13
SKYLINE RANCH ESTATES	HAYS	G	due 9-1-00	45
SOUTHWEST TERRITORY	HAYS	G	due 9-1-00	95

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
SOUTHWEST TEXAS STATE UNIVERSITY	HAYS	G	due 9-1-00	2,250
ST STEPHEN'S EPISCOPAL CHUR & SCH	HAYS	G	due 9-1-00	10
STRINGTOWN WATER SERVICE CORP	HAYS	W	due 9-1-00	62
TEXAS LEHIGH CEMENT COMPANY	HAYS	G	due 9-1-00	5
TWIN OAKS RANCH	HAYS	G	due 9-1-00	5
WIMBERLEY OAKS WSC	HAYS	G	due 9-1-00	22
WIMBERLEY VFW POST 6441	HAYS	G	due 9-1-00	2
WIMBERLEY WATER SUPPLY CORPORATION	HAYS	G	due 9-1-00	1,485
WONDERLAND SCHOOL WATER SYSTEM	HAYS	G	due 9-1-00	1
WOODCREEK UTILITY CO - NO 1	HAYS	G	due 9-1-00	669
WOODCREEK UTILITY CO - NO 2	HAYS	G	due 9-1-00	202
YELLOW ROCK MOBILE HOME PARK	HAYS	G	due 9-1-00	20
3-G WATER COOPERATIVE	LLANO	Y	due 9-1-00	219
BEACHCOMER'S PARK	LLANO	G	due 9-1-00	30
BLUFFTON TRAILER PARK	LLANO	G	due 9-1-00	70
BUCHANAN LAKE VILLAGE	LLANO	G	due 9-1-00	147
BUCHANAN VILLAGE RV PARK	LLANO	G	due 9-1-00	28
CAMP LONGHORN - MAIN CAMP	LLANO	S	due 9-1-00	0
CHAPEL OF THE HILLS BAPTIST CHURCH	LLANO	G	due 9-1-00	3
CHISM LODGES	LLANO	G	due 9-1-00	7
COMANCHE RANCHERIAS	LLANO	G	due 9-1-00	53
DRACE VACATION CAMP	LLANO	Y	due 9-1-00	41
EDGEWATER THE	LLANO	G	due 9-1-00	58
FLAG CREEK RANCH	LLANO	G	due 9-1-00	31
GRAN SABANA SUBDIVISION	LLANO	G	due 9-1-00	7
GRAVES LONG MOUNTAIN R V PARK INC	LLANO	G	due 9-1-00	43
HI LINE LAKE RESORT/ROD & REEL GRL	LLANO	G	due 9-1-00	25
KINGSLAND MOBILE HOME & RV PARK	LLANO	G	due 9-1-00	30
KINGSLAND WATER SUPPLY CORPORATION	LLANO	S	due 9-1-00	1,706
KOUNTRY KITCHEN	LLANO	G	due 9-1-00	1
LAKE BUCHANAN WATER SUPPLY CORP	LLANO	P	due 9-1-00	276
LAKE LBJ MUNICIPAL UTILITY DIST	LLANO	S	due 9-1-00	2,571
LLANO CITY OF	LLANO	S	due 9-1-00	1,644
LLANO COUNTY MUD NO 1	LLANO	S	due 9-1-00	236
LONGHORN RESORT	LLANO	G	due 9-1-00	26
PARADISE POINT WATER SUPPLY CORP	LLANO	S	due 9-1-00	140
PARKVIEW ACRES	LLANO	P	due 9-1-00	32
PECAN UTILITIES COMPANY	LLANO	G	due 9-1-00	141
RHODES END MOBILE HOME PARK	LLANO	G	due 9-1-00	32
RIO VISTA RESORT	LLANO	G	due 9-1-00	56
ROCK-A-WAY PARK	LLANO	P	due 9-1-00	25
SANDY HARBOR SUBDIVISION	LLANO	S	due 9-1-00	70
SANDY MOUNTAIN DEVELOPMENT CO.	LLANO	G	due 9-1-00	760
SHADY OAKS RV PARK	LLANO	G	due 9-1-00	64
STOVER MOBILE HOME PARK	LLANO	G	due 9-1-00	32
TOW VILLAGE PROPERTY OWNERS ASSN	LLANO	G	due 9-1-00	33

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
TPWD ENCHANTED ROCK S N A	LLANO	G	due 9-1-00	29
VALENTINE LAKESIDE RESORT	LLANO	G	due 9-1-00	17
VILLAGE QUICK STOP	LLANO	G	due 9-1-00	1
WATER WORKS NO 1 - FLOYD ACRES	LLANO	Y	due 9-1-00	24
WATER WORKS NO 2 - ISLAND LODGES	LLANO	Y	due 9-1-00	48
ALLEN'S LANDING MOTEL AND STORE	MATAGORDA	G	due 9-1-00	9
BERT'S R V PARK	MATAGORDA	G	due 9-1-00	40
CAMELOT FOREST WATER SYSTEM	MATAGORDA	G	due 9-1-00	117
CANEY CREEK HAVEN CLUB W S	MATAGORDA	G	due 9-1-00	90
CANEY CREEK MUNICIPAL UTILITY DIST	MATAGORDA	G	due 9-1-00	800
EL DORADO WATER COMPANY	MATAGORDA	G	due 9-1-00	100
EQUISTAR CHEMICAL LP	MATAGORDA	G	due 9-1-00	14
EXOTIC ISLE SUBDIV WATER SYSTEM	MATAGORDA	G	due 9-1-00	15
FROST MOBILE HOME PARK	MATAGORDA	G	due 9-1-00	37
H L & P-SOUTH TEXAS PROJECT - NTF	MATAGORDA	G	due 9-1-00	3
H L & P-SOUTH TX PROJECT-MAIN PLT	MATAGORDA	G	due 9-1-00	65
HOECHST/CELANESE CHEM LTD-BAY CITY	MATAGORDA	G	due 9-1-00	5
HUBERT-WATSON SUBD WATER SYST INC	MATAGORDA	G	due 9-1-00	30
L O B CIVIC WATER SUPPLY CORP	MATAGORDA	G	due 9-1-00	112
LETULLE ESTATES - CHINQUAPIN NO 1	MATAGORDA	G	due 9-1-00	70
LETULLE PARK-CITY OF BAY CITY	MATAGORDA	G	due 9-1-00	7
M M T POTABLE WATER SYSTEM	MATAGORDA	G	due 9-1-00	4
MARKHAM MUNICIPAL UTILITY DISTRICT	MATAGORDA	G	due 9-1-00	386
MATAGORDA COUNTY WCID NO 2	MATAGORDA	G	due 9-1-00	89
MATAGORDA COUNTY WCID NO 5	MATAGORDA	G	due 9-1-00	317
MATAGORDA COUNTY WCID NO 6	MATAGORDA	G	due 9-1-00	394
MATAGORDA DUNES SUBDIVISION	MATAGORDA	G	due 9-1-00	125
MATAGORDA WATER SUPPLY CORPORATION	MATAGORDA	G	due 9-1-00	370
MIDFIELD WATER SUPPLY CORPORATION	MATAGORDA	G	due 9-1-00	71
OAK HOLLOW SUBDIVISION	MATAGORDA	G	due 9-1-00	19
PALACIOS CITY OF	MATAGORDA	G	due 9-1-00	1,617
PALACIOS MARINE EDUCATION CENTER	MATAGORDA	G	due 9-1-00	3
PECAN SHADOWS WATER SUPPLY CORP	MATAGORDA	G	due 9-1-00	47
PETERSEN'S MOTEL	MATAGORDA	G	due 9-1-00	15
RIO COLORADO GOLF COURSE	MATAGORDA	G	due 9-1-00	2
RIVER BEND WATER SERVICES INC	MATAGORDA	G	due 9-1-00	40
RIVER OAKS SUBDIVISION	MATAGORDA	G	due 9-1-00	128
RIVERSIDE PARK WATER - BAY CITY	MATAGORDA	G	due 9-1-00	42
S & G BAR-B-QUE	MATAGORDA	G	due 9-1-00	2
SELKIRK ISLAND WATER SYSTEM	MATAGORDA	G	due 9-1-00	181
TIDEHAVEN HIGH SCHOOL - TISD	MATAGORDA	G	due 9-1-00	3
TIDEHAVEN INTERMEDIATE SCHL-TISD	MATAGORDA	G	due 9-1-00	3
TIDEWATER OAKS SUBDIVISION	MATAGORDA	G	due 9-1-00	55
TIGER QUICK STOP	MATAGORDA	G	due 9-1-00	3
TRES PALACIOS OAKS SUBDIVISION	MATAGORDA	G	due 9-1-00	150
USAF - AEROSTAT SITE	MATAGORDA	G	due 9-1-00	3

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
VFW POST NO 2438	MATAGORDA	G	due 9-1-00	1
WADSWORTH WATER SUPPLY CORP.	MATAGORDA	G	due 9-1-00	141
DAIRY QUEEN - GOLDTHWAITE	MILLS	G	due 9-1-00	2
GOLDTHWAITE CITY OF	MILLS	G	due 9-1-00	885
HEREFORD MOTEL	MILLS	G	due 9-1-00	20
MINUTE STOP	MILLS	G	due 9-1-00	1
MULLIN INDEPENDENT SCHOOL DISTRICT	MILLS	G	due 9-1-00	20
NEW HORIZONS RANCH & CENTER	MILLS	S	due 9-1-00	11
OLIVER'S RESTAURANT	MILLS	G	due 9-1-00	1
PRIDDY WSC	MILLS	G	due 9-1-00	86
STAR INDEPENDENT SCHOOL DISTRICT	MILLS	G	due 9-1-00	15
BAREFOOT FISHING CAMP	SAN SABA	G	due 9-1-00	38
CAMP BILLY GIBBONS	SAN SABA	G	due 9-1-00	0
CHEROKEE HOME FOR CHILDREN	SAN SABA	G	due 9-1-00	14
CHEROKEE INDEPENDENT SCHOOL DIST	SAN SABA	G	due 9-1-00	6
NORTH SAN SABA WTR SUPPLY CORP	SAN SABA	G	due 9-1-00	194
RICHLAND SPECIAL UTILITY DISTICT	SAN SABA	G	due 9-1-00	342
RICHLAND SPRINGS CITY OF	SAN SABA	G	due 9-1-00	209
SAN SABA CITY OF	SAN SABA	G	due 9-1-00	1,350
SULPHUR SPRINGS FISHING CAMP	SAN SABA	G	due 9-1-00	40
TPWD COLORADO BEND STATE PARK	SAN SABA	Y	due 9-1-00	4
620 OAKS OFFICE PARK	TRAVIS	G	due 9-1-00	20
6-M GROCERY	TRAVIS	P	due 9-1-00	2
7-ELEVEN NO 24002	TRAVIS	P	due 9-1-00	1
ALPENHOF STEAK HAUS	TRAVIS	G	due 9-1-00	1
APACHE SHORES UTILITY COMPANY INC	TRAVIS	G	due 9-1-00	560
APPLE TREE DAY CARE CENTER	TRAVIS	G	due 9-1-00	1
ARROYO DOBLE WATER SYSTEM INC	TRAVIS	G	due 9-1-00	265
AUSTIN WALDORF SCHOOL INC	TRAVIS	G	due 9-1-00	13
AUSTIN WHITE LIME COMPANY	TRAVIS	G	due 9-1-00	7
AUSTIN YMBL SUNSHINE NO 2	TRAVIS	G	due 9-1-00	6
BARTON CREEK LAKESIDE	TRAVIS	G	due 9-1-00	119
BARTON CREEK WATER SUPPLY CORP	TRAVIS	P	due 9-1-00	186
BARTON CREEK WEST WATER SUPPLY CO	TRAVIS	P	due 9-1-00	406
BARTON VALLEY SUBDIVISION	TRAVIS	G	due 9-1-00	27
BEAR CREEK PARK	TRAVIS	G	due 9-1-00	84
BERT & ERNIES	TRAVIS	G	due 9-1-00	1
BRANCH CREEK ESTATES	TRAVIS	P	due 9-1-00	310
BRIARCLIFF VILLAGE OF	TRAVIS	S	due 9-1-00	387
CAMP CHAUTAUQUA WATER SYSTEM	TRAVIS	G	due 9-1-00	22
CAMP TEXLAKE	TRAVIS	G	due 9-1-00	20
CENTER FOR CHRISTIAN GROWTH CAMP	TRAVIS	G	due 9-1-00	6
CHINATOWN WATER WORKS - AREA FOUR	TRAVIS	P	due 9-1-00	45
CHINATOWN WATER WORKS AREA ONE	TRAVIS	P	due 9-1-00	45
CHINATOWN WATER WORKS AREA THREE	TRAVIS	P	due 9-1-00	45
CHINATOWN WATER WORKS AREA TWO	TRAVIS	P	due 9-1-00	45

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	**County**	**Water Source[2]**	**Water Conservation Plan**	**# Connections**
CIRCLE K NO 3247	TRAVIS	P	due 9-1-00	1
COW CREEK LAKESIDE LODGE WS	TRAVIS	G	due 9-1-00	35
CREEDMOOR-MAHA WATER SUPPLY CORP	TRAVIS	G	due 9-1-00	1,478
CRYSTAL MOUNTAIN HOME OWNERS ASSN	TRAVIS	P	due 9-1-00	54
CST ALBANS EPISCOPAL CHURCH	TRAVIS	G	due 9-1-00	2
CYPRESS CREEK MARINA	TRAVIS	P	due 9-1-00	1
DAVENPORT RANCH MUD NO 1	TRAVIS	S	due 9-1-00	932
DEER CREEK RANCH WATER SYSTEM	TRAVIS	G	due 9-1-00	93
DESSAU PARK COMMUNITY WATER SYSTEM	TRAVIS	G	due 9-1-00	140
DESSAU SUPPLY COMPANY INCORPORATED	TRAVIS	G	due 9-1-00	225
DRAPER ESTATES WATER SYSTEM	TRAVIS	G	due 9-1-00	36
EMMA LONG METRO PARK	TRAVIS	S	due 9-1-00	40
FOREST OAKS MOBILE HOME COMMUNITY	TRAVIS	G	due 9-1-00	22
FORRISTER-VIER-WESTVIEW JOINT VENT	TRAVIS	G	due 9-1-00	3
GARFIELD WATER SUPPLY CORPORATION	TRAVIS	G	due 9-1-00	415
GLENLAKE WATER SUPPLY CORPORATION	TRAVIS	S	due 9-1-00	175
GREEN SHORES WATER SYSTEM	TRAVIS	G	due 9-1-00	18
HAZY HILLS WATER SYSTEM	TRAVIS	G	due 9-1-00	59
HIGH VALLEY WATER SUPPLY CORP	TRAVIS	P	due 9-1-00	80
HIGHLAND LAKES BAPTIST ENCAMPMENT	TRAVIS	G	due 9-1-00	26
HIGHWAY 71 STORAGE & MHP	TRAVIS	G	due 9-1-00	19
HILL COUNTRY KITCHEN	TRAVIS	G	due 9-1-00	10
HILL COUNTRY N W - CHERRY HOLLOW	TRAVIS	G	due 9-1-00	279
HILL COUNTRY SPRINGS	TRAVIS	Y	due 9-1-00	1
HILL OAKES MOBILE ESTATES	TRAVIS	P	due 9-1-00	45
HURST CREEK MUNICIPAL UTIL DIST	TRAVIS	S	due 9-1-00	542
INDIAN SPRINGS SUBDIVISION	TRAVIS	P	due 9-1-00	50
INVERNESS POINT WATER SYSTEM	TRAVIS	S	due 9-1-00	87
JONESTOWN WATER SUPPLY CORPORATION	TRAVIS	S	due 9-1-00	907
JOY OF AUSTIN	TRAVIS	G	due 9-1-00	2
KENNEDY RIDGE WATER SYSTEM	TRAVIS	W	due 9-1-00	66
KIDDIE ACRES	TRAVIS	G	due 9-1-00	2
LAGO VISTA CITY OF	TRAVIS	S	due 9-1-00	1,686
LAKEVIEW HILLS WSC	TRAVIS	G	due 9-1-00	26
LAKEWAY MUNICIPAL UTILITY DISTRICT	TRAVIS	S	due 9-1-00	3,270
LIVE OAKS WS - LEANDER HILLS SUBD	TRAVIS	G	due 9-1-00	172
LOOP 360 WATER SUPPLY CORP	TRAVIS	P	due 9-1-00	314
LOST CREEK MUNICIPAL UTILITY DIST	TRAVIS	P	due 9-1-00	1,240
MALONE ADDITION WATER SUPPLY	TRAVIS	G	due 9-1-00	17
MANCHACA V F D	TRAVIS	G	due 9-1-00	3
MANOR CITY OF	TRAVIS	W	due 9-1-00	447
MARBRIDGE FOUNDATION	TRAVIS	G	due 9-1-00	39
MARIANA'S COCINA	TRAVIS	W	due 9-1-00	3
MARSHA WATER SUPPLY CORPORATION	TRAVIS	P	due 9-1-00	80
MONTVIEW CO-OP	TRAVIS	P	due 9-1-00	29
MOON RIVER TAVERN	TRAVIS	G	due 9-1-00	2

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
MOORELAND WATER SUPPLY	TRAVIS	G	due 9-1-00	39
MYSTIC OAKS WATER CORPORATION	TRAVIS	G	due 9-1-00	44
NAMELESS HOLLOW CONDOMINIUMS	TRAVIS	G	due 9-1-00	72
NAMELESS VALLEY RANCH	TRAVIS	G	due 9-1-00	27
NICK'S GREAT PIZZA	TRAVIS	P	due 9-1-00	1
NIGHTHAWK WATER SUPPLY CORPORATION	TRAVIS	P	due 9-1-00	116
NORTH AUSTIN MUD NO 1	TRAVIS	P	due 9-1-00	2,043
NORTH TRAVIS COUNTY MUD NO 5	TRAVIS	W	due 9-1-00	272
NORTHRIDGE HOMEOWNERS ASSOCIATION	TRAVIS	P	due 9-1-00	125
NORTHTOWN MUNICIPAL UTILITY DIST	TRAVIS	P	due 9-1-00	347
OAK SHORES WATER SYSTEM	TRAVIS	G	due 9-1-00	28
ONION CREEK MEADOWS	TRAVIS	G	due 9-1-00	224
PACE BEND RECREATION AREA	TRAVIS	G	due 9-1-00	23
PALEFACE LAKE COUNTRY ESTATES	TRAVIS	G	due 9-1-00	30
PALEFACE PEDERNALES WATER SUP CORP	TRAVIS	G	due 9-1-00	17
PARK HILLS BAPTIST CHURCH	TRAVIS	G	due 9-1-00	1
PEACE LUTHERAN CHURCH	TRAVIS	G	due 9-1-00	1
PIER THE	TRAVIS	P	due 9-1-00	1
RAIL ROAD BBQ	TRAVIS	G	due 9-1-00	3
RESORT RANCH OF LAKE TRAVIS INC	TRAVIS	S	due 9-1-00	45
RIDGEWOOD VILLAGE WATER SYSTEM	TRAVIS	G	due 9-1-00	85
RIVER PLACE ON LAKE AUSTIN	TRAVIS	S	due 9-1-00	602
RIVER RIDGE	TRAVIS	G	due 9-1-00	77
RIVERCREST WATER SYSTEM INC	TRAVIS	P	due 9-1-00	219
ROLLINGWOOD CITY OF	TRAVIS	P	due 9-1-00	528
SAC-N-PAC NO 701	TRAVIS	G	due 9-1-00	3
SAIL HAVEN	TRAVIS	S	due 9-1-00	30
SAN LEANNA VILLAGE OF	TRAVIS	G	due 9-1-00	147
SANDY CREEK RANCHES SUBD	TRAVIS	G	due 9-1-00	369
SENNA HILLS MUNICIPAL UTILITY DIST	TRAVIS	P	due 9-1-00	50
SHADY HOLLOW ESTATES WATER SUPPLY	TRAVIS	G	due 9-1-00	226
SHADY HOLLOW MUD	TRAVIS	P	due 9-1-00	1,261
SLAUGHTER CREEK ACRES	TRAVIS	G	due 9-1-00	78
SMOKEY J'S BAR-B-Q NO 1	TRAVIS	P	due 9-1-00	1
SMOKEY J'S BAR-B-Q NO 3	TRAVIS	G	due 9-1-00	2
ST STEPHENS EPISCOPAL SCHOOL	TRAVIS	P	due 9-1-00	40
ST THOMAS MORE CATHOLIC CHURCH	TRAVIS	G	due 9-1-00	4
SUNSET VALLEY CITY OF	TRAVIS	G	due 9-1-00	92
TEXACO ONE STOP	TRAVIS	G	due 9-1-00	4
THUNDERCLOUD SUBS #28	TRAVIS	P	due 9-1-00	1
TRAVIS CO PRECINCT 3/WELL SYSTEM	TRAVIS	G	due 9-1-00	4
TRAVIS CO WCID - POINT VENTURE	TRAVIS	S	due 9-1-00	396
TRAVIS CO WCID 19-EST BARTON CREEK	TRAVIS	P	due 9-1-00	147
TRAVIS CO WCID NO 10	TRAVIS	P	due 9-1-00	2,372
TRAVIS CO WCID NO 18	TRAVIS	S	due 9-1-00	1,403
TRAVIS CO WCID NO 20	TRAVIS	S	due 9-1-00	260

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
TRAVIS COUNTY MUD NO 2	TRAVIS	G	due 9-1-00	6
TRAVIS SOUTH MOBILE HOME PARK	TRAVIS	G	due 9-1-00	28
TURNING POINT SOUTH	TRAVIS	G	due 9-1-00	2
TWIN CREEK PARK SUBDIVISION	TRAVIS	G	due 9-1-00	79
V J'S CAFE & GROCERY	TRAVIS	G	due 9-1-00	2
VFW POST NO 3377	TRAVIS	G	due 9-1-00	1
VILLAGE OF BEE CAVES	TRAVIS	P	due 9-1-00	19
VOLENTE BEACH RESTAURANT	TRAVIS	P	due 9-1-00	3
WATER VALLEY WATER CO-OP	TRAVIS	G	due 9-1-00	16
WELLS BRANCH MUD NO 1	TRAVIS	P	due 9-1-00	2,237
WINDERMERE WATER SYSTEM	TRAVIS	G	due 9-1-00	2,944
WOOD ISLAND COOP	TRAVIS	G	due 9-1-00	13
AMERICAN LEGION POST NO 226	WHARTON	G	due 9-1-00	1
BERNARD TIMBERS WATER SUPPLY CORP	WHARTON	G	due 9-1-00	31
BOLING ISD - NEW GULF ELEMENTARY	WHARTON	G	due 9-1-00	3
BOLING MUNICIPAL UTILITY DISTRICT	WHARTON	G	due 9-1-00	340
CZECH CATHOLIC HOME FOR AGED	WHARTON	G	due 9-1-00	7
DIAMOND MINI-MART #7	WHARTON	G	due 9-1-00	1
EAGLE CREEK TRAILER PARK	WHARTON	G	due 9-1-00	10
FAMILY LIFE TRAINING CENTER THE	WHARTON	G	due 9-1-00	39
GREENLEAF NURSERY- ADMINISTRATION	WHARTON	G	due 9-1-00	4
GREENLEAF NURSERY-SHIPPING/RECEIV	WHARTON	G	due 9-1-00	1
GRESHAM'S FOOD & FUEL	WHARTON	G	due 9-1-00	1
HILLSIDE DRIVE IN	WHARTON	G	due 9-1-00	1
HINZE'S BAR-B-QUE HUT INC	WHARTON	G	due 9-1-00	1
HUNGERFORD MUNICIPAL UTIL DISTRICT	WHARTON	G	due 9-1-00	165
IAGO JUNIOR HIGH SCHOOL	WHARTON	G	due 9-1-00	25
ISAACSON MUNICIPAL UTILITY DIST	WHARTON	W	due 9-1-00	175
KWIK CHECK FUEL STOP	WHARTON	G	due 9-1-00	1
LEEDO CABINETRY COMPANY	WHARTON	G	due 9-1-00	2
M I DRILLING FLUID COMPANY	WHARTON	G	due 9-1-00	2
MYRA S PRYOR GIRL SCOUT CAMP	WHARTON	G	due 9-1-00	8
NEW GULF - TEXAS GULF INC	WHARTON	G	due 9-1-00	10
PRASEK'S HILLJE SMOKEHOUSE	WHARTON	G	due 9-1-00	2
PYSSEN'S LIVE OAK ESTATES	WHARTON	G	due 9-1-00	45
TURTLE CREEK VILLAGE	WHARTON	G	due 9-1-00	26
VILLAGE ESTATES MOBILE HOME PARK	WHARTON	G	due 9-1-00	20
WHARTON COUNTY WCID NO 1 - LOUISE	WHARTON	G	due 9-1-00	348
WHARTON COUNTY WCID NO 2	WHARTON	G	due 9-1-00	670
WHARTON MUNICIPAL AIRPORT	WHARTON	G	due 9-1-00	2
ANDICE WATER SUPPLY	WILLIAMSON	G	due 9-1-00	19
BARTLETT CITY OF	WILLIAMSON	G	due 9-1-00	650
BLESSING MOBILE HOME PARK	WILLIAMSON	Y	due 9-1-00	105
BLOCKHOUSE MUNICIPAL UTILITY DIST	WILLIAMSON	W	due 9-1-00	838
CARRIAGE OAKS WATER SYSTEM	WILLIAMSON	G	due 9-1-00	114
CHANDLER CREEK BAPTIST CHURCH	WILLIAMSON	G	due 9-1-00	3

Table 1.15c (continued): Lower Colorado Region SB 1-Required Drought Contingency Plans (Retail Water Suppliers With < 3,300 Connections)

Retail Public Water Supplier (< 3,300 connections)[1]	County	Water Source[2]	Water Conservation Plan	# Connections
CHAPARRAL III	WILLIAMSON	G	due 9-1-00	57
CLASSIC SOFT TRIM	WILLIAMSON	G	due 9-1-00	1
COMMUNITY CHRISTIAN CHURCH	WILLIAMSON	G	due 9-1-00	2
DURHAM PARK WATER SUPPLY CORP	WILLIAMSON	G	due 9-1-00	107
FERN BLUFF MUD	WILLIAMSON	P	due 9-1-00	308
FLORENCE CITY OF	WILLIAMSON	G	due 9-1-00	533
GRANGER CITY OF	WILLIAMSON	G	due 9-1-00	540
GREEN ACRES WATER SUPPLY	WILLIAMSON	G	due 9-1-00	54
HIGH GABRIEL WATER SUPPLY CORP	WILLIAMSON	G	due 9-1-00	101
HOPE HOUSE INCORPORATED	WILLIAMSON	G	due 9-1-00	5
HUTTO CITY OF	WILLIAMSON	G	due 9-1-00	355
INNER SPACE CAVERN	WILLIAMSON	G	due 9-1-00	1
JARRELL-SCHWERTNER WATER SUPPLY CO	WILLIAMSON	G	due 9-1-00	1,005
JONAH WATER SPECIAL UTILITY DIST	WILLIAMSON	G	due 9-1-00	2,280
LEANDER CITY OF	WILLIAMSON	W	due 9-1-00	2,429
LIBERTY CHAPEL	WILLIAMSON	G	due 9-1-00	15
LIBERTY HILL MOBILE HOME PARK	WILLIAMSON	G	due 9-1-00	14
LIBERTY HILL WATER SUPPLY CORP	WILLIAMSON	G	due 9-1-00	434
LIVE OAKS AT BERRY CREEK RV PARK	WILLIAMSON	G	due 9-1-00	84
PREFERRED INCORPORATED	WILLIAMSON	G	due 9-1-00	1
RABBIT HILL SCHOOL & DAY CAMP	WILLIAMSON	G	due 9-1-00	4
RIVERSIDE MOBILE HOME PARK	WILLIAMSON	G	due 9-1-00	48
SAN GABRIEL RIVER RANCHES	WILLIAMSON	G	due 9-1-00	170
SOUTH SAN GABRIEL RANCHES	WILLIAMSON	W	due 9-1-00	91
SOUTHERN HILLS WATER SUPPLY CORP	WILLIAMSON	G	due 9-1-00	8
SPRINGWOODS MUNICIPAL UTILITY DIST	WILLIAMSON	P	due 9-1-00	1,431
TAL/TEX INCORPORATED	WILLIAMSON	W	due 9-1-00	275
THRALL CITY OF	WILLIAMSON	W	due 9-1-00	249
WALBURG WATER SYSTEM	WILLIAMSON	G	due 9-1-00	28
WEIR WATER WORKS	WILLIAMSON	G	due 9-1-00	57
WILLIAMSON COUNTY INCORPORATED	WILLIAMSON	W	due 9-1-00	182
WILLIAMSON COUNTY MUD #9-VISTA OAK	WILLIAMSON	P	due 9-1-00	355
WILLIAMSON/TRAVIS CO MUD NO 1	WILLIAMSON	P	due 9-1-00	1,286

Source: Public Drinking Water Public Water Supply System database, updated 3-23-00.

[1] MUD = Municipal Utility District; WCID = Water Control & Improvement District; WS = Water System or Water Supply.

[2] water source: G = groundwater; S = surface water; P = surface water purchased; W = groundwater purchased; Y = gw (under the influence of surface water); Z = gw (under the influence of surface water purchased)

APPENDIX 1A

THREATENED AND ENDANGERED SPECIES IN THE LOWER COLORADO REGIONAL WATER PLANNING AREA (Texas Parks and Wildlife Department – Annotated County Lists of Rare Species)

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

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CHAPTER 2.0: POPULATION PROJECTIONS AND WATER DEMAND PROJECTIONS

A key task in the preparation of the Senate Bill 1 (SB 1) regional water plan for the Lower Colorado Region is to estimate current and future water demands within the region. In subsequent chapters of this plan, these projections are compared with estimates of currently available water supply to identify the location, extent, and timing of future water shortages.

Table 2.1 below is a summary of regional population and water demand projections for the Lower Colorado Region.

Table 2.1: Population and Water Demand Projections for the Lower Colorado Region

Regional Total Projection	2000	2010	2020	2030	2040	2050
Population	1,041,948	1,243,247	1,505,722	1,751,931	1,923,941	2,107,106
Municipal Water Demand (ac-ft/yr)	227,616	258,794	302,075	346,430	375,510	409,297
Manufacturing Water Demand (ac-ft/yr)	33,833	55,841	57,903	60,165	63,185	66,962
Irrigation Water Demand (ac-ft/yr)	588,635	559,238	538,196	517,895	498,331	479,453
Steam Electric Water Demand (ac-ft/yr)	81,000	90,500	95,500	110,500	110,500	118,500
Mining Water Demand (ac-ft/yr)	34,554	26,879	28,353	30,072	32,229	34,820
Livestock Water Demand (ac-ft/yr)	14,275	14,275	14,275	14,275	14,275	14,275
TOTAL WATER DEMAND	**979,913**	**1,005,527**	**1,036,302**	**1,079,337**	**1,094,030**	**1,123,307**

As indicated, the population in the Lower Colorado Region is projected to more than double over the next 50 years. This projected increase in population is the principal "driver" underlying the projected increase in total water demand from approximately 980,000 acre-feet in the year 2000 to 1,123,000 acre-feet in the year 2050.

The following sections of this chapter describe the methodology used to develop regional population and water demand projections. This chapter also presents projections of population and water demand for cities, major providers of municipal and manufacturing water, and for categories of water use including municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock watering. Projected demands are also provided for each of the four river basins and two coastal basins that are partially located within the Lower Colorado Region.

2.1 TWDB GUIDELINES FOR REVISIONS TO POPULATION AND WATER DEMAND PROJECTIONS

SB 1 and associated rules of the Texas Water Development Board (TWDB) require the use of population and water demand projections from the 1997 State Water Plan. Specifically, Section 357.5 of TWDB rules for regional water planning state:

> *" In developing regional water plans, regional water planning groups shall use:*
>
> *(1) state population and water demand projections contained in the state water plan or adopted by the board after consultation with the Texas Natural Resource Conservation Commission and the Texas Parks and Wildlife Department, in preparation for revision of the state water plan; or*
>
> *(2) in lieu of paragraph (1) of this subsection, population and water demand projection revisions that have been adopted by the board, after coordination with the Texas Natural Resource Conservation Commission and the Texas Parks and Wildlife Department, based on changed conditions and availability of new information.*

In essence, TWDB rules require that the state's projections be used as the "default" for regional water planning unless there are substantiated reasons to revise those projections. The TWDB established guidelines to be used in developing proposed revisions. Based on these guidelines, a number of revisions to the state's "default" projections were proposed by the Lower Colorado Regional Water Planning Group and adopted by the TWDB.

2.2 POPULATION PROJECTIONS

The population and water demand projections presented in this chapter were developed by revising the State's "default" projections to reflect more current information, in accordance with TWDB guidelines. This section describes the methodology applied by the planning group to develop the TWDB-approved population projections for the Lower Colorado Region (TWDB approved on August 18, 1999).

2.2.1 Methodology

Municipal water demand projections are calculated as the product of three variables: current and projected population, per capita water use rates, and assumptions regarding the effects of certain water conservation measures.

The following describes the procedures followed in the development of the population projections presented in this chapter:

Identify the initial baseline projection: The baseline population projection for SB 1 regional water planning is the state's "most likely" scenario for each county, each city of 500 population and greater, and for cities of less than 500 population and rural areas ("County-Other"). These projections represent "default" values, which are used except where revisions were justified per TWDB guidelines.

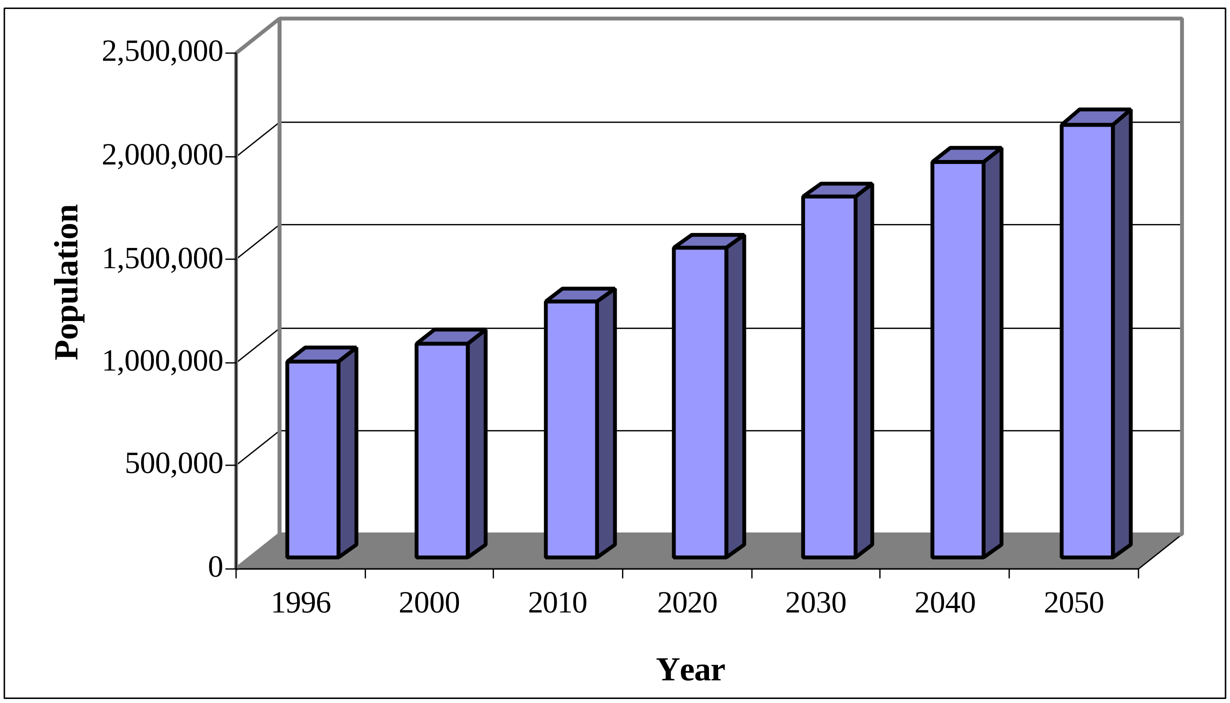
Evaluate recent population growth trends: As indicated in above, TWDB guidelines allow for adjustments of population projections if new or better information warrants such a revision. Using the 1990 census and a January 1998 population estimate provided by the State Data Center (SDC), the planning group calculated the growth rate for this period and extrapolated the trend to the year 2000. This adjusted year 2000 population estimate was then used as the starting point for the development of a revised population projection through 2050 using the growth rates in state's projections for each decade.

Select proposed population projection: Proposed population projections were determined after the TWDB default projections, the SDC revised projections, and other available projections were compared. The higher of either the TWDB or the SDC projection was selected as the proposed projection, except in cases where better information was available. These population projections are summarized in the following section.

2.2.2 Regional Population Projection

Projections of population growth for the Lower Colorado Region indicate a doubling of the region's population from approximately 1.0 million in 2000 to 2.1 million in the year 2050 (Figure 2.1). Table 1 presents these projections by county for each decade of the 50-year planning period. Each of the 14 counties in the region are projected to grow significantly over the planning period, with Travis County continuing to account for nearly 75 percent of the total population for the region, as shown in Table 2.2.

Figure 2.1: Lower Colorado Region Population Projections



As discussed in Chapter 1, the Lower Colorado Region covers a portion of four major river basins and two coastal basins. Of these, the Colorado River Basin is projected to contain approximately 92 percent of the region's population in the year 2050. Table 2.3 presents the population projections by river basin for the Lower Colorado Region.

Table 2.2: Population Projection by County

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	46,738	51,627	63,901	77,030	89,779	97,624	106,153
Blanco	7,352	8,253	9,874	11,644	12,964	13,688	13,799
Burnet	29,426	33,874	40,994	48,782	55,228	57,511	59,891
Colorado	19,574	20,462	21,496	22,972	23,664	24,481	25,094
Fayette	21,757	22,964	25,600	29,127	32,647	36,352	40,994
Gillespie	19,700	21,710	23,820	26,644	28,435	32,841	36,006
Hays (p)	17,662	22,111	33,448	42,429	53,138	65,106	73,578
Llano	12,852	13,685	14,207	15,474	15,770	16,368	17,865
Matagorda	38,183	41,146	45,947	51,165	57,008	63,405	71,119
Mills	4,964	5,575	5,708	5,898	6,021	6,074	6,129
San Saba	5,565	5,802	5,802	5,802	5,802	5,802	5,802
Travis	680,540	744,080	892,047	1,096,329	1,288,441	1,413,420	1,550,521
Wharton (p)	27,799	29,130	31,918	34,687	37,655	40,652	43,969
Williamson (p)	19,771	21,529	28,485	37,739	45,379	50,617	56,186
TOTAL	**951,883**	**1,041,948**	**1,243,247**	**1,505,722**	**1,751,931**	**1,923,941**	**2,107,106**

(p) Denotes that only the portion of the county in the Lower Colorado Region is considered.
** Population projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Table 2.3: Population Projection by River Basin

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	21,116	23,391	25,878	28,472	31,058	32,787	34,164
Brazos-Colorado	48,976	52,078	57,494	63,365	69,479	76,110	83,682
Colorado	855,143	938,388	1,128,689	1,379,310	1,613,311	1,773,516	1,943,950
Colorado-Lavaca	11,144	12,102	13,513	15,026	16,707	18,534	20,840
Guadalupe	6,618	6,952	7,953	9,064	10,017	10,721	11,149
Lavaca	8,886	9,037	9,720	10,485	11,359	12,273	13,321
TOTAL	**951,883**	**1,041,948**	**1,243,247**	**1,505,722**	**1,751,931**	**1,923,941**	**2,107,106**

2.3 WATER DEMAND PROJECTIONS

Total water demand for the Lower Colorado Region is projected to increase by approximately 143,000 acre-feet over the 50-year planning period. This relatively small increase (approximately 15 %) is largely due to the counter-effect of projected increases in municipal, manufacturing, and steam electric water demand and the projected decrease in irrigation water demand. The following figures (Figure 2.2 – 2.4) show the relative portion of projected water demand by type of use for the year 2000 and the year 2050.

Figure 2.2: Lower Colorado Region Total Water Demand Projections

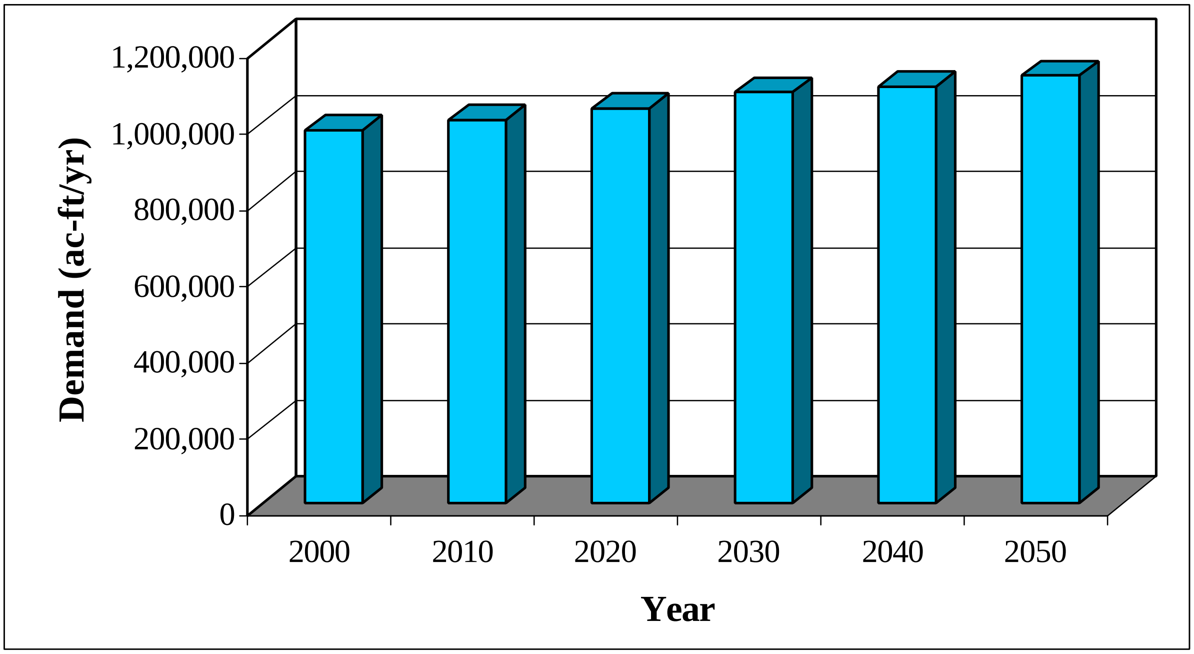


Figure 2.3: Year 2000 Total Water Demand by Type of Use

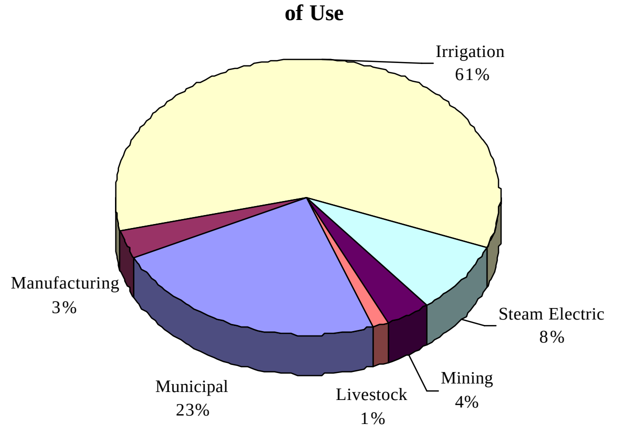
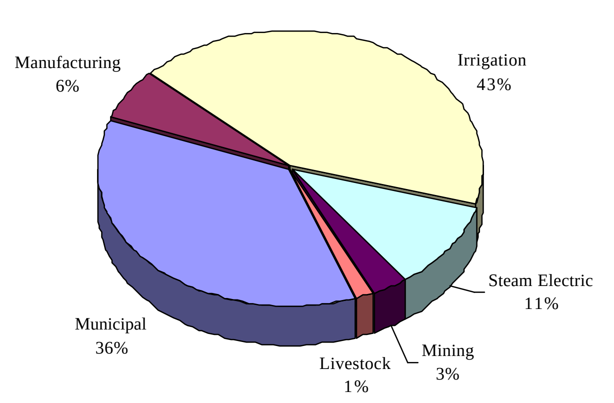


Figure 2.4: Year 2050 Total Water Demand by Type of Use



2.3.1 Municipal Water Demand Projections

2.3.1.1 Methodology

As with the population projections, the planning group generated the proposed municipal water demand projections by starting with the state default projections and making updates on the basis of better, more current information. The following procedure describes the methodology used for generating these projections:

1. ***Identify TWDB projected per capita use rate:*** Estimated per capita water use for the year 2000 under a "below normal rainfall" and "no conservation" scenario was identified. This value is based on historical per capita use values reported to the TWDB between 1982 and 1991.

2. ***Identify reported 1996 per capita water use rate:*** Using data provided by the TWDB, per capita water use for 1996 was calculated. This value was selected as a more recent measure of per capita use under "below normal rainfall" conditions, as drought conditions affected the entire region for much of 1996.

3. ***Select per capita water use rate:*** In order to provide a conservative starting point for revised municipal water demand projections, the greater of the 1996-reported per capita use and the TWDB projected per capita use was selected. For the great majority of cities and "County-Other" areas, the value selected was the TWDB per capita water use rate described in Step 1 above.

4. ***Apply "expected case" conservation:*** Projected per capita water savings due to "expected case" water conservation assumptions was applied to the per capita use values determined in the previous step to determine the proposed per capita use projections for the years 2000-2050. Expected case conservation includes water savings from three components: increases in plumbing efficiency due to new plumbing code, seasonal conservation due to water conservation programs, and other water savings including leak detection and water efficient washing machines and dishwashers.

5. ***Determine proposed municipal water demand projections:*** The proposed municipal water demand projections are the product of the proposed population projections and the proposed per capita projections described above.

2.3.1.2 Regional Municipal Water Demand Projections

Municipal water demand for the Lower Colorado Region is projected to increase by approximately 182,000 acre-feet per year over the 50-year planning period. While this is a significant increase in municipal water use over the planning period, this increase (approximately 80 %) is less than the increase in population over the same period (approximately 102 %). This is due to projected reductions in per capita water use associated with the adoption of various water conservation measures. Figure 2.5 and Table 2.4 present the projected municipal water demand by county for each of the 14 counties in the Lower Colorado Region.

As with population, the large majority of current and projected municipal water demand occurs in the Colorado River Basin (approximately 95 % in the year 2050). Table 2.5 presents these municipal water demand projections by river basin.

Figure 2.5: Lower Colorado Region Municipal Water Demand Projections

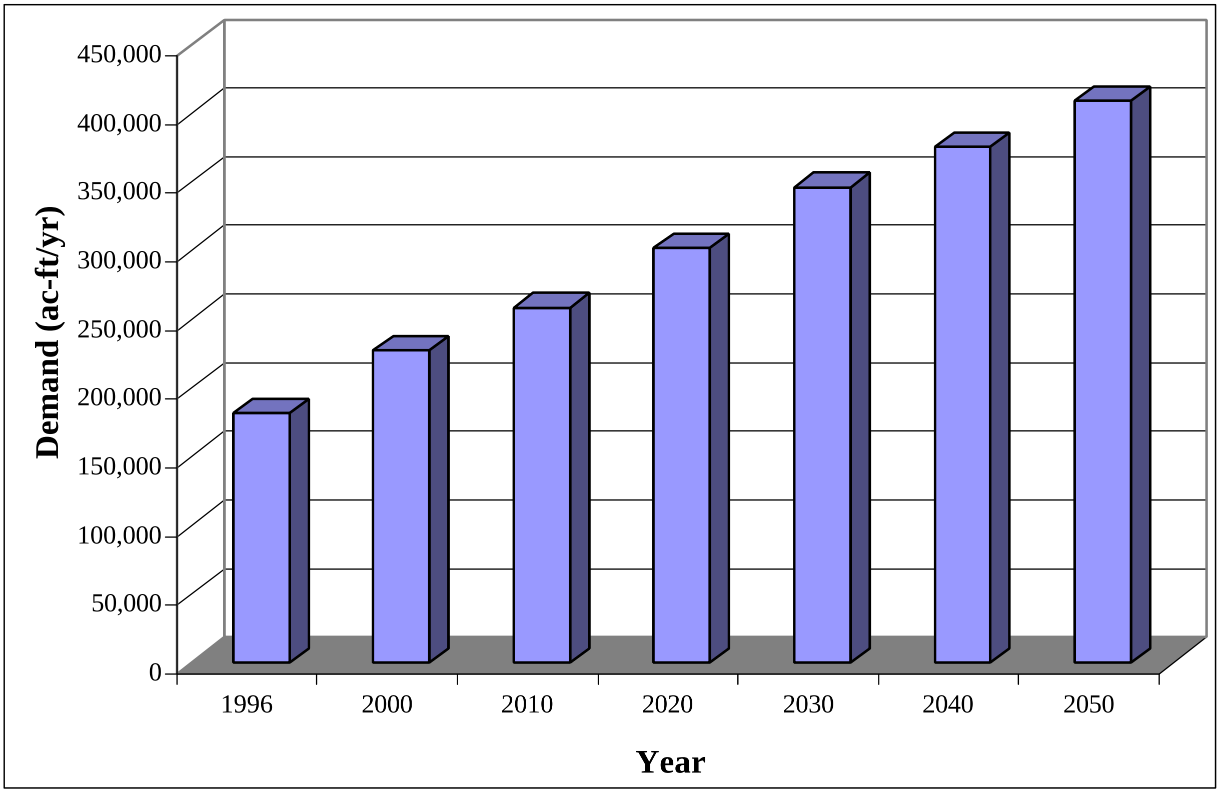


Table 2.4: Municipal Water Demand Projections by County (ac-ft/yr)

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	7,884	9,186	10,660	12,203	13,924	14,902	16,138
Blanco	1,078	1,362	1,495	1,633	1,764	1,812	1,823
Burnet	5,301	5,564	6,270	6,962	7,646	7,826	8,086
Colorado	3,082	3,286	3,283	3,318	3,390	3,433	3,523
Fayette	3,506	3,857	4,056	4,343	4,728	5,165	5,756
Gillespie	3,520	4,130	4,259	4,487	4,675	5,268	5,768
Hays (p)	2,991	3,421	4,667	5,571	6,807	8,249	9,231
Llano	2,852	3,067	3,020	3,103	3,086	3,140	3,393
Matagorda	5,460	6,072	6,363	6,649	7,200	7,777	8,606
Mills	936	999	964	941	933	914	916
San Saba	1,032	1,100	1,040	985	957	927	927
Travis	136,472	177,264	202,958	240,232	278,011	301,638	329,189
Wharton (p)	4,070	4,494	4,644	4,804	5,053	5,323	5,754
Williamson (p)	3,383	3,814	5,115	6,844	8,256	9,136	10,187
TOTAL	**181,567**	**227,616**	**258,794**	**302,075**	**346,430**	**375,510**	**409,297**

(p) Denotes that only the portion of the county in the Lower Colorado Region is considered.
** Municipal water demand projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Table 2.5: Municipal Water Demand Projections by River Basin (ac-ft/yr)

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	3,324	3,395	3,538	3,666	3,876	3,986	4,124
Brazos-Colorado	7,026	8,091	8,417	8,750	9,350	9,980	10,893
Colorado	166,973	211,746	242,278	284,914	328,129	356,151	388,450
Colorado-Lavaca	1,747	1,631	1,705	1,779	1,920	2,065	2,295
Guadalupe	1,109	1,258	1,330	1,406	1,507	1,577	1,641
Lavaca	1,388	1,496	1,526	1,560	1,648	1,751	1,894
TOTAL	**181,567**	**227,617**	**258,794**	**302,075**	**346,430**	**375,510**	**409,297**

2.3.2 Manufacturing Water Demand Projections

2.3.2.1 Methodology

For SB 1 regional water planning purposes, manufacturing water use is considered to be the cumulative water demand by county and river basin for all industries within specified industrial classifications (SIC) determined by the TWDB. Manufacturing water use projections that were developed by the TWDB and used in the 1997 State Water Plan are used as the default projections except where new information warranted a revision.

2.3.2.2 Regional Manufacturing Water Demand Projections

Annual manufacturing water demand for the Lower Colorado Region is projected to increase from 33,833 acre-feet in the year 2000 to 66,962 acre-feet per year in the year 2050. These demands are predominately from existing and future industries in Travis and Matagorda counties. The expected usage of manufacturing water rights that have already been purchased in Matagorda County is responsible for the large increase in manufacturing demand from the year 2000 to the year 2010. Figure 2.6 and Table 2.6 present the projected manufacturing water demand for each of county in the Lower Colorado Region.

Figure 2.6: Lower Colorado Region Manufacturing Water Demand Projections

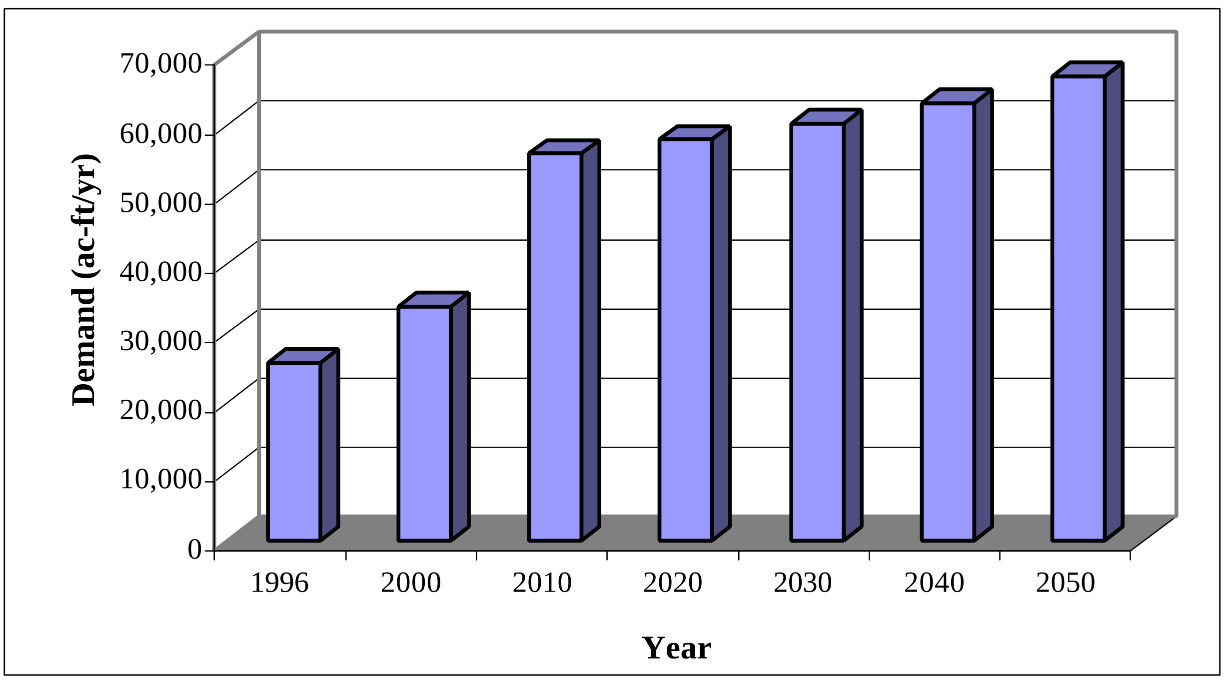


Table 2.6: Manufacturing Water Demand Projections by County (ac-ft/yr)

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	81	33	40	48	57	67	78
Blanco	0	0	0	0	0	0	0
Burnet	542	1,246	1,377	1,514	1,655	1,800	1,947
Colorado	176	1,150	1,224	1,297	1,369	1,438	1,508
Fayette	124	37	44	50	55	63	71
Gillespie	305	502	556	608	657	727	795
Hays (p)	395	288	340	389	435	478	523
Llano	2	0	0	0	0	0	0
Matagorda	10,536	13,022	32,532	32,715	32,835	33,352	33,849
Mills	1	0	0	0	0	0	0
San Saba	11	0	0	0	0	0	0
Travis	13,245	17,186	19,320	20,843	22,633	24,757	27,654
Wharton (p)	233	369	408	439	469	503	537
Williamson (p)	5	0	0	0	0	0	0
TOTAL	**25,656**	**33,833**	**55,841**	**57,903**	**60,165**	**63,185**	**66,962**

(p) Denotes that only the portion of the county in the Lower Colorado Region was considered.
** Manufacturing water demand projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Manufacturing water demand in the Lower Colorado Region is predominately in the Colorado and Brazos-Colorado River Basins. Table 2.7 presents these demands by river basin for the Lower Colorado Region.

Table 2.7: Manufacturing Water Demand Projections by River Basin (ac-ft/yr)

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	315	663	722	772	815	856	892
Brazos-Colorado	4,908	3,589	8,891	8,950	8,986	9,140	9,283
Colorado	20,189	29,405	46,013	47,946	50,109	52,908	56,476
Colorado-Lavaca	116	139	171	185	200	218	240
Guadalupe	4	0	0	0	0	0	0
Lavaca	124	37	44	50	55	63	71
TOTAL	**25,656**	**33,833**	**55,841**	**57,903**	**60,165**	**63,185**	**66,962**

2.3.3 Irrigation Water Demand Projections

2.3.3.1 Methodology

The irrigation water use projections that were developed by the TWDB and used in the 1997 State Water Plan were used as the default projections except in cases where better, more current information was submitted. The TWDB projections were determined with assistance from the Texas Agricultural Extension Service and they assume expected case water conservation practices with no reduction in Federal farm program subsidies.

2.3.3.2 Regional Irrigation Water Demand Projections

Irrigation water demand for the Lower Colorado Region is projected to decrease from 588,635 acre-feet in 2000 to 479,453 acre-feet per year in the year 2050. Irrigation water demand in the Lower Colorado Region is concentrated in Colorado, Matagorda, and Wharton counties and is largely used to meet irrigation needs for rice farming. Over the next 50 years a decrease in irrigation water demand is projected due to improvements in irrigation efficiency and reductions in irrigated acres due to forecasted unfavorable farming economics. Figure 2.7 and Table 2.8 present the projected irrigation water demands by county for the Lower Colorado Region.

Figure 2.7: Lower Colorado Region Irrigation Water Demand Projections

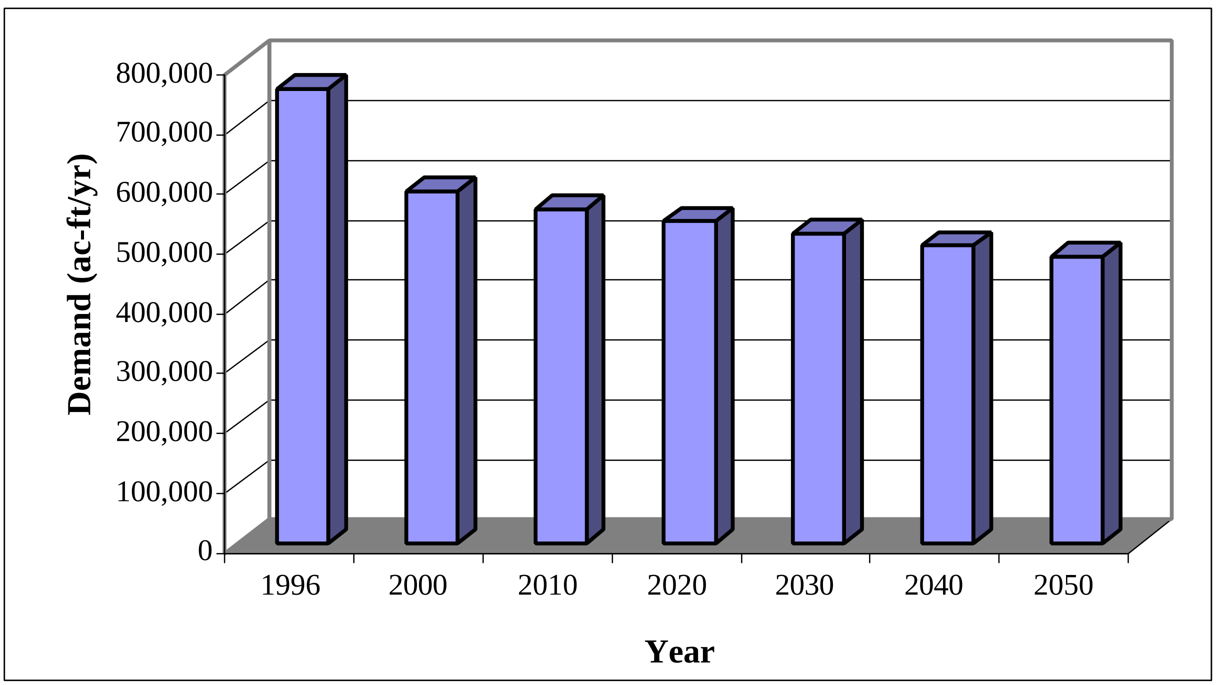


Table 2.8: Irrigation Water Demand Projections by County (ac-ft/yr)

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	738	563	491	429	374	327	285
Blanco	504	458	435	413	392	362	353
Burnet	213	295	290	285	280	275	271
Colorado	218,833	176,879	168,953	161,922	155,121	148,537	142,135
Fayette	608	375	351	329	308	288	270
Gillespie	3,720	1,184	1,169	1,154	1,139	1,124	1,110
Hays (p)	81	23	22	22	22	22	22
Llano	1,442	1,103	1,085	1,067	1,049	1,031	1,014
Matagorda	275,314	192,987	180,861	174,326	168,031	162,000	156,197
Mills	3,613	2,416	2,364	2,312	2,262	2,213	2,165
San Saba	3,245	5,549	5,369	5,196	5,028	4,866	4,708
Travis	1,165	736	677	622	572	526	484
Wharton (p)	250,417	206,067	197,171	190,119	183,317	176,760	170,439
Williamson (p)	0	0	0	0	0	0	0
TOTAL	**759,893**	**588,635**	**559,238**	**538,196**	**517,895**	**498,331**	**479,453**

(p) Denotes that only the portion of the county in the Lower Colorado Region was considered.
* *Irrigation water demand projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Because irrigation water demand is concentrated in the Lower Colorado Region's lower three counties, projected demand is greatest in the Brazos-Colorado and Colorado-Lavaca Coastal Basins. The Colorado and Lavaca River Basins also constitute a significant portion of irrigation water demand. Table 2.9 presents these projected irrigation water demands for the Lower Colorado Region.

Table 2.9: Irrigation Water Demand Projections by River Basin (ac-ft/yr)

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	396	31	27	24	21	18	16
Brazos-Colorado	353,917	251,385	238,748	229,983	221,532	213,394	205,530
Colorado	124,965	106,642	101,729	97,810	94,032	90,379	86,866
Colorado-Lavaca	157,896	126,164	118,975	114,727	110,630	106,700	102,926
Guadalupe	381	98	93	89	84	78	76
Lavaca	122,338	104,315	99,666	95,563	91,596	87,762	84,039
TOTAL	**759,893**	**588,635**	**559,238**	**538,196**	**517,895**	**498,331**	**479,453**

2.3.4 Steam Electric Water Demand Projections

2.3.4.1 Methodology

The steam electric water use projections that were developed by the TWDB and used on the 1997 State Water Plan were used as the default projections except where better, more current information indicated the need for revision.

2.3.4.2 Regional Steam Electric Water Demand Projections

Steam electric water demand is projected to increase from 81,000 acre-feet per year in the year 2000 to 118,500 acre-feet per year in the year 2050. Of the 14 counties in the Lower Colorado Region, only Bastrop, Fayette, Llano, Matagorda, and Travis counties have or are projected to have any steam-electric water demand. Figure 2.8 and Table 2.10 present the projected steam electric water demand by county for each of counties in the Lower Colorado Region.

Figure 2.8: Lower Colorado Region Steam Electric Water Demand Projections

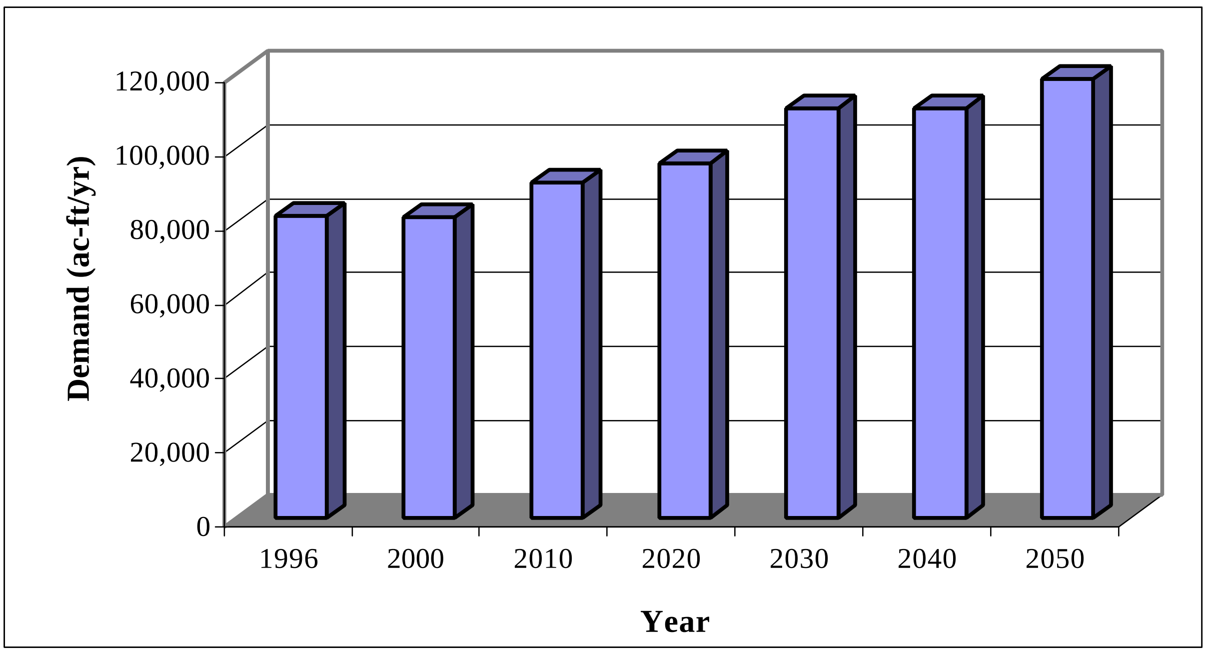


Table 2.10: Steam Electric Water Demand Projections by County (ac-ft/yr)

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	5,715	4,500	8,000	8,000	8,000	8,000	8,000
Blanco	0	0	0	0	0	0	0
Burnet	0	0	0	0	0	0	0
Colorado	0	0	0	0	0	0	0
Fayette	24,334	15,000	20,000	25,000	40,000	40,000	45,000
Gillespie	0	0	0	0	0	0	0
Hays (p)	0	0	0	0	0	0	0
Llano	1,976	1,000	2,000	2,000	2,000	2,000	2,000
Matagorda	40,362	47,000	47,000	47,000	47,000	47,000	47,000
Mills	0	0	0	0	0	0	0
San Saba	0	0	0	0	0	0	0
Travis	9,028	13,500	13,500	13,500	13,500	13,500	16,500
Wharton (p)	0	0	0	0	0	0	0
Williamson (p)	0	0	0	0	0	0	0
TOTAL	**81,415**	**81,000**	**90,500**	**95,500**	**110,500**	**110,500**	**118,500**

(p) Denotes that only the portion of the county in the Lower Colorado Region was considered.
** Steam electric water demand projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Since each of the Lower Colorado Region's steam-electric power generation facilities are located along the Colorado River, all of the projected steam-electric water demand is located within the Colorado River Basin. Table 2.11 shows the projected steam-electric water demand by basin.

Table 2.11: Steam-Electric Water Demand Projections by River Basin (ac-ft/yr)

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	0	0	0	0	0	0	0
Brazos-Colorado	0	0	0	0	0	0	0
Colorado	81,415	81,000	90,500	95,500	110,500	110,500	118,500
Colorado-Lavaca	0	0	0	0	0	0	0
Guadalupe	0	0	0	0	0	0	0
Lavaca	0	0	0	0	0	0	0
TOTAL	**81,415**	**81,000**	**90,500**	**95,500**	**110,500**	**110,500**	**118,500**

2.3.5 Mining Water Demand Projections

2.3.5.1 Methodology

The TWDB mining water use projections that were used in the 1997 State Water Plan were developed based on projected future production levels by mineral category and expected water use rates. These production projections were derived from state and national historic rates and were constrained by accessible mineral reserves in each region. The TWDB's 1997 State Water Plan mining water demand projections were used except where better, more current information was available.

2.3.5.2 Regional Mining Water Demand Projections

Mining water demand for the Lower Colorado Region is projected to experience a decline from the year 2000 to the year 2010. This decline is followed by a projected increase in mining water demand from 2010 to 2050. The effect is projected mining water demand that is relatively constant over the 50-year planning period. Table 2.12 presents the projected mining water demand by county for each of the counties in the Lower Colorado Region.

Figure 2.9: Lower Colorado Region Mining Water Demand Projections

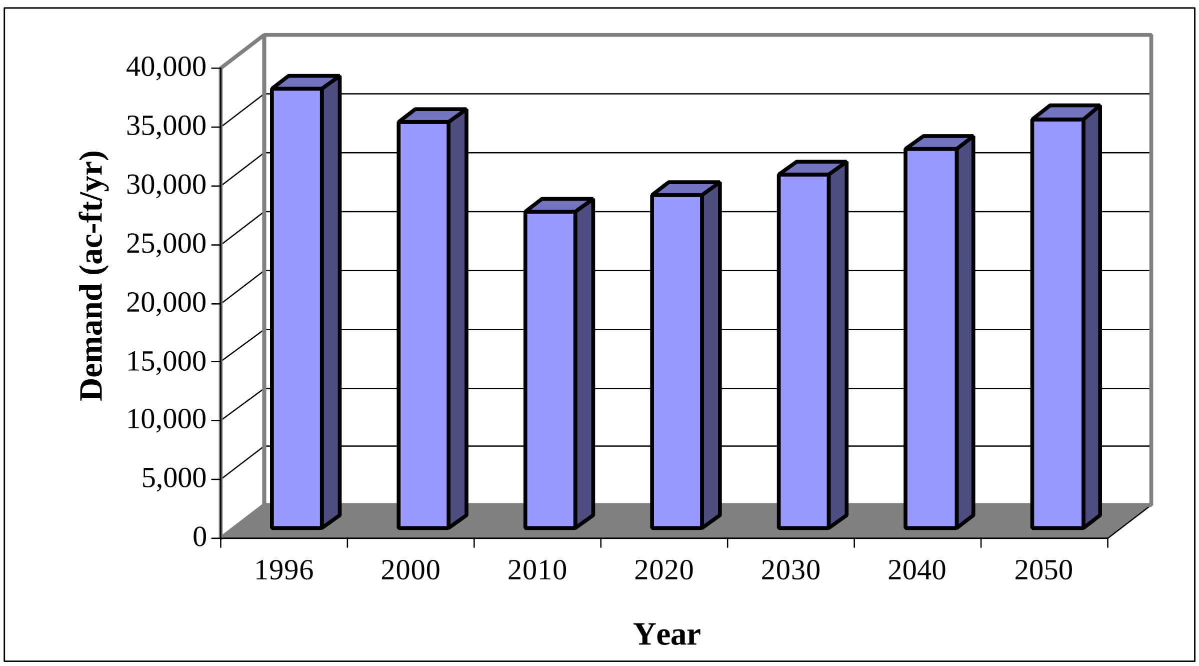


Table 2.12: Mining Water Demand Projections by County

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	28	56	46	38	33	34	43
Blanco	6	13	9	5	1	0	0
Burnet	1,359	1,013	987	1,006	1,028	1,058	1,091
Colorado	31,244	20,486	11,378	12,334	13,473	14,926	16,677
Fayette	46	92	64	46	17	7	3
Gillespie	9	5	3	1	0	0	0
Hays (p)	6	12	8	4	1	0	0
Llano	152	143	112	99	95	92	95
Matagorda	277	5,299	6,956	6,945	6,942	6,942	6,949
Mills	0	0	0	0	0	0	0
San Saba	163	172	133	124	123	122	126
Travis	3,312	4,880	4,746	5,246	5,791	6,407	7,116
Wharton (p)	809	2,370	2,428	2,500	2,567	2,641	2,720
Williamson (p)	6	13	9	5	1	0	0
TOTAL	**37,417**	**34,554**	**26,879**	**28,353**	**30,072**	**32,229**	**34,820**

(p) Denotes that only the portion of the county in the Lower Colorado Region was considered.
** Mining water demand projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Mining water demand for the Brazos, Colorado, Guadalupe, and Lavaca River basins is projected to decrease slightly over the 50-year planning period. Mining water demand for the Brazos-Colorado and the Colorado-Lavaca Coastal basins is projected to increase over this period. Table 2.13 presents the mining water demand projections by river basin.

Table 2.13: Mining Water Demand Projections by River Basin (ac-ft/yr)

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	71	111	80	53	28	20	20
Brazos-Colorado	979	2,627	2,645	2,653	2,626	2,670	2,750
Colorado	34,315	24,925	15,879	17,402	19,179	21,196	23,577
Colorado-Lavaca	281	5,158	6,806	6,839	6,915	6,942	6,949
Guadalupe	14	28	20	12	6	2	0
Lavaca	1,757	1,705	1,449	1,394	1,318	1,399	1,524
TOTAL	**37,417**	**34,554**	**26,879**	**28,353**	**30,072**	**32,229**	**34,820**

2.3.6 Livestock Water Demand Projections

2.3.6.1 Methodology

For all 14 counties in the Lower Colorado Region the livestock water use projections developed by the TWDB and used in the 1997 State Water Plan were used as the default projections. These projections were developed using Texas Agricultural Statistics Service projections of number of livestock by type and county and Texas Agricultural Extension Service estimates of water use rates by type of livestock.

2.3.6.2 Regional Livestock Water Demand Projections

Livestock water demand for the Lower Colorado Region represents approximately 1.5 percent of the total regional water demand. Livestock water demand is projected to remain constant over the 50-year planning period. This constant projected demand of 14,275 acre-feet is approximately 20 percent less than the value reported by the TWDB for 1996. Table 2.14 presents the projected livestock water demand by county for each of the 14 counties in the Lower Colorado Region.

Figure 2.10: Lower Colorado Region Livestock Water Demand Projections

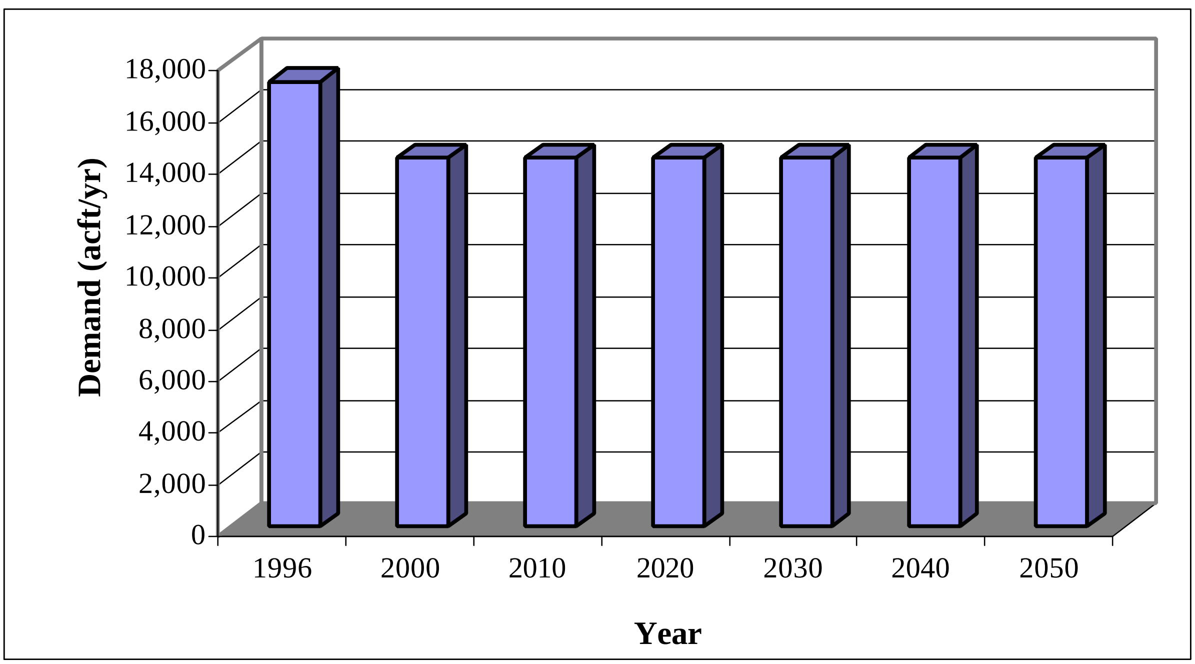


Table 2.14: Livestock Water Demand Projections by County (ac-ft/yr)

County	1996	2000	2010	2020	2030	2040	2050
Bastrop	1,760	1,525	1,525	1,525	1,525	1,525	1,525
Blanco	477	670	670	670	670	670	670
Burnet	652	794	794	794	794	794	794
Colorado	1,762	1,447	1,447	1,447	1,447	1,447	1,447
Fayette	1,895	2,621	2,621	2,621	2,621	2,621	2,621
Gillespie	1,836	1,294	1,294	1,294	1,294	1,294	1,294
Hays (p)	222	213	213	213	213	213	213
Llano	713	689	689	689	689	689	689
Matagorda	1,746	1,023	1,023	1,023	1,023	1,023	1,023
Mills	1,936	1,048	1,048	1,048	1,048	1,048	1,048
San Saba	1,743	1,200	1,200	1,200	1,200	1,200	1,200
Travis	1,778	906	906	906	906	906	906
Wharton (p)	680	844	844	844	844	844	844
Williamson (p)	2	1	1	1	1	1	1
TOTAL	**17,202**	**14,275**	**14,275**	**14,275**	**14,275**	**14,275**	**14,275**

(p) Denotes that only the portion of the county in the Lower Colorado Region was considered.
** Livestock water demand projections by city, county, and portion of a river basin within a county for each of the 14 counties in the Lower Colorado Region are provided in Appendix 2A.*

Livestock water demand in the Lower Colorado Region is located predominately in the Brazos and Brazos-Colorado River basins. Table 2.15 presents these demands by river basin for the Lower Colorado Region.

Table 2.15: Livestock Water Demand Projections by River Basin (ac-ft/yr)

River Basin	1996	2000	2010	2020	2030	2040	2050
Brazos	1,390	1,061	1,061	1,061	1,061	1,061	1,061
Brazos-Colorado	1,226	943	943	943	943	943	943
Colorado	12,349	10,227	10,227	10,227	10,227	10,227	10,227
Colorado-Lavaca	883	617	617	617	617	617	617
Guadalupe	426	458	458	458	458	458	458
Lavaca	928	969	969	969	969	969	969
TOTAL	**17,202**	**14,275**	**14,275**	**14,275**	**14,275**	**14,275**	**14,275**

2.4 ENVIRONMENTAL WATER DEMANDS [1]

Although not recognized by SB 1, an additional use category that is recognized by the Lower Colorado Regional Water Planning Group is environmental water demands. These demands are considered necessary to preserve the aquatic ecosystem within the region. In particular, environmental water demands have been determined to protect the habitat associated with the Colorado River and the Lavaca-Colorado estuary.

2.4.1 Instream Flow Requirements for the Colorado River

In 1992, the Lower Colorado River Authority (LCRA) completed an analysis of instream flow needs for the Colorado River. This analysis considered water quality and physical habitat requirements for the fish community native to the Colorado River. From this analysis, two sets of flow requirements were determined: critical and target flows.

Critical flow requirements are those necessary to maintain species population during severe drought conditions. From the LCRA analysis, it is recommended that a flow of at least 46 cubic feet per second (cfs) be maintained at the Austin gage at all times. If this flow should occur for an extended period of time, then operational releases will be made by the LCRA to temporary alleviate these low flow conditions. Specifically, if flow at the Austin gage is less than 65 cfs for 21 consecutive days, the LCRA will make operational releases from storage sufficient to maintain flow at the Austin gage of at least 200 cfs for two consecutive days. If this operational release condition persists for three consecutive cycles (69 days), then a minimum average daily flow of at least 75 cfs will be maintained for the next 30 days. In addition to the flow requirements at the Austin gage, a mean daily discharge of greater than 120 cfs will be maintained at the Bastrop gage. This minimum flow will be maintained at all times except March, April, and May (critical flow months) in order to provide adequate water quality conditions in the Colorado River.

Target flow requirements are those necessary to provide an optimal range of habitat complexity for the support of a well-balanced native aquatic community. These flow regimes (described in Table 2.16) are considered an optimal range and should be maintained whenever water resources are adequate. However, these flows should be classified as interruptible demand subject to curtailment during drought conditions.

Table 2.16: Instream Flow Requirements for the Colorado River

	Critical Flows (cfs)		Target Flows (cfs)		
Month	**Austin gage**	**Bastrop gage**	**Bastrop gage**	**Eagle Lake**	**Egypt**
January	46	120	370	300	240
February	46	120	430	340	280
March	46	500	560	500	360
April	46	500	600	500	390
May	46	500	1,030	820	670
June	46	120	830	660	540
July	46	120	370	300	240
August	46	120	240	200	160
September	46	120	400	320	260
October	46	120	470	380	310
November	46	120	370	290	240
December	46	120	340	270	220

[1] Taken from information provided by the LCRA.

In addition to critical and target flow requirements, periodic high flow conditions (or scouring flood flows) are needed to prevent siltation and dense macrophytic growth from occurring in the Colorado River.

2.4.2 Bay and Estuary Requirements

The Lavaca-Colorado estuary is the second largest estuary on the Texas Gulf Coast. This estuary, which is also known as the Matagorda Bay system, covers 352 square miles. While Matagorda Bay is the largest body of water, other major bays in the estuary system are Lavaca, East Matagorda, Keller, Carancahua, and Tres Palacios.

In 1985 the Texas Legislature directed the Texas Parks and Wildlife Department (TWPD) and the TWDB to continue studies of the estuaries to determine freshwater inflow requirements to be considered in the allocation of the state's water resources. These studies were to have been completed by December 31, 1989. However, due to a lack of funding, changes in priorities, and other factors, they have been delayed. To expedite the completion of this study, the LCRA entered into a cooperative agreement with TPWD, TWDB, and TNRCC in 1993. The LCRA agreed to modify existing methods used by the TPWD and TWDB and to apply those methods to compute alternative freshwater needs for the estuary.

The freshwater inflow needs are estimated by following a methodology that closely resembles the TPWD and TWDB study of the Guadalupe Estuary. The first major element in this process is the development of statistical relationships for the interactions between freshwater inflows and important indicators of estuarine ecosystem conditions. The parameters that were considered in this analysis are: salinity, species productivity, and nutrient inflows. The next major step in this process involves using the statistical functions to compute optimal monthly and seasonal freshwater inflow needs. This is accomplished using the TWDB's Texas Estuarine Mathematical Programming (TXEMP) Model. The TXEMP model estimates the freshwater inflow needs of an estuary by representing mathematically the varied and complex interactions between freshwater inflows and salinity, species productivity, and nutrient inflows. The third major element in the process of developing inflow needs is the simulation of the salinity conditions throughout the estuary using the TXBLEND model developed by the TWDB and modified by the LCRA. The application of the TWDB methodology and the resulting estimates of freshwater inflow needs are documented in "Freshwater Inflow Needs of the Matagorda Bay System" (LCRA: Martin, Q., D. Patek, J. and Gorham-Test, C., 1997).

The freshwater inflow needs for the estuarine ecosystem associated with Matagorda Bay system were estimated for two levels of inflow needs: target and critical. Target inflow needs were determined as the monthly and seasonal inflows that produced 98 percent of the maximum normalized population biomass for nine key estuarine finfish and shellfish species while maintaining specified salinity, population density, and nutrient inflow conditions. The critical inflow needs were determined by finding the minimum total annual inflow needed to keep salinity at or below 25 parts per thousand near the mouths of the Colorado and Lavaca Rivers. These inflow needs are termed critical since they provide a fishery sanctuary habitat during droughts.

Results of the needs analysis indicate that target inflows need to be approximately 2.0 million acre-feet per year. Of this, it is estimated that the Colorado River will need to contribute 1,033,100 acre-feet annually. For critical inflow needs approximately 171,000 acre-feet of the total required 287,400 acre-feet per year must come from the Colorado River. Both the target and critical monthly freshwater inflow needs from the Colorado River are indicated in Table 2.17.

Table 2.17: Colorado River Target & Critical Freshwater Inflow Needs for the Matagorda Bay System

Month	Target Needs (ac-ft)	Critical Needs (ac-ft)
January	44,100	14,260
February	45,300	14,260
March	129,100	14,260
April	150,700	14,260
May	162,200	14,260
June	159,300	14,260
July	107,000	14,260
August	59,400	14,260
September	38,800	14,260
October	47,400	14,260
November	44,400	14,260
December	45,200	14,260
Total	**1,033,100**	**171,100**

Total commitments of the Combined Firm Yield from the Highland Lakes for bays and estuaries (estuarine inflows) will be an average of 3,090 acre-feet (ac-ft) per year, with a maximum of 11,200 ac-ft in any one year; 19,700 ac-ft in any two consecutive years; 24,200 ac-ft in any three or four consecutive years; 28,200 ac-ft in any five consecutive years, and 30,900 ac-ft in any six to ten consecutive years.

2.5 MAJOR WATER PROVIDERS

The Lower Colorado Regional Water Planning Group has designated two entities as "major water providers"; the Lower Colorado River Authority (LCRA) and the City of Austin (COA). The COA is also a water customer of the LCRA, and together they supply a large portion of Region K's water needs. This distinction was made to satisfy the TWDB guidelines that require each RWPG to identify and designate "major water providers", which is defined by the TWDB as an entity "…which delivers and sells a significant amount of raw or treated water for municipal and/or manufacturing use on a wholesale and/or retail basis."

The intent of TWDB requirements is to ensure that there is an adequate future supply of water for each entity that receives all or a significant portion of its current water supply from another entity. This requires an analysis of projected water demands and currently available water supplies for the primary supplier, each of its wholesale customers, and all of the suppliers in the aggregate as a "system". For example, a city that serves both retail customers within its corporate limits as well as other nearby public water systems would need to have a supply source(s) that is adequate for the combined total of future retail water sales and future wholesale water sales. If there is a "system" deficit currently or in the future, then recommendations are to be included in the regional water plan with regard to strategies for meeting the "system" deficit.

2.5.1 City of Austin

The City of Austin provides water for municipal, manufacturing, and steam electric water uses. The City's existing service area covers portions of Travis and Williamson counties. The following table presents the aggregated demands of all users supplied by the City of Austin.

Table 2.18: Projected Water Demand for City of Austin Service Area (ac-ft/yr)

County/City	1996	2000	2010	2020	2030	2040	2050
Travis County							
Austin	107,515	152,755	176,336	210,137	243,955	265,274	289,942
Anderson Mill	28	35	34	34	33	32	34
Pflugerville	0	11,201	11,201	11,201	11,201	11,201	11,201
Rollingwood	372	454	508	588	675	726	793
Wells Branch	1,393	1,113	1,074	1,013	1,013	1,025	1,064
West Lake Hills	1,083	1,541	1,925	2,420	2,956	3,294	3,682
County-Other	10,605	3,885	4,009	4,373	4,742	4,935	5,211
Manufacturing	13,245	17,186	19,320	20,843	22,633	24,757	27,654
Steam Electric	9,028	13,500	13,500	13,500	13,500	13,500	16,500
Williamson County							
Austin	1,365	1,779	3,037	4,757	6,092	6,905	7,866
Anderson Mill	1,950	1,963	1,975	1,943	1,986	2,031	2,106
COA TOTAL	**146,584**	**205,412**	**232,919**	**270,809**	**308,786**	**333,680**	**366,053**

Travis County-Other water demand decreases between 1996 and 2000 due to annexations by the City of Austin, which correspondingly increases the City's water demand during that time period. In addition to the projected demands listed in the above table, the City of Austin currently has a water supply contract with the City of Round Rock to supply 6,161 acre-feet of water per year. This demand is not listed because this contract will expire in the year 2005.

The major water provider table indicates that the City of Austin is responsible for supplying a significant portion of the "County-Other" water in Travis County. This "County-Other" demand consists of demand for both individual service connections that are outside the city limits and demands for other public water systems served by the City of Austin. These wholesale water customers are listed in Appendix 2B.

The City of Austin has recently made commitments to provide treated water to the Spillar Ranch and Pfluger Ranch developments in Hays County, which will result in the expansion of the City's contractual water supply service area. This agreement (Mid-tex contract) is listed in Appendix 2C and corresponds to water supply option *Alternative H3* in Chapter 5.

2.5.2 Lower Colorado River Authority

The Lower Colorado River Authority (LCRA) supplies water for municipal, manufacturing, steam electric, and mining water uses. The LCRA currently supplies water to entities in Bastrop, Burnet, Colorado, Fayette, Llano, Matagorda, Travis, Wharton, and Williamson counties. Table 2.19 presents the projected water demands for each of the water user groups supplied by the LCRA.

Table 2.19: Projected Water Demand for the Lower Colorado River Authority (ac-ft/yr)

County/City	1996	2000	2010	2020	2030	2040	2050
Bastrop County							
Steam Electric	5,363	4,500	8,000	8,000	8,000	8,000	8,000
Burnet County							
Burnet	785	812	978	1,079	1,186	1,207	1,238
Cottonwood Shores	139	141	160	164	168	170	171
Granite Shoals	298	286	345	400	456	471	493
Marble Falls	1,275	1,372	1,624	1,874	2,105	2,177	2,264
County-Other	1,379	1,119	1,231	1,385	1,534	1,560	1,604
Colorado County							
Irrigation	146,716	139,260	129,790	123,460	114,310	111,590	104,700
Fayette County							
Steam Electric	18,813	15,000	20,000	25,000	40,000	40,000	45,000
Llano County							
Kingsland	540	522	502	472	463	472	493
County-Other	1,589	1,360	1,361	1,491	1,528	1,552	1,738
Steam Electric	1,606	1,000	2,000	2,000	2,000	2,000	2,000
Matagorda County							
Irrigation	178,491	166,770	158,810	151,610	146,090	140,230	136,020
Manufacturing	2,999	5,572	25,032	25,215	25,335	25,852	26,349
Mining	0	5,000	5,000	5,000	5,000	5,000	5,000
Steam Electric	38,905	47,000	47,000	47,000	47,000	47,000	47,000
Travis County							
Austin *	146,584	205,412	232,919	270,809	308,786	333,680	366,053
Jonestown	175	243	284	334	400	438	485
Lago Vista	849	1,821	2,128	2,519	2,995	3,291	3,630
Lakeway	1,042	1,587	1,868	2,240	2,693	2,964	3,287
County-Other	7,048	7,048	7,278	7,933	8,602	8,953	9,454
Wharton County							
Irrigation	127,031	120,360	112,150	107,010	102,110	96,740	91,320
Williamson County							
Cedar Park	5,400	16,100	16,100	16,100	16,100	16,100	16,100
Leander	0	4,000	4,000	4,000	4,000	4,000	4,000
LCRA TOTAL	**687,027**	**746,285**	**778,560**	**805,095**	**840,861**	**853,447**	**876,399**

* Note: The City of Austin is a water customer of the LCRA and is also a designated major water provider.

As with the City of Austin, the municipal "County-Other" water demands for Burnet, Llano, and Travis counties actually consist of water that is supplied to several smaller wholesale water customers. These LCRA wholesale water customers are listed in Appendix 2B.

The LCRA has recently made several commitments to entities in Bastrop, Travis, San Saba, and Williamson counties that will result in the expansion of the LCRA's contractual water supply service area. These include two irrigation agreements for Pecan Grove Plantation and the City of Cedar Park; and, five municipal agreements with the City of Cedar Park, Lakeway MUD, Brazos River Authority, Lometa, and WTCRWS. These agreements are listed in Appendix 2C and correspond to several water supply options in Chapter 5.

APPENDIX 2A

LCRWPG POPULATION & WATER DEMAND PROJECTIONS
(By County/River Basin; and City/County)

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 2B

LCRA AND COA WATER SUPPLY CUSTOMERS AND CONTRACTS

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 2C

ADDENDUM: RECENT LCRA AND COA WATER SUPPLY COMMITMENTS

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 2D

TWDB-REQUIRED TABLES
(Exhibit B Data Tables 1, 2, & 3)

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

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CHAPTER 3.0: IDENTIFICATION OF CURRENTLY AVAILABLE WATER SUPPLIES

A key task in the preparation of the Lower Colorado Regional Water Plan (LCRWP) is to determine the current available water supplies within the region. This information, when compared to the population and water demand projections, is critical in projecting water supply shortfalls and surpluses for the region, including the amount of shortfall, when a shortfall is expected to occur, and the county in which the shortfall is expected.

As stated in Chapter 2, the expected water demand in the Lower Colorado Regional Water Planning Area (LCRWPA) is projected to increase by approximately 15 percent while the population is projected to more than double over the next 50 years. Therefore, the need to accurately identify available water supplies is a critical component of developing the regional plan.

The following sections of the chapter describe the methodologies utilized in developing estimates of currently available water supplies for the LCRWPA. This chapter also presents regional water supplies by county, major providers of municipal water, and the six major water-use categories.

3.1 TWDB GUIDELINES FOR REVISIONS TO WATER SUPPLIES

The Texas Water Development Board (TWDB) has promulgated rules for SB 1 regional planning and has provided specific guidance to Regional Water Planning Groups (RWPGs) concerning the development of estimates of currently available water supplies. The specific guidance is provided in Exhibit B to the Regional Planning Contract and was further refined in subsequent memoranda issued by the TWDB. The guidance clearly indicates that the estimates of currently available water supply shall reflect water that is reliably available to the area during a repeat of the "drought-of-record" conditions. The specific methods used in determining the amount of currently available water vary depending upon whether it is a groundwater or surface water resource. A summary of TWDB guidelines and methods for estimating currently available water supply is presented below.

3.2 AVAILABLE WATER SUPPLIES TO THE LCRWPA

In accordance with the TWDB guidelines, five basic types of water supply exist within the LCRWPA. The types are as follows:

- Surface water supplies;
- Groundwater supplies;
- Supplies available through contractual arrangements;
- Supplies available through the operation of a system of reservoirs or other supplies; and,
- Reclaimed water.

Since supplies available through the last two categories originated from either surface or groundwater sources, all available water supplies will be discussed in terms of being either of surface water origin or groundwater origin. The following sections present information concerning the available supply of water within the LCRWPA. That is to say, water that is physically present within the LCRWPA, whether it is present due to natural circumstances, or it is present as a result of facilities constructed by one or more water users within the LCRWPA.

3.2.1 Surface Water Supplies

Surface water supplies include any water resource where water is obtained directly from a surface water body. This would include rivers, streams, creeks, lakes, ponds, and tanks. In the State of Texas, all water contained in water bodies defined as being "Waters of the State" belongs to the State. The State grants individuals, municipalities, and industries the right to divert and use this water through water rights permits. Water rights are considered property rights and can be bought, sold, or transferred with state approval. These permits are issued based on the concept of prior appropriation, or "first-in-time, first-in-right." Water rights issued by the State generally fall into two major categories - run-of-river rights and stored water rights:

- Run-of-river rights allow diversions of water directly from a water body as long as there is water in the stream and that water is not needed to meet a senior downstream water right. Run-of-river rights are greatly impacted by drought conditions, particularly in the upper portions of a river basin.
- Stored water rights allow the impoundment of water by a permittee in a reservoir. Water can be held for storage as long as the inflow is not needed to meet a senior downstream water right. Water stored in the reservoir can be withdrawn by the permittee at a later date to meet water demands. The storage of water in a reservoir gives the permittee a buffer against drought conditions.

A list of active water rights within the LCRWPA is contained in Appendix 3A.

In addition to the water rights permits issued by the State, individual landowners are allowed to use surface waters generated from their land without a specific permit. Landowners are allowed to construct impoundments with up to 200 acre-feet (ac-ft) of storage for agricultural purposes. These types of water sources are generally referred to as "Local Supply Sources." Individuals with land along a flowing water body can also divert water for domestic and livestock uses without a permit.

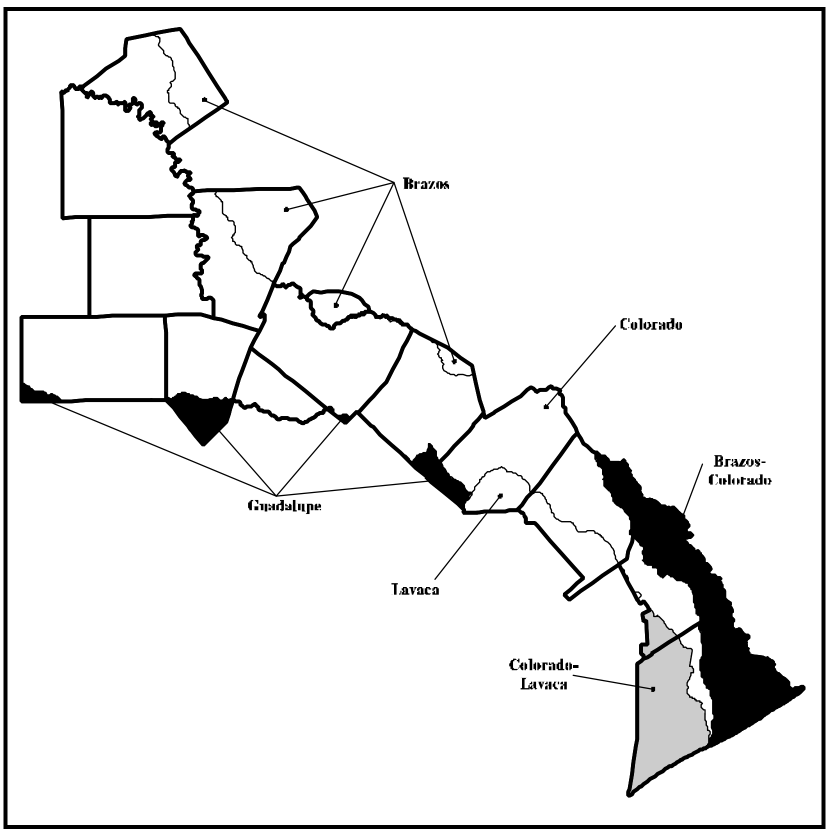
The TWDB guidance requires that the amount of surface water available from each source be determined with the following assumptions:

- Water availability must be estimated based on a "firm yield" analysis. For a reservoir system this analysis would produce the average annual withdrawals available during a repeat of the "drought of record" considering the long-term storage capabilities, projected inflows, and evaporation. For water rights based solely on run-of-river, the "drought of record" corresponds to the driest period on record. Without available storage, water is no longer available if the river goes dry.
- Water availability must be based on the assumption that all senior water rights in the basin are being fully utilized. That is, water user groups can not depend on "borrowing" water from downstream water rights holders in the future, even if the demand projections for downstream users is less than their water rights.

- Water availability is also based on the infrastructure that is in place. For example, water would not be considered to be available from a reservoir if a user still needed to construct the water intake and pipeline to convey the water from the reservoir to the area of need.

The LCRWPA traverses six different river basins, including the Brazos, Brazos-Colorado Coastal, Colorado, Colorado-Lavaca Coastal, Lavaca, and Guadalupe River basins. Figure 3.1 illustrates the location of each of these basins. The following sections discuss the available water sources in each river basin within the LCRWPA.

Figure 3.1 River Basins Within the LCRWPA (Region K)



3.2.1.1 Colorado River Basin

The majority of the LCRWPA is contained in the Colorado River Basin. The primary sources of water within this basin are the Highland Lakes and run-of-river water from the Colorado. However, several water user groups obtain water from tributaries or off-channel ponds.

3.2.1.1.1 Highland Lakes System

The Highland Lakes System is comprised of two major water storage reservoirs - Lakes Buchanan and Travis. These lakes are owned and operated by the LCRA. In addition, the system contains three intermediary lakes owned and operated by the LCRA – Inks Lake, Lake LBJ, and Lake Marble Falls. Lake Austin, the last in the Highland Lakes System, is owned by the City of Austin and is operated by the LCRA through an agreement.

The LCRA operates the Highland Lakes as a system to provide a reliable source of water to downstream customers. The LCRA developed a “Water Management Plan for the Lower Colorado River Basin” in response to requirements contained in a final order of adjudication of water rights to the LCRA. The Water Management Plan was originally adopted in 1989 and has been amended several times, most recently in March 1999. The Water Management Plan contains a detailed analysis of the water availability in the Colorado Basin during a repeat of the drought of record. The Water Management Plan also contains a management strategy for delivering water to customers during a drought in a manner that will make best use of the available water resources.

The firm yield of the Highland Lakes System was determined by modeling the Colorado River. The model developed by the LCRA for the Water Management Plan took the following factors into account:

- The hydrologic conditions in the 1941-1965 period are repeated;
- Downstream, senior water rights are being fully utilized during this period. The water rights in the Lower Colorado Region are included in Appendix 3A;
- The LCRA cannot impose its priority rights for Lakes Buchanan and Travis against any upstream, junior water right with a priority date senior to November 1, 1987;
- Historical net evaporation rates for the period of 1941 through 1965;
- Downstream water demands were assumed to be met with inflows to the river below the Highland Lakes, to the extent possible;
- Channel losses for water passed through the Highland Lakes to meet downstream, senior water rights; and,
- The firm yield of the Highland Lakes is reduced by 90,546 ac-ft/yr due to the agreement with the Colorado River Municipal Water District and the operation of the Owen Ivie Reservoir.

The resulting total firm yield for the Highland Lakes System is 445,766 ac-ft per year.

3.2.1.1.2 Minor Reservoirs

Several smaller reservoirs in the LCRWPA are also located within the Colorado River Basin. Estimates for the firm yield of these smaller reservoirs are based on the information provided by the TWDB for the 1997 State Water Plan with the following exceptions.

- The **City of Goldthwaite** owns and operates a two-reservoir system as part of its water supply facilities. The reservoirs include a small reservoir with a capacity of 40 ac-ft adjacent to the river and a larger reservoir with a capacity of 200 ac-ft, which is located off-channel. The city pumps water from the Colorado River into the smaller reservoir and then pumps it into the larger reservoir, from which water is drawn for treatment.

The size of the reservoirs are relatively small in comparison to the city's water demand, which is projected to decline from approximately 580 ac-ft in the year 2000 to 530 ac-ft in the year 2050. Based on the limited storage available, the firm yields of the reservoirs are dependent upon continued river flows throughout the year. It is estimated that the available storage would be depleted within four months once the river ceases flowing.

Stream gaging data are not available for the Colorado River at this location. The nearest downstream gage is located on the Colorado River near San Saba, Texas. This gage is also downstream of the San Saba River, which is a major tributary to the Colorado River. An attempt was made to estimate the stream flow at the Goldthwaite diversion point by using drainage area ratios. The results of this analysis indicate that the Colorado River continued flowing during the driest year on record, which for the San Saba gage occurred in 1984. However, anecdotal information provided by the City of Goldthwaite indicates that the river has ceased flowing on numerous occasions over the past several years. Most notably in 1996 when the City was unable to pump any water from the river during the months of May, June, and July.

Based on the anecdotal information provided by the City of Goldthwaite, the estimate of stream flows using drainage area ratios was discarded. Additional information concerning actual stream flows and or spring flows downstream of Goldthwaite is required to accurately determine the firm yield of the Goldthwaite system. Based on the lack of data and the anecdotal information provided, it is believed that the Goldthwaite system is not capable of supplying the City's full demands during a repeat of the drought of record. However, it is not possible to quantify the actual size of the deficit based on the available information. Therefore, it will be assumed that the Goldthwaite reservoir system has a firm yield of 400 ac-ft per year.

- The **City of Llano** owns and operates two reservoirs on the Llano River: City Lake and City Park Lake, both of which are small channel dams. The two reservoirs were estimated to have a combined capacity of 503 ac-ft in 1988. This is significantly less than the original design capacity of 700 ac-ft. The decreased capacity is due to sedimentation rates in the two reservoirs. A firm yield analysis of the Llano system was completed by Freese & Nichols, Inc. in a 1988 study. The firm yield at that time was estimated to be 400 ac-ft. The City recently initiated a program to remove sediment from these reservoirs in an attempt to restore some of the capacity.

- **Lake Walter E. Long (Decker Lake)** is owned and operated by the City of Austin. The lake is formed by a dam on Decker Creek, which is a tributary to the Colorado River in Travis County. The City of Austin uses Decker to supply cooling water for an electrical generating plant. The TWDB estimated that the firm yield of this lake due to inflows along Decker Creek is 1,000 ac-ft. The City of Austin supplements the water supply to Decker by pumping water from the Colorado River based on run-of-river rights.

- **Lake Bastrop** is owned and operated by the LCRA. The lake is formed by a dam on Spicer Creek, which is a tributary to Piney Creek and the Colorado River in Bastrop County. The LCRA uses water from Lake Bastrop for cooling purposes at its Sam Gideon Power Generating Station. The TWDB has estimated that the firm yield of Lake Bastrop due to inflows from Spicer Creek is 1,000 ac-ft per year. The LCRA supplements the water supply at this lake by pumping water into the Lake from the Colorado River. The water pumped into the Lake is stored water from the Highland Lakes.

- **Lake Fayette** is owned and operated by the LCRA. The lake is formed by a dam on Cedar Creek, which is a tributary to the Colorado River in Fayette County. The LCRA uses water from Lake Fayette for cooling purposes at the Fayette Power Project. The TWDB has estimated that the firm yield of Lake Fayette due to inflows from Cedar Creek is 1,400 ac-ft per year. The LCRA supplements the water supply at this lake by pumping water into the reservoir from the Colorado River. A portion of the water pumped is run-of-river water rights held by the City of Austin, which is a participant in the Fayette Power Project. The remainder of the water pumped into the reservoir is stored water from the Highland Lakes.

The estimated firm yields for all reservoirs within the Colorado River Basin are presented in Table 3.1.

Table 3.1: Reservoir Yields in the Colorado Basin (ac-ft/yr)

TWDB Reservoir Number	Reservoir Name	Year 2000 Firm Yield	Year 2050 Firm Yield	Data Source
14350	City of Goldthwaite	400	400	Anecdotal Inform.
140B0	Highland Lakes System	445,766	445,766	LCRA Mgmt Plan
14520	City of Llano	400	400	F & N, 1988
14250	Walter E. Long (Decker)	1,000	1,000	TWDB
14260	Lake Bastrop	1,000	1,000	TWDB
14490	Lake Fayette	1,400	1,400	TWDB
	Totals	**449,966**	**449,966**	

3.2.1.1.3 Run-of-River Water

Historically, the State of Texas has granted run-of-river rights through an adjudication process that considered historical uses. As a result, run-of-river rights can be granted for more water than is available in a river during drought conditions. The use of water during drought conditions is controlled by the priority system, with the oldest water rights having first call on whatever water is in the river. As part of the Water Management Plan development, the LCRA developed a hydrologic model of the Colorado River. This model estimates the amount of water available at various locations along the river by dividing the river into five reaches. The water available in each reach and conveyed downstream to the next reach, is calculated based on the following factors:

- Senior downstream water rights are assumed to be fully utilized;
- Intervening inflows are added to the river for each reach based on a repeat of the drought of record;
- Channel losses are calculated for each reach of the river;
- Return flows from irrigation or wastewater treatment plants are added to each reach; and,
- Inflows to the Highland Lakes are passed through the lakes to the extent that the water is needed to satisfy senior water rights downstream.

The results of this analysis for major run-of-river rights holders are presented in Table 3.2. The water availability presented in the table for most run-of-river rights is based on the amount of water that would be available during the driest year that occurred in the drought of record. The water availability for the City of Austin water rights is based on the average water availability during the 10-year drought-of-record period. This average availability was used since the City of Austin has contracted with LCRA to supply stored water to firm up its water rights during drought conditions.

Table 3.2: Major Run-of-the-River Rights in the Colorado Basin (ac-ft/yr)

TWDB Source Identifier	Water Rights Holder	Maximum Permitted Diversion	Priority Date	Water Availability During Drought of Record [1]	
				2000	2050
3461405434C	LCRA - Garwood	133,000	Nov 1, 1900	50,000	50,000
3461405475	LCRA - Lakeside	131,250	Jan 4, 1901	0	0
3461405476A	LCRA - Gulf Coast	262,500	Dec 1, 1900	0	0
3461405475	LCRA - Pierce Ranch	55,000	Sep 1, 1901	0	0
3461405477A	Lacy Armour - Pierce	55,000	Sep 1, 1901	0	0
3461405471A	City of Austin - (mun.)	272,403	Jun 30, 1913	165,313	165,313
3461405471A	City of Austin - (stm.)	24,000	Jun 30, 1913	4,547	4,547
3461405489A	City of Austin - (mun.)	20,300	Aug 20, 1945	7,360	7,360
3461405489A	City of Austin - (stm.)	16,156	Aug 20, 1945	2,612	2,612
3461405437	HL&P	102,000	Jun 10, 1974	41,320	41,320
3461405434B	City of Corpus Christi	35,000	Nov 1, 1900	26,132	26,132
	Totals	**1,106,609**		**297,284**	**297,284**

Data Source: Response Model results provided by LCRA.

[1] Downstream water availability reflects minimum year during the drought and does not include City of Austin return flows.

3.2.1.1.4 Local Surface Water Supplies

The final category of available surface water is local supplies. This category includes small diversions from the river or tributaries to the river, as well as stock ponds located on individual's property. Information concerning these supplies is limited. As a result, the information available from the TWDB was used as an initial estimate of the water availability. However, in several instances the availability numbers were increased to match the projected demands with the assumption that the supply and demand for local water will be self-limiting. The results of this process are presented in Table 3.3 and are organized by county.

Table 3.3: Other Surface Water Supply Sources in the Colorado Basin (ac-ft/yr)

TWDB Source Identifier	Source Name	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
11996	Irrig. - Bastrop Co.	786	786	786	786	786	786
14997	Livestock - basinwide	6,262	6,262	6,262	6,262	6,262	6,262
14999	Other - basinwide	27,642	19,282	20,890	22,717	24,883	27,470
16996	Irrig. - Blanco Co.	67	67	67	67	67	67
27996	Irrig. - Burnet Co.	276	276	276	276	276	276
45996	Irrig. - Colorado Co.	3,000	3,000	3,000	3,000	3,000	3,000
75996	Irrig. - Fayette Co.	534	534	534	534	534	534
86996	Irrig. - Gillespie Co.	880	880	880	880	880	880
105996	Irrig. - Hays Co.	41	41	41	41	41	41
150996	Irrig. - Llano Co.	440	440	440	440	440	440
161996	Irrig. - Matagorda Co.	900	900	900	900	900	900
167996	Irrig. - Mills Co.	2,378	2,378	2,378	2,378	2,378	2,378
206996	Irrig. - San Saba Co.	8,800	8,800	8,800	8,800	8,800	8,800
227996	Irrig. - Travis Co.	880	880	880	880	880	880
241996	Irrig. - Wharton Co.	7,650	7,650	7,650	7,650	7,650	7,650
	Totals	**60,536**	**52,176**	**53,784**	**55,611**	**57,777**	**60,364**

3.2.1.2 Brazos River Basin

A portion of the LCRWPA is located within the Brazos River Basin. This area is limited to portions of Bastrop, Burnet, Fayette, Mills, Travis, and Williamson counties. Surface water sources for these areas are limited to local sources. There are no major reservoirs within the LCRWPA portion of the Brazos River Basin. However, a portion of the City of Round Rock is within the LCRWPA portion of the Brazos Basin. The City of Round Rock obtains a portion of its water from Lake Georgetown in the Brazos Basin. It is assumed that a pro-rata share of this water will be used by the portion of Round Rock that is within Travis County. Table 3.4 contains a summary of the surface water available to the LCRWPA from the Brazos River Basin.

Table 3.4: Surface Water Supply Sources in the Brazos River Basin (ac-ft/yr)

TWDB Source Identifier	Source Name	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
12997	Livestock - basinwide	566	566	566	566	566	566
	Totals	**566**	**566**	**566**	**566**	**566**	**566**

3.2.1.3 Brazos-Colorado Coastal Basin

A portion of the LCRWPA is located within the Brazos-Colorado Coastal Basin. This area is limited to portions of Colorado, Matagorda, and Wharton counties. Surface water sources for these areas are limited to local sources. There are no major reservoirs within the LCRWPA and there are no water user groups

(WUGs) with rights to water from reservoirs in the Brazos-Colorado Coastal Basin. Table 3.5 contains a summary of the surface water available to the LCRWPA from the Brazos-Colorado Coastal Basin.

Table 3.5: Surface Water Supply Sources in the Brazos-Colorado Coastal Basin (ac-ft/yr)

TWDB Source Identifier	Source Name	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
13997	Livestock - basinwide	394	394	394	394	394	394
13999	Other - basinwide	1,655	1,696	1,746	1,793	1,844	1,900
161996	Irrig. - Matagorda Co.	4,000	4,000	4,000	4,000	4,000	4,000
241996	Irrig. - Wharton Co.	2,000	2,000	2,000	2,000	2,000	2,000
	Totals	**8,049**	**8,090**	**8,140**	**8,187**	**8,238**	**8,294**

3.2.1.4 Colorado-Lavaca Coastal Basin

A portion of the LCRWPA is located within the Colorado-Lavaca Coastal Basin. This area is limited to portions of Matagorda and Wharton counties. Surface water sources for these areas are limited to local sources. There are no major reservoirs within the LCRWPA and there are no WUGs with rights to water from reservoirs in the Colorado-Lavaca Coastal Basin. Table 3.6 contains a summary of the surface water available to the LCRWPA from the Colorado-Lavaca Coastal Basin.

Table 3.6: Surface Water Supply Sources in the Colorado-Lavaca Coastal Basin (ac-ft/yr)

TWDB Source Identifier	Source Name	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
15997	Livestock - basinwide	289	289	289	289	289	289
161996	Irrig. - Matagorda Co.	4,000	4,000	4,000	4,000	4,000	4,000
	Totals	**4,289**	**4,289**	**4,289**	**4,289**	**4,289**	**4,289**

3.2.1.5 Lavaca River Basin

A portion of the LCRWPA is located within the Lavaca River Basin. This area is limited to portions of Colorado and Fayette counties. Surface water sources for these areas are limited to local sources. There are no major reservoirs within the LCRWPA and there are no WUGs with rights to water from reservoirs in the Lavaca River Basin. Table 3.7 contains a summary of the surface water available to the LCRWPA from the Lavaca River Basin.

Table 3.7: Surface Water Supply Sources in the Lavaca River Basin (ac-ft/yr)

TWDB Source Identifier	Source Name	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
16997	Livestock - basinwide	649	649	649	649	649	649
45996	Irrig. - Colorado Co.	4,002	4,002	4,002	4,002	4,002	4,002
75996	Irrig. - Fayette Co.	20	20	20	20	20	20
	Totals	**4,671**	**4,671**	**4,671**	**4,671**	**4,671**	**4,671**

3.2.1.6 Guadalupe River Basin

A portion of the LCRWPA is located within the Guadalupe River Basin. This area is limited to portions of Bastrop, Blanco, Fayette, Hays, and Travis counties. Most of the surface water sources for these areas are limited to local sources. There are no major reservoirs within the LCRWPA and there are no WUGs with rights to water from reservoirs in the Guadalupe River Basin.

However, the City of Blanco owns and operates two, small, on-channel reservoirs on the Blanco River. The two reservoirs have a combined storage capacity of 168 ac-ft. The LCRA conducted a firm yield analysis of the two reservoirs in 1988. The analysis was based on stream gage data located at Wimberley, Texas, which is approximately 43 river miles downstream of the Blanco diversion. Stream flows at the Blanco diversion were estimated using a drainage area ratio. Based on this methodology, it was determined that the Blanco River would not cease flowing during a repeat of the drought of record and therefore, the firm yield of the reservoir system was estimated to be 925 ac-ft per year.

Anecdotal information provided by the City of Blanco indicates that the Blanco River has ceased flowing in the past, most notably during the summer of 1996. Information provided by the City of Blanco indicates that flow in the Blanco River ceased for a three-month period during that summer. The relatively small storage capacity of the two reservoirs will not sustain the projected demands from the City of Blanco for more than a four-month period when the river has ceased flowing.

Based on the anecdotal information presented, it appears as though the drainage area ratio analysis conducted in 1988 over-estimated the amount of water available to the City of Blanco. Unfortunately, better data are not available to reassess the water supply available to the City of Blanco. However, based on the anecdotal information it is believed that the available water supply is not sufficient to meet the City of Blanco’s current water demands during a repeat of the drought of record. Therefore, the available supply of water has been set to 300 ac-ft for planning purposes.

Table 3.8 contains a summary of the surface water available to the LCRWPA from the Guadalupe River Basin.

Table 3.8: Surface Water Supply Sources in the Guadalupe River Basin (ac-ft/yr)

TWDB Source Identifier	Source Name	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
16996	Irrig. - Blanco Co.	50	47	49	43	40	39
18997	Livestock - basinwide	298	298	298	298	298	298
18120	Blanco Reservoirs	300	300	300	300	300	300
	Totals	**648**	**645**	**647**	**641**	**638**	**637**

3.2.2 Groundwater Supplies

The groundwater resources located in the region have been traditionally divided into those aquifers that yield large quantities of water over a relatively large area (major aquifers) and those aquifers yielding smaller quantities of water over smaller areas (minor aquifers). In the LCRWPA there are five major aquifers and five minor aquifers that provide usable groundwater supplies. The following discussion of the groundwater resources of the LCRWPA is divided into these two categories.

3.2.2.1 Major Aquifers

The major aquifers in the Lower Colorado LCRWPA are the: Edwards-Trinity (Plateau), Trinity Group, Edwards, Carrizo, and the Gulf Coast. These five aquifers provide a significant component of the water supply used within the LCRWPA beyond that provided by the Colorado River.

Most of the cities in the planning region draw their water supply from one of these five aquifers. Due to the differences in each aquifer and the amount of information available for each aquifer, different approaches were applied to determine the water available from each aquifer. The technical approach applied to a specific aquifer will be described in the section pertaining to each of the aquifers below.

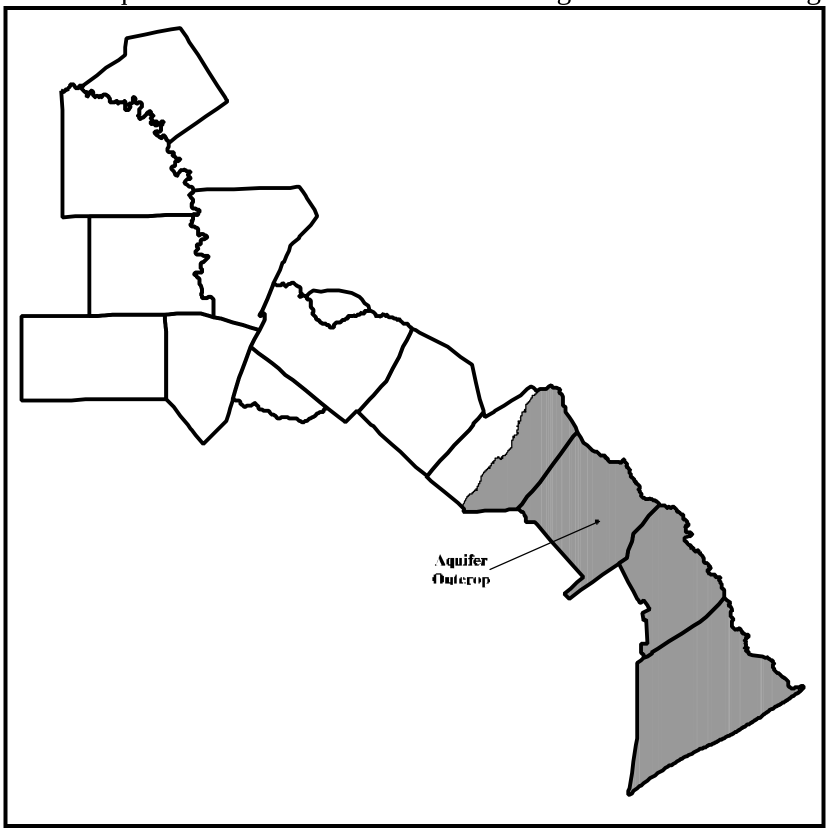
3.2.2.1.1 Gulf Coast Aquifer

Location and Use

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.

Groundwater use from the Gulf Coast aquifer within the LCRWPA occurs in Colorado, Fayette, Matagorda, and Wharton counties. TWDB records indicate that total groundwater pumpage from the Gulf Coast aquifer in the study area was 133,017 ac-ft for the year 1997. Municipal uses accounted for 11 percent of the total, manufacturing accounted for 4 percent, power plants accounted for 1 percent, mining accounted for 2 percent, irrigation accounted for 79 percent, and livestock accounted for 2 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.2.

Figure 3.2: Gulf Coast Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The Gulf Coast aquifer consists of complex interbedded clays, silts, sands, and gravels, which are hydrologically connected to form a large, leaky artesian aquifer system. The system is comprised of two major components in the study area. The Burkeville confining layer defines the bottom of the Evangeline aquifer, which is contained within the Fleming and Goliad sands. The Chicot aquifer, or upper component of the Gulf Coast aquifer system, consists of the Lissie, Willis, and Beaumont formations; and overlying alluvial deposits. Maximum total sand thickness ranges from about 700 feet in the south to 1,300 feet in the northern extent.

Water Quality

Water quality is generally good in the shallower portion of the aquifer. Groundwater containing less than 500 mg/l dissolved solids is usually encountered to a maximum depth of 3,200 feet in the aquifer from the San Antonio River basin northeastward to Louisiana.

Availability

The LCRWPG has established a policy for determining the availability of groundwater within the LCRWPA. The policy indicates that the long-term mining of groundwater within the region is not consistent with the LCRWPG's sustainability goals. Therefore, in determining the availability of water from aquifers within the region, the average recharge rate for the aquifer is typically used. However, the nature of the Gulf Coast aquifer makes it very difficult to determine the average recharge rate. As a result, the water availability from the Gulf Coast aquifer is established based on an estimate of maximum usage in the year 2050 by WUGs that are currently using the aquifer as a source plus the average water use for future conjunctive water use at the Lakeside, Gulf Coast, and Pierce Ranch Irrigation Districts. Based on these criteria, the water availability for the Gulf Coast aquifer was defined as presented in Table 3.9.

Table 3.9: Water Availability in the Gulf Coast Aquifer (ac-ft/yr)

County	**Supply Basin**	**Year 2000 Supply**	**Year 2010 Supply**	**Year 2020 Supply**	**Year 2030 Supply**	**Year 2040 Supply**	**Year 2050 Supply**
Colorado	Brazos-Colorado	11,506	11,506	11,506	11,506	11,506	11,506
Colorado	Colorado	17,436	17,436	17,436	17,436	17,436	17,436
Colorado	Lavaca	18,915	18,915	18,915	18,915	18,915	18,915
	County Total	***47,857***	***47,857***	***47,857***	***47,857***	***47,857***	***47,857***
Fayette	Brazos	65	65	65	65	65	65
Fayette	Colorado	3,300	3,300	3,300	3,300	3,300	3,300
Fayette	Guadalupe	144	144	144	144	144	144
Fayette	Lavaca	5,188	5,188	5,188	5,188	5,188	5,188
	County Total	***8,697***	***8,697***	***8,697***	***8,697***	***8,697***	***8,697***
Matagorda	Brazos-Colorado	22,423	22,423	22,423	22,423	22,423	22,423
Matagorda	Colorado	3,218	3,218	3,218	3,218	3,218	3,218
Matagorda	Colorado-Lavaca	23,580	23,580	23,580	23,580	23,580	23,580
	County Total	***49,221***	***49,221***	***49,221***	***49,221***	***49,221***	***49,221***
Wharton	Brazos-Colorado	42,295	42,295	42,295	42,295	42,295	42,295
Wharton	Colorado	41,812	41,812	41,812	41,812	41,812	41,812
Wharton	Colorado-Lavaca	8,543	8,543	8,543	8,543	8,543	8,543
	County Total	***92,650***	***92,650***	***92,650***	***92,650***	***92,650***	***92,650***
Region K	**Region Total**	**198,425**	**198,425**	**198,425**	**198,425**	**198,425**	**198,425**

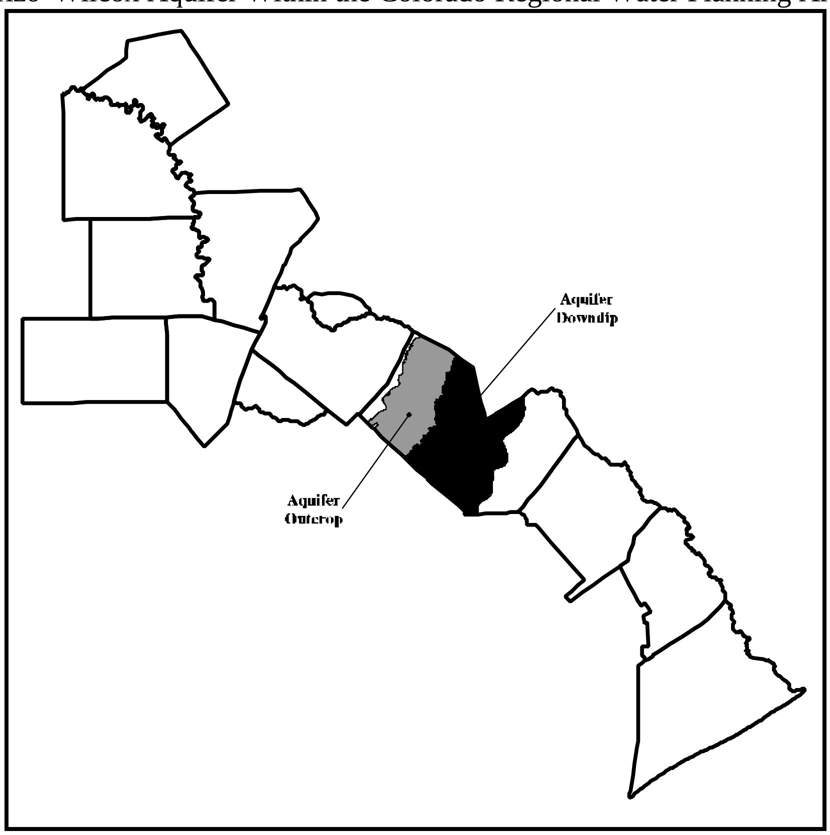
3.2.2.1.2 Carrizo-Wilcox Aquifer

Location and Use

The Wilcox Group and the overlying Carrizo Formation of the Claiborne Group form a hydrologically connected system known as the Carrizo-Wilcox aquifer. 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. The Carrizo Sand and Wilcox Group occur at the surface along a narrow band that parallels the Gulf Coast and dip beneath the land surface toward the coast except in the East Texas structural basin adjacent to the Sabine Uplift where the formations form a trough.

Users of water from the Carrizo-Wilcox aquifer in the LCRWPA occurs in Bastrop County. TWDB records indicate that the total groundwater pumpage from the Carrizo-Wilcox in the study area for 1997 was 8,689 ac-ft. Municipal uses accounted for 91 percent of the total, manufacturing uses accounted for 1 percent, irrigation accounted for 5 percent, and livestock accounted for 4 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.3.

Figure 3.3: Carrizo-Wilcox Aquifer Within the Colorado Regional Water Planning Area



Hydrogeology

The Carrizo-Wilcox aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. North of the Colorado River the Wilcox Group is generally divided into three distinct formations. From the oldest and deepest to youngest these are the Hooper, Simsboro, and Calvert Bluff. Of the three, the Simsboro typically contains the most massive and coarsest sands, which produces the largest quantities of water. South of the Colorado River, the Simsboro is absent as a distinct unit. The Wilcox portion of the aquifer varies significantly in thickness in the downdip artesian portion from 400 feet in portions of Fayette County (south of the Colorado River) to as much as 1,600 feet in Bastrop County. The Carrizo portion of the aquifer also varies in thickness in the downdip artesian portion from 200 feet to 400 feet across the LCRWPA.

Water Quality

Water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally.

Availability

As previously discussed, the LCRWPG has established the sustainable use of groundwater resources as a policy for the region. The Carrizo-Wilcox aquifer has been studied by the Bureau of Economic Geology (BEG). The BEG study indicates that the average annual recharge for the aquifer in the Lower Colorado Region is 21,900 ac-ft/yr. The available water, by river basin was established using a proportionate area method. The availability estimates are presented in Table 3.10.

Table 3.10: Water Availability in the Carrizo-Wilcox Aquifer (ac-ft/yr)

County	Supply Basin	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Bastrop	Brazos	1,880	1,880	1,880	1,880	1,880	1,880
Bastrop	Colorado	18,969	18,969	18,969	18,969	18,969	18,969
Bastrtop	Guadalupe	1,101	1,101	1,101	1,101	1,101	1,101
	County Total	***21,950***	***21,950***	***21,950***	***21,950***	***21,950***	***21,950***
Fayette	Colorado	290	290	290	290	290	290
Fayette	Guadalupe	66	66	66	66	66	66
Fayette	Lavaca	44	44	44	44	44	44
	County Total	***400***	***400***	***400***	***400***	***400***	***400***
Region K	**Region Total**	**22,350**	**22,350**	**22,350**	**22,350**	**22,350**	**22,350**

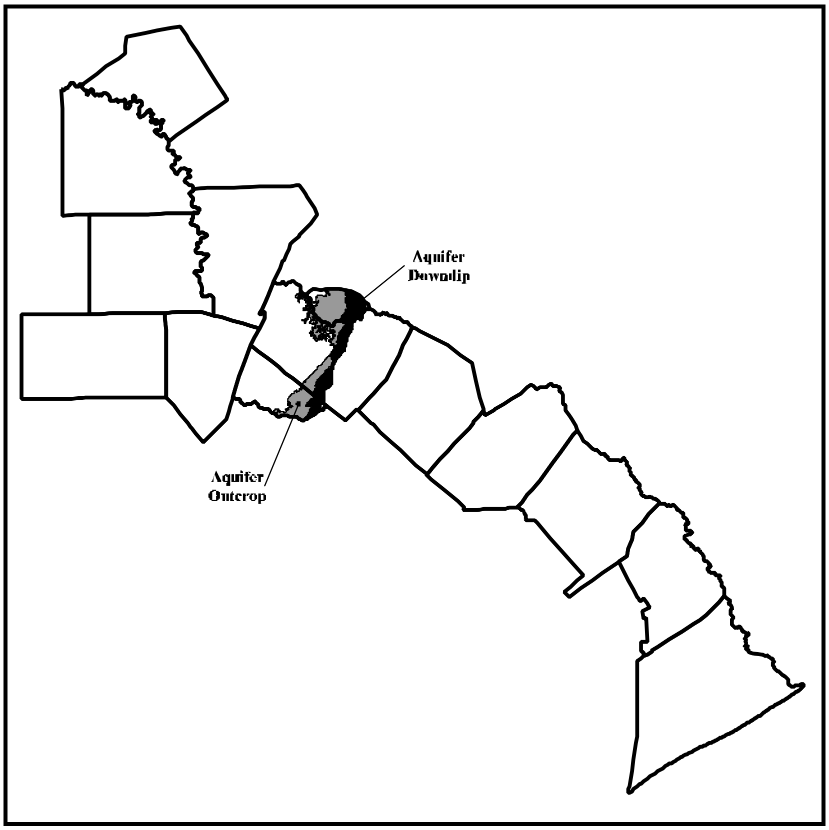
3.2.2.1.3 Edwards Aquifer (Balcones Fault Zone)

Location and Use

The Edwards (Balcones Fault Zone, or BFZ) aquifer covers approximately 4,350 square miles in parts of 11 counties. It forms a narrow belt extending from a groundwater divide in Kinney County through the San Antonio area northeastward to the Leon River in Bell County. A poorly defined groundwater divide near Kyle in Hays County hydrologically separates the aquifer into the San Antonio and Austin regions. The Austin region is further divided into the Barton Springs and Northern regions, which are also hydrologically separate. The name Edwards aquifer (BFZ) distinguishes this aquifer from the Edwards-Trinity (Plateau) and Edwards-Trinity (High Plains) aquifers.

Groundwater use from the Edwards aquifer (BFZ) within the LCRWPA occurs in Hays, Travis, and Williamson counties. TWDB records indicate that the total groundwater pumpage from the Edwards in the study area for 1997 was 8,641 ac-ft. Municipal uses accounted for 91 percent of the total, manufacturing accounted for 7 percent, and livestock accounted for 1 percent. Large springs feed several recreational areas and serve as habitat to several endangered species of plants and animals. Major river systems derive a significant amount of baseflow from Edwards (BFZ) spring flows that are utilized outside the Edwards Region mainly for industrial and agricultural needs. The location of the aquifer within the LCRWPA is illustrated in Figure 3.4.

Figure 3.4: Edwards Aquifer (BFZ) Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The aquifer, composed predominantly of limestone formed during the early Cretaceous Period, exists under water-table conditions in the outcrop and under artesian conditions where it is confined below the overlying Del Rio Clay. The Edwards BFZ aquifer consists of the Georgetown Limestone, formations of the Edwards Group (the primary water-bearing unit) and their equivalents, and the Comanche Peak Limestone where it exists. Thickness ranges from 200 to 600 feet.

Recharge to the aquifer occurs primarily by the downward percolation of surface water from streams draining off the Edwards Plateau to the north and west; and by direct infiltration of precipitation on the outcrop. This recharge reaches the aquifer through crevices, faults, and sinkholes in the unsaturated zone. Unknown amounts of groundwater enter the aquifer as lateral underflow from the Glen Rose Formation. Water in the aquifer generally moves from the recharge zone toward natural discharge points such as Comal, San Marcos, Barton, and Salado springs.

A natural hydrologic divide occurs in the aquifer near Kyle in Hays County that separates the San Antonio portion of the aquifer from the Barton Springs and Northern zones of the aquifer. The area included in the LCRWPA is the area north of this divide. The Barton Springs zone is hydrologically bounded to the north by the Colorado River. The Northern zone includes the area north of the Colorado River to Bell County.

In the updip portion, groundwater moving through the aquifer system has dissolved large amounts of rock to create highly permeable solution zones and channels, which facilitate rapid flow and relatively high storage capacity within the aquifer. Highly fractured strata in fault zones have also been preferentially dissolved to form conduits capable of transmitting large amounts of water. Due to its extensive honeycombed and cavernous character, the aquifer yields moderate to large quantities of water. Several wells yield in excess of 16,000 gal/min and one well drilled in Bexar County flowed 37,000 gal/min from a 30-inch diameter casing. The aquifer is significantly less permeable farther downdip where the concentration of dissolved solids in the water exceeds 1,000 mg/l.

Water Quality

The chemical quality of water in the aquifer is typically fresh, although hard, with dissolved solids concentrations averaging less than 500 mg/l. The downdip interface between fresh and slightly saline water represents the extent of water containing less than 1,000 mg/l. within a short distance down gradient of the “bad water line,” the groundwater becomes increasingly mineralized. The position of the bad water line generally coincides with the alignment of Interstate 35 through southern and central Travis County. North of the City of Pflugerville, the bad water line trends more toward the northeast, into Williamson County.

Availability

Due to its highly permeable nature in the fresh water zone, the Edwards BFZ aquifer responds quickly to changes and extremes in stress placed upon the system. This is indicated by the rapid fluctuations in water levels over relatively short periods of time. During times of adequate rainfall and recharge, the Edwards BFZ is able to supply sufficient amounts of water for all demands as well as sustain spring flows at many locations throughout its extent. However, when recharge is low, water withdrawn from wells and water discharged at the springs comes mainly from aquifer storage. If these conditions persist, water in storage within the aquifer continues to be depleted with corresponding water-level declines and reduced spring flows.

Estimates of annual groundwater availability for the Edwards BFZ aquifer in the LCRWPA are based on minimum spring flows and groundwater withdrawals that occurred in the Colorado and Brazos river basins during the long drought of the 1950s. In the Colorado River basin the estimate is based on minimum spring flow at Barton Springs in Travis County, which during the drought of the 1950s, flowed by effective recharge to the aquifer and not from water in storage.

The criteria for groundwater availability for future development of the Edwards BFZ in the LCRWPA involves consideration of issues such as future demand, water level declines, potential water quality deterioration, depletion of aquifer storage, and the availability of alternate surface water supplies. It allows for some increase in groundwater development to meet a portion of future demands, but utilizes available surface water to meet the majority of demands in order to minimize or eliminate negative effects on the aquifer system.

The BEG has recently completed a modeling study of the Edwards aquifer (BFZ) in the Barton Springs zone. The results of this study are used as sthe basis for the availability estimates in the LCRWPA. This information is presented in Table 3.11.

Table 3.11: Water Availability in the Edwards Aquifer (BFZ) (ac-ft/yr)

County	Supply Basin	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Hays	Colorado	9,310	9,310	9,310	9,310	9,310	9,310
Travis	Brazos	46	46	46	46	46	46
Travis	Colorado	7,954	7,954	7,954	7,954	7,954	7,954
	County Total	***8,000***	***8,000***	***8,000***	***8,000***	***8,000***	***8,000***
Williamson	Brazos	3,551	3,551	3,551	3,551	3,551	3,551
Williamson	Colorado	134	134	134	134	134	134
	County Total	***3,685***	***3,685***	***3,685***	***3,685***	***3,685***	***3,685***
Region K	**Region Total**	**20,995**	**20,995**	**20,995**	**20,995**	**20,995**	**20,995**

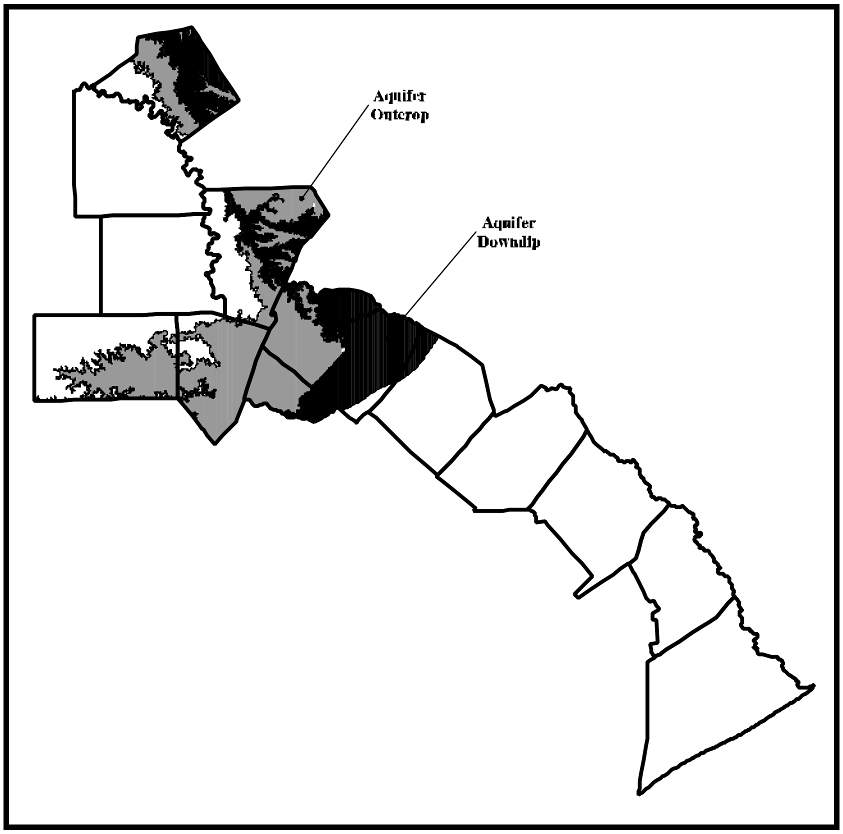
3.2.2.1.4 Trinity Aquifer

Location and Use

The Trinity aquifer consists of early Cretaceous age rocks of the Trinity Group formations, which occur in a band from the Red River in northern Texas to the Hill Country of south-central Texas and provides water in all or parts of 55 counties. Trinity Group deposits also occur as far west as the Panhandle and Trans-Pecos regions where they are included as part of the Edwards-Trinity (High Plains) and Edwards-Trinity (Plateau) aquifers.

Groundwater use from the Trinity aquifer in the LCRWPA occurs in Blanco, Burnet, Gillespie, Hays, Mills, and Travis counties. TWDB records indicate that the total groundwater pumpage from the Trinity in the study area for 1997 was 7,929 ac-ft. Municipal uses accounted for 62 percent of the total, irrigation accounted for 19 percent, and livestock accounted for 18 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.5.

Figure 3.5: Trinity Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The Trinity aquifer is composed of sand, clay, and limestone deposited during the Cretaceous Period. Formations comprising the aquifer in the LCRWPA include the Glen Rose and the underlying Travis Peak Formation. The Travis Peak Formation is subdivided into water-bearing members of the Hensell and Cow Creek, which are sometimes referred to as the Middle Trinity aquifer and the underlying water-bearing members of the Hosston and Sligo, which are sometimes referred to as the Lower Trinity aquifer. Groundwater well yields typically range from 100 to 300 gallons per minute in the Trinity aquifer.

Water Quality

Water quality from the Trinity aquifer is acceptable for most municipal and industrial purposes, however, excess concentrations of certain constituents in many places exceed drinking-water standards. Heavy pumpage and water level declines in this region have contributed to deteriorating water quality in the aquifer. Wells completed in the Middle Trinity (especially the Hensell member of the Travis Peak Formation) exhibit higher levels of sodium, sulfate, and chloride, which are believed to be the result of leakage from the overlying Glen Rose. This is less likely to be true for wells completed in the Lower Trinity. The Hammett Shale acts as an aquitard and effectively prevents leakage from the overlying formations. In some areas poor quality water occurs in and near wells that have not been properly cased. These wells may have deteriorated casings or the casing may have been perforated at multiple depths in an effort to maximize the amount of water pumped. These wells serve as a conduit for poor quality water originating in the evaporite beds in the upper portion of the Glen Rose. Water quality naturally declines in the downdip direction of all of the Trinity water-bearing units.

Availability

The TWDB groundwater staff has recently completed a computerized simulation model for the Trinity aquifer. The results from this effort have been used as a basis for developing the water availability numbers in the LCRWPA for most counties. The availability of the Trinity aquifer in Gillespie County is based on the Hill Country Underground Water Conservation District Water Management Plan. This information is presented in Table 3.12.

Table 3.12: Water Availability for the Trinity Aquifer (ac-ft/yr)

County	Supply Basin	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Bastrop	Colorado	12	12	12	10	10	8
Blanco	Colorado	1,149	1,149	1,149	1,149	1,149	942
Blanco	Guadalupe	451	451	451	451	451	373
	County Total	***1,600***	***1,600***	***1,600***	***1,600***	***1,600***	***1,315***
Burnet	Brazos	1,603	1,603	1,603	1,355	1,355	1,112
Burnet	Colorado	567	567	567	480	480	393
	County Total	***2,170***	***2,170***	***2,170***	***1,835***	***1,835***	***1,505***
Gillespie	Colorado	3,354	3,354	3,354	3,354	3,354	3,354
Gillespie	Guadalupe	46	46	46	46	46	46
	County Total	***3,400***	***3,400***	***3,400***	***3,400***	***3,400***	***3,400***
Hays	Colorado	597	597	597	597	597	490
	County Total	***597***	***597***	***597***	***597***	***597***	***490***
Mills	Brazos	1,430	1,430	1,430	1,254	1,254	1,028
Mills	Colorado	1,330	1,330	1,330	1,166	1,166	956
	County Total	***2,760***	***2,760***	***2,760***	***2,420***	***2,420***	***1,984***
Travis	Colorado	853	853	853	853	853	699
Travis	Guadalupe	2	2	2	2	2	2
	County Total	***855***	***855***	***855***	***855***	***855***	***701***
Williamson	Brazos	299	299	299	241	241	197
Williamson	Colorado	148	148	148	119	119	98
	County Total	***447***	***447***	***447***	***360***	***360***	***295***
Region K	**Region Total**	**11,841**	**11,841**	**11,841**	**11,077**	**11,077**	**9,698**

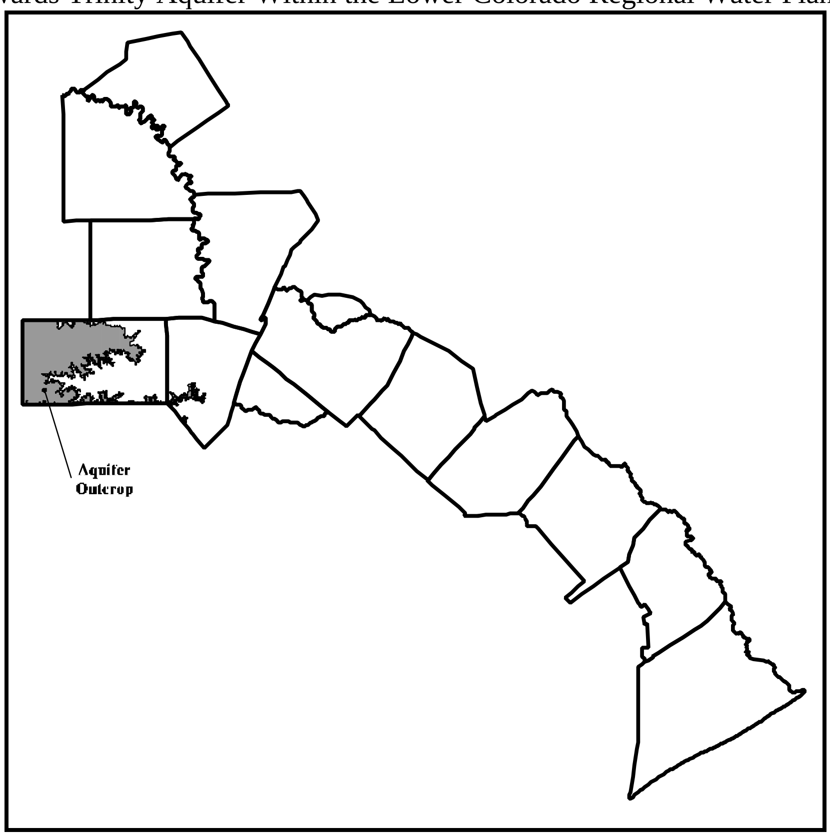
3.2.2.1.5: Edwards-Trinity (Plateau) Aquifer

Location and Use

The Edwards-Trinity (Plateau) aquifer underlies the Edwards Plateau east of the Pecos River and the Stockton Plateau west of the Pecos River, providing water to all or parts of 38 counties. The aquifer extends from the Hill Country of Central Texas to the Trans-Pecos region of West Texas.

Groundwater use from the Edwards-Trinity aquifer within the LCRWPA is limited to Gillespie County. TWDB records indicate that the total groundwater pumpage from the Edwards-Trinity (Plateau) in the study area for 1997 was 13 ac-ft, which was used exclusively for municipal purposes. The location of the aquifer within the LCRWPA is illustrated in Figure 3.6.

Figure 3.6: Edwards Trinity Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The aquifer consists of saturated sediments of lower Cretaceous age Trinity Group formations and overlying limestones and dolomites of the Comanche Peak, Edwards, and Georgetown Formations. Springs issuing from the aquifer form the headwaters for the Pedernales, Llano, and San Saba Rivers.

The aquifer generally exists under water table conditions, however, where the Trinity is fully saturated and a zone of low permeability occurs near the base of the overlying Edwards, artesian conditions may exist. Reported well yields commonly range from less than 50 gal/min where saturated thickness is thin to more than 1,000 gal/min where large capacity wells are completed in jointed and cavernous limestone.

Water Quality

Natural chemical quality of Edwards-Trinity (Plateau) water ranges from fresh to slightly saline. The water is typically hard and may vary widely in concentrations of dissolved solids, comprised mostly of calcium and bicarbonate. The salinity of the groundwater tends to increase toward the west. Water quality of springs issuing from the aquifer in the southern and eastern border areas is typically excellent.

Availability

There is little pumpage from the aquifer over most of its extent, and water levels have generally remained constant or have fluctuated only with seasonal precipitation. In some instances water levels have declined as a result of increased pumpage. None of the areas supplied by groundwater from the Edwards-Trinity (Plateau) aquifer have experienced declines greater than 20 feet since 1980. The availability of the Edwards-Trinity aquifer in Gillespie County is based on the Hill Country Underground Water Conservation District Water Management Plan. The availability of the Edwards-Trinity aquifer in Blanco County is based on the TWDB default number. This information is presented in Table 3.13.

Table 3.13: Water Availability from the Edwards-Trinity Aquifer (ac-ft/yr)

County	Supply Basin	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Blanco	Colorado	107	107	107	107	107	108
Blanco	Guadalupe	50	50	50	50	50	51
	County Total	***157***	***157***	***157***	***157***	***157***	***159***
Gillespie	Colorado	1,410	1,410	1,410	1,410	1,410	1,410
Gillespie	Guadalupe	90	90	90	90	90	90
	County Total	***1,500***	***1,500***	***1,500***	***1,500***	***1,500***	***1,500***
Region K	**Region Total**	**1,657**	**1,657**	**1,657**	**1,657**	**1,657**	**1,659**

3.2.2.2 Minor Aquifers

The minor aquifers in the LCRWPA are the Hickory, Queen City, Sparta, Ellenburger-San Saba, and Marble Falls aquifers. These aquifers provide water supply to many of the cities and towns in the hill country of Central Texas, or in the case of the Sparta and Queen City aquifers, to farms, ranches, and small towns in Bastrop and Fayette counties.

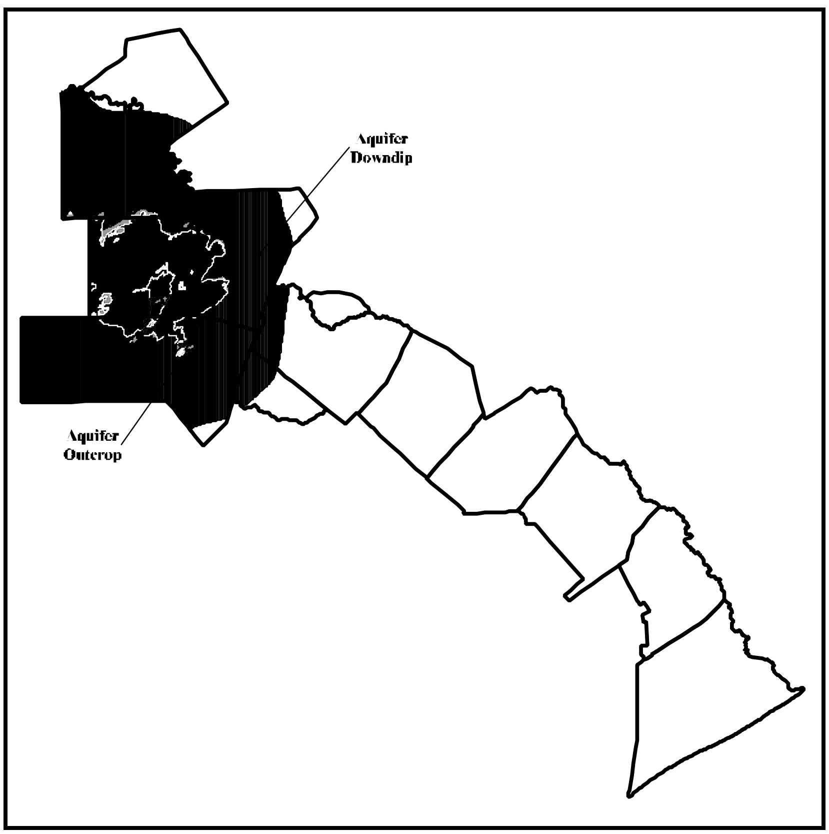
3.2.2.2.1 Hickory Aquifer

Location and Use

The Hickory aquifer underlies approximately 5,000 square miles in parts of 19 counties within the Llano Uplift region of Central Texas. Discontinuous outcrops of the Hickory sandstone overlie and flank the exposed Precambrian rocks that form the central core of the Uplift. The downdip artesian portion of the aquifer encircles the Uplift and extends to maximum depths approaching 4,500 feet.

Groundwater use from the Hickory aquifer within the LCRWPA occurs in Burnet, Gillespie, Llano, San Saba, and Blanco counties. TWDB records indicate that the total groundwater pumpage from the Hickory in the study area for 1997 was 3,442 ac-ft. Municipal uses accounted for 11 percent of the total, mining accounted for 9 percent, irrigation accounted for 66 percent, and livestock accounted for 14 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.7.

Figure 3.7: Hickory Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The Hickory aquifer, like the Marble Falls and Ellenburger-San Saba aquifers, was formed by the Llano Uplift, a distinct area of the state that includes portions of 19 counties. The Hickory Sandstone Member of the Cambrian Riley Formation is composed of some of the oldest sedimentary rocks found in Texas. In most of the northern and western portions of the aquifer, the Hickory Sandstone Member can be differentiated into lower, middle, and upper units, which reach a maximum thickness of 480 feet in southwestern McCulloch County just northwest of the LCRWPA. In the southern and eastern extent of the aquifer, the Hickory Sandstone Member consists of only two units, which range in thickness from about 150 to 400 feet.

The Hickory aquifer has been compartmentalized by block faulting. The vertical displacement of faults ranges from a few feet to as much as 2,000 feet. Significant lateral displacement is also associated with these faults. Throughout its extent, the thickness of the aquifer is affected by the relief of the underlying Precambrian surface. Both of these elements have contributed to the significant variability that occurs in groundwater availability, movement, quality, and productivity.

Large wells used for irrigation and municipal supply may range from 200 to 500 gal/min. Some exceptional wells have been reported to have yields in excess of 1,000 gal/min. These would typically occur outside of the LCRWPA, northwest of the Llano Uplift.

Water Quality

In general, the quality of water from the Hickory aquifer could be described as moderate to low quality. The total dissolved solids concentrations vary from 300 to 500 mg/l. In some areas the groundwater may have dissolved solids concentrations as high as 3,000 mg/l. The water may contain alpha particle and total radium concentrations that may exceed the new safe drinking water levels soon to be issued by the EPA. Radon gas may also be entrained. Most of the radioactive groundwater is thought to be produced from the middle Hickory unit, while the upper Hickory unit produces water that exceeds safe drinking water concentrations for iron. High nitrate levels may be found in the shallower portions of the aquifer where there may be interaction with surface activities such as fertilizer applications and septic systems.

Availability

The amount of water available from the Hickory aquifer is based on information obtained from the Hickory Underground Water Conservation District (UWCD) No. 1, the Hill Country UWCD, and the TWDB. These projections of availability are shown in Table 3.14 below.

Table 3.14: Water Availability from the Hickory Aquifer (ac-ft/yr)

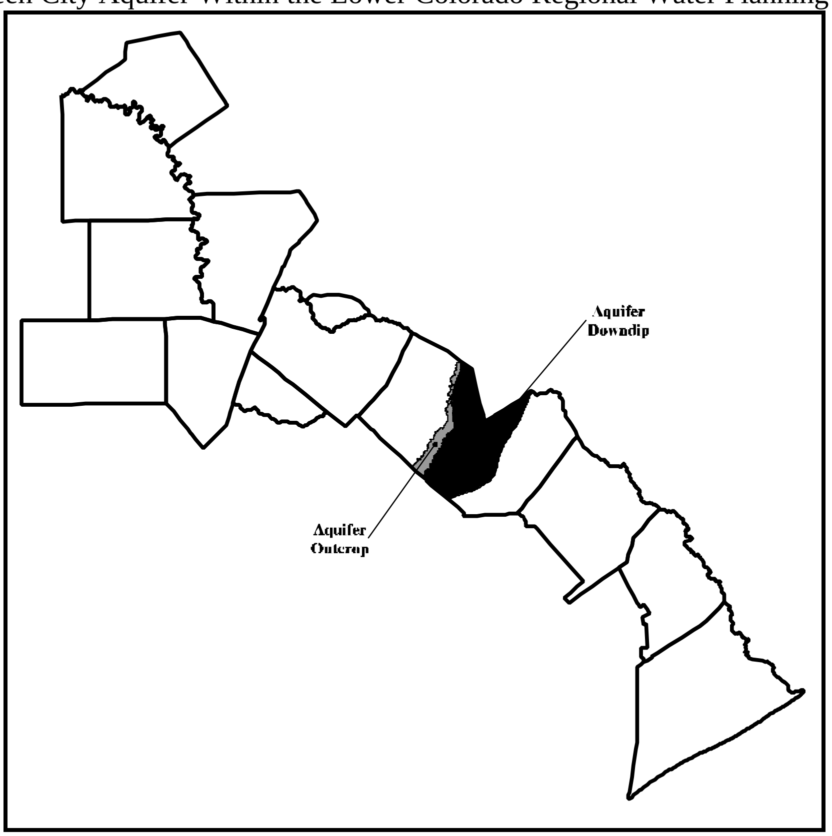
County	**Supply Basin**	**Year 2000 Supply**	**Year 2010 Supply**	**Year 2020 Supply**	**Year 2030 Supply**	**Year 2040 Supply**	**Year 2050 Supply**
Blanco	Colorado	747	747	747	747	747	747
Blanco	Guadalupe	165	165	165	165	165	165
	County Total	***912***	***912***	***912***	***912***	***912***	***912***
Burnet	Colorado	3,154	3,154	3,154	3,154	3,154	3,154
Burnet	Brazos	2,257	2,257	2,257	2,257	2,257	2,257
	County Total	***5,411***	***5,411***	***5,411***	***5,411***	***5,411***	***5,411***
Gillespie	Colorado	1,934	1,934	1,934	1,934	1,934	1,934
Gillespie	Guadalupe	66	66	66	66	66	66
	County Total	***2,000***	***2,000***	***2,000***	***2,000***	***2,000***	***2,000***
Llano	Colorado	12,517	12,517	12,517	12,517	12,517	12,517
San Saba	Colorado	6,540	6,540	6,540	6,540	6,540	6,540
Region K	**Region Total**	**27,380**	**27,380**	**27,380**	**27,380**	**27,380**	**27,380**

3.2.2.2.2 Queen City Aquifer

Location and Use

The Queen City aquifer extends in a band across most of the State from the Frio River in South Texas northeastward into Louisiana. The southwestern boundary is placed at the Frio River because of a facies change in the formation. This facies change results in reduced amounts of poorer quality water produced from this interval southwest of the Frio River. In 1997 only Fayette County is listed as using Queen City water in the study area. The reported usage for 1997 was 7 ac-ft, which was used for irrigation. The location of the aquifer within the LCRWPA is illustrated in Figure 3.8.

Figure 3.8: Queen City Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The Queen City aquifer is composed of sand, loosely cemented sandstone, and interbedded clay units of the Queen City Formation of the Tertiary Claiborne Group. These rocks slope downward or dip gently to the south and southeast toward the Gulf of Mexico. The total thickness of this aquifer is usually less than 500 feet in the LCRWPA. The Queen City aquifer generally parallels the Carrizo aquifer, and like the Carrizo it has both a water table and artesian portion. Well yields are generally low with a few exceeding 400 gal/min.

Water Quality

Throughout most of the LCRWPA the chemical quality of the Queen City aquifer water is excellent, but water quality may deteriorate fairly rapidly downdip. The water may be fairly acidic (low pH), have high iron concentrations, or contain hydrogen sulfide gas. All of these conditions are relatively easy to remedy with standard water treatment methods.

Availability

The water availability of the Queen City aquifer is based on aquifer-wide TWDB projections. The total supply available was distributed in proportion to the area occurring in each river basin. These projections are presented in Table 3.15 below.

Table 3.15: Water Availability from the Queen City Aquifer (ac-ft/yr)

County	Supply Basin	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Bastrop	Brazos	227	227	227	227	227	227
Bastrop	Colorado	2,126	2,126	2,126	2,126	2,126	2,126
Bastrop	Guadalupe	403	403	403	403	403	403
	County Total	***2,756***	***2,756***	***2,756***	***2,756***	***2,756***	***2,756***
Fayette	Colorado	1,034	1,034	1,034	1,034	1,034	1,034
Fayette	Lavaca	26	26	26	26	26	26
Fayette	Guadalupe	175	175	175	175	175	175
	County Total	***1,235***	***1,235***	***1,235***	***1,235***	***1,235***	***1,235***
Region K	**Region Total**	**3,991**	**3,991**	**3,991**	**3,991**	**3,991**	**3,991**

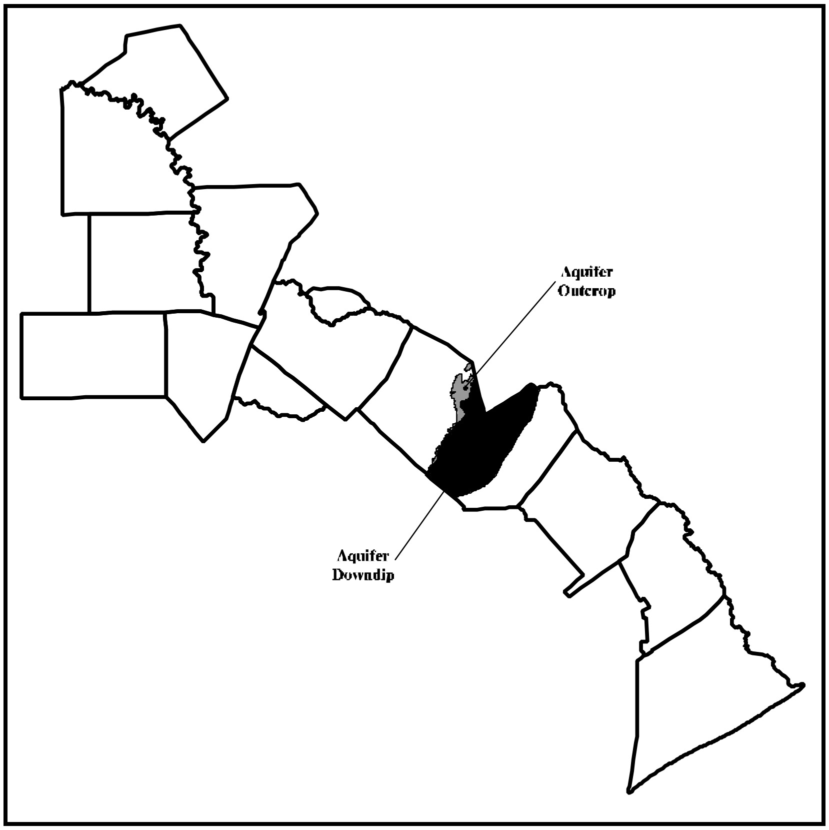
3.2.2.2.3 Sparta Aquifer

Location and Use

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 southwestern boundary is placed at the Frio River because of a facies change in the formation, which makes it difficult to delineate the boundaries of the Sparta and contiguous formations southwestward. The facies change results in reduced amounts of water and poorer quality water produced from the interval.

Groundwater use from the Sparta aquifer within the LCRWPA occurs in Bastrop and Fayette counties. TWDB records indicate that the total groundwater pumpage from the Sparta aquifer in the study area for 1997 was 143 ac-ft. Municipal uses accounted for 53 percent of the total, irrigation accounted for 23 percent, and livestock accounted for 24 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.9.

Figure 3.9: Sparta Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The Sparta Formation, like the Queen City, is part of the Claiborne Group. The aquifer consists of sand and interbedded clay with more massive sand beds in the basal section. Rocks composing the Sparta Formation also dip gently to the south and southeast toward the Gulf Coast, with a total thickness that can reach up to 300 feet. Yields of individual wells are generally low to moderate, but high capacity wells, producing 400 to 500 gal/min, are possible. The water occurs under water table conditions near the outcrop but becomes confined and is under artesian conditions downdip. Usable quality water may be recovered from as much as 2,000 feet below the surface.

Water Quality

Usable quality water is commonly found within the outcrop and for a few miles downdip. The water quality in most of this aquifer is excellent, but the quality does decrease in the downdip direction. In some areas the water can contain iron concentrations exceeding the safe drinking water standards.

Availability

The water availability from the Sparta aquifer is based on aquifer-wide TWDB projections. The total supply available was distributed in proportion to the area occurring in each basin. These projections are presented in Table 3.16 below.

Table 3.16: Water Availability from the Sparta Aquifer (ac-ft/yr)

County	**Supply Basin**	**Year 2000 Supply**	**Year 2010 Supply**	**Year 2020 Supply**	**Year 2030 Supply**	**Year 2040 Supply**	**Year 2050 Supply**
Fayette	Colorado	3,667	3,667	3,667	3,667	3,667	3,667
Fayette	Lavaca	235	235	235	235	235	235
Fayette	Guadalupe	598	598	598	598	598	598
	County Total	***4,500***	***4,500***	***4,500***	***4,500***	***4,500***	***4,500***
Bastrop	Brazos	49	49	49	49	49	49
Bastrop	Colorado	5,000	5,000	5,000	5,000	5,000	5,000
Bastrop	Guadalupe	340	340	340	340	340	340
	County Total	***5,389***	***5,389***	***5,389***	***5,389***	***5,389***	***5,389***
Region K	**Region Total**	**9,889**	**9,889**	**9,889**	**9,889**	**9,889**	**9,889**

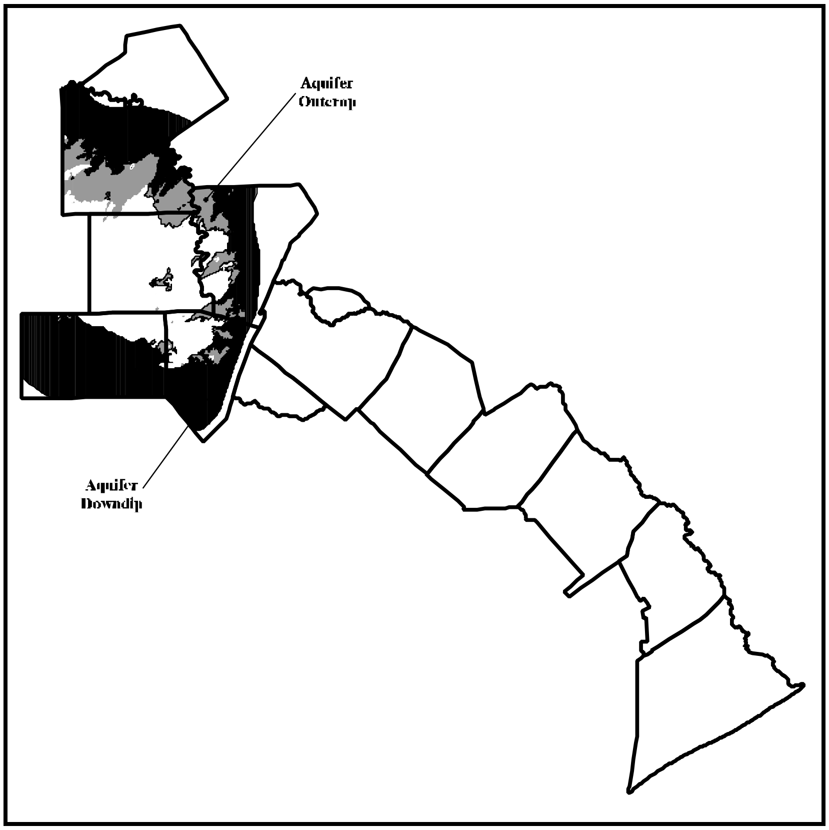
3.2.2.2.4 Ellenburger-San Saba Aquifer

Location and Use

The Ellenburger-San Saba aquifer underlies about 4,000 square miles in parts of 15 counties in the Llano Uplift area of Central Texas. Discontinuous outcrops of the aquifer generally encircle older rocks in the core of the uplift. The remaining downdip portion contains fresh to slightly saline water to depths of approximately 3,000 feet below land surface.

Groundwater use from the Ellenburger-San Saba aquifer within the LCRWPA occurs in Blanco, Burnet, Gillespie, Llano, and San Saba counties. TWDB records indicate that the total groundwater pumpage from the Ellenburger-San Saba in the study area for 1997 was 5,452 ac-ft. Municipal uses accounted for 70 percent of the total, irrigation accounted for 16 percent, and livestock accounted for 14 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.10.

Figure 3.10: Ellenburger-San Saba Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

The Ellenburger-San Saba aquifer occurs in limestone and dolomite facies of the San Saba Member of the Wilbern Formation of the Late Cambrian age; and in the Honeycut, Gorman, and Tanyard Formations of the Ellenburger Group. In the southeastern portion of the aquifer, these units have a combined maximum thickness of about 2,700 feet while in the northeastern portion of the aquifer and a maximum combined thickness is about 1,100 feet. In some areas where the overlying confining beds are thin or nonexistent the aquifer may be hydrologically connected to the Marble Falls aquifer.

Most of the water is under artesian conditions, even in the outcrop areas where impermeable carbonate rocks in the upper portion of the Ellenburger-San Saba function as confining layers. The aquifer is compartmentalized by block faulting with the fractures forming various sized cavities, which are the major water-bearing features.

The maximum capacity of wells used for municipal and irrigation purposes generally range from 200 to 600 gal/min. Most other wells produce less than 100 gal/min. The variable flow properties of the aquifer make it difficult to consistently obtain higher yield wells in some areas. Locations in the LCRWPA that have experienced this difficulty include the cities of Fredericksburg and Bertram.

Water Quality

Water produced from the aquifer may have dissolved concentrations that range from 200 mg/l to as high as 3,000 mg/l, but in most cases is usually less than 1,000 mg/l. The quality of water declines rapidly in the downdip direction.

Availability

The water available for the Ellenburger-San Saba aquifer is based on information from the Hill Country UWCD and the TWDB projections. GIS was used to apportion areas, which were then applied to separate the quantity available in the different river basins. The total supply available was distributed in proportion to the area occurring in each basin. These projections are shown in Table 3.17 below.

Table 3.17: Water Availability from the Ellenburger-San Saba Aquifer (ac-ft/yr)

County	Supply Basin	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Blanco	Colorado	2,849	2,849	2,849	2,849	2,849	2,849
Blanco	Guadalupe	1,025	1,025	1,025	1,025	1,025	1,025
	County Total	***3,874***	***3,874***	***3,874***	***3,874***	***3,874***	***3,874***
Burnet	Brazos	987	987	987	987	987	987
Burnet	Colorado	2,161	2,161	2,161	2,161	2,161	2,161
	County Total	***3,148***	***3,148***	***3,148***	***3,148***	***3,148***	***3,148***
Gillespie	Colorado	5,535	5,535	5,535	5,535	5,535	5,535
Gillespie	Guadalupe	65	65	65	65	65	65
	County Total	***5,600***	***5,600***	***5,600***	***5,600***	***5,600***	***5,600***
Llano	Colorado	758	758	758	758	758	758
San Saba	Colorado	10,194	10,194	10,194	10,194	10,194	10,194
Region K	**Region Total**	**23,574**	**23,574**	**23,574**	**23,574**	**23,574**	**23,574**

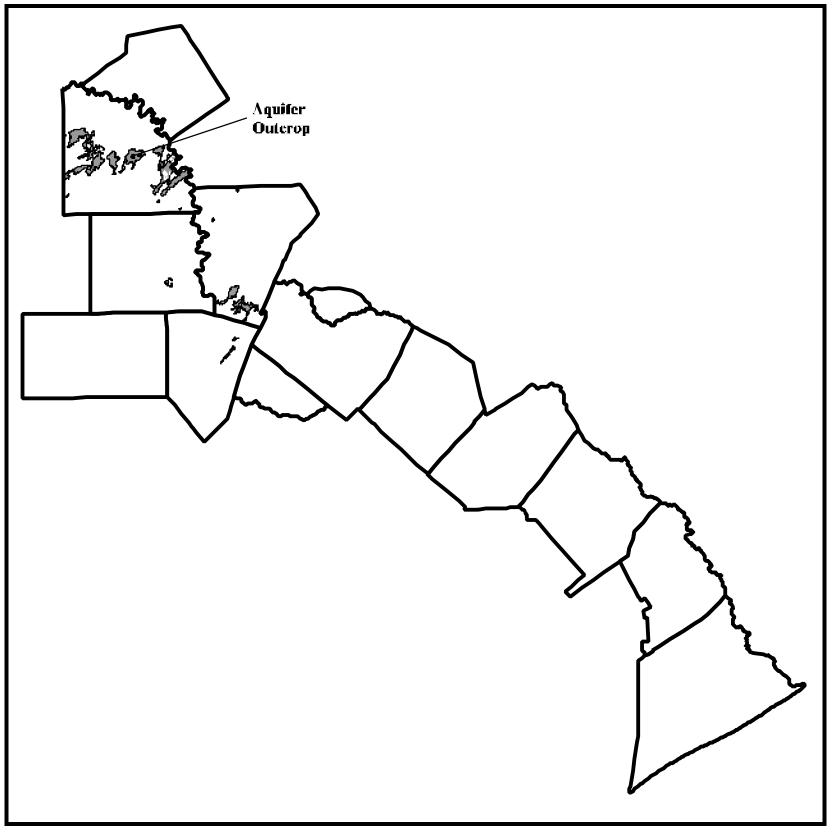
3.2.2.2.5 Marble Falls Aquifer

Location and Use

The Marble Falls aquifer occurs in several separated outcrops, primarily along the northern and eastern flanks of the Llano Uplift region of Central Texas. The downdip portion of the aquifer is of unknown extent.

Groundwater use from the Marble Falls aquifer within the LCRWPA occurs in Burnet and San Saba counties. TWDB records indicate that the total groundwater pumpage from the Marble Falls in the study area for 1997 was 1,501 acre-feet. Municipal uses accounted for 68 percent of the total, manufacturing accounted for 1 percent, irrigation accounted for 15 percent, and livestock accounted for 17 percent. The location of the aquifer within the LCRWPA is illustrated in Figure 3.11.

Figure 3.11: Marble Falls Aquifer Within the Lower Colorado Regional Water Planning Area



Hydrogeology

This aquifer occurs in the fractures, solution cavities, and channels of the limestone rocks of the Marble Falls Formation of the Pennsylvanian Bend Group. The maximum thickness of the formation is 600 feet. Numerous large springs discharge from the aquifer and provide a significant portion of the baseflow of the San Saba River in McCulloch and San Saba counties; and to the Colorado River in San Saba and Lampasas counties. The aquifer contributes flow to the San Saba springs, which is the source of drinking water for the City of San Saba. In some areas where the confining layers are thin or nonexistent, the Marble Falls aquifer may be hydrologically connected to the San Saba-Ellenburger aquifer. Some wells have been known to produce as much as 2,000 gal/min.; however, most wells produce at rates significantly less than this amount.

Water Quality

The water produced from this aquifer is suitable for most purposes, but some wells in Blanco County have produced water with high nitrate concentrations. The downdip portion of the aquifer is not extensive, but in these areas the water becomes highly mineralized. Because the limestone formation comprising this aquifer is relatively shallow, it is susceptible to pollution by surface uses and activities.

Availability

The availability of water within the counties shown below is based on former estimates of groundwater availability provided by the TWDB. These projections are shown in Table 3.18 below.

Table 3.18: Water Availability from the Marble Falls Aquifer (ac-ft/yr)

County	**Supply Basin**	**Year 2000 Supply**	**Year 2010 Supply**	**Year 2020 Supply**	**Year 2030 Supply**	**Year 2040 Supply**	**Year 2050 Supply**
Blanco	Colorado	300	300	300	300	300	300
Burnet	Brazos	291	291	291	291	291	291
Burnet	Colorado	5,334	5,334	5,334	5,334	5,334	5,334
	County Total	***5,625***	***5,625***	***5,625***	***5,625***	***5,625***	***5,625***
San Saba	Colorado	12,380	12,380	12,380	12,380	12,380	12,380
Region K	**Region Total**	**18,305**	**18,305**	**18,305**	**18,305**	**18,305**	**18,305**

3.2.3 Regional Water Supply Summary

The TWDB guidelines for the SB 1 regional water planning process require that a summary of the water sources available to the region be presented. The required table, TWDB Table 4, is presented in the Appendix 3B. This information is presented graphically in Figure 3.12 and is summarized in Table 3.19. As indicated, under current conditions, a total of nearly 1.2 million ac-ft of water is available annually to the LCRWPA under drought-of-record conditions. Of this amount, approximately 75 percent is from surface water sources and 25 percent is from groundwater sources.

Figure 3.12: Total Available Water Supplies

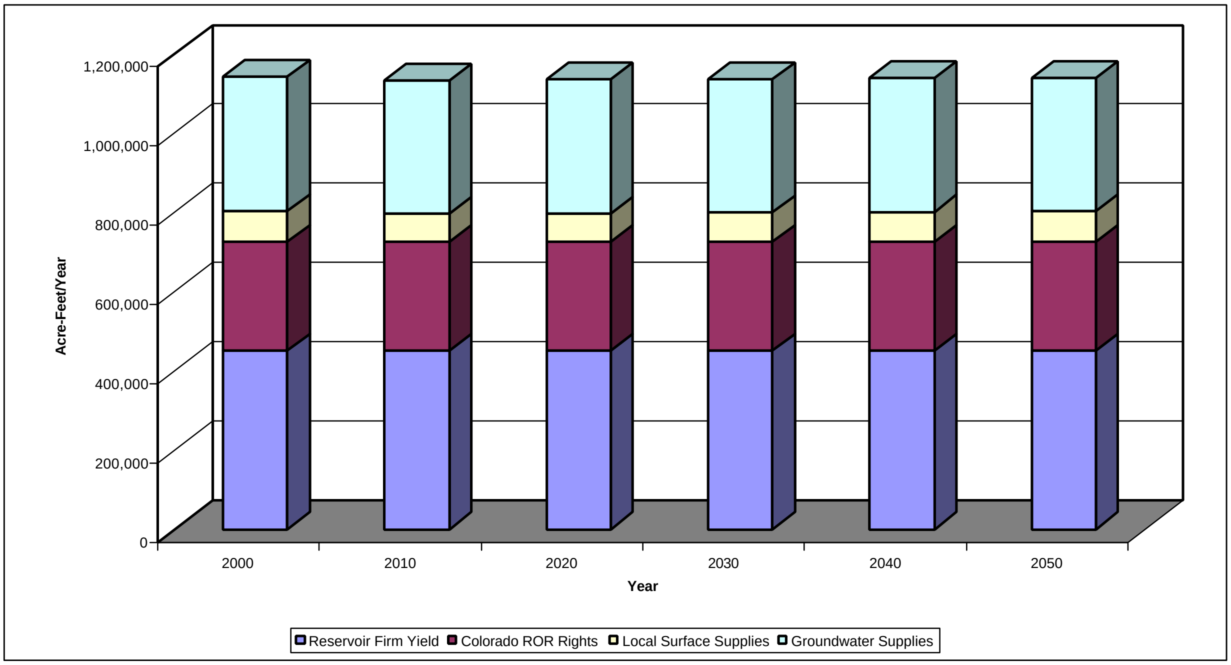


Table 3.19: Total Water Availability to the Lower Colorado Regional Planning Area (ac-ft/yr)

Water Source	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Blanco Reservoir	300	300	300	300	300	300
Carrizo-Wilcox Aquifer	22,350	22,350	22,350	22,350	22,350	22,350
Lake Fayette	1,400	1,400	1,400	1,400	1,400	1,400
City of Austin - ROR	179,832	179,832	179,832	179,832	179,832	179,832
Edwards Aquifer BFZ (Austin)	20,995	20,995	20,995	20,995	20,995	20,995
Edwards-Trinity Aquifer (Plateau)	1,657	1,657	1,657	1,657	1,657	1,659
Ellenburger-San Saba Aquifer	23,574	23,574	23,574	23,574	23,574	23,574
Goldthwaite Reservoir	400	400	400	400	400	400
Gulf Coast Aquifer	198,425	198,425	198,425	198,425	198,425	198,425
Hickory Aquifer	27,380	27,380	27,380	27,380	27,380	27,380
Highland Lakes	445,766	445,766	445,766	445,766	445,766	445,766
Houston Lighting & Power - ROR	41,320	41,320	41,320	41,320	41,320	41,320
Irrigation Local Supply	40,704	40,704	40,704	40,704	40,704	40,704
Lacy Armour Trust - Pierce ROR	4,232	4,232	4,232	4,232	4,232	4,232
Lake Bastrop	1,000	1,000	1,000	1,000	1,000	1,000
LCRA - Garwood ROR	50,000	50,000	50,000	50,000	50,000	50,000
LCRA - Gulf Coast ROR	-	-	-	-	-	-
LCRA - Lakeside ROR	-	-	-	-	-	-
LCRA - Pierce Ranch ROR	-	-	-	-	-	-
Livestock Local Supply	8,458	8,458	8,458	8,458	8,458	8,458
Llano Reservoir	400	400	400	400	400	400
Marble Falls Aquifer	18,305	18,305	18,305	18,305	18,305	18,305
Other Local Supply	29,297	20,978	22,636	24,510	26,727	29,370
Queen City Aquifer	3,991	3,991	3,991	3,991	3,991	3,991
Sparta Aquifer	9,889	9,889	9,889	9,889	9,889	9,889
Trinity Aquifer	11,841	11,841	11,841	11,077	11,077	9,698
Walter E. Long (Decker Lake)	1,000	1,000	1,000	1,000	1,000	1,000
Regional Totals	**1,142,516**	**1,134,197**	**1,135,855**	**1,136,965**	**1,139,182**	**1,140,448**

Note: Downstream water availability does not include City of Austin return flows.
The water availability numbers in this table reflect water that is physically present in the region. This does not necessarily mean that this water is available to WUGs for immediate use as defined in Table 3.26.

3.3 WATER SUPPLIES AVAILABLE TO WATER USER GROUPS

The previous sections presented estimates of the total available supply of water within the LCRWPA. However, the availability of this water to each of the water user groups is dependent upon its location and the infrastructure that is in place to move the water where it is needed. The following sections discuss the currently available water supplies for each of the water user groups within the LCRWPA.

3.3.1 Major Water Providers

The RWPGs are required to prepare estimates of the water available to the Major Water Providers within each region. The LCRWPG has identified two Major Water Providers, the LCRA, and the City of Austin. The water supplies available to these two entities are discussed in the following sections. Detailed information concerning the availability of water is presented in Appendix 3B in the required TWDB formatted Table 6.

3.3.1.1 LCRA Water Availability

The LCRA has acquired the rights to significant quantities of water within the LCRWPA. The majority of water that is available to LCRA during a repeat of the drought of record is associated with the Highland Lakes System. However, the LCRA also has two smaller reservoirs that it operates in association with two power generating facilities. In addition, the LCRA has acquired many of the senior rights for irrigation water in the lower basin. Table 3.20 contains a summary of the water that is available to the LCRA

Table 3.20: Total Water Availability to the Lower Colorado River Authority (ac-ft/yr)

TWDB Source Identifier	Water Rights Holder	Water Availability During Drought of Record					
		2000	2010	2020	2030	2040	2050
3461405434A	LCRA - Garwood	50,000	50,000	50,000	50,000	50,000	50,000
3461405475	LCRA - Lakeside	0	0	0	0	0	0
3461405476A	LCRA - Gulf Coast	0	0	0	0	0	0
3461405475	LCRA - Pierce Ranch	0	0	0	0	0	0
140B0	LCRA - Highland Lakes	445,766	445,766	445,766	445,766	445,766	445,766
14260	LCRA - Lake Bastrop	1,000	1,000	1,000	1,000	1,000	1,000
14490	LCRA - Lake Fayette	1,400	1,400	1,400	1,400	1,400	1,400
	Totals	**498,166**	**498,166**	**498,166**	**498,166**	**498,166**	**498,166**

Note: Downstream water availability does not include City of Austin return flows.

The LCRA makes the majority of this water available to other entities for final consumption through water sales contracts. The majority of these water sales contracts are for stored water from the Highland Lakes System. A complete listing of firm water supply commitments is provided in Appendix 2B. In addition, the LCRA operates three irrigation districts in the lower basin. These districts provide irrigation water for rice production in Colorado, Wharton, and Matagorda counties. Table 3.21 contains a summary of current LCRA water supply commitments, including rice irrigation, by Water User Groups.

Table 3.21: LCRA Water Commitment Summary (ac-ft/yr)

TWDB WUG Identifier	County	Water User Group (WUG)	Commitment Volume
111002011	Bastrop	Steam Electric	10,750
111004011	Bastrop	Irrigation	892
110132000	Burnet	City of Burnet	4,100
110208000	Burnet	City of Cottonwood Shores	138
110358000	Burnet	City of Granite Shoals	830
110561000	Burnet	City of Marble Falls	2,000
110996027	Burnet	County Other	1,549
111001027	Burnet	Manufacturing	500
111004027	Burnet	Irrigation	102
111004045	Colorado	Irrigation	35,000 [1]
111002075	Fayette	Steam Electric	38,101
111002075	Fayette	Steam Electric (COA)	3,500 [2]
111004075	Fayette	Irrigation	27
111003086	Gillespie	Mining	180
070536141	Lampasas	Lometa	450
110471000	Llano	Kingsland (CDP)	497
110996150	Llano	County Other	341
111002150	Llano	Irrigation	1,040
111004150	Llano	Steam Electric	15,000
111001161	Matagorda	Manufacturing	23,033
111002161	Matagorda	Steam Electric	5,680
111003161	Matagorda	Mining	5,000
111004161	Matagorda	Irrigation	- [3]
111004206	San Saba	Irrigation	20
110045000	Travis	City of Austin (Mun.)	152,327
110045000	Travis	City of Austin (Stm. El.)	35,197
110452000	Travis	City of Jonestown	270
110496000	Travis	City of Lago Vista	2,000
110506000	Travis	City of Lakeway	1,688
110996227	Travis	County Other	28,235
111001227	Travis	Manufacturing	43
111004227	Travis	Irrigation	2,057
111004241	Wharton	Irrigation	15,000 [4]
070152246	Williamson	Cedar Park	16,100
70996246	Williamson	Williamson County-Other	25,000 [5]
070514246	Williamson	Leander	6,000
		Totals	**432,647**

[1] Represents 70 percent of Garwood ROR water in minimum year.
[2] Represents 1999 contract with COA.
[3] LCRA provides water under its Gulf Coast ROR right when available.
[4] Represents 30 percent of Garwood ROR water in minimum year.
[5] Represents an out-of-basin demand from Region G.

The LCRA has typically entered into 20-year contracts with its customers for the supply of water. Many of the commitments identified in Table 3.21 expire before 2030. In accordance with the TWDB guidance, water provided under these commitments will be shown as not being available to the WUG once the contract has expired. However, the LCRA generally considers these contracts to be commitments to supply water in perpetuity. Renewal and extension of these contracts will be discussed in Chapter 5 of this plan.

In addition to these firm commitments for water, the LCRA also provides water to users on an interruptible supply basis. Based on the LCRA Water Management Plan, the LCRA will release water from storage on an interruptible basis when the levels in the Highland Lakes are above a prescribed level at the beginning of the year. During drought conditions, this water may not be available for users. Therefore, in accordance with the TWDB guidance, interruptible water supplied by LCRA is not being considered as a "currently available water supply". The actual availability of this water will be addressed in Chapter 5 discussing management strategies to meet identified water shortages.

3.3.1.2 City of Austin Water Availability

The City of Austin has the right to divert and use water from the Colorado River. However, this right is a run-of-river right. Hydrologic analyses of the Colorado River have indicated that water would not always be available to the City of Austin under these water rights. As a result, the City of Austin has entered into a contract with LCRA to firm-up these water rights with water stored in the Highland Lakes. Table 3.22 contains a summary of the water available to the City of Austin.

Table 3.22: City of Austin Water Availability (ac-ft/yr)

TWDB Source Identifier	Water Rights Holder [1]	Water Availability During Drought of Record					
		2000	2010	2020	2030	2040	2050
3461405471A	City of Austin (Mun)	165,313	165,313	165,313	165,313	165,313	165,313
3461405471A	City of Austin (Stm. El.)	4,547	4,547	4,547	4,547	4,547	4,547
3461405489A	City of Austin (Mun)	7,360	7,360	7,360	7,360	7,360	7,360
3461405489A	City of Austin (Stm El)	2,612	2,612	2,612	2,612	2,612	2,612
3491401172	LCRA Contract (Mun)	152,327	152,327	152,327	152,327	152,327	152,327
3491401172	LCRA Contract (Stm El.)	35,197	35,197	35,197	35,197	35,197	35,197
3491401172	LCRA Contract (Stm. El.)	3,500	3,500	3,500	3,500	3,500	3,500
14250	Walter E. Long (Decker)	1,000	1,000	1,000	1,000	1,000	1,000
	Totals	**371,856**	**371,856**	**371,856**	**371,856**	**371,856**	**371,856**

[1] Municipal (Mun); Steam Electric (Stm. El.)

The City of Austin provides treated water to customers within its service area. In addition, the City has contracts to provide treated water on a wholesale basis to utility districts and cities in surrounding areas. Table 3.23 contains a summary of the City of Austin water commitments.

Table 3.23 - City of Austin Wholesale Contracts

Utility Name	Demand Condition	Contract Expiration
Anderson Mill MUD	District Demand	To become retail cust.
Branch Creek Estates	0.2 MGD	7/15/16
Creedmoor-Maha WSC	50 gpm	11/30/11
High Valley WSC	0.061 MGD	6/25/17
Hill Country WSC	2.0 MGD	9/28/15
Lost Creek MUD	District Demand	7/7/07
Manville WSC	200 gpm	6/29/14
Marsha WSC	0.024 MGD	4/23/17
Mid-Tex Utilities	Service Area Demand	4/14/30
Nighthawk WSC	0.038 MGD	12/23/16
North Austin MUD #1	District Demand	5/8/24
Northtown MUD	District Demand	1/6/26
Pflugerville, City of	10 MGD	none
Rollingwood, City of	1 MGD	2/1/30
Round Rock, City of	5.5 MGD	5/12/05
Shady Hollow Estates	Standby	1/27/00
Shady Hollow MUD	District Demand	11/7/20
Springwoods MUD	District Demand	To become retail cust.
Sunset Valley, City of	City Demand	None
Travis County WCID 10	District Demand	8/30/20
Wells Branch MUD	10,000 gpm	4/13/21
Windermere Utility	Standby	none

3.3.2 Surface Water Supplies

As previously stated, there are three primary categories of surface water to be considered. The three categories include water stored in reservoirs, run-of-river water rights, and local surface water supplies. The surface water supplies are available to the water user groups in a variety of methods. Many users of water throughout the basin have contracts with one of the two designated Major Water Providers within the Region. Other users of surface water generally obtain water from small reservoirs or from other local sources.

Information concerning the available surface water supply for each county within the LCRWPA is presented in Table 3.24. Detailed information concerning water supply availability for individual WUGs is presented in the required TWDB format (Table 5) in Appendix 3B.

Table 3.24: Summary of Surface Water Available to WUGs by County (ac-ft/yr)

County	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Bastrop	14,261	14,217	13,365	13,365	13,365	13,367
Blanco	548	554	560	566	568	567
Burnet	11,171	11,193	9,058	8,334	4,375	4,572
Colorado	62,382	54,042	54,995	56,115	57,522	59,202
Fayette	48,606	48,521	48,509	48,509	48,509	48,509
Gillespie	1,746	1,566	1,566	1,566	1,566	1,566
Hays	233	233	233	233	233	233
Llano	19,457	19,453	17,839	16,322	16,233	16,233
Matagorda	75,389	56,346	56,346	56,346	50,666	50,666
Mills	3,092	3,092	3,092	3,092	3,092	3,092
San Saba	9,024	9,024	9,024	9,024	9,024	9,024
Travis	398,298	397,485	382,817	346,140	346,589	347,574
Wharton	15,875	15,916	15,966	16,013	16,064	16,120
Williamson	9,451	7,476	7,476	7,476	7,476	7,476
Regional Totals	**669,533**	**639,118**	**620,846**	**583,101**	**575,282**	**578,201**

Note: Surface water availability excludes City of Austin return flows.

3.3.3 Groundwater Supplies Available to Water User Groups

Groundwater supplies were allocated to the various WUGs within the LCRWPA using data from various sources. A primary source of information is data from the 1997 State Water Plan provided by the TWDB, which shows projected user demands and projected user allocations for the LCRWPA. Most of the groundwater users are found in the TWDB allocation tables; however, additional users are included based on information provided in the TWDB demand tables and the demand projections provided in Chapter 2 of this report. The TWDB allocation tables provided data in the form of an allocation percent or allocation limit for each user. To estimate the projected supply of water available to each user from the applicable water sources, the percent allocation value was applied to the amount of available water determined in Section 3.2.2 of this report and shown in Table 4 of Appendix 3B. The following are exceptions to that methodology:

- When the allocation table provided an estimate representing the limit in ac-ft/year of water available to a user, that number was used for the allocation;
- When a user was not included in the allocation tables but was listed in the demand projections, the values from the projected demand tables were used to represent the supply available to that user;
- When a user was not included in the allocation tables or in the demand projections, but listed in the TWDB demand tables, the values from the demand tables were used to represent the supply available to that user;
- When the TWDB allocation for a user was given as 100 percent of the water available from the associated water source, the resulting value (1.00 x available water from Section 3.2.2) was reduced by the sum of the supply values listed for other users also drawing from a particular groundwater supply. Example: User "C" is allocated 100 percent of the supply from a particular aquifer. User

"A" is allocated an amount "N" from this aquifer and user "B" is allocated an amount "M" also from this aquifer. The total amount available from this aquifer is "Q". Therefore the amount to be used in Table 5 for user C = Q – N – M;

- When available, results for municipalities were compared with information provided in the 1990 TWDB Facility Plan Summaries. Additionally, users were contacted individually to confirm their current maximum sustainable groundwater supply capacity and the supply estimates were adjusted where appropriate.

Information concerning the available groundwater supply for each county within the LCRWPA is presented in Table 3.25.

Table 3.25: Summary of Groundwater Available to WUGs by County (ac-ft/yr)

County	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Bastrop	25,361	25,361	25,361	25,361	25,361	25,361
Blanco	14,442	14,442	14,442	14,442	14,442	14,163
Burnet	14,035	14,028	14,018	13,949	13,942	13,886
Colorado	47,082	46,958	46,958	46,958	46,958	46,958
Fayette	12,267	12,246	12,229	12,211	12,205	12,204
Gillespie	12,189	12,189	12,189	12,189	12,189	12,189
Hays	6,552	6,552	6,552	6,552	6,552	6,445
Llano	21,916	21,916	21,916	21,916	21,916	21,916
Matagorda	35,786	35,786	35,786	35,786	35,786	35,786
Mills	4,056	4,056	4,056	3,871	3,871	3,634
San Saba	30,109	30,109	30,109	30,109	30,109	30,109
Travis	16,594	16,594	16,594	16,594	16,594	16,440
Wharton	78,867	78,867	78,867	78,867	78,867	78,867
Williamson	5,219	5,219	5,219	5,157	5,157	5,111
Regional Totals	**324,475**	**324,323**	**324,296**	**323,962**	**323,949**	**323,069**

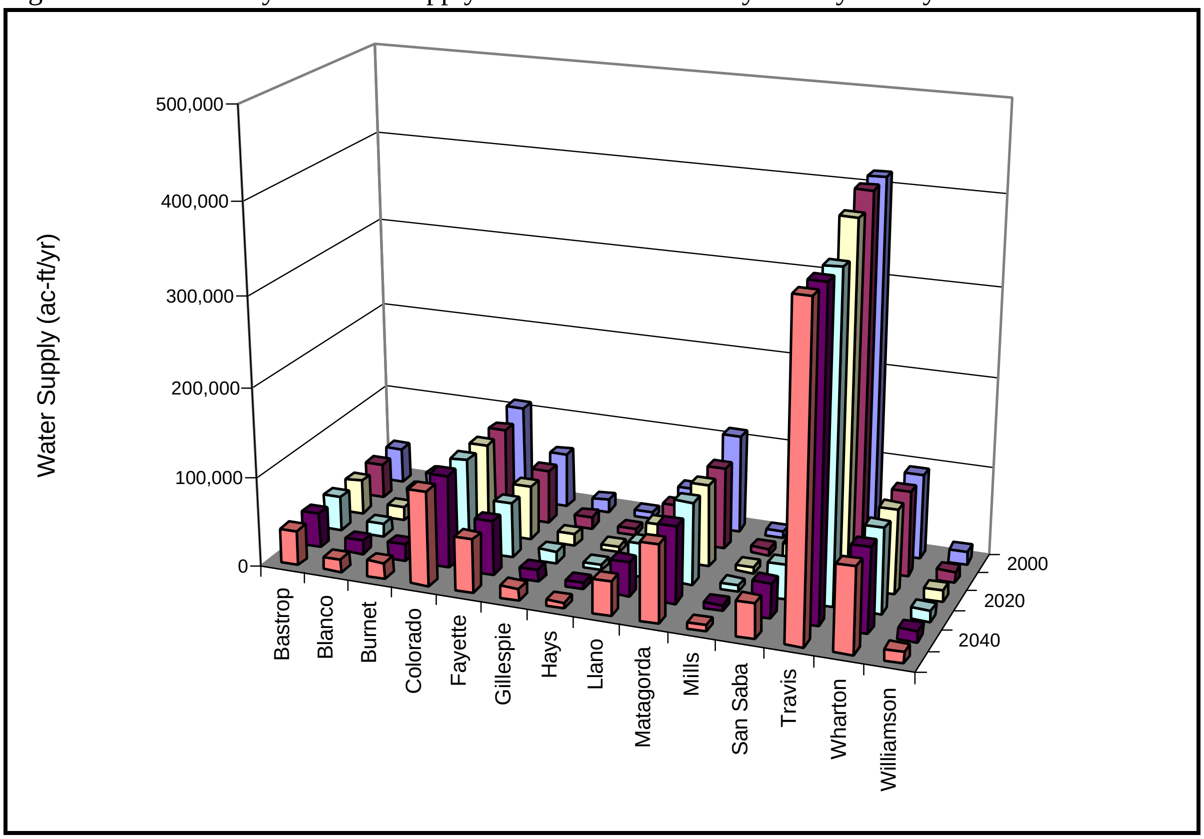
3.3.4 WUG Water Supply Summary

Information concerning the available water supply to WUGs in each county within the LCRWPA is presented in Table 3.26 and Figure 3.13. Detailed information concerning water supply availability for individual WUGs, in the required TWDB format (Table 5), is presented in Appendix 3B.

Table 3.26 - Summary of Water Available to WUGs by County (ac-ft/yr)

County	Year 2000 Supply	Year 2010 Supply	Year 2020 Supply	Year 2030 Supply	Year 2040 Supply	Year 2050 Supply
Bastrop	39,622	39,578	38,726	38,726	38,726	38,728
Blanco	14,990	14,996	15,002	15,008	15,010	14,729
Burnet	25,206	25,221	23,076	22,283	18,317	18,458
Colorado	109,464	101,000	101,953	103,073	104,480	106,160
Fayette	60,873	60,767	60,738	60,720	60,714	60,713
Gillespie	13,935	13,755	13,755	13,755	13,755	13,755
Hays	6,785	6,785	6,785	6,785	6,785	6,678
Llano	41,373	41,369	39,755	38,238	38,149	38,149
Matagorda	111,175	92,132	92,132	92,132	86,451	86,451
Mills	7,148	7,148	7,148	6,963	6,963	6,726
San Saba	39,133	39,133	39,133	39,133	39,133	39,133
Travis	414,891	414,078	399,410	362,733	363,182	364,013
Wharton	94,742	94,783	94,833	94,880	94,931	94,987
Williamson	14,670	12,695	12,695	12,633	12,633	12,587
Regional Totals	**994,007**	**963,440**	**945,141**	**907,062**	**899,229**	**901,267**

Figure 3.13: Summary of Water Supply Available to WUGs by County and by Decade



APPENDIX 3A

WATER RIGHTS HELD IN THE LOWER COLORADO REGIONAL WATER PLANNING AREA

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 3B

TWDB-REQUIRED TABLES FOR CURRENTLY AVAILABLE WATER SUPPLIES
(Exhibit B Data Tables 4, 5, & 6)

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

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CHAPTER 4.0: COMPARISON OF WATER DEMANDS WITH WATER SUPPLIES TO DETERMINE NEEDS

The comparison of water demands for each water user group (WUG) to the water supplies available to each WUG within the Lower Colorado Regional Water Planning Area (LCRWPA) is a simple mathematical comparison of the estimates developed in Chapters 2 and 3 of this report. This comparison was completed and summarized in three different ways. First, a comparison of water demands and supplies was completed on a county-by-county basis. Second, the comparison has been completed and summarized for each of the six river basins. Finally, a comparison of the water demands and supplies for the two designated major water providers within the LCRWPA was also completed.

Region-wide, the comparison of available water supplies and water demands identified 38 separate WUGs that have projected water supply shortages, or "needs", by the year 2030, and an additional 4 WUGs with projected water supply shortages before the year 2050. The estimated water need is approximately 391,000 acre-feet per year (ac-ft/yr) in 2030 and 387,000 ac-ft/yr in 2050. This identified shortage is based on availability estimates, which exclude water available from LCRA on an interruptible basis and water available as a result of Austin's return flows to the Colorado River. Water needs have been identified in five of the six water use categories. Figure 4.1 contains an illustration of the distribution, by use category, of the number of WUGs with identified water needs in the years 2030 and 2050. Figure 4.2 contains an illustration of the magnitude of the identified needs, by use category for the years 2030 and 2050.

Figure 4.1: WUGs With Identified Water Needs in the LCRWPA

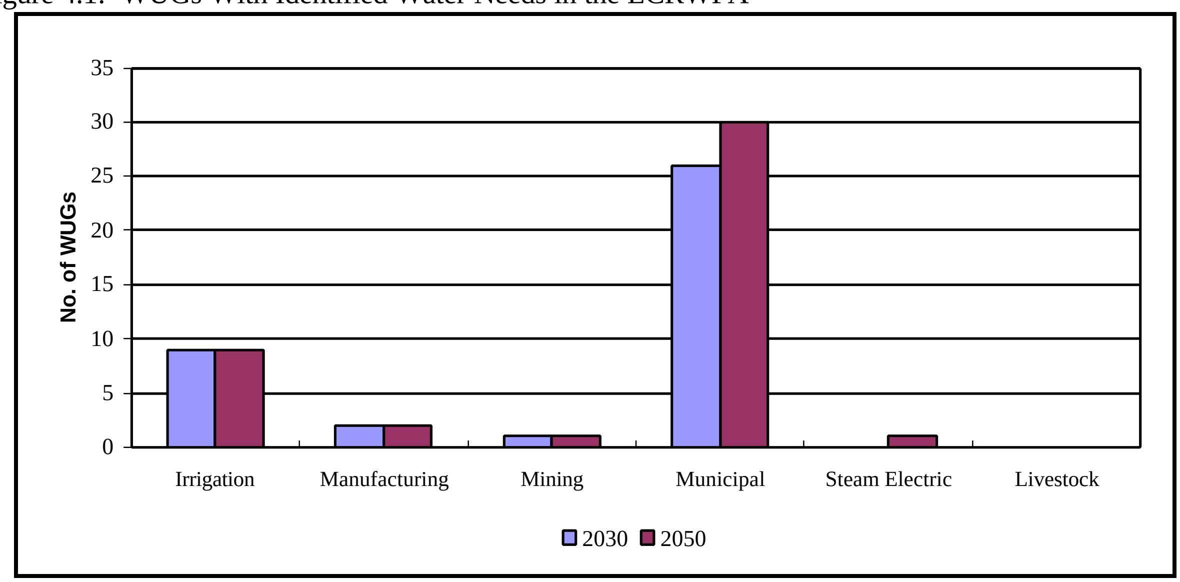
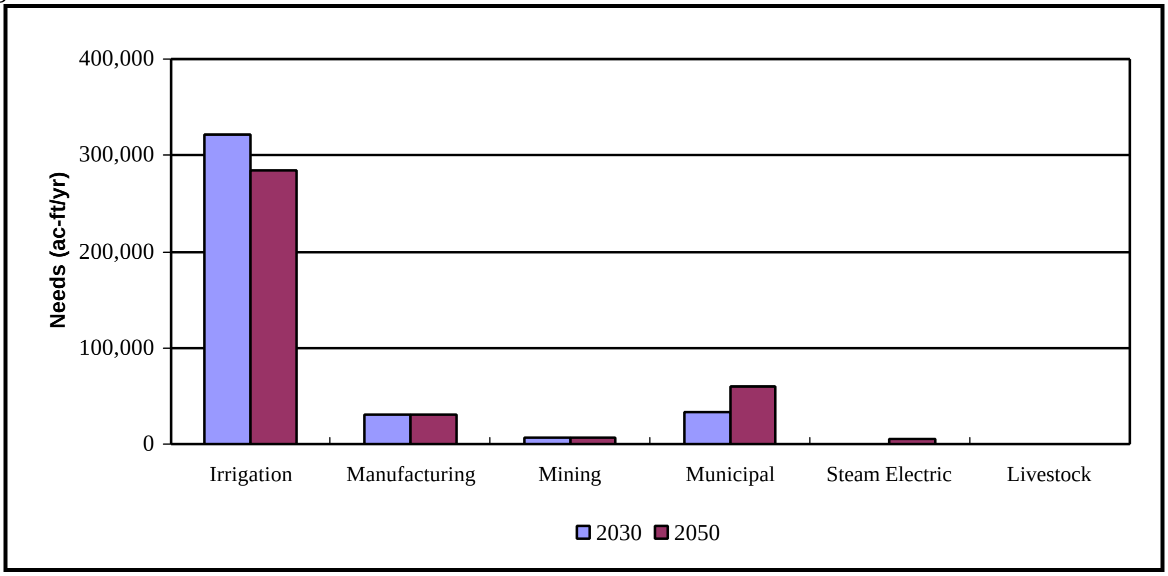


Figure 4.2: Identified Water Needs in the LCRWPA



The majority of the identified water supply shortages fall into two main categories. The first shortage is associated with rice irrigation demands in the lower three counties of Matagorda, Wharton, and Colorado. It is estimated that irrigators in these three counties would experience a water supply shortage of approximately 391,000 ac-ft/year under the existing demand conditions (year 2000), should a repeat of the driest year during the drought-of-record occur. This shortage is estimated to decrease to 322,000 ac-ft/yr in 2030 (18% decrease); and to 284,000 ac-ft/yr in 2050 (27% decrease) due to projected declining irrigation demands.

These estimated shortfalls are based on the available firm supply determined in Chapter 3. In accordance with Texas Water Development Board (TWDB) rules, the available supply of water for irrigators was estimated based on the available run-of-river water rights and groundwater supplies in the area. The interruptible supply of water provided by the Lower Colorado River Authority (LCRA) and the City of Austin return flows were not considered in these calculations since this supply, by definition, is not firm. As a result, the estimated shortages for rice irrigation in Matagorda, Wharton, and Colorado counties are overstated. The continued use of interruptible water supplies to meet estimated irrigation demands will be considered as one of the water management strategies.

The second category of identified shortages includes WUGs that purchase water from one of the two designated major water providers within the LCRWPA - the City of Austin and the LCRA. In accordance with TWDB rules, water available to WUGs under wholesale contracts is no longer considered available once the contract expires. Since the City of Austin and the LCRA contracts generally extend for less than 50 years, most wholesale customers of these two major water providers will have an identified water shortage. The renewal and expansion of these wholesale water contracts will be considered as a water management strategy in Chapter 5. However, since both the City of Austin and the LCRA anticipate continuing these wholesale contracts in perpetuity, these demands have been considered in evaluating the water supply needs for the City of Austin and the LCRA.

4.1 COUNTY SUMMARIES OF WATER NEEDS

The following sections provide summaries of the needs and surpluses identified for each county within the LCRWPA. The tables presented in these sections provide a listing of individual WUGs with identified water supply needs (negative numbers in the tables indicate a water supply shortage). WUGs with water supply needs resulting from the expiration of a wholesale contract appear shaded and italicized in the following tables. Following the information for the individual WUGs with water supply needs is a summation of the total needs identified within the county. This information is presented in the required TWDB format (Table 7) in Appendix 4A.

4.1.1 Bastrop County

The primary sources of water for Bastrop County are the Carrizo-Wilcox and Queen City aquifers. Surface water supplies are primarily associated with power generation and are supplied from a combination of firm water from the Highland Lakes and Lake Bastrop. Local surface water supplies are available to irrigation and livestock users. Municipal water demands account for over one-half the total demand in Bastrop County. Steam electric generation accounts for an additional one-third of the total demand. A summary of the estimated water shortages identified for Bastrop County is presented in Table 4.1.

Table 4.1: Bastrop County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Garfield - CDP*	0	0	0	0	-1	-11
Bastrop Co.Total Needs	**0**	**0**	**0**	**0**	**-1**	**-11**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized
*CDP – Census Designated Place

4.1.2 Blanco County

Groundwater is available to users in Blanco County from the Ellenburger-San Saba, Trinity, Edwards-Trinity Plateau, and Hickory aquifers. Surface water supplies in the county are available from the City of Blanco's reservoirs and other local supplies. Municipal water demands account for over one-half of the total water demands in Blanco County. The remainder of the demand is divided between irrigation and livestock needs. A summary of the estimated water shortages identified for Blanco County is presented in Table 4.2.

Table 4.2: Blanco County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Blanco County-Other	-24	-70	-119	-163	-183	-215
City of Blanco	-52	-40	-23	-15	-5	-5
Blanco Co. Total Needs	**-76**	**-110**	**-142**	**-178**	**-188**	**-220**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.3 Burnet County

Groundwater is available to users in Burnet County from the Ellenburger-San Saba, Trinity, Marble Falls, and Hickory aquifers. Surface water supplies in the county are available from the Highland Lakes through contracts with the LCRA and other local supplies. Municipal water demands account for over one-half of the total water demands in Burnet County. The only water shortages identified in Burnet County are municipal shortages. Several of these shortages have been identified due to wholesale contract expirations. A summary of the estimated water shortages identified for Burnet County is presented in Table 4.3.

Table 4.3: Burnet County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Cottonwood Shores	*-3*	*-22*	*-164*	*-168*	*-170*	*-171*
Granite Shoals	*0*	*0*	*0*	*-456*	*-471*	*-493*
Marble Falls	*0*	*0*	*-1,874*	*-2,105*	*-2,177*	*-2,264*
County - Other	*-880*	*-1,103*	*-1,417*	*-1,652*	*-1,686*	*-1,779*
Burnet Co.Total Needs	**-883**	**-1,125**	**-3,455**	**-4,381**	**-4,504**	**-4,707**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.4 Colorado County

The primary source of groundwater in Colorado County is the Gulf Coast aquifer. Surface water supplies are available through the irrigation district operated by LCRA and its run-of-river water rights, as well as other local supply sources. Irrigation demands in Colorado County represent three-fourths of the water demand in the county and are the primary water supply shortage identified. A summary of the estimated water shortages identified for Colorado County is presented in Table 4.4.

Table 4.4: Colorado County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Irrigation	-100,861	-92,935	-85,904	-79,103	-72,519	-66,117
Colorado Co. Total Needs	**-100,861**	**-92,935**	**-85,904**	**-79,103**	**-72,519**	**-66,117**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.5 Fayette County

Groundwater supplies in Fayette County are available from the Gulf Coast, Sparta, and Queen City aquifers. Surface water is available for steam electric generation through the LCRA and the City of Austin. Steam electric generation represents three-fourths of the total water demand in the county with the remainder of the demand split primarily between municipal and livestock needs. It is estimated that the water supplies available to users in Fayette County are sufficient to meet the projected demands. No water supply needs were identified for Fayette County.

4.1.6 Gillespie County

Groundwater supplies in Gillespie County are available from the Ellenburger-San Saba, Edwards-Trinity, Trinity, and Hickory aquifers. Surface water is primarily available from local sources. Municipal water demands represent more than one-half of the total water demand in the county. Livestock and irrigation needs make up the majority of the remaining water demand. The only estimated water shortages identified for Gillespie County is associated with County-Other demands, as presented in Table 4.5.

Table 4.5: Gillespie County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
County - Other	-438	-478	-548	-608	-818	-944
Gillespie Co. Total Needs	**-438**	**-478**	**-548**	**-608**	**-818**	**-944**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.7 Hays County

Groundwater supplies in Hays County are available from the Edwards-BFZ and Trinity aquifers. Surface water availability is limited to local sources. Municipal demand represents over 80 percent of the total demand in the county and is the only water supply shortage identified for Hays County, as presented in Table 4.6.

Table 4.6: Hays County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
City of Dripping Springs	0	0	0	-22	-135	-364
County - Other	-990	-1795	-2558	-3525	-4643	-5227
Hays Co. Total Needs	**-990**	**-1795**	**-2558**	**-3547**	**-4778**	**-5591**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.8 Llano County

Groundwater supplies in Llano County are available from the Hickory and Ellenburger-San Saba aquifers. Surface water is available from the City of Llano reservoir and other local sources. Municipal demands represent one-half of the total demand in the county and all of the identified water supply shortage. Two of the shortages identified are the result of wholesale contract expirations. The remainder of the demand is primarily irrigation, steam electric generation, and livestock demands. A summary of the estimated water shortages identified for Llano County is presented in Table 4.7.

Table 4.7: Llano County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
County - Other	*0*	*0*	*0*	*-1334*	*-1449*	*-1653*
Kingsland CDP	*-25*	*-5*	*-472*	*-463*	*-472*	*-493*
City of Llano	-660	-633	-603	-555	-574	-602
Llano Co. Total Needs	**-685**	**-638**	**-1075**	**-2352**	**-2495**	**-2748**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.9 Matagorda County

The primary source of groundwater in Matagorda County is the Gulf Coast aquifer. Surface water supplies are available through the irrigation district operated by LCRA and its run-of-river water rights, as well as other local supply sources. Irrigation demands in Matagorda County represent three-fourths of the water demand in the county with steam electric generation being the second largest demand. Significant water supply shortages have been identified for irrigation, manufacturing, steam electric generation, and mining. All of these shortages, except the irrigation shortage, are associated with contract expirations. A summary of the estimated water shortages identified for Matagorda County is presented in Table 4.8.

Table 4.8: Matagorda County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Manufacturing	*-1,709*	*-29,751*	*-29,927*	*-30,035*	*-30,539*	*-31,019*
Steam Electric	*0*	*0*	*0*	*0*	*-5,237*	*-5,237*
Mining	*-4,475*	*-6,129*	*-6,168*	*-6,249*	*-6,278*	*-6,285*
Irrigation	-171,508	-159,382	-152,847	-146,822	-140,521	-134,718
Matagorda Co. Total Needs	**-177,692**	**-195,262**	**-188,942**	**-183,106**	**-182,575**	**-177,259**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.10 Mills County

The primary source of groundwater in Mills County is the Trinity aquifer. Surface water supplies are available through the City of Goldthwaite Reservoir and other local supply sources. Irrigation demands in Mills County represent one-half of the water demand in the county with the remainder of the demand being livestock and municipal demand. A summary of the estimated water shortages identified for Mills County is presented in Table 4.9.

Table 4.9: Mills County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
City of Goldthwaite	-117	-101	-88	-89	-85	-88
Mills Co. Total Needs	**-117**	**-101**	**-88**	**-89**	**-85**	**-88**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

In addition to the shortage identified for the City of Goldthwaite, isolated portions of Mills County are projected to have shortages for the County-Other category due to the inconsistency of the aquifers in the county. The shortage has not been quantified because of the isolated nature of the shortages.

4.1.11 San Saba County

Groundwater supplies in San Saba County are available from the Ellenburger-San Saba, Marble Falls, and Hickory aquifers. Surface water availability is limited to local sources. Irrigation demand represents two-thirds of the total demand in the county with the remaining demand being livestock and municipal demands. It is estimated that the water supplies available to users in San Saba County are sufficient to meet the projected demands. No water supply needs were identified for San Saba County.

4.1.12 Travis County

Groundwater supplies in Travis County are available from the Edwards-BFZ and Trinity aquifers. Surface water is available through the LCRA and City of Austin run-of-river water rights. Municipal water demands represent more than 80 percent of the total demand in the county. Manufacturing and steam electric generation account for most of the remaining demands. All of the identified water shortages are for municipal demands, with the majority of these shortages being associated with wholesale contract expirations. A summary of the estimated water shortages identified for Travis County is presented in Table 4.10.

Table 4.10: Travis County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Anderson Mill (CDP)	*0*	*-34*	*-34*	*-33*	*-32*	*-34*
Austin	0	0	0	0	0	-20,517
Garfield CDP	0	0	0	0	-46	-117
Jonestown	*0*	*0*	*0*	*-40*	*-438*	*-485*
Lago Vista	*0*	*0*	*0*	*-2,995*	*-3,291*	*-3,630*
Lakeway	*0*	*-180*	*-2,240*	*-2,693*	*-2,964*	*-3,287*
Pflugerville	*-291*	*-793*	*-1,476*	*-2,323*	*-2,825*	*-3,378*
Rollingwood	*0*	*0*	*0*	*-675*	*-726*	*-793*
Wells Branch CDP	*0*	*0*	*0*	*-1,013*	*-1,025*	*-1,064*
West Lake Hills	*0*	*0*	*0*	*-2,956*	*-3,294*	*-3,682*
County-Other	*-60*	*-66*	*-80*	*-7,438*	*-7,954*	*-8,797*
Travis Co. Total Needs	**-351**	**-1,073**	**-3,830**	**-20,166**	**-22,595**	**-45,784**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.13 Wharton County

The primary source of groundwater in Wharton County is the Gulf Coast aquifer. Surface water supplies are available through the irrigation districts operated by the LCRA and the Pierce Ranch Irrigation District; and the associated run-of-river water rights. In addition, surface water is available from other local supply sources. Irrigation demands in Wharton County represent 95 percent of the water demand in the county with municipal demands being the second largest demand. A summary of the estimated water shortages identified for Wharton County is presented in Table 4.11.

Table 4.11: Wharton County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Irrigation	-118,974	-110,078	-103,026	-96,224	-89,667	-83,346
Wharton Co. Total Needs	**-118,974**	**-110,078**	**-103,026**	**-96,224**	**-89,667**	**-83,346**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.1.14 Williamson County

Groundwater supplies in Williamson County are available from the Edwards-BFZ aquifer. Surface water is available through the City of Austin. Municipal water demands represent 99 percent of the demand in the County. The majority of the water supply shortages identified for Williamson County is associated with municipal demands and wholesale contract expirations. A summary of the water shortages identified for Williamson County is presented in Table 4.12.

Table 4.12: Williamson County Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
*Anderson Mill CDP**	*0*	*-1,975*	*-1,943*	*-1,986*	*-2,031*	*-2,106*
Austin	0	0	0	0	0	-391
County-Other	*-72*	*-103*	*-144*	*-178*	*-200*	*-215*
Williamson Co. Total Needs	**-72**	**-2,078**	**-2,087**	**-2,164**	**-2,231**	**-2,712**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized
* CDP – Census Designated Place

4.1.15 County-Wide Surpluses

The TWDB guidelines for SB 1 regional water planning require that areas with water supply surpluses be identified as well as areas with water supply needs. This analysis was conducted by comparing the countywide estimated water supplies with the countywide estimated water demands. It is important to note that although a particular county may have a countywide water supply surplus, individual WUGs within that county may have water supply needs because they do not have access to the surplus water. Table 4.13 contains a summary of the water supply condition within each county. It is also important to note that the regional totals shown in Table 4.13 are less than the water supply needs identified in Figure 4.2 due to surpluses in some counties. The fact that the regional totals show water supply needs despite considering the surpluses in some counties indicates that additional water must be developed to meet all of the needs in the LCRWPA. Simply moving surplus water from one area to another will not be sufficient to meet the needs of all WUGs in the LCRWPA.

Table 4.13: County and Regional Water Supply Condition Summary (+Surplus / -Deficit, ac-ft/yr)

County [1]	2000	2010	2020	2030	2040	2050
Bastrop	23,759	18,816	16,483	14,814	13,871	12,659
Blanco	12,487	12,387	12,281	12,181	12,166	11,883
Burnet	15,331	14,540	11,552	9,917	5,600	5,306
Colorado	-93,026	-84,526	-77,605	-70,968	-64,542	-58,372
Fayette	38,891	33,631	28,349	12,991	12,570	6,992
Gillespie	6,820	6,474	6,211	5,990	5,342	4,788
Hays	2,828	1,535	586	-693	-2,177	-3,311
Llano	35,371	34,463	32,797	31,319	31,197	30,958
Matagorda	-154,228	-182,603	-176,527	-170,899	-171,642	-167,171
Mills	2,685	2,772	2,847	2,720	2,788	2,598
San Saba	31,112	31,391	31,628	31,825	32,018	32,172
Travis	214,167	186,804	133,389	57,302	32,426	776
Wharton	-108,634	-99,944	-93,105	-86,602	-80,372	-74,539
Williamson	6,013	2,741	1,016	-398	-1,277	-2,332
Regional Totals [2]	**33,575**	**-21,520**	**-70,098**	**-150,500**	**-172,031**	**-197,593**

[1] Overall County Surplus/Deficit = Countywide Water Supply – Countywide Water Demand;
[2] Overall Regional Surplus/Deficit = Summation of County Surplus/Deficit.

4.2 BASIN SUMMARIES OF WATER NEEDS

The following sections contain summaries of the water shortages identified in each of the six basins within the Lower Colorado Regional Planning Area.

4.2.1 Brazos River Basin

The only shortage identified in the Brazos River Basin is in Williamson County and is due to the expiration of a wholesale water contract. Table 4.14 contains the detailed information.

Table 4.14: Brazos River Basin Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Anderson Mill CDP	*0*	*-1975*	*-1943*	*-1986*	*-2031*	*-2106*
Travis County-Other	*-48*	*-51*	*-58*	*-66*	*-70*	*-76*
Brazos Basin Total Needs	**-48**	**-2026**	**-2001**	**-2052**	**-2101**	**-2182**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.2.2 Brazos-Colorado Coastal Basin

Water supply shortages in the Brazos-Colorado Coastal Basin were identified for irrigation in Colorado, Matagorda, and Wharton counties. In addition, a manufacturing shortage was identified for Matagorda County due to the expiration of a wholesale water contract. Table 4.15 contains the detailed information.

Table 4.15: Brazos-Colorado Coastal Basin Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Irrigation (Colorado Co.)	-30,494	-28,335	26,431	-24,592	-22,811	-21,082
Manufacturing (Matagorda Co.)	*-1,709*	*-7,000*	*-7,051*	*-7,077*	*-7,217*	*-7,345*
Irrigation (Matagorda Co.)	-82,262	-76,587	-73,529	84	-67,763	-65,038
Irrigation (Wharton Co.)	-74,714	-69,911	-66,108	-62,441	-58,905	-55,495
Braz.-Col. Basin Total Needs	**-189,179**	**-181,833**	**-120,257**	**-94,026**	**-156,696**	**-148,960**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.2.3 Colorado River Basin

Water supply shortages were identified throughout the Colorado River Basin. Many of these shortages are associated with the expiration of wholesale water contracts. Table 4.16 contains the detailed information.

Table 4.16: Colorado River Basin Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Garfield CDP (Bastrop)	0	0	0	0	-1	-11
Cottonwood Shores	*-3*	*-22*	*-164*	*-168*	*-170*	*-171*
Granite Shoals	*0*	*0*	*0*	*-456*	*-471*	*-493*
Marble Falls	*0*	*0*	*-1,874*	*-2,105*	*-2,177*	*-2,264*
Irrigation (Colorado)	-5,943	-4,824	-3,799	-2,803	-1,833	-882
Burnet County-Other	*-6,222*	*-5,103*	*-4,078*	*-3,082*	*-2,112*	*-1,161*
Gillespie County-Other	-438	-478	-548	-608	-818	-944
Dripping Springs	0	0	0	-22	-135	-364
Hays County-Other	-990	-1,795	-2,558	-3,525	-4,643	-5,227
Kingsland CDP	*-25*	*-5*	*-472*	*-463*	*-472*	*-493*
Llano	-660	-633	-603	-555	-574	-602
Llano County-Other	*0*	*0*	*0*	*-1,334*	*-1,449*	*-1,653*
Manufacturing (Matagorda	*0*	*-22,751*	*-22,876*	*-22,958*	*-23,322*	*-23,674*
Steam Elect. (Matagorda)	*0*	*0*	*0*	*0*	*-5,237*	*-5,237*
Irrigation (Matagorda)	-9,758	-8,995	-8,581	-8,183	-7,799	-7,429
Goldthwaite	-117	-101	-88	-89	-85	-88
Anderson Mill CDP (Travis)	*0*	*-34*	*-34*	*-33*	*-32*	*-34*
Austin (Travis)	0	0	0	0	0	-20,517
Garfield CDP (Travis)	0	0	0	0	-49	-120
Jonestown	*0*	*0*	*0*	*-40*	*-438*	*-485*
Lago Vista	*0*	*0*	*0*	*-2,995*	*-3,291*	*-3,630*
Lakeway	*0*	*-180*	*-2,240*	*-2,693*	*-2,964*	*-3,287*
Pflugerville	*-291*	*-793*	*-1,476*	*-2,323*	*-2,825*	*-3,378*
Rollingwood	*0*	*0*	*0*	*-675*	*-726*	*-793*
Wells Branch CDP	*0*	*0*	*0*	*-1,013*	*-1,025*	*-1,064*
West Lake Hills	*0*	*0*	*0*	*-2,956*	*-3,294*	*-3,682*
Travis County-Other	*0*	*0*	*0*	*-7,342*	*-7,851*	*-8,682*
Irrigation (Wharton)	-15,752	-13,160	-11,096	-9,106	-7,189	-5,344
Austin (Williamson)	0	0	0	0	0	-391
Williamson County-Other	*-72*	*-103*	*-144*	*-178*	*-200*	*-215*
Colorado Basin Total Needs	**-40,270**	**-58,976**	**-60,630**	**-75,704**	**-81,181**	**-102,314**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized
WUGs have been sorted by County

4.2.4 Colorado-Lavaca Coastal Basin

The only water supply shortage identified in the Colorado-Lavaca Coastal Basin was for irrigation demands in Matagorda County. Table 4.17 contains the detailed information.

Table 4.17: Colorado-Lavaca Coastal Basin Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Mining (Matagorda Co.)	-4,475	-6,129	-6,168	-6,249	-6,278	-6,285
Irrigation (Matagorda Co.)	-79,488	-73,800	-70,737	-67,785	-64,959	-62,251
Irrigation (Wharton Co.)	-28,508	-27,007	-25,822	-24,677	-23,573	-22,507
Col.-Lav. Basin Total Needs	**-112,472**	**-106,937**	**-102,728**	**-98,712**	**-94,811**	**-91,044**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.2.5 Lavaca River Basin

The only water supply shortages identified in the Lavaca River Basin were in Colorado County. The shortages were identified for irrigation and mining. Table 4.18 contains the detailed information.

Table 4.18: Lavaca River Basin Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
Irrigation (Colorado Co.)	-64,424	-59,776	-55,674	-51,708	-47,875	-44,153
Lavaca Basin Total Needs	**-64,424**	**-59,776**	**-55,674**	**-51,708**	**-47,875**	**-44,153**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.2.6 Guadalupe River Basin

Water supply shortages in the Guadalupe River Basin were identified for Bastrop, Blanco, and Travis counties. Table 4.19 contains the detailed information.

Table 4.19: Guadalupe River Basin Water Supply Needs (ac-ft/yr)

Water User Group Name	2000 Needs	2010 Needs	2020 Needs	2030 Needs	2040 Needs	2050 Needs
City of Blanco	-52	-40	-23	-15	-5	-5
Blanco County-Other	-24	-70	-119	-163	-183	-215
Travis County-Other	-12	-15	-22	-30	-33	-39
Guadalupe Basin Total Needs	**-88**	**-125**	**-164**	**-208**	**-221**	**-260**

WUGs with water supply needs resulting from the expiration of a wholesale contract are shaded and italicized

4.3 DESIGNATED MAJOR WATER PROVIDERS

As previously discussed, the LCRA and City of Austin have been identified as major providers of water within the Lower Colorado Regional Planning Area. The following sections present a comparison of the water supplies for these two entities and their water supply commitments.

4.3.1 Lower Colorado River Authority

The LCRA has two major sources for its water. These sources include the Highland Lakes System and run-of-river water rights in the lower portion of the basin. The LCRA has commitments to provide water to individual users and cities throughout the basin. In addition, the LCRA uses water at its electric generating facilities. Table 4.20 contains a comparison of LCRA's water supplies to its water commitments.

Table 4.20: LCRA Water Supply/Commitment Comparison (ac-ft/yr)

LCRA Water Supply	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Firm Water Supply	498,166	498,166	498,166	498,166	498,166	498,166
Firm Water Commitments	432,647	432,647	432,647	432,647	432,647	432,647
Interruptible Water Needs	379,642	353,710	334,899	318,249	301,059	284,384
Water Surplus/Deficit	**-314,123**	**-288,191**	**-269,380**	**-252,730**	**-235,540**	**-218,865**

Note: The water supply is detailed in Table 3.20.
The water commitments are detailed in Table 3.21. The sum presented in Table 4.20 represents all commitments, regardless of expiration since the LCRA plans to continue providing these services. The total water commitment includes all rice irrigation demands. Commitments also include the out-of-basin 25,000 ac-ft/yr demand from Region G in Williamson Co.

This table indicates that the LCRA does not have enough water to meet all of its water commitments, although it does have enough water to meet its firm water commitments through the year 2050. It is also important to recognize that this analysis does not include interruptible water supplies available through the implementation of the Water Management Plan or City of Austin return flows. These supplies are discussed in Chapter 5 as water management strategies.

4.3.2 City of Austin

The City of Austin (COA) has two major sources for its water. These sources include the run-of-river water rights and a contract with LCRA to receive water from the Highland Lakes during drought conditions. These rights are separated by the use of the water. The City of Austin has separate rights for municipal uses and steam electric generation. Tables 4.21 and 4.22 contain comparisons of the City of Austin's water supplies to its water commitments in these two areas.

Table 4.21: COA Municipal & Manufacturing Water Supply/Commitment Comparison (ac-ft/yr)

COA Water Supply	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Municipal Water Supply	325,000	325,000	325,000	325,000	325,000	325,000
Municipal Water Commitment	198,073	225,580	263,470	301,447	326,341	355,714
Water Surplus / Need	**126,927**	**99,420**	**61,530**	**23,553**	**-1,341**	**-30,714**

Note: The water supply is detailed in Table 3.22.
The water commitments are detailed in Table 2.16. The sum presented in Table 4.21 represents all commitments, regardless of expiration since the City of Austin plans to continue providing these services. This includes the 6,161 ac-ft/yr for the City of Round Rock.

This table indicates that the City of Austin has sufficient water to meet its municipal and manufacturing needs through the year 2030. By the year 2050, it is anticipated that the City of Austin will have a deficit of approximately 31,000 ac-ft/yr, or approximately 9 percent of its demands.

Table 4.22: COA Steam Electric Water Supply/Commitment Comparison (ac-ft/yr)

COA Water Supply	Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
Stm. Elec. Water Supply	46,856	46,856	46,856	46,856	46,856	46,856
Stm. Elec. Water Commitment	21,500	21,500	21,500	21,500	21,500	24,500
Water Surplus	**25,356**	**25,356**	**25,356**	**25,356**	**25,356**	**22,356**

Note: The water supply is detailed in Table 3.22.
The water commitments are detailed in Table 2.16. The sum presented in Table 4.22 represents all steam electric generating needs for Travis County plus 8,000 ac-ft/yr at the Fayette Power Project.

This table indicates that the City of Austin has a surplus of water for its steam electric generating needs as a whole.

The comparison of water demands to water supplies available to each WUG within the Lower Colorado Regional Water Planning Area (LCRWPA) has identified 38 separate water user groups that are projected to have water supply shortages by the year 2030, and an additional 4 WUGs that are projected to have a deficit by 2050. The estimated water need is approximately 390,000 acre-feet per year (ac-ft/yr) in 2030 and 2050. This identified shortage excludes water available from LCRA on an interruptible basis and water available as a result of Austin's return flows to the Colorado River. The water management strategies detailed in Chapter 5.0 have been designed to alleviate these projected water supply shortages.

APPENDIX 4A

TWDB-REQUIRED TABLES FOR COMPARISON OF WATER DEMANDS AND WATER SUPPLIES (EXHIBIT B DATA TABLES 7 & 8)

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

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CHAPTER 5.0: IDENTIFICATION, EVALUATION, AND SELECTION OF WATER MANAGEMENT STRATEGIES

The primary emphasis of the regional water planning effort mandated in SB 1 is the development of regional water management strategies sufficient to meet the projected needs of water user groups (WUGs) throughout the state. Water needs are determined by comparing user group water demands to the water supplies available to that user group. The following sections present information concerning the identification, evaluation, and selection of specific water management strategies to meet specific projected water supply shortages for the Lower Colorado Regional Planning Area (Region K). It should be noted that local plans that are not inconsistent with the regional water supply plan are also eligible to apply for TWDB financial assistance even though they have not been specifically recommended in this plan.

5.1 TWDB GUIDELINES FOR WATER MANAGEMENT PLAN DEVELOPMENT

The Texas Water Development Board (TWDB) has promulgated rules for SB 1 regional planning and has provided guidance to Regional Water Planning Groups (RWPGs) concerning the development of regional water plans. Specific TWDB requirements for the development of a regional plan include the following:

- Regional water plans must include specific recommendations of water management strategies to meet the near-term needs (2000-2030) in sufficient detail to allow state agencies to make financial or regulatory decisions to determine the consistency of the proposed action before the state agency with an approved regional water plan. (31 TAC 357.7 (a)(8)(A))
- Regional water plans must include identified alternatives for long-term water management scenarios that meet the long-term needs (2030-2050) of the region. An alternative long-term scenario is a combination of various water management strategies. (31 TAC 357.7 (a)(8)(B)). The level of detail required for long-term alternative scenarios is much less than for the short-term strategies.
- Regional water plans must include an evaluation of all water management strategies determined to be potentially feasible by theRWPG. (31 TAC 357.7(a)(6))
- Water management strategies shall be evaluated using the following criteria: (31 TAC 357.7(a)(7))
  - The quantity, reliability, and cost of water delivered and treated for the end users' requirements;
  - Environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and impacts of upstream development on bays, estuaries, and arms of the Gulf of Mexico;
  - Impacts on other water resources of the state including other water management strategies and groundwater/surface water interrelationships;
  - Impacts of water management strategies on threats to agricultural and natural resources of the Regional Water Planning Area;
  - Any other factors deemed relevant by the RWPG including recreational impacts;
  - Equitable comparison and consistent application of all water management strategies the RWPG deem potentially feasible for each water supply need;
  - Consideration of the provisions in §11.085(k)(1) of the Texas Water Code, regarding interbasin transfers; and,
  - Consideration of third party social and economic impacts resulting from voluntary redistribution of water supplies.

5.2 SUMMARY OF REGIONAL WATER NEEDS

The comparison of available water supplies and water demands has identified 38 separate water user groups (WUGs) that have projected water demand deficits, or needs, by the year 2030 and an additional five WUGs with projected water demand deficits before the year 2050. The total estimated water need for the region is approximately 391,000 acre-feet per year (ac-ft/yr) in the year 2030 and decreases to 387,000 ac-ft/yr in 2050. (*It is important to note that this statement of needs does not include the availability of interruptible water supplies, the renewal of expired water sales contracts, or the continuation of return flows. The actual amount of new water needed in the basin is much less.*) Water needs have been identified in five of the six water use categories, as shown in Figure 5.1, which contains an illustration of the distribution of the number of WUGs with identified water needs in the years 2030 and 2050. Figure 5.2 contains an illustration of the magnitude of the identified needs, by use category, for the years 2030 and 2050.

Figure 5.1: WUGs With Identified Water Needs in the LCRWPA

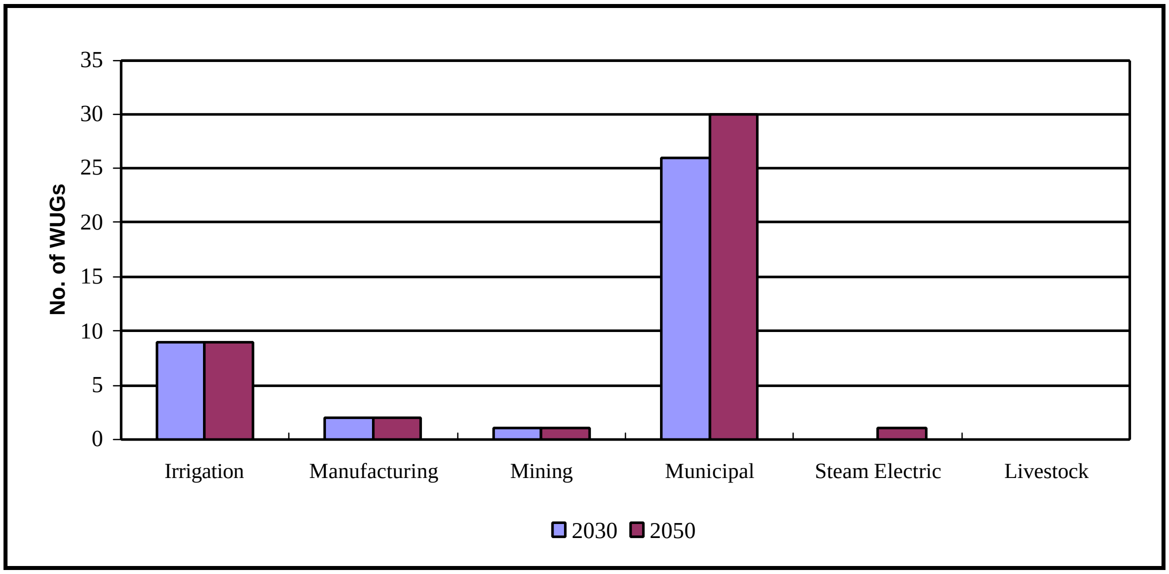
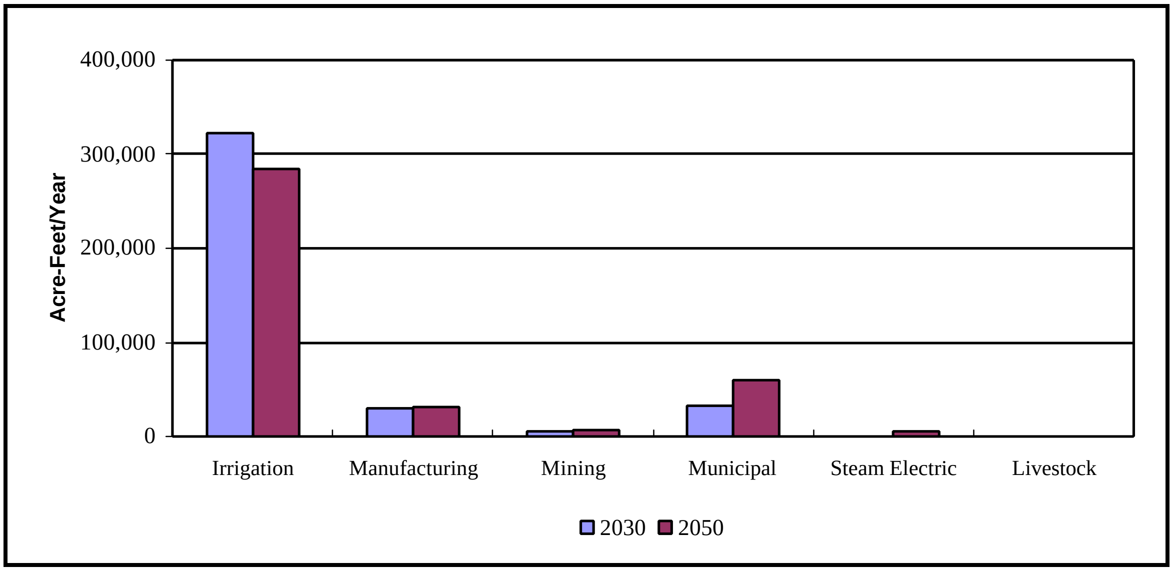


Figure 5.2: Identified Water Needs in the LCRWPA



The following sections contain more detailed information concerning the WUGs with identified water demand needs. The WUGs with identified needs have been grouped either geographically or by user classification for discussion purposes.

5.2.1 Major Water Provider Deficits

As previously discussed, the LCRWPG has identified two major water providers of municipal and industrial water within the planning area: the Lower Colorado River Authority (LCRA) and the City of Austin (COA). Both of these major water providers have been identified as having water supply shortages within the planning period. These shortages are presented in the following section.

5.2.1.1 Lower Colorado River Authority

The LCRA has two major sources of water within the region: the Highland Lakes System; and run-of-river rights, which are concentrated primarily within the lower basin. The LCRA exercises its water rights to provide water to municipalities, industries, irrigators, and other water consumers on a contract basis. The LCRA provides two types of water; firm water, which is guaranteed during drought periods as severe as the drought of record; and interruptible water, which is subject to curtailment based on water levels in the reservoirs.

As indicated in Table 3.21, the LCRA has commitments for firm water supplies totaling 432,647 ac-ft/yr. This includes the water that can be supplied to the rice irrigators in the lower basin using firm run-of-river water rights. The LCRA has a dependable water availability of 498,166 ac-ft/yr, excluding the City of Austin's return flows. Based on this analysis, the LCRA has adequate water to meet its firm commitments. However, the LCRA also has commitments to provide interruptible water to the rice irrigators to meet their demands. In accordance with TWDB guidelines, the supply of interruptible water was not considered in Chapters 3 and 4. In addition, the continuation of Austin return flows was not considered in previous chapters. Based on the assumption that this water is not available, it is estimated that the maximum annual deficit for rice irrigation would be approximately 391,000 ac-ft/yr in the year 2000. The average annual deficit during the critical drought would be considerably less. In addition, this deficit would decrease over time due to projected decreasing irrigation demands. The deficit would be approximately 322,000 ac-ft/yr in 2030 and 284,000 ac-ft/yr in 2050.

5.2.1.2 City of Austin

The COA has two sources of water: the City has run-of-river rights for water from the Colorado River; and a recently amended agreement with the LCRA to obtain water stored in the Highland Lakes System. The 1999 amendment provides the COA with a firm water supply for municipal, industrial, and wholesale water needs totaling 325,000 ac-ft/yr. In addition, the City has run-of-river rights and an agreement with the LCRA for water to be used at its steam electric plants.

The water supply analysis in Chapter 4 indicates that the City has sufficient water to meet its steam electric needs through 2050. The City has sufficient water to meet its municipal, industrial, and wholesale water needs through 2030. However, the projected municipal, industrial, and wholesale demands (including all wholesale contracts, regardless of contract expiration) are projected to exceed the available supply of water by 2040. The City is projected to have a water supply shortage of 30,714 ac-ft/yr in 2050.

5.2.2 Wholesale Water Customers with Contractual Demand Deficits

The LCRA and the City of Austin both have numerous contracts with water user groups for the sale of water. In most instances, these contracts have a term less than the 50-year planning period. In accordance with TWDB guidelines, the water supplied under these contracts was assumed to no longer be available once the contracts expire. As a result, water user groups dependent on water from these contracts show a water demand need after the expiration dates of the contracts. In addition, a few WUGs have contracted for less water than the projections indicate will ultimately be required. Table 5.1 contains a list of 19 WUGs for which contractual shortages have been identified. These 19 WUGs make up half of the total number of WUGs (38) identified with water demand shortages.

Table 5.1: LCRWPA Water User Groups with Contractual Water Demand Deficits (ac-ft/yr)

WUG	County	2000	2010	2020	2030	2040	2050
Cottonwood Shores	Burnet	-3	-22	-164	-168	-170	-171
Granite Shoals	Burnet	0	0	0	-456	-471	-493
Marble Falls	Burnet	0	0	-1,874	-2,105	-2,177	-2,264
County-Other	Burnet	-880	-1,103	-1,417	-1,652	-1,686	-1,779
County-Other	Llano	0	0	0	-1,334	-1,449	-1,653
Kingsland	Llano	-25	-5	-472	-463	-472	-493
Manufacturing	Matagorda	-1,709	-29,751	-29,927	-30,035	-30,539	-31,019
Steam Electric	Matagorda	0	0	0	0	-5,237	-5,237
Mining	Matagorda	-4,475	-6,129	-6,168	-6,249	-6,278	-6,285
Anderson Mill	Travis	0	-34	-34	-33	-32	-34
Jonestown	Travis	0	0	0	-40	-438	-485
Lago Vista	Travis	0	0	0	-2,995	-3,291	-3,630
Lakeway	Travis	0	-180	-2,240	-2,693	-2,964	-3,287
Rollingwood	Travis	0	0	0	-675	-726	-793
Wells Branch	Travis	0	0	0	-1,013	-1,025	-1,064
West Lake Hills	Travis	0	0	0	-2,956	-3,294	-3,682
County-Other	Travis	-60	-66	-80	-7,438	-7,954	-8,797
Anderson Mill[1]	Williamson	0	-1,975	-1,943	-1,986	-2,031	-2,106
County-Other	Williamson	-72	-103	-144	-178	-200	-215
Regional Total		**-7,678**	**-39,876**	**-45,045**	**-62,469**	**-70,434**	**-73,487**

[1] Becomes City retail customer in 2004.

5.2.3 Irrigation Demand Deficits

As previously discussed, irrigators in Colorado, Wharton, and Matagorda counties would currently have a significant water demand deficit during a repeat of the drought of record. Irrigators have five primary sources of water: run-of-river rights from the Colorado River; return flows from the City of Austin; groundwater supplies from the Gulf Coast aquifer; local surface water supplies from local streams; and interruptible water supplies from the LCRA. The interruptible supply of water from the LCRA and Austin's return flows were not initially considered as part of the water availability analysis in Chapter 4 since they may not be available in the future. Therefore, the Gross Projected Water Shortage in Table 5.2 excludes the availability of the availability of these supplies. However, it is anticipated that the interruptible water supply and return flows will be available to the irrigators in varying amounts throughout the planning period. Providing these supplies to the irrigators increases their ability to better utilize their run-of-river rights because more acreage will be in production and the irrigation districts will be able to capture and utilize more storm water flows during the irrigation season. The Net Projected

Shortage in Table 5.2 reflects the inclusion and anticipated continuation of the LCRA's interruptible water supply and City of Austin return flows.

Table 5.2: LCRWPA Rice Irrigation Demand and Supply Analysis

	2000	2010	2020	2030	2040	2050
Rice Irrigation Demand	575,933	546,985	526,367	506,469	487,317	468,771
Available Water Supplies[1]						
Gulf Coast Aquifer	108,038	108,038	108,038	108,038	108,038	108,038
Other Aquifer	1,000	1,000	1,000	1,000	1,000	1,000
Dependable ROR Rights	50,000	50,000	50,000	50,000	50,000	50,000
Local Surface Water	25,552	25,552	25,552	25,552	25,552	25,552
Gross Projected Shortage[2]	***-391,343***	***-362,395***	***-341,777***	***-321,879***	***-302,727***	***-284,181***
Interruptible Water Supply[3]	290,095	214,760	172,801	116,051	100,643	96,585
City of Austin Return Flow	52,249	72,334	83,083	83,401	61,814	21,018
Net Projected Shortage[4]	**-48,999**	**-75,301**	**-85,893**	**-122,427**	**-140,270**	**-166,578**

1 Supply analysis based on worst year during the 10-year critical drought period.
2 Corresponds to shortages reported in Chapter 4 using TWDB guidelines.
3 Interruptible supply number includes water released from Highland Lakes plus additional run-of-river rights available for use due to the availability of the interruptible water. Taken from LCRA e-mail dated 12/6/00.
4 Corresponds to actual water shortage expected.

5.2.4 Austin Metropolitan Area Demand Deficits

Water user groups in the Austin Metropolitan Area generally receive water from either the City of Austin or the LCRA. Several of these WUGs have needs identified due to contractual issues, which were discussed previously. While the supply of water to these contract users was shown to go away once the contracts expired, the demand placed on the City of Austin, as a Major Water Provider, was continued since the City fully expects to continue to serve these customers and is compelled to plan for their needs as part of its own water planning effort. As a result, the City of Austin is shown to have a shortage of 30,714 ac-ft/yr identified in 2050.

The City of Pflugerville is one of Austin's wholesale customers, which has a contract to purchase up to 10 million gallons per day (mgd) from the City of Austin. This contract does not contain an expiration date. However, the City of Pflugerville was still identified as having a shortage since it does not currently have the infrastructure in place to receive water from Austin. The other major water shortage identified for the Austin Metropolitan Area is for the Hays "County-Other" category and the City of Dripping Springs. The shortages for the Austin Metropolitan Area are shown on Table 5.3.

Table 5.3: Austin Metropolitan Area Water Demand Deficits (ac-ft/yr)

WUG	2000	2010	2020	2030	2040	2050
City of Austin[1]	0	0	0	0	-1,341	-30,714
City of Pflugerville	-476	-978	-1,661	-2,508	-3,010	-3,563
Hays County-Other	-990	-1,795	-2,558	-3,525	-4,643	-5,227
City of Dripping Springs	0	0	0	-22	-135	-364
Total [2]	**-990**	**-1,795**	**-2,558**	**-3,547**	**-6,119**	**-36,305**

[1] City of Austin includes all municipal, industrial, and wholesale water demands.
[2] City of Pflugerville shortage not included in total since it is included in Austin demands.

5.2.5 Hill Country Municipal Demand Deficits

Several communities in the Hill Country have identified water demand deficits. These communities are generally located in areas where groundwater resources are scarce and sufficient storage is not currently available to make surface water supplies reliable. Table 5.4 provides a summary of the needs identified in the Hill Country portion of the LCRWPA.

Table 5.4: Hill Country Municipal Water Demand Deficits (ac-ft/yr)

WUG	2000	2010	2020	2030	2040	2050
City of Blanco	-52	-40	-23	-15	-5	-5
Blanco County-Other	-24	-70	-119	-163	-183	-215
Gillespie County-Other	-507	-547	-617	-677	-887	-1,013
City of Llano	-660	-633	-603	-555	-574	-602
City of Goldthwaite	-117	-101	-88	-89	-85	-88
Total	**-1,360**	**-1,391**	**-1,450**	**-1,499**	**-1,734**	**-1,923**

In addition to the shortages identified in Table 5.4, isolated portion of Mills County are projected to have shortages due to the inconsistency of the aquifers in that area. The shortage for Mills County-Other has not been quantified due to the isolated nature of the problem.

5.3 ECONOMIC LOSSES OF EXPECTED FUTURE WATER SUPPLY SHORTAGES

Water supply shortages in the region are expected to have significant economic, social, and demographic impacts within the LCRWPA during drought of record conditions. If the anticipated water supply shortages from a repeat of the drought of record (identified in Chapter 4) were allowed to occur under projected conditions with no action other than continuation of the LCRA's Drought Management Plan, businesses would relocate, production would be reduced, and employment would be disrupted. Incomes would be negatively impacted as a result of employment declines and population levels would likely decline in the region. Identified shortages would occur if public and private agencies responsible for providing water services failed to act beyond execution of the LCRA's Drought Management Plan. This section of the report summarizes the potential economic losses expected to accrue within the LCRWPA from the failure to eliminate the identified water supply shortages. This analysis is limited to the period between years 2000 and 2030.

The staff of the TWDB estimated the economic impacts of not eliminating the projected shortages. The impact estimates are based on shortages expected under worst case assumptions estimated by using "firm" water supplies to calculate shortages. That is, the TWDB staff estimates assume that long-term municipal water contracts will not be renewed and that interruptible water supplies would not be available to rice irrigators.

Three adjustments are needed to get from a statement of gross economic impacts provided by the TWDB staff to an estimate of expected economic losses of water supply shortages to the Lower Colorado Region. First, the magnitudes of the projected shortages have been modified to represent expected conditions during the average shortage year of the drought of record rather than the firm water estimates on which the TWDB impact study is based. This change includes the addition of LCRA interruptible water supplies, the continuation of return flows from Austin, and the elimination of projected contract water shortages that are the basis for the TWDB staff's analysis of impacts. The resulting projected shortages represent expected conditions under the drought of record with the LCRA's Drought Management Plan in operation. Second, opportunity costs have been provided to convert the TWDB's estimates from impacts to regional economic losses. Third, the analysis has been adjusted to represent the changes at the economic margin rather than the average.

The TWDB staff analysis is based, in the first instance, on estimates of direct income, employment and valued added per dollar of a sector's delivery to final demand. For example, estimates from the input-output modeling system, which measures these values for the average conditions show that the direct loss of income from a one-dollar reduction of rice exports is $0.293. Since it is clear that the first units of export reductions due to water shortages would come from marginal lands and/or marginal managers of rice farms rather the average land/farmer, adjustments are needed. Marginal farmers/lands can return about as much income from an alternative crop, or by going out of production. The TWDB staff average estimate was adjusted to represent the direct income loss for the year 2030 shortage of 122,427 acre-feet, the marginal change from a total demand of 506,469 acre-feet. The estimates were derived from information contained in the Technical Memorandum: "Rice Irrigation Economics and an Agriculture-to-Agriculture Transfer Option" (Appendix 5B), and an April 3, 2000 version of the paper. The result is to reduce the direct income loss estimate from $47 dollars per acre-foot to $13 per acre-foot, representing the marginal change rather than the average.

In the case of municipal shortages in the small cities of the Hill Country area, adjustments to the average income and employment losses from projected shortages are needed. A part of the economic impacts of these municipal shortages comes from growth at the margin (new people and businesses). To convert the implied economic losses from the TWDB staff estimates to expected economic losses, the growth part of the economic impact estimates was eliminated. From the region's perspective, income and employment growth in one place is as good as another. Since the TWDB staff analysis implies that water shortages would prevent the growth in the identified places and in the region, a more reasonable assumption is that the growth otherwise attracted to small cities and rural areas in the Hill Country would simply go to surrounding places with available water supplies. That is, if water shortages would prevent growth in these areas, with the growth instead occurring out-of-basin, it is more reasonable that this marginal growth would go to nearby Hill Country areas within the Colorado River Basin that do have adequate water supplies.

The TWDB staff analysis for economic impacts of projected shortages is summarized in Table 5.5. The income impacts and projected water shortages are shown in Figure 5.3. The impacts are calculated assuming worst-case water shortages where existing wholesale contracts for water would not be renewed (although the water is projected to be available); and interruptible water supplies (that are a major portion of the irrigation water source) are not available. The employment impacts range from 7,719 in year 2000 to 62,270 in year 2030. The income impacts are estimated to be $162 million in year 2000 rising to $1.9 billion in 2030. Population impacts are estimated to rise from 14,674 in year 2000 to 121,995 in 2030. These gross impact estimates are adjusted to represent expected economic losses and are reported in the following sections.

The result of the above-mentioned three adjustments (reported in the following sections) is to provide a basis for comparing the costs of various strategies with the expected benefits of the Lower Colorado Regional Water Plan adopted by the LCRWPG. The benefits of the adopted plan are the avoidance of the expected economic losses that would come from the water supply shortages under continuation of current practices. If the adopted plan costs more than the benefits, then there would be an expected net economic loss from the Regional Water Plan. If benefits (economic losses avoided) exceed the costs, there will be a net economic gain from the plan. (The analysis presented here is based on the average drought year income loss. The income loss avoided by the plan should be large enough to pay for a strategy that avoids shortages during the maximum shortage year of the drought of record.)

5.3.1 Economic Analysis Adjustment to Estimate the Expected Size of the Shortage

The adjustments to the magnitude of water supply shortages represents expected (rather than worst-case firm water) conditions during the average drought year. This results in the regional shortage for the year 2030 being reduced from the worst-case estimate of 399,785 ac-ft/yr to 125,658 ac-ft/yr. The expected shortages that sum to the reduced amount of 125,658 ac-ft are in (1) municipal shortages in Hays County, Gillespie County-Other, and the cities of Blanco, Llano, and Goldthwaite; and (2) rice irrigation. Figure 5.3 illustrates the water supply shortages and income impacts estimated by the TWDB staff for the projected shortage case (excluding the LCRA's interruptible water supply and including water shortages associated with wholesale contract expirations). The detailed income, production, employment, and population impacts of the "No Action" Alternative are shown in Table 5.5.

Figure 5.3: Regional Income Impact of Projected Water Shortages

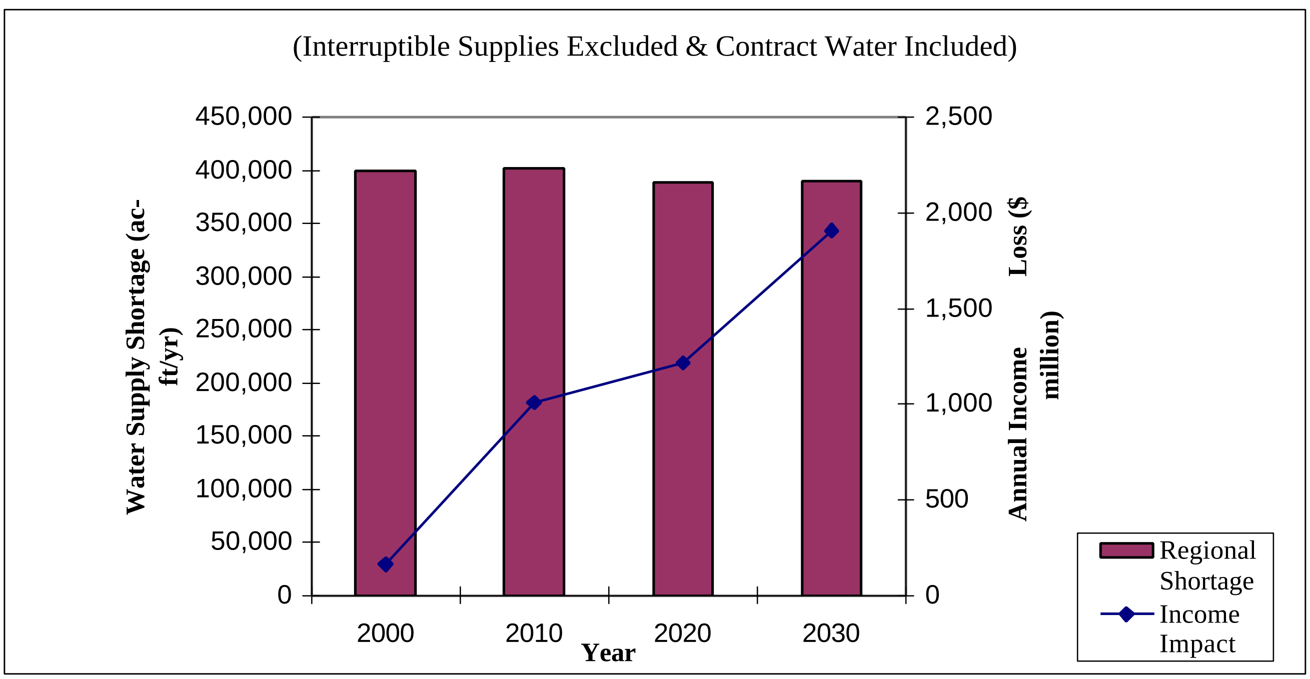


Table 5.5: LCRWPA Summary of Income Impacts for Projected Water Supply Shortages [2]

(Excluding Interruptible Supplies and Including Contract Shortages)

Water Use Category	Decade	Water Supply Need (ac-ft/yr)	Impact of Need on Employment	Impact of Need on Gross Business Output [1] ($ million/yr)	Impact of Need on Population	Impact of Need on School Enrollment	Impact of Need on Income [1] ($ million/yr)	# WUGs With Needs
Municipal	2000	(3,090)	3,998	$ 309	7,600	1,660	$ 111	11
Manufacturing	2000	-	-	$ -	-	-	$ -	0
Steam Elec.	2000	-	-	$ -	-	-	$ -	0
Mining	2000	(4,598)	453	$ 65	860	188	$ 18.34	4
Irrigation	2000	(391,343)	3,269	$ 101	6,214	1,364	$ 32.10	10
Livestock	2000	-	-	$ -	-	-	$ -	0
TOTAL		**(399,030)**	**7,719**	**$ 474**	**14,674**	**3,212**	**$ 162**	**25**
Municipal	2010	(6,238)	6,801	$ 550	12,960	2,820	$ 188	15
Manufacturing	2010	(27,176)	19,765	$ 2,525	37,790	8,499	$ 766	2
Steam Elec.	2010	-	-	$ -	-	-	$ -	0
Mining	2010	(6,202)	611	$ 87	1,155	250	$ 24.73	3
Irrigation	2010	(362,395)	3,027	$ 93	5,733	1,231	$ 29.73	9
Livestock	2010	-	-	$ -	-	-	$ -	0
TOTAL		**(402,010)**	**30,204**	**$ 3,255**	**57,638**	**12,800**	**$ 1,008**	**29**
Municipal	2020	(12,647)	13,990	$ 1,127	26,977	6,194	$ 387	16
Manufacturing	2020	(27,551)	20,038	$ 2,559	38,834	8,817	$ 777	2
Steam Elec.	2020	-	-	$ -	-	-	$ -	0
Mining	2020	(6,268)	618	$ 88	1,191	278	$ 25.00	3
Irrigation	2020	(341,777)	2,855	$ 88	5,502	1,290	$ 28.04	9
Livestock	2020	-	-	$ -	-	-	$ -	0
TOTAL		**(388,242)**	**37,500**	**$ 3,863**	**72,504**	**16,579**	**$ 1,216**	**30**
Municipal	2030	(33,679)	38,696	$ 3,085	75,814	17,397	$ 1,071	24
Manufacturing	2030	(27,853)	20,258	$ 2,587	39,706	9,116	$ 785	2
Steam Elec.	2030	-	-	$ -	-	-	$ -	0
Mining	2030	(6,375)	628	$ 90	1,225	283	$ 25.42	3
Irrigation	2030	(321,879)	2,689	$ 83	5,250	1,204	$ 26.41	9
Livestock	2030	-	-	$ -	-	-	$ -	0
TOTAL		**(389,785)**	**62,270**	**$ 5,845**	**121,995**	**28,000**	**$ 1,908**	**38**

[1] Calculated in 2nd quarter 1999 US Dollars.

[2] Water shortages and monetary losses are negative numbers displayed in parentheses.

Figure 5.4 shows the shortage and income impacts of the expected water shortage after including LCRA interruptible water supplies and excluding contract water shortages from the calculations. The income impacts range from $52 million per year in year 2000 to $113 million in 2030. Employment impacts are 2,139 in year 2000 and 4,732 in 2030. Population impacts associated with the employment impacts are 4,066 in year 2000 and 9,264 in 2030 (see Table 5.6). Table 5.6 shows the detailed income, production, employment, and population impacts of shortage levels with the LCRA Drought Management Plan in place, and assuming the continuation of expired long-term contracts.

Figure 5.4: Regional Income Impacts of Anticipated Water Supply Shortages

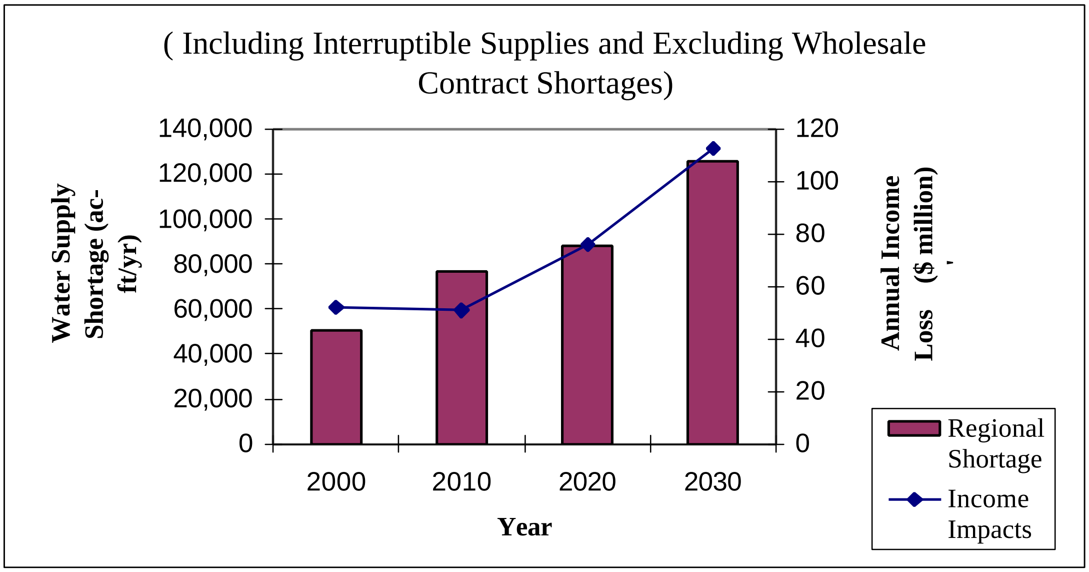


Table 5.6: LCRWPA Summary of Income Impacts for Anticipated Water Supply Shortages [2]

(Including Interruptible Supplies and Excluding Contract Shortages)								
Water Use Category	**Decade**	**Water Supply Need (ac-ft/yr)**	**Impact of Need on Employment**	**Impact of Need on Gross Business Output [1] ($ millions/yr)**	**Impact of Need on Population**	**Impact of Need on School Enrollment**	**Impact of Need on Income [1] ($ millions/yr)**	**Unit Income Loss ($/ac-ft)**
Municipal	2000	(1,329)	1,720	$ 133	3,269	714	$ 48	$ (35,949)
Manufacturing	2000	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2000	-	-	$ -	-	-	$ -	$ -
Mining	2000	(98)	10	$ 1.38	18	$ 4.01	$ 0.39	$ (3,988)
Irrigation	2000	(48,999)	409	$ 13	778	171	$ 4.02	$ (82)
Livestock	2000	-	-	$ -	-	-	$ -	$ -
TOTAL		**(50,426)**	**2,139**	**$ 147**	**4,066**	**889**	**$ 52**	**$ (1,035)**
Municipal	2010	(1,483)	1,617	$ 131	3,081	670	$ 45	$ (30,117)
Manufacturing	2010	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2010	-	-	$ -	-	-	$ -	$ -
Mining	2010	(17)	2	$ 0.24	3	$ 0.67	$ 0.07	$ (3,988)
Irrigation	2010	(75,301)	629	$ 19.37	1,191	256	$ 6.18	$ (82)
Livestock	2010	-	-	$ -	-	-	$ -	$ -
TOTAL		**(76,801)**	**2,247**	**$ 150**	**4,276**	**927**	**$ 51**	**$ (663)**
Municipal	2020	(2,256)	2,495	$ 201	4,812	1,105	$ 69	$ (30,571)
Manufacturing	2020	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2020	-	-	$ -	-	-	$ -	$ -
Mining	2020	(10)	1	$ 0.14	2	$ 0.44	$ 0.04	$ (3,988)
Irrigation	2020	(85,893)	717	$ 22.09	1,383	324	$ 7.05	$ (82)
Livestock	2020	-	-	$ -	-	-	$ -	$ -
TOTAL		**(88,159)**	**3,214**	**$ 223**	**6,197**	**1,430**	**$ 76**	**$ (863)**
Municipal	2030	(3,228)	3,709	$ 296	7,267	1,667	$ 103	$ (31,797)
Manufacturing	2030	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2030	-	-	$ -	-	-	$ -	$ -
Mining	2030	(3)	0	$ 0.04	1	$ 0.13	$ 0.01	$ (3,988)
Irrigation	2030	(122,427)	1,023	$ 31.49	1,997	458	$ 10.04	$ (82)
Livestock	2030	-	-	$ -	-	-	$ -	$ -
TOTAL		**(125,658)**	**4,732**	**$ 327**	**9,264**	**2,126**	**$ 113**	**$ (897)**

[1] Calculated in 2nd quarter 1999 US Dollars.

[2] Water shortages and monetary losses are negative numbers displayed in parentheses.

5.3.2 Including Opportunity Costs

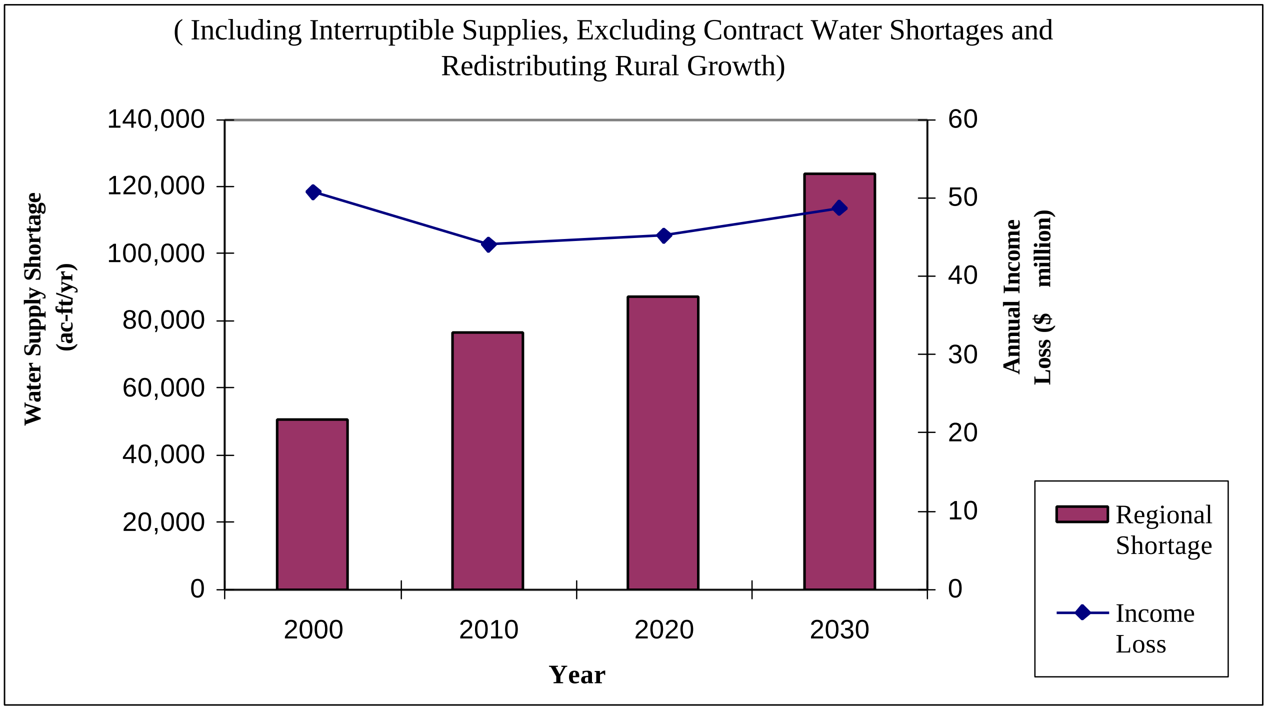
The opportunity costs of rice irrigation (grass production) are included in the TWDB's staff analysis. This is one of two classes of water users where water supply shortages are projected after magnitude adjustments (discussed in the prior section). The opportunity costs of the rural area municipal water supply shortages can be accounted for in two parts. First, the shortages associated with growth in the cities of Llano, Goldthwaite, and Blanco; Hays County-Other, and Gillespie County-Other areas have opportunity costs equal to the value of water use in the rural area of shortage. Small towns and rural areas in the western part of the region (Hill Country) with surplus water can absorb the economic growth that is otherwise projected for these water-short communities at no income loss to the region.

The remaining opportunity costs (associated with year 2000 shortages) could be approximated by use of relocation costs of existing users in sufficient numbers to eliminate the shortages. To fail to account for opportunity costs would be equivalent to saying that the water supply shortage would result in the moving of this economic activity out of the LCRWPA. Accounting for opportunity costs could be reasonably estimated by taking account of the cost of relocation within the area. This is reasonable because there are comparable economic conditions in surrounding communities with surplus water. The relocation cost of economic activity from the cities of Llano, Goldthwaite, and Blanco; Hays County-Other, Mills County-Other, and Gillespie County-Other areas to surrounding towns and rural areas with surplus water is a reasonable means of estimating of the opportunity costs of the shortages associated with the current users in these rural towns. The most accurate relocation cost should be measured at the margin. That is, the income loss of not meeting these water needs is equal to the gross income loss in the water-short community minus the income that could be earned in the neighboring communities with surplus water, less the cost of relocation. These opportunity costs could not be estimated within the time available for completing this report, but it is clear that such costs would not exceed the cost of losing the economic activity to a neighboring region (outside of the LCRWPA). Therefore, the opportunity costs to the LCRWPA are assumed to be zero and the TWDB staff estimates are adopted for the purposes of this report.

The employment losses to the region after including opportunity costs range from 2,139 in year 2000 to 2,550 in 2030. Population losses to the region range from 4,066 in year 2000 to 4,989 in 2030 (Table 5.7). The income loss to the Lower Colorado Region after adjustments for expected water supply shortages and opportunity costs are shown in Figure 5.5. Table 5.7 shows the detailed income, production, employment, and population losses to the region after adjustment for opportunity costs and marginal changes (rather than average changes) in rice farming. The income losses are on the order of $50 million per year for the average year shortage of the drought of record. Approximately 90 percent of the regional income loss in 2030 is associated with the rural municipal shortages. Most of the regional income loss would accrue to the Hill Country communities of Llano, Goldthwaite, and Blanco; Hays County-Other, and Gillespie County-Other areas. The remaining income loss would accrue to the rice-producing communities in Colorado, Matagorda and Wharton counties.

The income loss to the region is approximately $50 million per year over the 30 year period even though the size of the shortage rises from 50,426 acre feet in year 2000 to 123,759 acre feet in year 2030. This result is due to the changing mix of municipal, mining and irrigation shortages over the period and the differing income values of water among the three user classes (see Table 5.7).

Figure 5.5: Adjusted Regional Income Impact of Anticipated Water Supply Shortage



The regional income and employment losses from expected water shortages are relatively small, amounting to less than 1 percent of regional income and employment in year 2030. The income and employment losses to particular groups and isolated areas however, would be potentially large. The rice industry would lose approximately 20 percent of its production in 2030 under drought-of-record conditions. Most of the economic consequences of such a decline would fall on Colorado, Matagorda and Wharton counties. The net income effects of a 20 percent rice production decline would be considerably less than 20 percent, however, since income would be earned from alternative enterprises such as grass and livestock production.

Income and employment losses from failure to deal with water shortages in the municipal category would fall mostly on the communities of Goldthwaite, Llano, Blanco, Hays, and Gillespie counties. In short, the economic consequences of failing to address shortages would fall heavily on rural areas and small communities in the northwestern and southeastern parts of the region.

The translation of these severe drought-year income losses into an investment equivalent estimate provides an idea of the size of an up-front investment that could be economically justified to avoid the projected water supply shortages (Table 5.8). The estimate is based on a 30-year period of expected regional income loss, where the probability of the average-year-size shortage is one year in five, and the discount rate is six percent (the Lower Colorado Region has had one drought-of-record of approximately 10 years duration within a 50-year period). The result of this economic analysis suggests that the use of an economic equivalent of up to a $190 million investment of regional resources to solve the problem would be justifiable. Any investment equivalent that is less costly than the $190 million would have a net positive economic benefit to the region. An investment greater than $190 million would result in an economic loss from the plan.

Table 5.7: Summary of Adjusted Income Impacts of Anticipated Water Supply Shortages [2]

(Including Interruptible Supplies and Excluding Contract Shortages and Redistributing Municipal Growth)

Water Use Category	Decade	Water Supply Need (ac-ft/yr)	Impact of Need on Employment	Impact of Need on Gross Business Output [1] ($ millions/yr)	Impact of Need on Population	Impact of Need on School Enrollment	Impact of Need on Income [1] ($ millions/yr)	Unit Income Loss ($/ac-ft)
Municipal	2000	(1,329)	1,720	$ 133	3,269	714	$ 48	$ (35,949)
Manufacturing	2000	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2000	-	-	$ -	-	-	$ -	$ -
Mining	2000	(98)	9.66	$ 1.38	18	4	$ 0.39	$ (3,988)
Irrigation	2000	(48,999)	409	$ 11.03	778	171	$ 2.57	$ (52)
Livestock	2000	-	-	$ -	-	-	$ -	$ -
TOTAL		**(50,426)**	**2,139**	**$ 145**	**4,066**	**889**	**$ 51**	**$ (1,006)**
Municipal	2010	(1,329)	1,449	$ 117	2,761	601	$ 40	$ (30,117)
Manufacturing	2010	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2010	-	-	$ -	-	-	$ -	$ -
Mining	2010	(16.71)	1.65	$ 0.24	3	1	$ 0.07	$ (3,988)
Irrigation	2010	(75,301)	629	$ 16.96	1,191	256	$ 3.94	$ (52)
Livestock	2010	-	-	$ -	-	-	$ -	$ -
TOTAL		**(76,647)**	**2,080**	**$ 134**	**3,956**	**857**	**$ 44**	**$ (575)**
Municipal	2020	(1,329)	1,470	$ 118	2,835	651	$ 41	$ (30,571)
Manufacturing	2020	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2020	-	-	$ -	-	-	$ -	$ -
Mining	2020	(10.00)	0.99	$ 0.14	1.90	0.44	$ 0.04	$ (3,988)
Irrigation	2020	(85,893)	717	$ 19.34	1,383	324	$ 4.50	$ (52)
Livestock	2020	-	-	$ -	-	-	$ -	$ -
TOTAL		**(87,232)**	**2,188**	**$ 138**	**4,219**	**976**	**$ 45**	**$ (518)**
Municipal	2030	(1,329)	1,527	$ 122	2,992	687	$ 42	$ (31,797)
Manufacturing	2030	-	-	$ -	-	-	$ -	$ -
Steam Elec.	2030	-	-	$ -	-	-	$ -	$ -
Mining	2030	(3.00)	0.30	$ 0.04	0.58	0.13	$ 0.01	$ (3,988)
Irrigation	2030	(122,427)	1,023	$ 27.57	1,997	458	$ 6.41	$ (52)
Livestock	2030	-	-	$ -	-	-	$ -	$ -
TOTAL		**(123,759)**	**2,550**	**$ 149**	**4,989**	**1,145**	**$ 49**	**$ (393)**

[1] Calculated in 2nd quarter 1999 US Dollars.

[2] Water shortages and monetary losses are negative numbers displayed in parentheses.

Table 5.8: Net Present Value of Lost Income Stream for Losses Through 2030

Year	Average Shortage Year Income Loss ($million/yr)	Probability of Occurrence (%)	Discount Factor (using a 6 % Discount Rate)	Net Present Value of Each Decade ($ million/yr)
2000	$ 51	20%	0.94	$ 96
2010	$ 44	20%	0.56	$ 49
2020	$ 45	20%	0.31	$ 28
2030	$ 49	20%	0.17	$ 17
Net Present Value Sum				**$ 190**

5.3.3 Paying for the Cost of Preventing Future Shortages

Approximately $17 million of the $190 million figure is due to the lost value of rice production and the remainder to rural Hill Country income losses. The $17 million investment value for rice production is relatively small in part because rice shortages are large in the later years of the period but small in the early years. The income loss to the rice farming area (valued at $52 per acre foot) is probably less than the lowest cost set of water management strategies available for solving the problem, which appears to have an investment equivalent cost several times the $17 million. The opposite appears to be true of the municipal shortages.

In the aggregate, the costs of solving the problem for the region seem to be less than the income losses of not solving the problem. The expected income loss from failing to eliminate the shortages range from $1,006 per acre-foot in year 2000 to $393 per acre-foot in year 2030 (last column in Table 5.7). The costs of solving the problem range from $98 to $1,562 per acre-foot for municipal shortages. The costs for solving irrigation shortages range from $20 to $77 per acre-foot (see Chapter 6). Since the costs of the likely alternative strategies are less than the benefits (avoiding the income loss of shortages), the region should be able to solve the problem at a net economic gain to the region. Mechanisms for allocating the cost of avoiding the shortages from within the region, however, would be difficult for any plan that requires groups to pay more than their lost income would justify.

Perhaps the best economic option for resolving the future shortage problem is to develop additional water supplies in the lower basin and market some of the resulting supply to neighboring regions. Such additional water can be developed from excess stream flow. New supplies can be marketed for more than the cost of producing the water, thus creating a net income flow to the region sufficient to pay the full cost of avoiding the region's shortages. Based on the estimates of the LCRA in a plan to accomplish such a result, the cost is less than the equivalent of a $190 million investment and would be adequate to pay the full cost of avoiding the projected shortages. In short, a $190 million size problem could be solved at zero net cost to the region. However, there is an on-going discussion about whether such a plan would be harmful (and therefore costly) to the region because of impacts on the economic value of the Matagorda Bay fish and wildlife resources and related recreation and fishing industry benefits.

5.3.4 Missing Components of Economic Analyses Required by SB 1

The SB 1 planning process focuses on planning and analysis for the region with little attention to the consequences on neighboring regions. An analysis of the combined interregional economic losses from a statewide condition of the drought of record is needed to account for the interregional effects. For example, a significant rice-industry income loss of not meeting the shortage in the LCRWPA will accrue to the neighboring region where most of the rice mills that process this region's rice production are located. This example points out a problem with the SB 1 planning process. A combined Gulf Coast economic impact study of rice-irrigation industry losses from shortages in the Gulf Coast is needed to understand the importance of drought year shortages on the rice industry. The SB 1 process ignores this type of interregional effect.

5.3.5 Economic Analysis Summary

Estimates of the expected income losses from projected regional water supply shortages are approximately $50 million per year for years in which the average year of the drought of record conditions are present. By assigning a reasonable probability of occurrence to the prospect of income losses, the shortage problem can be converted to the equivalent of an economic investment problem. The estimates provided here show that the problem is one that could justify up to a $190 million investment. Perhaps the most economical prospect of solving the problem from a regional perspective is to develop additional water supplies from excess river flows in the lower basin and market the water to buyers outside the region at a price sufficient to cover the regional cost of solving the shortage problem. (Note: Appendix 5A, Tables 9 and 10 required by the TWDB contain the impacts of worst-case assumptions as displayed in Table 5.5, not the net economic loss estimates presented here).

5.4 RECOMMENDED REGIONAL PLAN TO MEET 2030 NEEDS

The Lower Colorado Regional Water Plan to meet the needs identified through the year 2030 was developed in accordance with TWDB guidelines. Public input into the process was sought throughout the process at all of the RWPG meetings. Meetings were held in almost every county in the region (Williamson County was the exception). In addition, the consultants met with local officials and members of focus groups to discuss the regional planning process and specific alternative water supply strategies.

Whenever it was feasible, the recommended regional plan incorporates projects that have been endorsed by local entities or a focus group representing local interests. In many instances, cities, counties, and other entities have passed resolutions indicating the preferred water supply strategy. Copies of these resolutions are presented in Appendix 6A to the Regional Water Plan.

The recommended regional water plan is actually a conglomeration of several alternative strategies to meet specific water shortages within the planning area. (Information concerning the recommended plan and feasible alternatives evaluated is presented in the required formats for TWDB Tables 11, 12, and 13 are presented in Appendix 5A.) These alternatives were selected from numerous alternatives that were evaluated by the LCRWPG. **(It is important to note that evaluated alternatives are discussed in Sections 5.6 through 5.10 of this chapter. Presentation of alternatives in those sections does not constitute inclusion in the Regional Water Plan. Only those alternatives presented in Sections 5.4 and 5.5 are included in the recommended Regional Water Plan.)** Table 5.9 contains a matrix used to evaluate all of the alternatives investigated and highlights the selected alternatives. Table 5.10 presents a summary of the environmental considerations for each of the selected alternatives. In addition, the LCRWPG has adopted several resolutions concerning strategies and policies, such as brush management, water conservation, and groundwater protection, which may affect the supply of water on a region-wide basis. In addition, the water management strategies included in the regional plan will not adversely affect navigation of area waterways. These recommendations are discussed in Chapter 6 of this report and copies of resolutions are contained in Appendix 6A. The selected alternatives are discussed in more detail in the following sections.

Table 5.9: LCRWPA 2030 Regional Water Plan Decision Matrix

Water Management Strategy	Water User Group	Strategy Description	Cost of Water ($/ac-ft)	Firm Yield (ac-ft/yr)	Decision Matrix Factors [1]					Included in Plan
					Cost	Yield	Environ-ment	Local Pref-erence	Institu-tional Constraints	
C1	Varies	Renew LCRA WS Contracts for Raw Water	$ 105	102,034	High	High	High	High	High	Yes
C2	Varies	Renew COA WS Contracts for Treated Water	$ 651	19,118	High	High	High	High	High	Yes
R1	Rice Irrigators	Continued Implementation - LCRA WMP	$ 4.50	96,585	High	Med.	High	High	High	Yes
R1A	Rice Irrigators	Utilization of COA Return Flows	N/A	21,018	High	High	High	High	High	Yes
R2B	Rice Irrigators	Improve Canal Water Delivery Efficiencies	$ 20	45,650	High	Med.	High	High	High	Yes
R2A	Rice Irrigators	On-Farm Water Conservation Measures	$ 56	37,348	Med.	Med.	High	High	High	Yes
R3	Rice Irrigators	4 New Off-Channel Reservoirs for Irrigation	$ 77	142,000	Med.	High	Low	High	Med.	Yes
R3A	Rice Irrigators	4 New Off-Channel Reservoirs for Municipal	N/A	150,000	High	High	Low	Med.	Med.	Yes
R4	Rice Irrigators	Construction of Shaw's Bend Reservoir	$ 430	51,576	Low	Med.	Low	Low	Low	No
R5	Rice Irrigators	Construction of Fox Crossing Reservoir	$ 423	72,589	Low	High	Med.	Med.	Low	No
R9	Rice Irrigators	Water Efficient Crops - Varietal Improvements	N/A	35,000	N/A	Med.	High	High	High	Yes
R6	Rice Irrigators	Conjunctive Use of Groundwater	$ 59	50,000	Med.	Med.	High	Med.	Med.	Yes
R7	Rice Irrigators	Construction of the Altair Channel Dam	$ 33	24,870	High	Med.	Med.	Med.	Low	No
R8	Rice Irrigators	Agricultural Transfer Options	$ 38	157,228	Med.	Low	High	Low	Med.	No
H1	Hays County-Other	LCRA Waterline to Dripping Springs	$ 1,259	2,240	Low	Med.	Low	High	Med.	Yes
H2	Hays County-Other	GBRA Waterline to Buda	$ 647	4,480	Med.	High	Low	High	Med.	Yes
H3	Hays County-Other	COA Connection to Hays County-Other	$ 818	1,100	Low	Med.	Low	High	Med.	Yes
H4	Hays County-Other	Dripping Springs Reservoir	$ 965	3,100	Med.	High	Low	Med.	Med.	No
H5	Hays County-Other	Driftwood Reservoir	$ 330	9,300	High	High	Low	Med.	Med.	No
H6	Hays County-Other	Onion Creek Recharge Dams	$ 98	4,000	High	High	Med.	Med.	Med.	Yes
GL1	Gillespie Cty-Other	Aquifer Storage and Recovery	$ 839	1,120	Med.	High	Med.	Med.	Low	Yes
GL2	Gillespie Cty-Other	Groundwater Development	$ 350	180	High	Low	Med.	Med.	High	Yes
PF1	City of Pflugerville	Aquifer Storage and Recovery	$ 710	7,600	Med.	Low	Med.	Med.	Med.	Yes
PF2	City of Pflugerville	Colorado River Supply	$ 538	11,540	High	High	Med.	High	High	Yes
PF3	City of Pflugerville	Carrizo-Wilcox Groundwater	$ 439	7,000	High	Med.	Med.	Med.	Med.	Yes
BL1	City of Blanco	Dredge Existing Reservoirs	$ 1,217	52	Med.	Low	High	High	High	No
BL3	City of Blanco	Construct an Off-Channel Reservoir	$ 2,003	200	Med.	High	Med.	Med.	Med.	No
BL2	City of Blanco	Construct a New Channel Dam	$ 2,228	100	Low	Med.	Med.	Med.	Med.	No
BL4	City of Blanco	Construct Pipeline to West Comal County System	$ 2,400	300	Low	High	High	High	Med.	No
BL5	City of Blanco	Construct Pipeline to Canyon Lake WSS	$ 1,317	300	Med.	High	High	High	Med.	Yes
BL6	City of Blanco	Construct Pipeline to Pedernales River	$ 1,562	300	Med.	High	High	High	Med.	No
BL7	City of Blanco	Develop Hensell/Cow Creek Aquifer West of Town	$ 2,760	52	Low	Low	High	Med.	High	No
BL8	City of Blanco	Develop Ellenburger Aquifer North of Town	$ 767	300	High	Med.	High	Med.	High	No
L1	City of Llano	Dredge Existing Reservoirs	$ 710	100	Med.	Low	High	High	High	Yes
L2	City of Llano	Construct a New Channel Dam	$ 462	1,300	Med.	High	Med.	Med.	Med.	Yes
L3	City of Llano	Construct an Off-Channel Reservoir	$ 1,975	200	Low	Med.	Med.	Med.	Med.	No
L4	City of Llano	Develop Ellenburger Aquifer Southeast of Town	$ 417	660	High	High	High	Med.	High	No
G1	City of Goldthwaite	Dredge Existing Reservoirs	$ 1,150	40	Med.	Low	High	High	High	Yes
G2	City of Goldthwaite	Construct a New Channel Dam	$ 750	400	Med.	High	Med.	High	Med.	Yes
G3	City of Goldthwaite	Construct an Off-Channel Reservoir	$ 1,425	200	Low	Med.	High	High	Med.	Yes
G4	City of Goldthwaite	Participate in Mills Co. Reservoir (FCWD)	$ 384	1,120	High	High	Med.	High	Med.	Yes
G5	City of Goldthwaite	Participate in Fox Crossing Reservoir	$ 650	117	Med.	High	Med.	High	Low	No
G6	City of Goldthwaite	Develop Trinity Aquifer Southwest of Town	$ 735	117	Med.	Med.	High	Med.	High	No

[1] Consultant ranked decision factors based on favorability.

*options highlighted & **bolded** are recommended in the plan.

FCWD = Fox Crossing Water District

Table 5.10: Environmental Considerations for Selected Alternatives

No.	Management Strategy	Environmental Flows	Wildlife Habitat	Cultural Resources	Agricultural Resources	Other Water Resources	Social/Economic
	Renew/expand water sales contracts	Minimal impact associated with expansion of contracts. Environmental flows addressed in LCRA Water Management Plan	None anticipated.	None anticipated.	None anticipated.	None anticipated.	None anticipated
R1	LCRA Water Management Plan	Status Quo	None anticipated.	None anticipated.	None anticipated.	None anticipated.	None anticipated.
R1A	Utilize Austin Return Flows	Status Quo	None anticipated.	None anticipated.	None anticipated.	None anticipated.	None anticipated.
R2A	On-Farm Conservation	Reduced irrigation return flows to bay and estuaries.	None anticipated.	None anticipated.	None anticipated.	None anticipated.	Cost exceeds irrigators' ability to pay.
R2B	Irrigation Delivery System Improvements	Reduced irrigation return flows to bay and estuaries.	None anticipated.	None anticipated.	None anticipated.	None anticipated.	Cost exceeds irrigators' ability to pay.
R3	Off-Channel Reservoirs for Irrigation	Reduced flows to bay and estuaries increases salinity levels.	Increased salinity levels may impact bay production. Construction of reservoirs will impact localized area.	Construction of reservoirs will impact localized area. Avoidance of cultural resources to be included in design.	Loss of agricultural land for the construction of the off-channel reservoirs.	None anticipated.	Cost exceeds irrigators' ability to pay.
R3A	Off-Channel Reservoirs for Municipal Needs	Reduced flows to bay and estuaries increases salinity levels.	Increased salinity levels may impact bay production. Construction of reservoirs will impact localized area.	Construction of reservoirs will impact localized area. Avoidance of cultural resources to be included in design.	Loss of agricultural land for the construction of the off-channel reservoirs.	None anticipated.	Implementation dependent on the City of San Antonio funding all improvements.
R9	Development of New Rice Varieties	None anticipated.	None anticipated.	None anticipated.	None anticipated.	None anticipated.	Cost exceeds irrigators' ability to pay.
R6	Conjunctive Groundwater Use	Increased irrigation return flows to bay and estuaries.	None anticipated.	None anticipated.	None anticipated.	Localized drawdowns of aquifer may affect wells.	Cost exceeds irrigators' ability to pay.
H1	Pipeline from LCRA West Travis County System	Additional use of stored water addressed in LCRA Water Management Plan.	Potential impacts associated with construction to be addressed in design. Potential for increased development in the area impacting endangered species habitat.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Decrease in groundwater reliance should improve water levels in area.	Potential for increased development in the area.
H2	Pipeline from GBRA/San Marcos System	None anticipated.	Potential impacts associated with construction to be addressed in design.	Potential impacts due to construction to be addressed in design.	None anticipated.	Decrease in groundwater reliance should improve water levels in area.	Potential for increased development in the area.
H3	Pipeline from COA System	Additional use of stored water addressed in LCRA Water Management Plan.	Potential impacts associated with construction to be addressed in design.	Potential impacts due to construction to be addressed in design.	None anticipated.	Decrease in groundwater reliance should improve water levels in area.	Potential for increased development in the area.
H6	Recharge Structures on Onion Creek	Decreases in stream flows during peak events should be compensated for by increased base flows due to springflow.	Potential impacts associated with construction to be addressed in design. Higher groundwater levels advantageous to endangered species.	Potential impacts due to construction to be addressed in design.	None anticipated.	Groundwater levels maintained at higher levels in the area.	None anticipated.

Table 5.10: Environmental Considerations for Selected Alternatives (Continued)

No.	Management Strategy	Environmental Flows	Wildlife Habitat	Cultural Resources	Agricultural Resources	Other Water Resources	Social/Economic
PF1	Aquifer Storage and Recovery	Additional use of stored water addressed in LCRA Water Management Plan.	Impact on receiving aquifer must be identified in design.	None anticipated.	None anticipated.	Groundwater levels maintained at higher levels in the area.	City of Austin must agree to seasonal charge variation.
PF2	Colorado River Water Supply	Additional use of stored water addressed in LCRA Water Management Plan.	Potential impacts due to construction to be addressed in design.	Potential impacts due to construction to be addressed in design.	None anticipated.	Decrease in groundwater reliance should improve water levels in area.	Potential for increased development in the area.
PF3	Carrizo-Wilcox Groundwater	Additional return flows increase instream flows.	Potential impacts due to construction to be addressed in design.	Potential impacts due to construction to be addressed in design.	None anticipated.	None anticipated.	Potential for increased development in the area.
BL5	Pipeline from Canyon Lake	None anticipated.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Decrease in groundwater reliance should improve water levels in area.	Potential for increased development in the area.
L2	Additional Channel Dam	Negligible decreases in flows to Highland Lakes associated with additional evaporation.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Negligible decrease in inflows to Highland Lakes associated with increased evaporation.	Potential for increased development in the area.
G1	Dredge Existing Reservoirs	None anticipated.	None anticipated.	None anticipated.	None anticipated.	Disposal of dredge material must be such that it does not impact quality of adjacent waters.	None anticipated.
G2	Construct a New Off-Channel Reservoir	None anticipated.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	None anticipated.	None anticipated.
G3	Construct a Channel Dam on Colorado	Negligible decreases in flows to Highland Lakes associated with additional evaporation.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Negligible decrease in inflows to Highland Lakes associated with increased evaporation.	None anticipated.
G4	Construct Mills County Reservoir	Potential decreases in flows to Highland Lakes. Downstream flows addressed in LCRA Water Management Plan.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Potential decrease in firm yield of the Highland Lakes.	Potential for increased development in the area.
GL1	Aquifer Storage and Recovery	None anticipated.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Decrease in groundwater reliance should improve water levels in area.	None anticipated.
GL2	Additional Groundwater Development	None anticipated.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	Potential decrease in groundwater levels in the area.	None anticipated.
A1	Advanced Water Conservation in Austin	None anticipated.	None anticipated.	None anticipated.	None anticipated.	None anticipated.	Requires change in behavior.
A2	Use of Reclaimed Water	Potential decreases in instream flows.	Potential impacts associated with construction to be addressed in design.	Potential impacts associated with construction to be addressed in design.	None anticipated.	None anticipated.	General acceptance of reclaimed water use.

5.4.1 Recommended Plan to Meet Contractual Shortages Through 2030

The two Major Water Providers in the Region, LCRA and the City of Austin, have wholesale contracts with numerous water user groups. These contracts generally expire within the 50-year planning period. It is recommended that these entities renew these contracts for water before they expire and, as necessary, increase the contract amount to meet the projected demands throughout the planning period. Capital expenditures for water supply purposes would not be required to implement this alternative. The average cost of providing water under this alternative would be $105/ac-ft for raw water from LCRA and $651/ac-ft for treated water from the City of Austin.

5.4.2 Recommended Plan to Meet Irrigation Demands Through 2030

The existing water supplies available to irrigators in Colorado, Wharton, and Matagorda counties are not sufficient to meet the projected needs through the year 2030. A shortage would occur in all decades between 2000 and 2030 should the critical drought be repeated. The maximum annual shortage is projected to decrease from just over 391,000 ac-ft/yr in 2000 to approximately 322,000 ac-ft/yr in 2030. The shortage is expected to continue to decrease through 2050 due to projected decreases in the amount of acreage placed in rice production. As a result, the recommended plan to meet the shortage in 2030 is also expected to meet the shortage 2050.

The recommended plan to meet the rice irrigation shortage is based on recommendations presented by the Irrigation Water Supply Working Group of the LCRWPG. This Working Group included several rice irrigators, representatives from the affected counties, a representative from LCRA, environmental representatives, and representatives interested in the impacts on the Highland Lakes. The recommended plan includes the following components, in priority order.

- ***Alternative R1 - LCRA Water Management Plan*** - Continued implementation of the LCRA Water Management Plan will provide interruptible water to rice irrigators when sufficient water is available in the Highland Lakes System. Capital expenditures are not required to implement this alternative. The unit cost of water supplied under this alternative is set by LCRA to be $4.50 / ac-ft. It is anticipated that the amount of water available from storage and increased run-of-river rights will decrease from approximately 290,000 ac-ft/yr in 2000 to 97,000 ac-ft/yr in 2050.

- ***Alternative R1A – Utilization of City of Austin Return Flows*** - The City of Austin currently returns approximately 60 percent of its water demand to the Colorado River as wastewater discharges. Once discharged to the river, this water belongs to the State and is subject to diversion under existing water rights permits for downstream irrigators. The City of Austin has indicated its intention to dramatically expand its reuse of wastewater effluent. The quantity of return flows is projected to increase over the 50-year planning period due to increased water demands in Austin even though the quantity of water reused during this period will increase as well. However, the City's dependence on reclaimed water is projected to be so great beyond the year 2050 that return flows are projected to rapidly decline in subsequent years, and the City may achieve full utilization (zero return flow) during the ninth decade of this century. The City of Austin is offering its return flows as a temporary water management strategy to meet irrigation shortages through the 50-year planning period. Therefore, the availability of this water is included as a water supply alternative rather than being embedded in the baseline river hydrology. Even though the City is not required to return its effluent, this temporary management strategy projects about a 50 percent return flow in the year 2050. This alternative anticipates that the amount of return flow usable by the irrigators will be approximately 50,000 ac-ft/yr in the year 2000 and will increase to slightly more than 80,000 ac-ft/yr in the year 2030 and decrease to approximately 20,000 ac-ft/yr in 2050 (as shown in Table 5.2). There are no capital costs associated with the diversion of this water under existing water rights permits with existing infrastructure. Thus far, return flows have contributed to the instream river flow necessary for the ecological stability of various ecosystems. As the return flows diminish in the future due to enhanced reclamation of water, other sources may need to be dedicated or developed if other mitigation measures cannot be identified for this loss of instream flows. (see Section 6.2.4)

- ***Alternative R2A – On-Farm Water Conservation*** - It is anticipated that significant water savings can be achieved through the use of precision land leveling, multiple field inlets, and reduced levee intervals. The precision land leveling would require a capital expenditure of $16.8 million. The operation and maintenance costs for all of the conservation practices are expected to be $875,000 per year, yielding a total annual cost (including debt service) of $2.1 million. It is expected that the combination of these practices can produce a water savings of 37,348 ac-ft/yr at a combined unit cost of $56/ac-ft.

- ***Alternative R2B – Improve Efficiency of Irrigation Delivery System*** - In addition to the water conservation measures implemented on-farm, substantial water can be saved by improving the efficiency of the canal systems that deliver water to the individual irrigator. These improvements would include improving the flow control structures by adding checks structures, automating the operation of the flow control structures, and adding flow regulating reservoirs to balance flows. The implementation of these improvements would require a capital expenditure of $10 million. The total annual cost of this alternative is $925,000, which includes annual operations and maintenance costs of $200,000. These improvements are expected to provide 45,650 ac-ft/yr in water savings at an average unit cost of $20/ac-ft.

- ***Alternative R3 -Construct Four Off-Channel Reservoirs for Irrigation Demands*** - This alternative would involve the construction of a series of four off-channel reservoirs in Colorado, Wharton, and Matagorda counties. The locations of the reservoirs have not been identified. However, it is anticipated that the reservoirs will be located relatively close to the Colorado River and will be constructed using perimeter berms (similar to the South Texas Project Reservoir). Water would be released from the reservoirs to meet irrigation demands in excess of available river flows. The reservoirs would be refilled during the winter months or during times of excess storm water flows during the irrigation season. Implementation of this alternative would require a capital expenditure of $139.6 million. The total annual cost of this alternative is expected to be $11.4 million. It is expected that the operation of these off-channel reservoirs could increase the supply of water by at least 106,600 ac-ft/yr at an average unit cost of $107/ac-ft.

- ***Alternative R3A – Construct Four Off-Channel Reservoirs for Municipal Demands*** - This alternative would be the same as R3 except water would be made available for municipal demands as well as irrigation demands. It is anticipated that the municipal demands would be made available to WUGs outside the region in exchange for funding the construction of the facilities and the facilities' operation and maintenance. The same four off-channel reservoirs would be constructed. However, the capacity of the diversion facilities would be increased from 200 to 500 cfs to increase the overall yield of the reservoirs. The increased diversion capacity would allow the reservoirs to refill more rapidly and take advantage of more flood flows. Implementation of this alternative would require a capital expenditure of $168 million. The total annual cost of this alternative is expected to be $13.7

million. It is expected that the operation of these off-channel reservoirs could produce an annual supply of at least 131,000 ac-ft/yr at an average unit cost of $111/ac-ft.

- ***Alternative R9 - Development of New Rice Varieties*** **-** This alternative would include the funding of a long-term agricultural research program to develop new varieties of rice that would use less water. It is anticipated that the development of new rice varieties would take 10 years and approximately $2,000,000 could potentially reduce water demands by as much as 15 percent. This level of water savings would represent approximately 35,000 ac-ft/yr in 2050.

- ***Alternative R6 - Conjunctive Use of Groundwater*** **-** This alternative would involve the construction of 47 wells scattered throughout the Lakeside and Gulf Coast Irrigation Districts. The wells in the Lakeside District would be completed into Evangeline and Chicot Formations. The wells in the Gulf Coast would be completed into the Chicot Formation. Groundwater would be pumped from these wells into the irrigation canal systems during drought conditions when surface water availability is not sufficient to meet the demands. Implementation of this alternative would require a capital expenditure of $16.9 million. The total annual expenditure is expected to be $2.9 million, including $1.7 million in operations and maintenance costs. It is anticipated that this alternative could generate an average yield of 50,000 ac-ft/yr at a unit cost of $59 per ac-ft. In addition, conjunctive use of groundwater within the Pierce Ranch Irrigation District could produce an additional 18,000 – 25,000 ac-ft/yr, although this additional use was not modeled.

5.4.3 Recommended Plan to Meet Hays County-Other Demands Through 2030

Northern Hays County is experiencing significant population growth due to its proximity to the Austin Metropolitan Area. Currently, water users in this area rely on groundwater resources to meet their needs. The groundwater supplies in the area are presently showing signs of stress as a result of this intense growth. During drought conditions, the area is projected to have a shortage of 990 ac-ft/yr beginning in 2010. This shortage steadily increases to 3,525 ac-ft/yr in 2030 and ultimately 5,227 ac-ft/yr in 2050. It is anticipated that the water supply strategies implemented to meet the 2030 demands will also be sufficient to meet the 2050 demands.

The recommended plan to meet water supply shortages in the Hays County-Other category includes the following components.

- ***Alternative H1 – Obtain Surface Water from LCRA West Travis County Regional System*** **-** This alternative would include the construction of booster pump stations, transmission mains, and storage facilities to convey treated surface water from the LCRA West Travis County Regional Waster System to users in the vicinity of Dripping Springs. The first phase of this project includes a pipeline, which generally follows U.S. Highway 290 from the Travis County Line almost to Dripping Springs. Construction of this first phase is anticipated to begin by the end of 2000. The anticipated capital expenditure required for this first phase is expected to be $23.6 million. The total annual expenditures are expected to be $2.8 million, which includes $1.1 million for operations and maintenance. The first phase of the project is expected to provide a capacity of 2,240 ac-ft/yr at a unit cost of $1,259/ac-ft. A second phase of this project would include an additional water treatment plant, pump stations, and transmission mains. The second phase of the project would increase the available water supply to Hays County by an additional 1,120 ac-ft/yr.

- ***Alternative H2 - Obtain Surface Water from GBRA/San Marcos Regional System*** - This alternative would include the construction of a booster pump station at the San Marcos Regional Water Treatment Plant and a transmission line north, generally along IH 35. This system will provide water to several water users between San Marcos and Austin. Only a portion of the water supply from this project would serve WUGs in the Lower Colorado Region. The anticipated capital expenditure required to implement this alternative is expected to be $15.1 million. The total annual expenditures for this alternative are expected to be $2.9 million, which includes $1.8 million for operations and maintenance and a prorate share of the raw water delivery system. This project is expected to provide a total water supply of 4,480 ac-ft/yr, however, only 1,680 ac-ft/yr of this supply would be for WUGs in the Lower Colorado Region. The anticipated unit cost of providing this water is $647/ac-ft.

- ***Alternative H3 - Obtain Treated Water from COA*** - This alternative would include the construction of a 16-inch looped transmission system from the City of Austin's existing water distribution system to provide water to the Spillar Ranch and Pfluger Ranch developments in Northern Hays County. It is estimated that implementation of this alternative would require a capital expenditure of $2.2 million. The system would be able to supply approximately 1,100 ac-ft/yr at a unit cost of $818 per ac-ft.

- ***Alternative H6 - Construct Recharge Enhancing Structures Along Onion Creek*** - This alternative would involve the construction of one or more channel dams across Onion Creek to temporarily retain runoff. The water retained would be released under controlled conditions to maximize recharge in downstream reaches of Onion Creek. Several channel dam locations have been evaluated in the past. For comparison purposes, information concerning the Rutherford Recharge Dam has been presented. However, other sites would also be acceptable. The anticipated capital expenditure required to implement this alternative for the Rutherford site is expected to be $4.6 million. The total annual expenditures are expected to be $0.4 million, which includes $61,000 for operations and maintenance. The anticipated yield due to the enhanced recharge is expected to be 4,000 ac-ft/yr at a unit cost of $98/ac-ft.

The Barton Springs/Edwards Aquifer Conservation District has passed a resolution concerning this plan. A copy of the resolution is in Appendix 6A.

5.4.4 Recommended Plan to Meet the City of Dripping Springs Demands Through 2030

The Dripping Springs area and Northern Hays County are experiencing significant population growth due to its proximity to the Austin Metropolitan Area. Currently, water users in this area rely on groundwater resources to meet their needs. The groundwater supplies in the area are presently showing signs of stress as a result of this intense growth. During drought conditions, the City of Dripping Springs is projected to have a shortage of 22 ac-ft/yr beginning in 2030. This shortage increases to 364 ac-ft/yr in 2050. It is anticipated that the water supply strategies implemented to meet the 2030 demands will also be sufficient to meet the 2050 demands.

The recommended plan to meet water supply shortages in Dripping Springs includes the following components.

- ***Alternative H1 – Obtain Surface Water from LCRA West Travis County Regional System*** - This alternative would include the construction of booster pump stations, transmission mains, and storage facilities to convey treated surface water from the LCRA West Travis County Regional Waster System to users in the vicinity of Dripping Springs. The first phase of this project includes a pipeline, which generally follows U.S. Highway 290 from the Travis County Line almost to Dripping Springs. Construction of this first phase is anticipated to begin by the end of 2000. The anticipated capital expenditure required for this first phase is expected to be $23.6 million. The total annual expenditures are expected to be $2.8 million, which includes $1.1 million for operations and maintenance. The first phase of the project is expected to provide a capacity of 2,240 ac-ft/yr at a unit cost of $1,259/ac-ft. A second phase of this project would include an additional water treatment plant, pump stations, and transmission mains. The second phase of the project would increase the available water supply to Hays County by an additional 1,120 ac-ft/yr.

5.4.5 Recommended Plan to Meet the City of Pflugerville Demands Through 2030

The City of Pflugerville currently relies on groundwater to supply all of its water demands. In order to secure a firm supply of water for the future, the City of Pflugerville executed a wholesale contract with the City of Austin for the supply of up to 10 mgd. The City of Pflugerville anticipates that it will begin purchasing water from the City of Austin at the end of 2000. Full utilization of this contract would provide enough water for the City of Pflugerville to meet its projected needs through 2050. However, the City of Pflugerville is not certain that it will rely on the City of Austin as its main supplemental supply source. The City of Pflugerville has requested that the following projects be included in the Regional Water Plan.

- ***Alternative PF1 – Aquifer Storage and Recovery –*** This alternative would involve the construction of an aquifer storage and recovery well. The City of Pflugerville would purchase treated water from the City of Austin and store this water in the aquifer during low demand periods. This stored water would be recovered during the peak demand period (summer). The opinion of probable costs for implementing the ASR wells is $4.7 million. The unit cost of operating this system, including purchasing the treated water from the City of Austin, is $710/ac-ft.
- ***Alternative PF2 – Colorado River Water Supply*** - This alternative would involve the construction of a raw water intake on the Colorado River above its confluence with Walnut Creek, a raw water pump station, raw water transmission main, raw water storage reservoir for balancing purposes, and a water treatment plant. Implementation of this alternative would require a capital expenditure of $45 million. The anticipated annual expenditures would be $6.2 million. The unit cost of water is projected to be $538/ac-ft.
- ***Alternative PF3– Carrizo-Wilcox Water Supply*** - This alternative would involve the construction of a well field in the Carrizo-Wilcox Aquifer east of town and pumping groundwater back to town. The City of Pflugerville is currently investigating this alternative but has not completed the evaluation. A preliminary review indicates that the opinion of probable capital cost for this alternative is $25.7 million with a unit cost of $439/ac-ft.

5.4.6 Recommended Plan to Meet the City of Blanco Demands Through 2030

The City of Blanco has the right to divert water from the Blanco River in quantities that would meet its demands through the 50-year planning period. However, the City lacks sufficient storage capacity to provide the firm yield to meet its current demands during drought conditions. The City of Blanco would exhaust its supply of stored water if the flow in the Blanco River ceases for an extended period. The

City's water demands are projected to decrease due to the anticipated water conservation assumed in the TWDB projections. Therefore, the recommended plan to meet the 2030 demands will also be sufficient to meet the 2050 projected demands.

The recommended plan to meet the shortages identified for the City of Blanco includes the following components.

- ***Alternative BL5 - Purchase Treated Water from Canyon Lake Water Supply Corporation* -** This alternative would involve the construction of a booster pump station, ground storage facility, and transmission main along U.S. Highway 281 from Highway 305 in Comal County to the City of Blanco. This pipeline would convey treated water from Canyon Lake Water Supply Corporation to the City of Blanco. The City would be responsible for purchasing the raw water from GBRA. The pipeline would have the capacity to provide additional water to potential developments along U.S. 281. Implementation of this alternative would require a capital expenditure of $2.9 million. The anticipated annual expenditures would be $395,000, which would include raw water charges, treated water charges, and operations and maintenance charges for a supply of 300 ac-ft/yr. The unit cost of this water is projected to be $1,562/ac-ft.

The City Council for Blanco officially endorsed this plan by resolution at its July 11, 2000 meeting. A copy of that resolution is included in Appendix 6A.

5.4.7 Recommended Plan to Meet Blanco County-Other Demands Through 2030

The rural area surrounding the City of Blanco, primarily to the south, is projected to experience significant growth in the future. Currently, this area of the County is dependent on the Trinity Aquifer for water. The projections indicate that during the drought of record, the rural area of Blanco County in the Guadalupe River Basin would have a shortage of 24 ac-ft/yr in the year 2000. This shortage increases to 163 ac-ft/yr in 2030 and 215 ac-ft/yr in 2050.

The recommended plan to meet the shortages identified for the Blanco County-Other includes the following components.

- ***Alternative BL5 - Purchase Treated Water from Canyon Lake Water Supply Corporation* -** This alternative would involve the construction of a booster pump station, ground storage facility, and transmission main along U.S. Highway 281 from Highway 305 in Comal County to the City of Blanco. This pipeline would convey treated water from Canyon Lake Water Supply Corporation to the City of Blanco. The City would be responsible for purchasing the raw water from GBRA. The pipeline would have the capacity to provide additional water to potential developments along U.S. 281. Implementation of this alternative would require a capital expenditure of $2.9 million. The anticipated annual expenditures would be $395,000, which would include raw water charges, treated water charges, and operations and maintenance charges for a supply of 300 ac-ft/yr. The unit cost of this water is projected to be $1,562/ac-ft.

5.4.8 Recommended Plan to Meet the City of Llano Demands Through 2030

The City of Llano has the right to divert water from the Llano River in quantities that would meet its demands through the 50-year planning period. However, the City lacks sufficient storage capacity to provide the firm yield to meet its current demands during drought conditions. The City of Llano would exhaust its supply of stored water if the flow in the Llano River ceases for an extended period. The City's water demands are projected to decrease due to the anticipated water conservation assumed in the TWDB projections. Therefore, the recommended plan to meet the 2030 demands will also be sufficient to meet the 2050 projected demands.

The recommended plan to meet the shortages identified for the City of Llano includes the following components.

- ***Alternative L1 – Dredge Existing Reservoirs*** - The City's existing reservoirs have experienced sedimentation over the years. The amount of sedimentation is not known. The City has recently completed some dredging activities. It is anticipated that the City will continue to maintain its reservoirs through dredging in the future. The anticipated unit cost to maintain the increased firm yield associated with the removal of this material is $710 per ac-ft.
- ***Alternative L2 – Additional Channel Dam*** - This alternative includes the construction of a new channel dam downstream of the existing reservoirs. The new reservoir would impound water below the existing intake structure. A transfer pump station would need to be constructed to transfer water from the new reservoir to the existing reservoir for ultimate delivery to the treatment plant. The anticipated capital cost associated with implementation of this alternative is $2.5 million. The anticipated total annual expenditure is anticipated to be $600,000. The unit cost of producing 1,300 ac-ft/yr with this alternative is expected to be $461 per ac-ft.

The City Council for Llano has officially endorsed this plan and a copy of the resolution is included in Appendix 6A.

5.4.9 Recommended Plan to Meet the City of Goldthwaite Demands Through 2030

The City of Goldthwaite has the right to divert water from the Colorado River in quantities that would meet its demands through the 50-year planning period. However, the City lacks sufficient storage capacity to provide the firm yield to meet its current demands during drought conditions. The City of Goldthwaite would exhaust its supply of stored water if the flow in the Colorado River ceases for an extended period. The City's water demands are projected to decrease due to the anticipated water conservation assumed in the TWDB projections. Therefore, the recommended plan to meet the 2030 demands will also be sufficient to meet the 2050 projected demands.

Shortages were not identified for the County-Other category, since the availability of groundwater in Mills County as a whole is sufficient to meet the overall demands for the County-Other category. However, there are isolated areas within the County where it is difficult to find wells that produce adequate water to meet the rural demands. The Fox Crossing Water District has been working toward the development of a Countywide Water Supply Plan that would include the City of Goldthwaite. The City of Goldthwaite has expressed interest in cooperating with the Fox Crossing Water District in the development of a countywide plan.

The Fox Crossing Water District is pursuing federal funding for a feasibility study of several reservoir locations within Mills County. In the absence of the results from that feasibility study, the City of Goldthwaite City Council passed a resolution indicating the City's desire to have the regional plan include the following components, in priority order.

- ***Alternative G1 – Dredge Existing Reservoirs*** - The City's existing reservoirs have experienced sedimentation over the years. The amount of sedimentation is not known. It is anticipated that additional firm yield capacity could be generated by removing this sediment and implementing a routine maintenance program to keep the reservoirs free of sediment. The anticipated unit cost to develop and maintain increased firm yield associated with the removal of this material is $1,150 per ac-ft.

- ***Alternative G3 - Construction of a New Off-Channel Reservoir -*** This alternative would involve the construction of an additional, off-channel reservoir adjacent to the City's existing reservoir on the San Saba Highway. The reservoir would have a capacity of 200 ac-ft and would be constructed using a perimeter berm. The anticipated capital expenditure required to implement this alternative is $2.9 million. The total annual expenditure is expected to be $285,000, which includes $95,000 in operations and maintenance costs. The anticipated unit cost of this additional firm yield supply is expected to be $1,425 per ac-ft.
- ***Alternative G2 - Construction of a Channel Dam on the Colorado River*** - This alternative would involve the construction of a channel dam on the Colorado River below the City's existing diversion structure. The water impounded behind this dam would provide a consistent source of water from which to pump, as well as an additional 400 ac-ft/yr of firm yield. The City would consider entering into a partnership with the Fox Crossing Water District, LCRA, or private landowners to construct the channel dam. The anticipated capital expenditure required to implement this alternative is $2.4 million. The total annual expenditure is expected to be $300,000, which includes $140,000 in operations and maintenance costs. The anticipated unit cost of this additional firm yield supply is expected to be $750 per ac-ft.
- ***Alternative G4 – Construction of a Mills County Reservoir (FCWD) -*** This alternative would involve the construction of a reservoir within Mills County. The Fox Crossing Water District anticipates beginning a feasibility study of several sites in Fiscal Year 2001. It is anticipated that the City would be a potential participant in the construction of a reservoir by the Fox Crossing Water District if the feasibility study determines that the construction of a reservoir is feasible and advantageous to the City. It is anticipated that a reservoir could be constructed with a capital expenditure of $4.5 million. The unit cost of water developed in this reservoir is anticipated to be $384 per ac-ft.

In addition to these plan components, the City of Goldthwaite City Council recognizes the importance of implementing its drought management plan in response to drought conditions. The City Council officially endorsed this plan through a resolution passed on July 6, 2000 (see Appendix 6A).

5.4.10 Recommended Plan to Meet the Mills County-Other Demands Through 2030

The rural portions of Mills County are dependent on groundwater resources to meet their water demands. The aquifers in this area are very inconsistent. As a result, isolated areas within the County have difficulty obtaining water. Due to the isolated nature of these shortages, it was not possible to quantify the shortage. However, a plan to meet these shortages has been included in the plant.

- ***Alternative G4 – Construction of a Mills County Reservoir (FCWD) -*** This alternative would involve the construction of a reservoir within Mills County. The Fox Crossing Water District anticipates beginning a feasibility study of several sites in Fiscal Year 2001. It is anticipated that the City would be a potential participant in the construction of a reservoir by the Fox Crossing Water District if the feasibility study determines that the construction of a reservoir is feasible and advantageous to the City. It is anticipated that a reservoir could be constructed with a capital expenditure of $4.5 million. The unit cost of water developed in this reservoir is anticipated to be $384 per ac-ft.

5.4.11 Recommended Plan to Meet the Gillespie County-Other Demands Through 2030

Municipal water demands in Gillespie County are dependent on groundwater supplies. The County-Other category was identified as having a shortage under current conditions during severe drought conditions. It is anticipated that these shortages are associated with development in the vicinity of Fredericksburg. In addition, continued growth in the vicinity of Fredericksburg is expected to increase the shortage. As the demand for water increases in the area, the City of Fredericksburg may experience water supply problems due to the competition for water. The regional water plan to address this shortage is based on the approved Water Management Plan for the Hill Country Underground Water Conservation District and includes the following component.

- ***Alternative GL1 – Develop Aquifer Storage and Recovery System*** **-** This alternative would involve the construction of a raw water intake structure and pump station on the Pedernales River (an alternative of using shallow alluvial wells at the river is also being evaluated), a surface water treatment plant, transmission pipelines, and an ASR well. The LCRA completed a Phase 1 study for a small system with a capacity of 1,120 ac-ft/yr. The anticipated capital expenditure necessary to implement a system this size is $8.0 million. The expected annual expenditures would be $0.9 million, including $350,000 for operations and maintenance. The anticipated unit cost of water for this alternative is $839 per ac-ft. The Hill Country Underground Water Conservation District intends to conduct additional studies of this alternative, including the ability to increase the capacity of the system.
- ***Alternative GL2 – Develop Additional Groundwater Resources*** **-** This alternative would involve the development of additional groundwater resources. As additional subdivisions are developed in the county, these subdivisions would drill additional wells to meet their demands. Depending upon where the subdivisions are developed, the aquifer may be depleted in certain areas of the county. When this occurs, it is anticipated that new development will be moved to areas of the county with remaining groundwater, or groundwater from other areas of the county will be piped to the location of the new subdivisions. Since the location of these subdivisions and their relative density is not known, it is difficult to develop a detailed opinion of probable costs for the development of additional groundwater resources. However, it is assumed that groundwater in this area could be developed at a capital cost of $300,000 and a unit cost of $350/ac-ft.

The Hill Country Underground Water Conservation District also understands the importance of water conservation efforts and intends to pursue these efforts.

5.5 RECOMMENDED REGIONAL PLAN TO MEET 2050 NEEDS

It is anticipated that the water supply strategies developed to meet the 2030 needs will also meet the needs for 2050 with the exception of the City of Austin. Since the City of Austin is projected to have adequate water supplies to meet its needs through 2030, it was not included in the 2030 Regional Plan. However, the City of Austin is projected to develop a water supply shortage beginning in 2040.

5.5.1 Recommended Plan to Meet the City of Austin Needs Through 2050

The City of Austin recently executed a water supply agreement with the LCRA to firm up the City's run-of-river rights to 325,000 ac-ft/yr using stored water from the Highland Lakes System. At the time the agreement was executed, the City indicated that water demands in excess of 325,000 ac-ft/yr would be met through a combination of water conservation and reuse. These two components are included in the regional plan for the City of Austin.

- ***Alternative A1 – Water Conservation*** - The City of Austin began an aggressive water conservation campaign in the mid 1980s in response to rapid growth and a series of particularly dry years. The City has achieved significant reductions in both per capita consumption and peak day demands. Since the Regional Planning Group projections for the City of Austin demands are based on 1984 data, the projections do not reflect these achievements. However, the Regional Planning Group projections include approximately 10 percent savings due to anticipated water conservation programs. The City of Austin intends to continue its programs in the areas of public education, rebate and incentive programs, and water saving ordinances.
- ***Alternative A2 - Reclaimed Water Initiative*** - This alternative includes the development of one or more reclaimed water distribution systems to provide reclaimed water to meet nonpotable water demands within the City's service area. The City is currently constructing the first phase of its North-Central Reuse System. This system is expected to have an ultimate capacity of 18,000 ac-ft/yr. In addition, the City is currently completing a Master Plan for its South Reclaimed Water System and is evaluating the feasibility of developing water factories in other areas of the city. The City intends to develop the use of reclaimed water to the maximum extent possible, up to and including reclaiming 100 percent of its wastewater flows to meet any demands in excess of 325,000 ac-ft/yr. As the level of reclaimed water use in the City of Austin increases, the amount of flow it returns to the Colorado River will decrease. Development of reclaimed water facilities necessary to provide for the 2050 demands is anticipated to require a capital expenditure of $108 million. The unit cost of reclaimed water is expected to be $394 per ac-ft.

5.6 REGION-WIDE WATER MANAGEMENT ALTERNATIVE STRATEGIES EVALUATED

The TWDB rules require the RWPG to evaluate all potentially feasible water management strategies to meet the region's identified demand deficits. Feasibility is based on evaluation criteria established by the TWDB and the RWPG including project cost, unit cost, yield, reliability, environmental impact, local preference, and institutional constraints. Several water management strategies were identified and evaluated in terms of the potential impact on the Lower Colorado Region as a whole. These strategies are discussed in the following sections.

5.6.1 Brush Management

Texas rangelands were generally described as grassland or open savanna prior to widespread settlement of the area. The pressure on the vegetation created by grazing animals tended to be light and/or periodic, allowing for the establishment of a robust stand of grass. Tree seedlings that were able to survive the competition with the grass stands tended to perish in wildfires, which periodically occur in "natural" rangelands. Thus, with fire and light grazing pressure, grasslands and savannas were stable and sustainable ecosystems characteristic of many Texas rangelands.

Over time, however, the character of rangelands has been altered through increased grazing and fire suppression activities. These changes allowed the development of large stands of trees and other woody vegetation, termed “brush”. Continuous, often heavy, livestock grazing pressure reduced the ability of grasses to suppress tree seedling establishment. Furthermore, some invasive woody species (e.g., juniper and mesquite) have noxious chemicals in their leaves, resulting in livestock tending to avoid the tree seedlings, while repeatedly grazing the adjacent palatable grasses. This selective grazing behavior gives noxious-tasting tree seedlings a competitive advantage over the native grasses.

These changes have allowed juniper and mesquite trees to dominate large areas of the Edwards Plateau. These species have been documented to adversely affect the water yield from the land (groundwater recharge and surface runoff) due to the significant evapotranspiration rates. It has been documented that juniper and the associated litter have an annual interception loss averaging 73 percent of precipitation, compared with 46 percent interception loss for live oak and 14 percent interception loss for grass (Thurow and Hester, 1997). These data indicate that the amount of water reaching the soil is markedly different depending on the type of vegetation.

Brush management as a water supply strategy is currently being investigated within the State of Texas. Both field studies and modeling investigations conclude that water yield increases exponentially as brush cover declines (i.e., very little change in water yield from dense brush cover down to about 15 percent brush cover, and a rapid rise in water yield from 15 percent cover to 0 percent brush cover). These findings imply that it is necessary to have sustained removal of most of the brush cover to maximize water yield potential. This conclusion is corroborated by numerous anecdotal observations by ranchers and agency personnel with brush control experience in the region (cf. Kelton, 1975; Willard et al., 1993). The exponential pattern of water yield increase relative to a decrease in brush cover has also been postulated for the Colorado River Basin (Hibbert, 1983). The exponential relationship is believed to occur because the intraspecific competition among trees (Ansley et al., 1998) and interspecific competition with herbaceous vegetation results in little increase in water yield until the tree density becomes sparse. In other words, trees have a capability for luxuriant water use, thus if a stand is thinned the remaining trees will in a short time expand their root systems to use the extra water. Only when the thinning reduces tree cover to less than about 15 percent is an opportunity created for significant yields of surplus water.

The use of brush management to increase the supply of water may provide excellent results for individual owners of large tracts of land. However, brush management on a regional scale requires the cooperation of numerous private landowners. It is not realistic to expect communities like Blanco or Goldthwaite to influence the range management practices of enough landowners to make this alternative a reliable long-term source of water. Although brush management is a preferred water supply strategy within the LCRWPA, the LCRWPG supports efforts to develop brush management on a statewide basis, as indicated in Chapter 6 of the regional water planning report.

5.6.2 Weather Modification

The modern science of weather modification began in 1946. By the 1960s and 1970s, Texas was the site for many weather modification studies, including cloud seeding. Water droplets that form in the atmosphere by condensation of water vapor onto existing particles suspended in the atmosphere are called cloud condensation nuclei (CCN). Concentrations of CCN vary from place to place and even from day to day at a given location, and are affected by proximity to cities and industrial areas. The most successful attempts to deliberately modify clouds have involved some modification of the population of CCN on which cloud droplets form, or of the ice nuclei (IN), which are responsible for the appearance of ice and are important in the formation of precipitation in some clouds. The background aerosol or small particle concentration in the atmosphere varies between 1,000 particles per cubic centimeter in clean air, to around 100,000 particles/cm^3 in heavily polluted air. These particles range in size from less than 0.01 microns to over 10 microns in diameter; where one micron is one thousandth of a millimeter. An ambitious cloud seeding program might increase (locally and for a very short time) this atmospheric load by 15 percent in the case of clean air or 0.15 percent in an urban environment. Any nuclei added would be almost immediately swept up into the treated cloud and washed out in the resulting rainfall. Silver iodide, dry ice, and potassium chloride crystals have been used as CCN, none of which are harmful to the environment.

Cloud seeding has been used to reduce hail damage in the High Plains and has been investigated as a means of drought prevention in the Edwards aquifer area, Corpus Christi, and West Central Texas. San Angelo and the Colorado River Municipal Water District in Big Spring sponsored testing to see if weather modification increases the amount of water in lakes and boosts cotton yields.

Different sizes and types of clouds are seeded depending upon the weather modification goal. To lessen hail damage, large thunderstorms likely to produce hail are seeded. To increase rainfall, smaller clouds that are likely to grow are seeded. Successful cloud seeding involves many variables due to the array of environmental conditions and seeding procedures that exist; therefore, a successful seeding program in one region does not guarantee success in another. In addition, the unpredictable nature of weather modification in general continues to fuel debate within the scientific community regarding its validity.

As with brush management, weather modification has demonstrated the capacity to provide additional water to a region, but the results may not provide a reliable quantifiable source of additional water to help meet the demand deficits identified within the LCRWPA. Therefore, these strategies should be dealt with more as long-term best management practices rather than specific water supply options to meet demands. In addition, issues concerning the negative impact on rainfall amounts in areas surrounding the target area persist.

5.6.3 Municipal Conservation

The LCRWPG's water demand projections for municipal uses identified in Chapter 2 include an "expected" level of municipal water conservation. The TWDB required that this level of assumed water conservation be reflected in all municipal water demand projections statewide. This "expected" level of water conservation includes impacts resulting from the State Water-Efficient Plumbing Act of 1991 and the availability of water saving fixtures for new construction and replacement. In most areas of the LCRWPA, the "expected" level of water conservation may be difficult to achieve due to low growth rates and low fixture replacement rates. Additional water savings beyond the "expected" level are not anticipated for most areas and therefore, have not been evaluated as a water management strategy.

However, municipal water conservation in the Austin Metropolitan Area is expected to impact the projected demand scenario significantly. Information concerning water conservation in the Austin Metropolitan Area is presented later in Section 5.9.1.

5.6.4 Water Reuse

The use of reclaimed water to meet nonpotable water demands is increasing in Texas. However, with the exception of the Austin Metropolitan Area, this strategy is not deemed appropriate due to the nature of the identified demand deficits. The largest single water need identified in the LCRWPA is for rice irrigation. Rice irrigators already benefit from any wastewater effluent discharged to the Colorado River upstream of their diversion points. The municipal needs identified in the Hill Country area are generally isolated and stem from a lack of sufficient storage to draw from during extended dry periods when river flows cease. These municipalities generally restrict non-essential water use when the river stops flowing. Therefore, the use of reclaimed water would not extend their water supply.

The City of Austin is currently constructing the major infrastructure needed to allow the use of reclaimed water as an additional source of water. Information concerning the City's Water Reclamation Initiative is presented in Section 5.9.1

5.6.5 Rainwater Harvesting

Rainwater catchment systems provide a source of soft, high-quality water, reduce reliance on wells and other water sources, and can be cost-effective. In light of Texas' current regional water planning efforts and increased attention on conservation and sustainability, a renewed interest in rainwater harvesting has emerged due to the following:

- The escalating environmental and economic costs of providing water by centralized water systems or be well drilling;
- Health concerns regarding the source and treatment of polluted waters;
- A perception that there are cost efficiencies associated with reliance on rainwater.

RWPG and the TWDB should focus on rainwater catchment as a water management strategy and develop specific cost and yield data that will enable the consideration of this strategy as a meaningful source of water.

5.7 EVALUATION OF WATER MANAGEMENT STRATEGIES TO ADDRESS CONTRACTUAL SHORTAGES

As previously indicated, the two Major Providers of water for municipal and industrial uses in the LCRWPA, the City of Austin and the LCRA, both provide water under contractual arrangements. These water supply contracts generally expire before the end of the 50-year planning period. While the two major providers of water are not obligated under the contract to continue providing water to these entities, both the LCRA and the City have indicated that they expect to continue providing water to these entities throughout the 50-year planning period.

As a result, it was assumed that the preferred strategy for these contractual users would be to renew the contracts with the City of Austin or the LCRA, as appropriate, to meet their needs through the 50-year planning period. In order to verify this understanding, the City and LCRA sent letters to each of their customers indicating that this would be the preferred water management strategy included in the regional water plan. Table 5.11 contains a summary of the WUGs for which this alternative applies, the amount of water planned for in the contract extension, and the price of this water in 1999 dollars.

Table 5.11: LCRWPA Water User Groups Requiring Contractual Extensions

WUG	County	Supply Source	Contract Quantity (ac-ft/yr)	Unit Cost of Water ($/ac-ft)
Cottonwood Shores	Burnet	LCRA[1]	171	$ 105
Granite Shoals	Burnet	LCRA[1]	493	$ 105
Marble Falls	Burnet	LCRA[1]	2,264	$ 105
County-Other	Burnet	LCRA[1]	1,641	$ 105
County-Other	Llano	LCRA[1]	1,738	$ 105
Kingsland CDP	Llano	LCRA[1]	522	$ 105
Manufacturing	Matagorda	LCRA[1]	26,349	$ 105
Steam Electric	Matagorda	LCRA[1]	47,000	$ 105
Mining	Matagorda	LCRA[1]	5,000	$ 105
Anderson Mill CDP	Travis	COA[2]	35	$ 652
Jonestown	Travis	LCRA[1]	485	$ 105
Lago Vista	Travis	LCRA[1]	3,630	$ 105
Lakeway	Travis	LCRA[1]	3,287	$ 105
Pflugerville	Travis	COA[2]	5,963	$ 652
Rollingwood	Travis	COA[2]	793	$ 652
Wells Branch CDP	Travis	COA[2]	1,113	$ 652
West Lake Hills	Travis	COA[2]	3,682	$ 652
County-Other	Travis	COA[2]	5,211	$ 652
County-Other	Travis	LCRA[1]	9,454	$ 105
Anderson Mill CDP	Williamson	COA[2]	2.106	$ 652
County-Other	Williamson	COA[2]	215	$ 652

[1] Cost of water for LCRA customers reflects raw water charges only.
[2] Cost of water for COA customers reflects average wholesale treated water costs.

5.8 EVALUATION OF WATER MANAGEMENT STRATEGIES TO MEET IRRIGATION DEMAND DEFICITS

The water needed for irrigation in Colorado, Wharton, and Matagorda counties is the largest deficit identified within the LCRWPA. Several alternative water management strategies to address this issue have been identified and are discussed in the following sections.

5.8.1 Alternative R1 - Continuation of the LCRA Water Management Plan

The LCRA operates four major irrigation districts within the three rice-producing counties. The primary source of water for these districts is run-of-river rights for Colorado River water. However, during drought conditions, sufficient run-of-river water is not available in the river at the time it is needed to meet irrigation demands. The LCRA has committed to providing water stored in the Highland Lakes system to the rice irrigators on an interruptible basis during periods of low flow. This interruptible water is available since the firm yield of the Highland Lakes System is not currently fully allocated. In addition, firm water customers have generally reserved enough water to meet their anticipated needs at some future date. As a result, the current demand for firm water is less than the contracted amount.

The LCRA manages the availability of the interruptible water supply based on its approved 1993 Water Management Plan. Each year, the LCRA determines the amount of interruptible supply that will be available from the Highland Lakes System. The annual supply is determined based on the January 1 lake levels and the projected water demands for the coming year. The current Water Management Plan indicates that all interruptible water demands will be met if the combined storage in the Highland Lakes System is at least 1,100,000 acre-feet (52% of the total maximum storage). Interruptible water is gradually curtailed when storage levels on January 1 are less than 52 percent. The curtailment is approximately a 4 percent reduction in available interruptible supply for each 100,000 acre-foot decrease in combined storage. All interruptible supply is cut off when the combined storage is less than 325,000 acre-feet on January 1.

The LCRA completed an analysis of the amount of interruptible water expected to be available during each decade of the planning period. The availability analysis utilized the LCRA's Response Model and the projected water demands within the LCRWPA for each decade. Table 5.12 presents the results of this analysis.

Table 5.12: Alternative R1 – Available Interruptible LCRA Water Supply[1]

Decade	Average[2] Interruptible Water Supply (ac-ft/yr)	Minimum[3] Interruptible Water Supply (ac-ft/yr)
2000	290,095	46,594
2010	214,760	35,102
2020	172,801	28,379
2030	116,051	19,246
2040	100,643	7,490
2050	96,585	5,714

[1] Availability of interruptible supply taken from LCRA e-mail dated 12/6/00.
[2] Average annual interruptible water supply over the 10-year critical drought period.
[3] Minimum interruptible water supply available in the worst year of the critical drought period.

As the table indicates, the availability of interruptible water supply is expected to decrease significantly in the future as the demands for firm water increase.

5.8.2 Alternative R1A – Utilization of City of Austin Return Flows

The City of Austin currently returns approximately 60 percent of its water demand to the Colorado River as wastewater discharges. Once discharged to the river, this water belongs to the State and is subject to diversion under existing water rights permits for downstream irrigators. The City of Austin has indicated its intention to dramatically expand its reuse of wastewater effluent. The quantity of return flows is projected to increase over the planning period due to increased demands in the City of Austin even though the quantity of reclaimed water used by the City will increase as well. However, the City's dependence on reclaimed water is projected to be so great beyond the year 2050 that return flows are projected to rapidly decline in subsequent years, and the City may achieve full utilization (zero return flow) during the ninth decade of this century. The City of Austin is offering its return flows as a temporary water management strategy for irrigation through the 50-year planning period. Therefore, the availability of this water is included as a water supply alternative rather than being embedded in the baseline river hydrology. Even though the City is not required to return its effluent, this temporary management strategy projects about a 50 percent return flow in the year 2050. This alternative anticipates that the amount of return flow available to the irrigators will be approximately 50,000 ac-ft/yr in the year 2000 and this will increase approximately 60 percent to slightly more than 80,000 ac-ft/yr by 2030. By the year 2050, these return flows are projected to decrease to a total of 20,000 ac-ft/yr, which is an approximate decrease of 75 percent from the year 2030. (see Table 5.2 above, page 5-6). There are no costs associated with the diversion of this water under existing water rights permits with existing infrastructure. Thus far, return flows have contributed to the instream river flow necessary for the ecological stability of various ecosystems. As the return flows diminish in the future due to enhanced reclamation of water, other sources may need to be dedicated or developed if other mitigation measures cannot be identified (see Section 6.2.4)

5.8.2 Alternative R2A – Rice Irrigation On-Farm Water Conservation Measures

Rice utilizes significantly more water than other Texas crops because of the growing environment adopted for rice production. Rice is grown in standing water during most of its vegetative and reproductive stages to minimize competition from plants that cannot tolerate standing water, basically as a weed control measure. The flood culture is not required to grow rice, but is almost universally accepted as the most economical method to control weeds and sustain the rice crop.

Shallow levees are used to separate the individual cuts in a rice field. Maintenance of a uniform shallow water depth allows the levees to maintain greater freeboard or levee height above the water surface. If there is insufficient freeboard, rainfall can cause the levees to overtop and fail with the worst-case result being loss of water from the entire field. Minimizing the flooding depth allows the producer to capture rainwater, replacing an equal amount of water that would normally have been diverted from the river or pumped from wells. The amount of water saved can vary with rainfall during the growing season, but can replace a significant quantity of the water normally diverted from the river and minimize the amount of tail water or rice field runoff water that can carry dissolved fertilizer and potential pollutants downstream.

There are many potential on-farm irrigation improvements, but in general water savings can best be achieved by minimizing flooding depth and improving management of the flushing and flooding operations. The techniques that have the most significant impact in accomplishing these goals include precision or laser land leveling, use of a field lateral with multiple field inlets, reducing the vertical interval or elevation difference between levees, improved management of water control activities, and improved record keeping. Individual water conservation measures are discussed in the following sections.

5.8.2.1 Laser Land Leveling

In the production of rice, there are many benefits to having fields that are almost level but still have some slope for drainage, typically 0.15 foot or less in elevation change for 100 feet of distance. An almost level field will allow a more uniform shallow water depth across the field, reducing the total amount of water applied to the field. Land grading can give a field this desired condition by using a laser guided grader. Precision leveling or land grading can reduce the amount of water used by 25 to 30 percent and increase production by 10 to 15 percent.

The Lower Colorado Regional Water Planning Group (LCRWPG) formed a subgroup to focus on water conservation issues. The Rice Irrigation Working Group agreed that the amount of savings that could typically be realized with the implementation of land leveling alone was 0.6 ac-ft of water per acre irrigated each year. This does not included water conservation in the ratoon crop, because a ratoon crop may or may not be grown. Economic conditions, weather, and other factors can factor into the individual farmer's decision of whether or not to raise a ratoon crop following harvest of the main crop. This approach of not considering additional water savings in the ratoon crop will apply to the evaluation of subsequent water conservation practices.

The cost of precision leveling may vary significantly and is dependent upon existing topography and soil depth. The cost could range from $60 to $200 per acre. The LCRWPG Rice Irrigation Working Group agreed that the typical cost is about $150 per acre. In addition, there is a maintenance leveling requirement after three crops have been grown or every 10 years. The working group agreed on an estimate for this cost of $52.50 per acre every 10 years. Rice is commonly grown in a three year rotation, so a farmer must level three times as much land or maintain leveling on three times as much land as he farms in any single year. The capital cost and maintenance cost must both be tripled to account for this approach.

The working group also reached an agreement on an estimate of the fraction of land currently treated with land leveling of 20 percent, and an estimate of the maximum amount of land in production that could be treated of 70 percent. The difference between these estimates is the amount of land remaining to be treated by land leveling, which is 50 percent. The total land remaining to be leveled is 50 percent of the 74,696 acres, or 37,348 acres. The cost to level this land including the 3 year rotation factor, which in essence triples the cost, is estimated at $16.8 million, and amortizing this amount at 6 percent interest for 30 years results in an annual cost of about $1.2 million. The maintenance cost is handled similarly except that it is expected to be required every 10 years, so the annualized maintenance cost is about $0.8 million. The total cost considering both capital and maintenance cost of land leveling is estimated at $2.0 million per year.

By applying the conservation savings of 0.6 ac-ft of water per acre irrigated to the remaining 37,348 acres to be land leveled could result in a total annual water savings of 22,409 ac-ft/yr. The total annual water savings of 22,409 ac-ft/yr can be combined with the total annualized cost of $2.0 million results to result in a saved water value of $90.15 per ac-ft.

In most cases, land is leased on an annual basis for rice production. There is no long-term agreement between the landowner and farmer. This makes it difficult for the farmer to justify a significant capital expenditure and limits the amount of land where precision leveling is being implemented. The topography and soil type also may limit the amount of land where this practice could be implemented.

5.8.2.2 Use of Multiple Field Inlets

Another method used by rice producers to conserve water is the utilization of multiple field inlets for applying water to the individual cuts or land sections between levees. The use of multiple inlets allows for many benefits that result in water savings. The water savings is further enhanced when multiple inlets are applied in combination with land leveling. The most significant benefits are the ability to apply water where it is needed and at a shallower depth. Because of the shallow water, rice production is increased while the total water applied is minimized. A side lateral with multiple inlets is often paired with a similar drain, as opposed to draining all water from a field through the lowest cut. This allows the field to drain much quicker, shortening the time to harvest and increasing the potential for production of a ratoon crop.

The LCRWPG Rice Irrigation Working Group agreed that the amount of savings that could typically be realized with the implementation of multiple inlets alone was 0.7 ac-ft of water per acre irrigated each year. The working group agreed that the typical installation cost is about $2.00 per acre and that this cost should be applied every year as a maintenance cost rather than a capital cost.

The working group also reached an agreement on an estimate of the fraction of land currently treated with multiple inlets of 30 percent, and an estimate of the maximum amount of land in production that could be treated of 80 percent. The difference between these estimates is the amount of land remaining to be treated by multiple inlets, which is 50 percent. The total land remaining to apply multiple inlets is 50 percent of the 74,696 acres, or 37,348 acres. The total annual cost to install multiple inlets is estimated at about $75,000.

By applying the conservation savings of 0.7 ac-ft of water per acre irrigated to the remaining 37,348 acres to use multiple inlets could result in a total annual water savings of 26,144 ac-ft/year. The total annual water savings of 26,144 ac-ft/yr can be combined with the total annualized cost of $75,000 to yield a saved water value of $2.86 per ac-ft.

5.8.2.3 Reduced Levee Intervals

Another approach to minimizing the water depth is to reduce the typical interval between levees from 0.2 ft to 0.15 feet. The cost associated with making this change can be very minimal with only a few additional levees plowed into place at the beginning of the rice-growing season. The smaller interval allows average flooding depth to be minimized, which is both more compatible with the current dwarf varieties of rice that are grown and allows more freeboard for capturing rainfall. The levees themselves can also be smaller resulting in not only less rice being grown on the levees because they are narrower, but the yield from rice grown on the levees is less impacted. Smaller levees also results in less wear and tear on equipment that must cross the levees during production and harvest. Reducing the levee interval can save about 0.3 feet per acre irrigated when used in conjunction with precision land leveling and 0.4 feet per acre irrigated when applied without precision leveling.

The LCRWPG Rice Irrigation Working Group agreed that the amount of savings that could typically be realized with the implementation of reduced levee interval alone was 0.4 ac-ft of water per acre irrigated each year. The group agreed that the typical installation cost is about $0.50 per acre and should be applied every year as a maintenance cost rather than as a capital cost.

The working group also reached an agreement on an estimate of the fraction of land currently treated with reduced levee intervals of 40 percent, and an estimate of the maximum amount of land in production that could be treated of 50 percent. The difference between these estimates is the amount of land remaining to be treated by reduced levee intervals, which is 10 percent. The total land remaining to apply reduced levee intervals is 10 percent of the 74,696 acres, or 7,470 acres. The total annual cost to install reduced levee intervals is estimated at about $3,735.

By applying the conservation savings of 0.4 ac-ft of water per acre irrigated to the remaining 7,470 acres to implement reduced levee intervals could result in a total annual water savings of 2,988 ac-ft/yr. The total annual water savings of 2,988 ac-ft/yr can be combined with the total annualized cost of $3,735 to yield a saved water value of $1.25 per ac-ft.

5.8.2.4 Combining Land Leveling with Multiple Field Inlets

Several combinations of conservation practices could be evaluated, but the LCRWPG Rice Irrigation Working Group decided that the most common combined approach that would result in the greatest water savings would be the combination of land leveling with the use of multiple inlets. In many cases the farmers that use these two conservation practices may also implement a reduced levee interval, but the cost associated with the additional combination of conservation practices becomes less discernible as does the water savings.

The LCRWPG Rice Irrigation Working Group agreed that the amount of savings that could typically be realized with the combination of land leveling and multiple inlets is 1.0 ac-ft of water per acre irrigated each year. The total annualized cost of land leveling is added to the annual cost for multiple inlets to result in a total annual cost of $2.1 million.

The working group also reached an agreement on an estimate of the fraction of land currently treated with both practices at 20 percent, and an estimate of the maximum amount of land in production that could be treated of 70 percent. The difference between these estimates is the amount of land remaining to be treated by both land leveling and multiple inlets, which is 50 percent. The total land remaining to apply both practices is 50 percent of the 74,696 acres, or 37,348 acres.

By applying the conservation savings of 1.0 ac-ft. per acre irrigated to the remaining 37,348 acres to implement reduced levee intervals could result in a total annual water savings of 37,348 ac-ft/yr. The total annual water savings of 37,348 ac-ft/yr can be combined with the total annualized cost of $2.1 million to yield a saved water value of approximately $56 per ac-ft.

5.8.3 Alternative R2B – Irrigation District Conveyance Improvements

From 1994 through 1999, average diversions by the LCRA for the Lake Side Water District and the Gulf Coast Irrigation District were 283,000 ac-ft/yr. Delivery to the rice producers was only about 200,000 ac-ft/yr, resulting in a loss of about 84,000 ac-ft/yr. This is about 29.5 percent of the total water diverted from the river. These losses can be attributed to evaporation from the canals, seepage out of the canals, evapotranspiration (or use of water by plants growing along the banks of canals), canal leakage through cracks in canals and structures, and management losses.

Evaporation has been estimated to account for a very small portion of the system losses at only about one percent. Thorough measurement and inventory of all of the potential losses have not been performed, but the most readily identifiable losses appear to be associated with system management losses. These are losses that result from farmers requesting or ordering water for fields in advance and then not being able to take the water delivery due to changing climatic conditions. The fully charged canal system cannot simply be tuned off, because it is designed to flow to the end of the system. The result is that much of this water that is not diverted to a farmer is discharged to the drainage ditches and lost from the system. During the early portion of the irrigation season it has been estimated that management losses can account for as much as 50 percent of the water diverted from the river.

Several techniques may be implemented to significantly reduce the management losses from the system. These techniques are discussed in the following sections.

5.8.3.1 Balancing Reservoirs

Two types of balancing reservoirs have been proposed for consideration to capture irrigation water carried by the canal system when it is apparent that the water will not be used, and return this water to the canal system at a later time for use downstream. Both the LSWD and GCWD could implement intermediate balancing reservoirs. Three reservoirs are proposed for each system. These reservoirs would be located at about the midpoint of the major branches of each system. Each of these reservoirs is estimated to cost about $1.5 million to construct including the water control structures and pump stations needed to get water in and out of the reservoirs. Each of the reservoirs would need to hold about 300 ac-ft. so that the total intermediate storage in each system would approach 1,000 ac-ft. As an alternative to the 3 large reservoirs smaller on farm reservoirs could also be used to accomplish this water balancing function. The annual operation and maintenance cost associated with these reservoirs is estimated to be about $270,000, resulting in a total annual cost of $0.9 million. If 30 percent of the 83,000 ac-ft. currently lost is saved by these reservoirs, then the annual water savings will be 24,900 ac-ft. The value of the water saved is estimated at $37 per ac-ft. These estimates of water savings and reservoir size will need to be evaluated through detailed engineering analysis to verify costs and water savings.

5.8.3.2 Addition of Automated Checks and SCADA System

Check structures are used in the canal system to hold-up or check the flow of water as it moves down the canals. Addition of check structures to the existing canal system would allow for better control of the flow. Automation of these structures would further enhance the control and shorten the amount of time required to react to system changes. Use of a Supervisory Control and Data Acquisition (SCADA) system to monitor water levels between checks and relay this information to the pump stations would further reduce the amount of water lost from the system by reducing pumpage faster when climatic conditions change and farmers cease taking water deliveries.

It is estimated that automated check structures could be installed for about $10,000 each and that ten structures could be added to each of the systems. Addition of a SCADA system could be accomplished for about $1 million on each system. The total capital cost for addition of 20 automated check structures and two SCADA systems would come to $4 million. The annual operation and maintenance cost for these systems is estimated at $80,000. The total annualized cost of the capital investment in these improvements comes to $370,596.

Estimating that these improvements could also save 30 percent of the current system losses would result in savings of 24,900 ac-ft/yr. The value of this savings would be about $15 per ac-ft. These improvements would also require further engineering analysis to confirm the costs and savings.

5.8.3.3 Combination of Regulating Reservoirs with Addition of Automated Checks and SCADA

The two previously described alternatives for improvement could be combined to produce even greater water savings. The total capital costs for combining these systems comes to $13 million. The operation and maintenance costs are estimated at $260,000 and the total annualized cost comes to $1.2 million. Water savings for this combined approach is estimated at 55 percent or 45,650 ac-ft/yr. These water savings are valued at $26 per ac-ft.

5.8.4 Alternative R3 – Off-Channel Storage Reservoirs

During a repeat of the drought of record, the water rights contracted for the production of rice in the lower Colorado River Basin would be underutilized due to a lack of flow in the river during the irrigation season. A possible management strategy to increase water availability during drought conditions would be to provide storage capacity in the lower basin using off-channel storage ponds. The off-channel storage ponds envisioned in this alternative would be formed by earthen dikes enclosing an area to be impounded (similar to the South Texas Project Reservoir).

Water would be diverted from the river, primarily during the winter months, to fill the off-channel reservoirs. Then during the irrigation season, water would be released from the reservoirs back to the river when flows in the river were not sufficient to meet the daily irrigation demands. In addition, the reservoir could be partially refilled during the irrigation season when spring and summer storms increase the flows above what are needed to meet the daily irrigation demand.

5.8.4.1 Hydrologic Analysis

In order to complete an analysis of the water available from this alternative, the following assumptions were made:

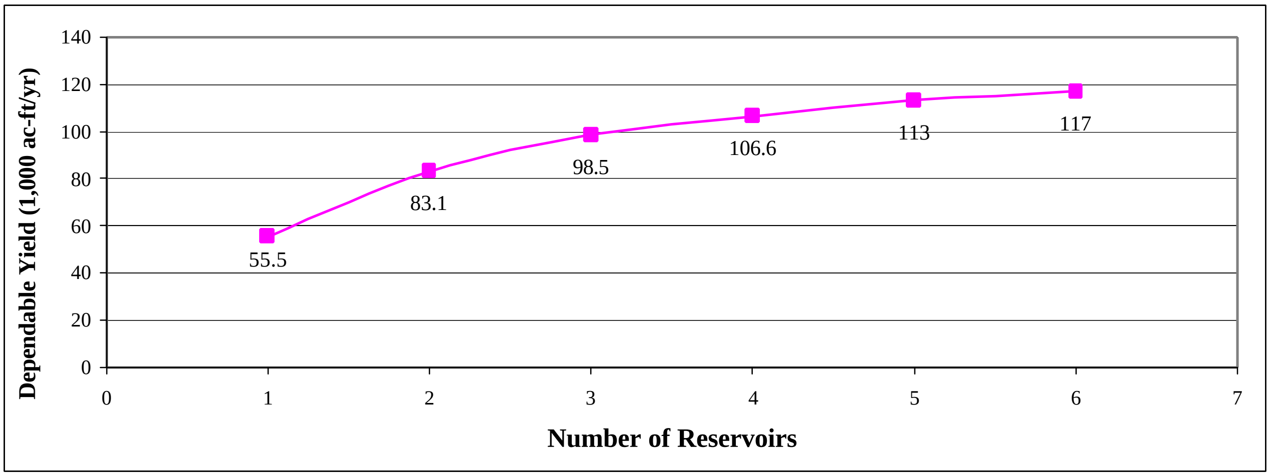
- Daily river flows available for diversion were assumed to be the simulated flows passing Bay City over the period 1941-1965 under the year 2050 SB1 water demand conditions from the LCRA Water Management Plan strategy; coupled with the use of return flows from the City of Austin. These daily flows were derived from the LCRA RESPONSE hydrologic simulation model (LCRA, 1998). The computer program simulates the daily hydrologic conditions on the river and estimates the water supply available to the major run-of-river water rights, all of which are senior to the water rights for the Highland Lakes System. The model also calculates the water available from storage in the Highland Lakes and operates them on a monthly basis to meet water needs that are not satisfied by the natural river flow, including environmental needs.

- Water diverted from the Colorado River is assumed to be withdrawn under existing, underutilized water rights held by the LCRA for the Gulf Coast, Garwood, Pierce Ranch, and Lakeside irrigation systems. The use of these rights may require environmental flow restrictions, subject to TNRCC decisions.
- Two alternative daily water demand distributions were assumed: irrigation and uniform demands.
  - The irrigation demand distribution is the historical daily usage fraction of the annual demand for the existing four major irrigation districts: Lakeside, Gulf Coast, Pierce Ranch, and Garwood (LCRA Water Management Plan, 1999, page 104).
  - For the uniform demand distribution, the annual water need was distributed equally each day. This distribution represents the likely demand for water if its use were for municipal purposes, including those outside the Colorado River basin.
- A maximum daily diversion capacity of 200 cfs was assumed in the operation of each reservoir when operated to meet the irrigation demand distribution. When a uniform demand distribution is assumed, each reservoir would have a maximum diversion capacity of 500 cfs.
- The consideration of flow pass-through for environmental needs was considered in two alternative ways: with and without Consensus Water Planning Environmental Criteria (CWPEC). The CWPEC may be applied in this case since there are no site-specific environmental flow criteria for Matagorda Bay freshwater inflows. There are site-specific inflow criteria for operation of the LCRA Highland Lakes, but these do not apply to any other water users in the basin.
  - Since the water would be diverted under existing irrigation water rights and may not be subject to additional flow restrictions, the water supply was computed assuming that only the flow releases required under the LCRA Water Management Plan for the Highland Lakes were passed. This flow is equivalent to a minimum flow of 18 cfs and represents stored water released for the Highland Lakes to meet freshwater inflow needs in Matagorda Bay.
  - The second scenario required that the diversions exclude river flows that must pass according to the CWPEC.
- The location of each reservoir was assumed to be in close proximity of the river somewhere in southern Wharton or northern Matagorda counties. The specific locations of the projects will depend on land availability.
- Each reservoir was assumed to have a capacity of 25,000 acre-feet and a surface area of 1,340 acres.
- The annual evaporation rate from each lake was assumed to be the average of the historical rates from 1947-1956, with the monthly rates distributed according to the monthly average during that period.
- The daily flows potentially available for diversion to the off-channel reservoirs are the flows passing Bay City calculated by the RESPONSE model, plus the year 2050 surface water demands at Bay City. These demands consists of: (1) the portion of the Gulf Coast Irrigation District's demand at Bay City (56% of the total district demand based on total diversion capacity); and (2) the manufacturing, mining, and stream electric demands.

The simulated operation of a potential off-channel reservoir used a daily time-step. For each day, the river flow was evaluated to determine if there was sufficient water to divert to the reservoir. If flows in the river exceeded 25 cfs, after the irrigation demands were met, then it was assumed water in excess of 25 cfs could be pumped out of the river at a rate of up to 200 cfs to refill the reservoir. Based on this analysis, the dependable supply of water available from a single off-channel reservoir was determined to be 55,500 ac-ft/yr.

In order to evaluate the full potential of developing additional, dependable water supplies through the use of off-channel reservoirs, the impact of additional reservoirs on the firm yield analysis was determined. In general, the available yield from additional reservoirs decreases with each reservoir constructed. Figure 5.6 illustrates the yield from additional reservoirs.

Figure 5.6: Water Availability for Irrigation Demands from Off-Channel Reservoirs



5.8.4.2 Opinion of Probable Costs

Information concerning the probable cost of a single off-channel reservoir is provided in Table 5.13. The probable construction cost for an off-channel reservoir is estimated to be $20 million. The total project cost, including engineering, surveying, permitting, land acquisition, etc., is estimated to be approximately $35 million. The annual costs, including debt retirement and operations and maintenance is estimated to be $2.84 million. Based on a firm yield of 56,000 ac-ft/yr, the unit cost of developing this additional water supply source is $48 per ac-ft.

Table 5.13: Alternative R3 (Single Off-Channel Reservoir) Probable Unit Costs [1]

Phase	Cost Opinion
Capital Costs	
River Intake and Pump Station (200 cfs; 2,110 hp)	$ 3,701,000
Transmission Pipeline (72 in, 1 mile)	$ 1,000,000
Reservoir Construction (25,000 ac-ft)	$ 15,418,000
Power Connection Costs ($125/ HP)	$ 263,750
Total Capital Costs	**$ 20,382,750**
Transmission Line Engineering, Contingencies and Legal Services (30%)	$ 1,490,000
Reservoir Engineering, Contingencies and Legal Services (35%)	$ 5,396,300
Transmission Line Land Acquisition and Survey (5 acres)	$ 47,441
Reservoir Land Acquisition and Survey (1,340 acres)	$ 1,670,000
Environmental and Archeological Studies, Mitigation, and Permitting	$ 2,069,543
Interest Accrued During Construction	$ 7,450,000
Interest Earned on Unused Principal	$ (2,990,000)
Total Project Costs	**$ 35,516,034**
Annual Costs	
Pipeline Debt Service (6 % for 30 years)	$ 545,000
Reservoir Debt Service (6 % for 40 years)	$ 1,860,000
Intake, Transmission Line, and Pump Station Operation and Maintenance	$ 50,000
Reservoir Operation and Maintenance	$ 285,000
Pumping Energy Costs ($0.06/kWh)	$ 100,000
Total Annual Costs	**$ 2,840,000**

[1] Cost information obtained from Region L Plan as prepared by HDR Engineering, Inc.

The probable cost for developing additional, similar off-channel reservoirs is assumed to be linear. That is, each additional off-channel reservoir would cost approximately $35 million to develop. Since the cost for developing additional reservoirs is expected to be linear and the yield per reservoir is expected to decline with each reservoir developed, the cost per acre-foot of water developed will increase with each reservoir developed. Table 5.14 presents information concerning the costs of water for varying the number of reservoirs.

Table 5.14: Alternative R3 Probable Unit Cost of Water for Multiple Off-Channel Reservoirs

# Off-Channel Reservoirs	Incremental Yield [1] (ac-ft/yr)	Cumulative Yield (ac-ft/yr)	Incremental Unit Cost ($/ac-ft)	Cumulative Unit Cost ($/ac-ft)
1	55,500	55,500	$ 51	$ 51
2	27,600	83,100	$ 103	$ 68
3	15,400	98,500	$ 184	$ 86
4	8,100	106,600	$ 351	$ 107
5	6,400	113,000	$ 444	$ 126
6	4,000	117,000	$ 710	$ 146

[1] Yield with consensus flow information obtained from LCRA Technical Memorandum dated 12/12/00.

5.8.4.3 Environmental Impacts

The environmental impacts of the construction of one or more off-channel reservoirs would depend on the final location of the intake structures and reservoirs. A detailed environmental assessment, to include wetlands delineation and an endangered species survey would need to be conducted prior to implementing this alternative.

In addition to the potential environmental impact resulting from the construction activities, the operation of one or more off-channel reservoirs will have an impact on the available freshwater inflows to the Matagorda Bay system. The LCRA, in cooperation with the Texas Parks and Wildlife Department (TPWD), the TWDB, and the Texas Natural Resource Conservation Commission (TNRCC) has determined the critical freshwater inflow needed to maintain critical salinity levels. A target level of 1.03 million ac-ft/yr has been established as the preferred needs and 171,000 ac-ft/yr has been established as the critical need.

As water is diverted from the river to the off-channel reservoirs for later use, and to make-up evaporative losses in the reservoirs, this water will not be directly available for discharge to Matagorda Bay. However, once water is withdrawn from the reservoirs and used for irrigation, the return flow from the fields will generally be discharged to the bay. Table 5.15 contains estimates of the decreases in freshwater inflows to Matagorda Bay depending on the number of off-channel reservoirs developed.

Table 5.15: Alternative R3 (Off-Channel Reservoirs) Freshwater Inflows to Matagorda Bay [1]

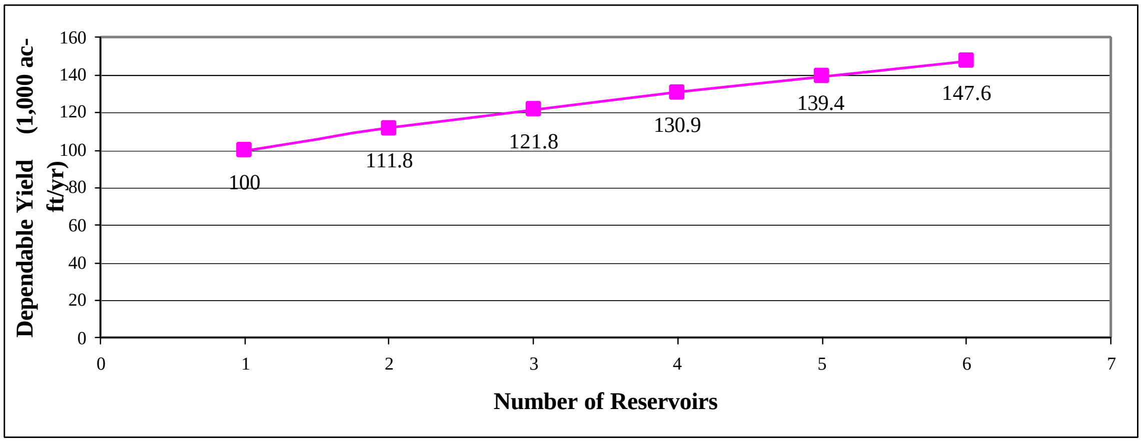
# Off-Channel Reservoirs	Avg. Annual Drought Condition (1000 ac-ft/yr)	Minimum Annual Drought Condition (1000 ac-ft/yr)
0	476	186
1	417	128
2	389	109
3	373	99
4	364	95
5	357	83

[1] Inflow information obtained from LCRA memorandum dated 12/12/00.

5.8.5 Alternative R3A – Off-Channel Reservoirs With a Municipal Supply Component

An initial analysis of Alternative R3 indicates that the off-channel reservoirs will refill quickly once the irrigation season is completed. During most years, additional flow in the river during the winter months would still be available for diversion. This water could be diverted to the off-channel reservoirs and made available to meet other demands, possibly outside the Lower Colorado Region, specifically to the South-Central Region and the San Antonio area. In order to increase the yield of these off-channel reservoirs, the maximum diversion rate from the river would be increased from 200 cfs to 500 cfs. This will allow the reservoirs to recover much faster during wet weather events and will provide more diversion capabilities during the winter months. Figure 5.7 illustrates the potential dependable supply that could be developed using this alternative.

Figure 5.7: Alternative R3A - Dependable Municipal Supply Availability from Off-Channel Reservoir(s)



The cost of this alternative is very similar to the costs established for Alternative R3. However, there would be some additional cost associated with increasing the available diversion capacity from 200 to 500 cfs. The opinion of probable cost for a single off-channel reservoir with municipal supply capabilities is presented in Table 5.16.

Table 5.16: Alternative R3A Unit Costs (Off-Channel Reservoir for Municipal Needs) [1]

Phase	Cost Opinion
Capital Costs	
River Intake and Pump Station (500 cfs, 5,275 HP)	$ 6,500,000
Transmission Pipeline (2-84 in, 1 mile)	$ 2,350,000
Reservoir Construction (25,000 ac-ft)	$ 15,418,000
Power Connection Costs ($125/ HP)	$ 660,000
Total Capital Costs	**$ 24,928,000**
Transmission Line Engineering, Contingencies and Legal Services (30%)	$ 2,850,000
Reservoir Engineering, Contingencies and Legal Services (35%)	$ 5,396,300
Transmission Line Land Acquisition and Survey (7 acres)	$ 65,000
Reservoir Land Acquisition and Survey (1,340 acres)	$ 1,670,000
Environmental and Archeological Studies, Mitigation, and Permitting	$ 2,069,543
Interest Accrued During Construction	$ 8,870,000
Interest Earned on Unused Principal	$ (3,550,000)
Total Project Costs	**$ 42,298,843**
Annual Costs	
Debt Service (6 % for 30 years)	$ 1,040,000
Debt Service (6 % for 40 years)	$ 1,860,000
Intake, Transmission Line, and Pump Station Operation and Maintenance	$ 75,000
Reservoir Operation and Maintenance	$ 285,000
Pumping Energy Costs ($0.06.kWh)	$ 175,000
Total Annual Costs	**$ 3,435,000**

[1] Cost information adapted from Region L Plan as prepared by HDR Engineering.

The probable cost for developing additional, similar off-channel reservoirs is assumed to be linear. That is, each additional off-channel reservoir would cost approximately $42 million to develop. Since the cost for developing additional reservoirs is expected to be linear and the yield per reservoir is expected to decline with each reservoir developed, the cost per acre-foot of water developed will increase with each reservoir developed. Table 5.17 presents information concerning the cost of water for varying the number of reservoirs

Table 5.17: Alternative R3A Unit Cost of Water (Multiple Municipal Off-Channel Reservoirs) [1]

No. of Off-Channel Reservoirs	Incremental Yield [1] (ac-ft/yr)	Cumulative Yield (ac-ft/yr)	Incremental Unit Cost ($/ac-ft)	Cumulative Unit Cost ($/ac-ft)
1	100,000	100,000	$ 34	$ 34
2	11,800	111,800	$ 291	$ 61
3	10,000	121,800	$ 344	$ 85
4	9,100	130,900	$ 377	$ 105
5	8,500	139,400	$ 404	$ 123
6	8,200	147,600	$ 419	$ 140

[1] Average cost of raw water produced. It is anticipated that the municipal user will contribute toward the total capital cost to offset the cost to irrigators. In addition, the municipal water would need to be conveyed to the user's location and treated. These costs are not included in this table.

The diversion of additional water for municipal needs will further reduce the available inflow to Matagorda Bay, as discussed in the previous section. The anticipated inflows to Matagorda Bay for this alternative are presented in Table 5.18.

Table 5.18: Alternative R3A (Multiple Municipal Off-Channel Reservoirs) Freshwater Inflows to

No. of Off-Channel Reservoirs	Avg. Annual Drought Condition (ac-ft/yr)	Min. Annual Drought Condition (ac-ft/yr)
0	476	186
4	341	87

[1] Inflow information obtained from LCRA Technical Memorandum dated 12/12/00.

In addition to a diversion from the Lower Colorado and the four off-channel reservoirs, Region L has discussed diverting up to 28,000 ac-ft/yr from the Colorado River at a more upstream location, specifically Bastrop County. The impact of this proposed diversion has not been fully evaluated. As a result, the LCRWPG expressed a preference that water be diverted in Matagorda County where the off-channel reservoirs are located. However, if an upstream diversion is necessary to provide water to Hays County, this diversion could be located between Lake Travis and Bastrop, subject to the following condition: The intent of the LCRWPG is that the full water supply benefit to Region K envisioned by the water sharing plan with Region L be achieved regardless of the location of water diversions from the Colorado River to Region L.
Matagorda Bay

5.8.6 Alternative R4 – Shaws Bend Reservoir

The water supply associated with Shaws Bend Reservoir was evaluated in order to give a relative comparison of the cost of water from a major reservoir to other alternatives evaluated. **(It is important to note that this alternative is not included in the Regional Water Plan due to overwhelming opposition from local residents and Regional Planning Group Members. The Regional Planning Group has taken an official position in opposition to this reservoir as an alternative for water supply for the Lower Colorado Region, or any other region.)** Shaws Bend Reservoir would require the construction of a major dam and reservoir on the Colorado River between La Grange and Columbus in Fayette and Colorado counties. The site for the Shaws Bend Dam would be approximately five miles west of the City of Columbus. An earth-filled embankment would form the reservoir. Releases from the reservoir would be made through a gated spillway. The dam embankment would extend approximately 5,600 feet across the Colorado River valley. The crest elevation would be 241 feet above mean-sea-level (msl). The reservoir would provide a conservation storage capacity of 132,220 acre-feet at an elevation of 220 feet msl. Approximately 12,400 acres would be inundated at this elevation. The reservoir pool would extend about 34.5 river miles upstream of the dam. This reservoir could also be used to meet the rice irrigation demand deficit.

5.8.6.1 Hydrologic Analysis

The Shaws Bend Dam would impound unappropriated water and store the water for later use. This water would be released from the reservoir as needed to pass storm flows, meet inflow requirements to Matagorda Bay, and meet rice irrigation demands. The firm yield of this reservoir was determined utilizing the LCRA's Response Model and a reservoir operation model. The results of this analysis indicated that a firm yield of 51,576 ac-ft/yr would be available from this reservoir.

5.8.6.2 Opinion of Probable Costs

Information concerning the probable cost of implementing this alternative is presented in Table 5.19. The probable capital cost associated with the dam is $83 million. Other project costs, including engineering, surveying, permitting, and land acquisition increase the total project cost to $315 million. The probable annual cost for operating the reservoir, including debt retirement is $22 million. Based on a firm yield of 51,576 ac-ft/yr, the probable unit cost of water for this alternative is $430 per ac-ft.

Table 5.19: Alternative R4 (Shaws Bend Reservoir) Opinion of Probable Cost [1]

Phase	Cost Opinion
Capital Costs	
Reservoir Construction	$83,246,000
Total Capital Costs	**$83,246,000**
Engineering, Contingencies and Legal Services (35%)	$29,136,100
Land Acquisition and Survey	$81,410,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$81,529,000
Interest Accrued During Construction	$66,077,064
Interest Earned on Unused Principal	($26,475,428)
Total Project Costs	**$314,922,736**
Annual Costs	
Debt Service (6 % for 40 years)	$20,930,249
Operation and Maintenance	$1,249,000
Total Annual Costs	**$22,179,249**
Unit Cost of Water ($/ac-ft)	**$430**

[1] Cost and yield information taken from Region L Plan as prepared by HDR Engineering.

5.8.6.3 Environmental Impacts

The Shaws Bend Reservoir would impound the lower Colorado River in Colorado and Fayette counties. The proposed dam site is located approximately 4.1 river miles above the U.S. Highway 71 bridge crossing near Columbus in Colorado County. Preliminary field studies were conducted by the United States Bureau of Reclamation (USBR). The results are presented in the following sections. The implementation of the Shaws Bend Reservoir project would require additional field surveys for protected species, vegetation, and habitats.

Vegetation

The proposed reservoir lies entirely within the Texas Blackland Prairie Ecoregion. The Post Oak Savannah vegetational area of Texas lies immediately to the north of the upper reservoir boundary. The Blackland Prairie vegetational area places the reservoir in the Texas Biotic Province, which can be characterized as a broad transitional zone between western grasslands and eastern forests. Blair's biogeographical listing of the wildlife fauna of this region, like the vegetation, is a mix of western grassland-associated and eastern forest-associated organisms.

The Post Oak Savannah is characterized by gently rolling hilly terrain with an understory that consists typically of tall prairie grass and an overstory that is primarily post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*). Most of the Post Oak Savannah has been converted to improved pastures and small farms. The Blackland Prairie's gently rolling to nearly level plains are largely under cultivation with a few areas in native hay meadows and improved pastures. The soils of the East Central Texas Plains are characteristically dry alfisols. Within the reservoir site are clayey and loamy Brazoria-Norwood soils, typical of floodplains and river terraces. Brazoria soils are poorly drained hydric soils that support hydrophytic vegetation. These areas may be considered jurisdictional wetlands by the United States Army Corps of Engineers (USACE).

The vegetation of the reservoir site is primarily influenced by its location in the Colorado River floodplain. The wetlands and river terrace are primarily forested with pecans, cottonwoods, sycamores, and willows. Live oak, post oak and water oak cover the upper river terraces and upland areas. Grassland and pasture comprise about half of the reservoir area. The USBR study applied the Unites States Fish and Wildlife Service (USFWS) Habitat Evaluation Procedures cover type categories to the vegetation communities to be affected by the proposed reservoir. The vegetation cover types have been grouped into categories and are presented in Table 5.20 along with the approximate area of each habitat. These acreages are based on USFWS classification criteria and it is uncertain what portion of the wetlands will be USACE jurisdictional wetlands. It should be noted that, next to actual riverine and forested wetlands, riparian woodlands are presently among the highest priorities for conservation among both state and federal regulatory agencies.

Table 5.20: Land Types That Would be Inundated by Shaws Bend

Land Types Within Conservation Pool[1]	Acres Inundated
Crop	0
Upland Woodland	3,092
Park	1,193
Brushland	0
Grassland and Pasture	5,781
Riverine (R2) Wetland	1,016
Forested Wetland	1,318
Total	12,400

[1] USBR 1986 report concluding the study on Colorado Coastal Plains Project, Texas, Southwest Region, Amarillo, Texas

The USBR report concluded that the continued existence of protected species or candidates for protection would not be affected by the project. Surveys for five protected or rare plant species failed to locate Texas meadow-rue, Navasota ladies'-tresses, blue-star, spikerush, or prairie dawn within the project area. Additional field studies revealed that the project area soils are unsuitable for populations of Navasota ladies'-tresses. However, the study also recommended that the proposed dam site, adjacent uplands, and lands within the conservation pool should be thoroughly surveyed again for Texas meadow-rue prior to construction, since this plant adapts to prairie and oak forest with a shrub-grass understory.

The environmentally unique areas of the Harvey Creek and Horseshoe Bend woodlands would be affected by the proposed reservoir. Harvey Creek is about 30 acres of relatively undisturbed mature oaks, elms, and hackberry trees. The creek provides a continuous water supply to the numerous pools and riffles along the reach above the confluence with the Colorado River. This pristine bottomland with pools and riffles would be totally inundated by the conservation pool. Horseshoe Bend woodlands, relatively undisturbed for more than 30 years, is approximately 100 acres dominated by an elm-ash-hackberry community with relatively homogeneous stands of cottonwood, hackberry, and other bottomland trees. The central portion of this woodland has a remnant oxbow lake that was cut off from the Colorado River during the 1940s. Other area oxbow lakes have generally been cleared for agricultural purposes. The Horseshoe Bend woodlands would be 70 percent inundated by the conservation pool.

The USBR agreed to a mitigation plan with the USFWS for the habitat that would be inundated. Mitigation included planting 4,000 acres of bottomland with native hardwoods to create a forested wetland within a 6,000-acre wildlife management area. Mitigation plans included areas directly affected by the reservoir inundation, areas disturbed by construction, and an estimated 2,180 acres of pecan orchard adjoining the reservoir site that may be killed by the raised groundwater table. Results of a Habitat Evaluation Procedure conducted by the USFWS indicated that about 46,000 acres managed to encourage woodland development could be needed to compensate for terrestrial habitat losses.

Animal Species and Habitats

The Texas garter snake may be present in wetland habitats and grasslands. The timber rattlesnake is associated with dense bottomlands woods. The Texas horned lizard and the western smooth green snake may be present in grassland areas. Two fish, the blue sucker and the Guadalupe bass, are known to inhabit this portion of the Colorado River. Additional surveys for threatened and endangered species would need to be completed prior to implementation of this alternative.

Cultural Resources

Approximately 200 to 250 prehistoric and historic sites have been identified within the project area. Some of these sites would be destroyed by project construction and others would be less vulnerable to disturbance by human activity as a result of inundation. Burnham's Crossing, a historic ferry crossing and trade center, would be inundated regardless of conservation pool level since most of the site lies below the 200-foot contour. A site mitigation plan will be required to avoid the loss of historically significant resources. A systematic survey of the entire site would be required to search for surface indications of cultural deposits, while a geomorphic study to evaluate the potential for buried deposits is also a likely requirement. Sites located would have to be tested for archaeological or historic significance and for eligibility for listing on the National Register, and the need for additional study, salvage, or other mitigation determined prior to construction.

5.8.7 Alternative R5 – Fox Crossing Reservoir

Rice irrigation demand deficits could also be met with the historically proposed Fox Crossing Reservoir site; which would be located on the Colorado River and Pecan Bayou confluence in Mills and San Saba counties. The site was originally studied in the 1960s. Information concerning the size of dam and elevation of the spillway is not currently available for the Fox Crossing Alternative. It is assumed that the dam would be of earthen construction. The conservation pool capacity of the reservoir has previously been assumed to be 950,000 acre-feet.

5.8.7.1 Hydrologic Analysis

The Fox Crossing Reservoir site has been studied since the 1960s. Most recently, the LCRA conducted an update study of information pertaining to a number of reservoirs in the upper basin. Fox Crossing was one of the reservoir sites included in this update. The LCRA's Response Model was utilized to determine the firm yield available from the Fox Crossing Reservoir without negatively impacting the yield from the Highland Lakes System. This analysis indicated that the firm yield available is 72,589 ac-ft/yr. This yield is based on the assumption that all reservoirs are full at the beginning of a repeat of the drought of record. Inflow to Fox Crossing is passed through whenever reservoirs within the Highland Lakes System are below capacity.

5.8.7.2 Opinion of Probable Cost

Information concerning the probable cost of implementing this alternative is presented in Table 5.21. The probable capital cost associated with the dam is $205 million. Other project costs, including engineering, surveying, permitting, and land acquisition increase the total project cost to $447 million. The probable annual cost for operating the reservoir, including debt retirement is $31 million. Based on a firm yield of 72,589 ac-ft/yr, the probable unit cost of water for this alternative is $421 per acre-foot.

Table 5.21: Alternative R5 (Fox Crossing Reservoir) Opinion of Probable Cost [1]

Phase	Cost Opinion
Capital Costs	
Reservoir Construction	$205,578,947
Total Capital Costs	**$205,578,947**
Engineering, Contingencies and Legal Services (35%)	$71,952,632
Environmental and Archeological Studies, Mitigation, and Permitting	$114,503,818
Interest Accrued During Construction	$94,088,495
Interest Earned on Unused Principal	($37,698,908)
Total Project Costs	**$448,424,985**
Annual Costs	
Debt Service (6 % for 40 years)	$29,803,013
Operation and Maintenance	$900,630
Total Annual Costs	**$30,703,643**
Unit Cost of Water ($/ac-ft)	**$421**

[1] Cost and yield information taken from LCRA report prepared by Freese & Nichols, Inc. "Water Conservation and Flood Control Study Upstream of the Highland Lakes", September 1998.

5.8.7.3 Environmental Impact

Environmental impacts specific to the proposed Fox Crossing Reservoir site were not included in the LCRA report. Following is a summary of general environmental impacts, which may occur if a new reservoir is constructed:

- Trees, shrubs, and other types of vegetation would be affected during construction, whenever the water supply reservoirs are filled, and for periods of time when the flood control portion of a reservoir is used. The degree of impact would depend on the particular tolerance for inundation;

- Wildlife species living in an affected area would be displaced to outlying areas during construction, whenever the water supply reservoirs are filled, and for periods of time when the flood control portion of reservoirs is used. Some species (particularly ground dwelling and ground nesting species) would be displaced, while migratory birds and other species may be attracted to the water body;
- Significant flooding depths and severity of water surface elevations could induce erosion and retard re-growth of new vegetation after floodwaters recede;
- Aquatic species may be impacted (e.g., upstream migration of fish, etc.);
- Temporary impacts, including such things as an increase in noise and dust particles in the air, or an increase in water turbidity may be caused;
- The character of the landscape near a constructed reservoir would change. Land-use in the immediate vicinity of a reservoir or within the flood zone of the reservoir may change; and,
- Cultural resources may be impacted (e.g., historic or pre-historic sites).

A complete environmental assessment would need to be completed for this alternative before it is implemented.

5.8.8 Alternative R6 – Conjunctive Use of Groundwater Resources

Groundwater aquifers located within in the three rice irrigation counties are a potential source of water for the irrigators. These groundwater resources could be developed in a manner to be used conjunctively with the existing surface water supply. The groundwater wells would only be used to provide water when the surface water available was not sufficient to meet the demands. During these drought conditions, water would be pumped from the ground and released into the irrigation distribution canals.

Three alternative scenarios were evaluated to supplement the supply of water to the Lakeside and Gulf Coast Irrigation Districts with groundwater. The three scenarios included various levels of average groundwater dependence, 25,000 ac-ft/yr, 50,000 ac-ft/yr, and 100,000 ac-ft/yr. It was assumed that the wells would be constructed so that they would be scattered throughout the two irrigation districts. All of the wells in the Gulf Coast Irrigation District were assumed to be located within the Chicot formation of the Gulf Coast aquifer. For the 25,000 ac-ft/yr alternative, all of the wells in the Lakeside Irrigation District would be in the Evangeline formation. For the 50,000 and 100,000 ac-ft/yr alternatives, one-third of the wells in the Lakeside Irrigation District would be in the Chicot formation and the remainder would be in the Evangeline formation.

The three alternatives were modeled using the Gulf Coast aquifer hydrologic model to determine the temporary and long-term impacts of the conjunctive use alternatives. The demand for groundwater was simulated based on results from the LCRA's Response Model for various levels of irrigation demands, which incorporates the following assumptions:

- A full drought cycle was modeled based on the 1941-1965 historic rainfall condition;
- The drought cycle would begin in the year 2026 and continue through 2050;
- If groundwater pumping is required, it would occur during the first six months of the year;
- The modeling cycle was extended by 10 years to evaluate the aquifer recovery after the drought cycle;

- Each well would have a capacity of 2,700 gpm, which equates to an annual capacity of 2,178 ac-ft based on 6 months of operation;
- The number of wells required was based on the peak demand plus 10 percent; and,
- The projected demands for groundwater from other WUGs were imposed on the model at the same time.

The number of wells required for each of the alternative scenarios is presented in Table 5.22.

Table 5.22: Alternative R6 – Number of Wells Required for Conjunctive Use

Aquifer	25,000 ac-ft/yr Conjunctive Use	50,000 ac-ft/yr Conjunctive Use	100,000 ac-ft/yr Conjunctive Use
Lakeside District			
Evangeline	16	12	24
Chicot	0	5	11
Gulf Coast District			
Chicot	17	20	42

The conjunctive use of the groundwater wells will have both short-term and long-term impacts on groundwater levels in the region. The predicted impacts on these two formations are presented in Table 5.23.

Table 5.23: Alternative R6 – Impact of Conjunctive Use on Aquifer Levels

	No Conjunctive Use	25,000 ac-ft/yr Conjunctive Use	50,000 ac-ft/yr Conjunctive Use	100,000 ac-ft/yr Conjunctive Use
Evangeline Formation				
Maximum Short-Term Drawdown	30	90	100	190
Maximum Long-Term Drawdown	30	40	50	60
Chico Formation				
Maximum Short-Term Drawdown	10	75	90	170
Maximum Long-Term Drawdown	10	12	12	15

As the table indicates, the model results show that the Chicot formation will almost fully recover following the drought cycle. In addition, the maximum temporary aquifer drawdowns in the Chicot formation are associated with pumpage from the Gulf Coast District. The temporary drawdowns in the Lakeside District are smaller. The Evangeline formation is shown to have much larger temporary drawdowns and does not fully recover following the drought cycle.

An opinion of the probable project costs for each of the three scenarios is presented in Table 5.24.

Table 5.24: Alternative R6 (Conjunctive Groundwater Use) Opinion of Probable Costs

Phase	25,000 ac-ft/yr Alternative	50,000 ac-ft/yr Alternative	100,000 ac-ft/yr Alternative
Capital Costs			
Well Construction	$5,994,000	$6,648,000	$13,820,000
Site Work (Piping and pumps)	$4,224,000	$4,736,000	$9,856,000
Total Capital Costs	**$10,218,000**	**$11,384,000**	**$23,676,000**
Engineering, Contingencies and Legal Services (35%)	$3,575,000	$3,985,000	$8,285,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$200,000	$250,000	$400,000
Site Acquisition	$0	$0	$0
Interest Accrued During Construction	$1,680,000	$1,870,000	$3,885,000
Interest Earned on Unused Principal	($500,000)	($560,000)	($1,165,000)
Total Project Costs	**$15,173,000**	**$16,929,000**	**$35,081,000**
Annual Costs			
Debt Service (6 % for 30 years)	$1,100,000	$1,230,000	$2,550,000
Operation and Maintenance	$766,000	$1,715,000	$3,410,000
Total Annual Costs	**$1,866,000**	**$2,945,000**	**$5,960,000**
Firm Annual Withdrawal (ac-ft)	**25,000**	**50,000**	**100,000**
Unit Cost of Water ($/ac-ft)	**$75**	**$59**	**$60**

This alternative was specifically evaluated for the Lakeside and Gulf Coast Irrigation Districts. However, it should be possible to obtain similar results through the conjunctive use of groundwater in the Pierce Ranch Irrigation District. While specific modeling was not conducted for the Pierce Ranch District, it is anticipated that 18,000 to 25,000 ac-ft/yr could be generated within this district.

5.8.9 Alternative R7 – Construction of the Altair Channel Dam

Another alternative designed to meet rice irrigation demand deficits is the proposed Altair dam site, which is approximately 1 mile downstream of the Highway 90A bridge and downstream of the Lakeside Irrigation District's diversion point. This site is immediately upstream of a critical reach of aquatic habitat. A 15-foot high adjustable dam is proposed for this site. The dam height is the number of feet that the water surface will be raised from its current annual average at the dam. The dam will create a pool of water almost 20 miles long with a volume of 3,970 ac-ft.

5.8.9.1 Hydrologic Analysis

The proposed dam would be operated in a manner that would allow the water surface elevation to fluctuate as needed. In order to maximize the amount of water that can be captured in the impoundment, the dam would normally be full at the beginning of the irrigation season. Releases from the dam would be required to meet irrigation demands before any releases from the Highland Lakes System are made. After this initial release, the dam would normally be kept lowered to an elevation of 3 to 4 feet. The dam would be raised to capture excess flows associated with wet weather events. This newly captured water would then be released to meet irrigation demands instead of using additional releases from the Highland Lakes Systems. This cycle would continue throughout the irrigation season. Based on this mode of operation, the firm yield available from the Altair Channel Dam has been estimated to be 21,870 ac-ft/yr.

5.8.9.2 Opinion of Probable Cost

Information concerning the probable cost of implementing this alternative is presented in Table 5.25. The total project costs are expected to be $9.6 million. The annual operations and maintenance costs are expected to be $155,000. However, implementation of this alternative will also result in a cost savings in the pumping costs for the Lakeside Irrigation District due to increased water surface elevations at the diversion point.

Table 5.25: Alternative R7 (Altair Channel Dam) Opinion of Probable Cost [1]

Phase	Cost Opinion
Capital Costs	
Reservoir Construction	$5,265,000
Total Capital Costs	**$5,265,000**
Engineering, Contingencies and Legal Services (35%)	$1,840,000
Land Acquisition and Survey	$625,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$1,190,000
Interest Accrued During Construction	$1,070,000
Interest Earned on Unused Principal	($320,000)
Total Project Costs	**$9,670,000**
Annual Costs	
Debt Service (6 % for 40 years)	$640,000
Operation and Maintenance	$155,000
Lakeside Pump Savings	($65,000)
Total Annual Costs	**$730,000**
Unit Cost of Water ($/ac-ft)	**$33**

[1] Cost and yield information taken from LCRA report "Lower Colorado River Channel Dams Feasibility Study", October 1997.

5.8.9.3 Environmental Impacts

Construction of the Altair Channel Dam would have significant environmental impacts associated with the construction of the dam structure. In addition, the inundation of water will change the character of the river upstream. Currently, the reach upstream of the proposed dam site has riverine and riparian habitats. These habitat areas would be lost due to inundation. However, it is likely that new riparian habitat areas would emerge at the boundary of the inundation.

5.8.10 Alternative R8 – Demand Management Through Agricultural Transfer Options

An alternative to meeting the rice irrigation demand deficits through the development of additional sources of water would be to manage the demand for water during critical drought periods. This could be accomplished through the establishment of a program where irrigators can accept payments from other irrigators to forego water deliveries, thus making the water available to these irrigators willing to make the payments. The program would involve a bidding system similar to the one used by the Federal Government to gain commitments for the Acreage Reduction Program (ARP). The ARP system relies heavily on farmers to bid a price for removing acreage from production. Such a program for eliminating water supply shortages within the LCRWPA could be funded by a surcharge on the use of water by those remaining on the system.

The program might work roughly as follows. First, the LCRA would announce the likely curtailments on water irrigation delivery in early spring. Farmers would be given a period of time to submit a price (bid) for reducing their take of water, for either the first or second crop depending on the curtailment. The bids would be ordered starting with the lowest bid. Bids would be accepted beginning with the lowest and continue until the predicted water supply shortage was eliminated.

Payments to the accepted bids would be funded by a surcharge on the water provided to the remaining users. The cost for implementing such a program would vary from year-to-year depending upon the water supply shortage level and the bids received. For shortage levels of 48,999 acre-feet the costs are $5.87. At the year 2050 with an average annual shortage level of 166,578 acre-feet, the cost is $31.41 per acre-foot. An approximation of the potential costs for implementing this program is shown on Table 5.26. Appendix 5B contains a Technical Memorandum on the topic. Note that the estimates of the per acre-foot cost in Appendix 5B are slightly different from those in Table 5.26 because the shortage estimates at the time of the Memorandum differ from the final estimates in Table 5.26.

It is important to emphasize that the costs presented above in Table 5.25 represent the costs associated with managing the demand for water for rice irrigation. Implementation of this alternative would imply that the total acreage of rice production would be decreased during drought conditions. It is likely that the failure to meet the full demands for rice irrigation would have a significant impact on the local economy. The income loss to the Lower Colorado Region due to the impacts on agri-business suppliers, rice milling in the region, and associated aggregate business activity is estimated to be $39.43 per acre-foot of irrigation water supply shortage.

Table 5.26: Alternative R8 (Agricultural Transfers) - Opinion of Probable Costs [2]

Year	Annual Maximum Drought of Record Shortage [1] (ac-ft/yr)	Annual Average Drought of Record Shortage (ac-ft/yr)	Marginal Value of Maximum Shortage ($/ ac- ft)	Marginal Value of Average Shortage ($/ ac- ft)	Extra Cost of Average Shortage to Remaining Users ($/ ac- ft)
2000	223,514	48,999	$ 43.09	$ 30.00	$ 5.87
2010	101,280	75,301	$ 33.92	$ 31.97	$ 9.92
2020	118,260	85,893	$ 35.19	$ 32.77	$ 11.77
2030	144,679	122,427	$ 37.18	$ 35.51	$ 19.30
2040	162,649	140,270	$ 38.52	$ 36.85	$ 23.73
2050	190,029	166,578	$ 40.58	$ 38.86	$ 31.41

[1] Maximum Annual Shortage based on availability of interruptible water.

[2] Cost information from Resource Economics, Inc. Technical Memorandum dated 5-10-00, updated.

5.8.11 Alternative R9 - Development of New Rice Varieties

The availability and cost of water for rice irrigation is a key factor in the continued economic viability of the rice industry in the region. Reducing the amount of water needed to irrigate the rice fields would provide the producers a financial benefit, while at the same time this would address the overall water supply shortage within the basin. Agricultural research has been successful in developing new varieties of crops that meet specific requirements. The development of new, high yield-low water use rice varieties could provide a significant reduction in the water demands.

Since this Alternative involves the development of new "technology", specific information concerning the cost and yield of this alternative could not be provided at this time. However, the following specific items would be included in this alternative:

- A goal of 15 percent savings of on-farm water consumption should be established for this alternative. This would result in a savings of 35,000 ac-ft/yr in 2050;
- Producer surveys should be conducted and utilized to determine whether a desirable level of market penetration could be achieved by such a rice variety;
- If market penetration appears achievable then research to develop such a variety should be fully funded and undertaken. It is anticipated that the research program would take up to 10 years; and,
- Funding should also be provided for a producer awareness and education campaign to assure the deepest market penetration possible.

5.8.12 Summary of the Alternatives to Meet Rice Irrigation Demand Deficits

A total of eight alternatives (R1-R7) were investigated to meet the identified needs for rice irrigation in Colorado, Wharton, and Matagorda counties. These alternatives generally include the development of additional surface water availability during the time when water is needed for irrigation through the creation of storage reservoirs. In addition, a ninth alternative (R8) was evaluated to mitigate the water supply shortage through an open market competition for the water that would actually be available for a given year. These alternatives are summarized on Table 5.27.

Table 5.27: Summary of Alternative Strategies Evaluated to Meet Rice Irrigation Shortages

Water Management Strategy	Strategy Description	Capital Cost ($)	Debt Service ($)	O&M Cost ($)	Total Annual Cost ($)	2050 Firm Yield (ac-ft/yr)	Unit Cost ($/ac-ft)	Summary of Environmental Impacts
R1	Continued Implementation of LCRA Water Management Plan	$ -	$ -	$ 434,633	$ 434,633	96,585	$ 4.50	Current operations maintained, no significant impact.
R1A	Continued Utilization of City of Austin Return Flows	$ -	$ -	$ -	$ -	21,018	$ -	Current operations maintained, no significant impact.
R2A	On-Farm Water Conservation Measures	$ 16,806,000	$ 1,220,000	$ 875,000	$ 2,095,000	37,348	$ 56	Bay and Estuary inflows increased during normal flow conditions.
R2B	Improve Canal Water Delivery Efficiencies	$ 10,000,000	$ 725,000	$ 200,000	$ 925,000	45,650	$ 20	Bay and Estuary inflows increased during normal flow conditions.
R3	Construction of Four Off-Channel Reservoirs w/Diversion from Colorado River for Irrigation Demands	$ 139,600,000	$ 9,620,000	$ 1,740,000	$ 11,360,000	142,000	$ 80	Reduced bay and estuary inflow, inundation of large areas, increased water fowl habitat, potential impacts at river intake
R3A	Construction of Four Off-Channel Reservoirs w/Diversion from Colorado River for Municipal Demands	$ 169,200,000	$ 11,600,000	$ 2,140,000	$ 13,740,000	199,000	$ 69	Reduced bay and estuary inflow, inundation of large areas, increased water fowl habitat, potential impacts at river intake
R4	Construction of Shaw's Bend Reservoir	$ 315,000,000	$ 20,930,000	$ 1,250,000	$ 22,180,000	51,576	$ 430	Reduced bay and estuary inflow, inundation of large areas, loss of habitat, loss of cultural resources
R5	Construction of Fox Crossing Reservoir	$ 448,400,000	$ 29,800,000	$ 900,000	$ 30,700,000	72,589	$ 423	Limited information available, inundation of large areas
R6	Conjunctive Use of Groundwater	$ 15,173,000	$ 1,100,000	$ 766,000	$ 1,866,000	25,000	$ 75	Increased bay and estuary inflow, increased water fowl habitat, decreases in aquifer levels
R7	Construction of the Altair Channel Dam	$ 9,670,000	$ 640,000	$ 90,000	$ 730,000	21,870	$ 33	Inundation of significant reach, loss of small reach of critical habitat, loss of riparian habitat
R8	Agricultural Transfer Options	$ -	$ -	$ 5,999,820	$ 5,999,820	157,228	$ 38	Decreased water fowl habitat
R9	Develop New Rice Varieties	$ -	$ -	$ -	$ -	35,000	N/A	None anticipated.

5.9 EVALUATION OF WATER MANAGEMENT STRATEGIES TO MEET AUSTIN METROPOLITAN AREA DEMAND DEFICITS

As previously discussed, water demand deficits in the Austin Metropolitan Area include numerous contractual shortages. It has been determined that these contractual shortages will be addressed through the renewal and expansion of existing contracts in order to meet the projected water demands for these WUGs. In addition, the City of Austin, as a Major Provider of water for municipal and industrial needs has a water supply shortage identified beyond 2030. The other shortages identified in this region of the planning area are for Hays County-Other and the City of Pflugerville. Water management strategies to meet these shortages are presented in the following sections.

5.9.1 City of Austin Water Management Strategy Alternatives

The City of Austin's current water supply is projected to be adequate to meet all of the City's demands, including municipal, industrial, and wholesale demands through 2030. The City has indicated that it will seek to manage its demands for Colorado River water through water conservation and the use of reclaimed water. Demand Deficits projected beyond 2030 are discussed in Section 5.9.1

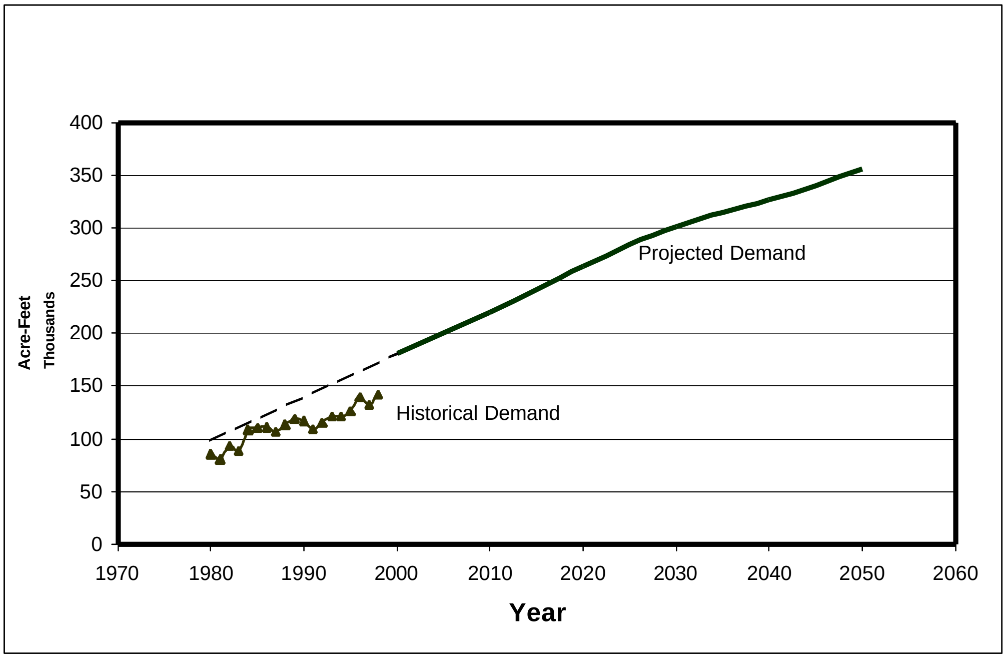
5.9.1.1 Alternative A1 – Water Conservation

The municipal, industrial, and wholesale water demands for the City of Austin (COA) and the wholesale customers of the COA are projected to increase from 180,711 ac-ft/yr in the year 2000 to 355,714 ac-ft/yr in 2050. (These demand projections are detailed in Chapter 2 of the regional water plan.) The water demand projections were initially based on the Texas Water Development Board projections that were developed for the 1997 State Water Plan and have been revised for this current planning effort. The projection for water demand in 2000 is based on water consumption records from 1984, which represent COA's highest historical per capita consumption and is assumed to be representative of dry-year conditions. The projection for 2050 assumes that expected water conservation measures would reduce the per capita water consumption rates by approximately 10 percent.

The City's staff has indicated that the Lower Colorado Regional Water Planning Group's water demand projections do not accurately reflect the additional water conservation that has been achieved in the City of Austin since 1984. The RWPG has estimated the COA's water demand to be 180,711 ac-ft/yr in 2000. This level of water demand is significantly higher than the historical water demand trend for the City of Austin, as shown on Figure 5.8.

There are three primary reasons that the estimates adopted by the RWPG exceed the historical trend. The first is that the RWPG projections include demands for the cities of Round Rock and Pflugerville. These cities entered into contracts with the City of Austin to firm-up future supplies of water. The City of Round Rock has a contract for the delivery of up to 5.5 mgd (6,161 ac-ft/yr) and the City of Pflugerville has a contract for up to 10 mgd (11,201 ac-ft/yr).

Figure 5.8: City of Austin Historic and Projected Water Demands



The demands for these two cities have been included since they represent a firm commitment by the City of Austin. However, neither city has yet to purchase any water under these contracts. As a result, the demands associated with these two wholesale contracts are assumed to "ramp up" over time. The year 2000 demand for both contracts is assumed to be zero. The city of Round Rock contract demand is projected to increase by 616 ac-ft/yr each year, beginning in 2001 and will reach its full contract amount by 2010. The city of Pflugerville wholesale contract demand is projected to increase by 560 ac-ft/yr each year, beginning in 2001 and will reach its full contract amount by 2020.

The second cause for the discrepancy is the fact that the Regional Water Planning Group was required under TWDB guidance to develop demand projections associated with extreme dry-year conditions. The dry-year demands should be reflective of the water demands only during critical drought-of-record conditions. The City's historical trends show the effects of wet years intermingled with dry years.

The third cause for the discrepancy between the Regional Water Planning Group projections and the historical use is that the RWPG adopted estimates generated by the Texas Water Development Board (TWDB) using historical consumption records from 1984. That year was a dry year and the City of Austin experienced a sharp increase in water consumption. This sharp increase in water consumption and the population growth during the early 1980s were prominent factors toward the City of Austin initiating its aggressive conservation program, which began in 1986. As a result, the City implemented an aggressive water conservation program to reduce both the average and peak day demands for water within its service area. The City has implemented and anticipates continuing water conservation programs in the following areas:

- Public education;
- Rebate and incentive programs; and,
- Water saving ordinances.

Through these programs, the City has made significant advances toward reducing the per capita consumption of water in its service area. As a result, the 1984 data does not reflect the additional water conservation advances that the COA has made over the last 14 years.

The City of Austin has estimated its year 2000 demand for water to be 165,880 ac-ft/yr. The difference between the RWPG's projections and the City of Austin projections is 14,831 ac-ft/yr. This difference is presumed to be the result of the accelerated water conservation efforts that the city has pursued. The savings due to conservation represents a savings of approximately 8 percent. It is important to point out that these projected water savings are based on water demands during a critical drought period.

Over time, the difference between the City of Austin's projections (including the cities of Round Rock and Pflugerville) and the RWPG's projections for the City of Austin gradually decreases until it disappears in 2042. At this point, the water conservation assumptions in the RWPG's projections catch up to the City of Austin's accelerated water conservation program. Additional water demand savings, beyond those included in the LCRWPG's estimates for the COA are not anticipated. The COA must have a long-term commitment to continue its water conservation programs in order to meet the water conservation expectations included in the demand projections.

5.9.1.2 Alternative A2 – City of Austin Reclaimed Water Initiative

In addition to the aggressive water conservation measures the city of Austin has implemented to reduce water demands, the COA is pursuing the development of reclaimed water as an additional supply of water to meet nonpotable demands in the area. The City of Austin has indicated that it will develop and use reclaimed water as the primary strategy to meet the projected needs in 2050, and likely beyond. To meet the total projected water demands, the Water Reclamation Initiative would need to supply up to 30,714 ac-ft/yr for nonpotable purposes by the year 2050.

The City is currently using reclaimed water from its South Austin Regional Wastewater Treatment Plant to irrigate several golf courses in South Austin. The City estimates this use to be 2,000 ac-ft/yr. In order to expand the availability and use of reclaimed water, the COA has completed a series of planning activities, which have resulted in the publication of the 1998 Water Reclamation Initiative (WRI) Planning Document.

The WRI Planning Document identifies the proposed development of a major distribution system to convey reclaimed water from the Walnut Creek Wastewater Treatment Plant (WCWWTP) to potential customers in the central and northeast portions of the City. The COA has initiated the design and construction of the first phase of this Central-Northeast System. The anticipated, future demands for reclaimed water from the Central-Northeast System are 28.3 mgd during peak day and 16.1 mgd during average day conditions. This would equate to approximately 18,000 ac-ft/yr.

The COA has recently begun planning efforts for further development of the South Reclaimed Water System. A Master Plan for this system is expected to be completed later this year. In addition, the COA continues to evaluate the feasibility of constructing additional Water Factories to provide reclaimed water in other areas of the City.

The City anticipates that the use of reclaimed water will increase steadily from the current level of 2,000 ac-ft/yr. The COA will continue to pursue the expeditious implementation of its WRI and anticipates that the ability to reuse additional volumes of water will be in place well before it is needed to meet the needs identified in 2050. Table 5.28 shows the projected capacity increases for each decade of the planning period.

Table 5.28: Alternative A2 – Anticipated Reclaimed Water Capacity [1]

Decade	Annual Capacity (ac-ft/yr)
2000	2,000
2010	10,774
2020	16,075
2030	27,075
2040	30,714
2050	30,714

[1] Anticipated capacity information provided by City of Austin.

Projected Reduction of Return Flows

The City of Austin recognizes that the water demand projections contained in the Lower Colorado Regional Water Plan are only projections. Actual water demands may increase faster or slower than projected. The City will monitor the growth of its water demands and adjust its Reclaimed Water program accordingly. As a result, the City may need to increase the use of reclaimed water at a faster rate than projected. In addition, the increased use of reclaimed water is expected to provide a monetary benefit to the COA through decreased raw water costs and delayed capital expenditures. As the City increases its use of reclaimed water, the City's return flows from its wastewater treatment plants to the Colorado River will correspondingly decrease.

The decrease in return flows will likely be gradual. However, the City intends to use reclaimed water to the maximum extent feasible to meet all demands above 325,000 ac-ft/yr, whether those demands occur before or after 2050. As a result, this strategy could result in the City potentially reusing all of its effluent to meet growing demands and ultimately, the City could have zero return flow to the Colorado River from its wastewater treatment plants. The LCRWPG formally recognized the City of Austin's legal right to reuse 100 percent of its effluent through the passage of a resolution on May 10, 2000 (Appendix 6A).

Opinion of Probable Costs

The use of reclaimed water has been identified as the primary source of water to meet the City of Austin's projected demand deficits in 2050. The City has completed planning studies for a Reclaimed Water System to serve potential customers in the Central and Northeast portions of the City. This system will provide a portion of the water supply required to meet the COA's identified needs. Planning efforts for additional systems in the south and northwest portions of the City are in progress, but will not be completed in time to include in the Lower Colorado Regional Water Plan. As a result, the cost information for the Central–Northeast System will be used as a template for the other systems in order to obtain a total cost.

Table 5.29 presents the opinion of probable cost for the ultimate build out of the Central–Northeast System. As previously indicated, the Central-Northeast System is designed to have a capacity of 18,000 ac-ft/yr. Based on the opinion of probable cost for these improvements, the average capital cost per ac-ft/yr capacity is $3,512. Therefore, the opinion of probable cost for Austin to meet all of its identified needs through the use of reclaimed water (31,000 ac-ft/yr) is approximately $108,000,000. This would result in a total annual cost (including operations and maintenance) of approximately $12.1 million/yr. The opinion of probable unit cost of reclaimed water is $394 per ac-ft, or approximately $1.21 per 1000 gallons.

Table 5.29: Alternative A2 (COA Reclaimed Water) Opinion of Probable Unit Costs

Phase		Cost Opinion
Capital Costs		
WCWWTP Pump Station, Storage, & Misc. Improvements [1]		$8,500,000
Transmission System [2]		$23,700,000
System Pumping and Storage [1]		$6,400,000
Total Capital Costs		**$38,600,000**
Engineering, Contingencies and Legal Services (35%)		$13,510,000
Land Acquisition and Survey (5%)		$1,930,000
Env. and Arch. Studies, Mitigation, and Permitting (2%)		$772,000
Interest Accrued During Construction		$13,154,880
Interest Earned on Unused Principal		($4,757,682)
Total Project Costs		**$63,209,198**
Annual Costs		
Debt Service (6 percent for 30 years)		$4,592,079
Operation and Maintenance [3]		$2,500,000
Total Annual Costs		**$7,092,079**
Unit Cost of Water ($/ac-ft)		**$394**
Unit Cost of Water ($/1000 gallons)	**$**	**1.21**

[1] Cost updated from Water Reclamation Initiative Planning Document, GSG, Inc., March 1998 based on phone conversation with Robert Hinojosa, COA, 6/5/00.
[2] Cost taken from Water Reclamation Initiative Planning Document, GSG, Inc., March 1998.
[3] Cost provided by City of Austin personal communication June 27, 2000.

Environmental Impacts

The use of reclaimed water is regulated by the TNRCC through 30 TAC Chapter 210. Reclaimed water projects authorized under these regulations are presumed to be protective of human health and the environment. The potential impacts generated through the construction of the proposed pipelines and pump stations will need to be addressed in the preliminary engineering studies to be conducted for these projects.

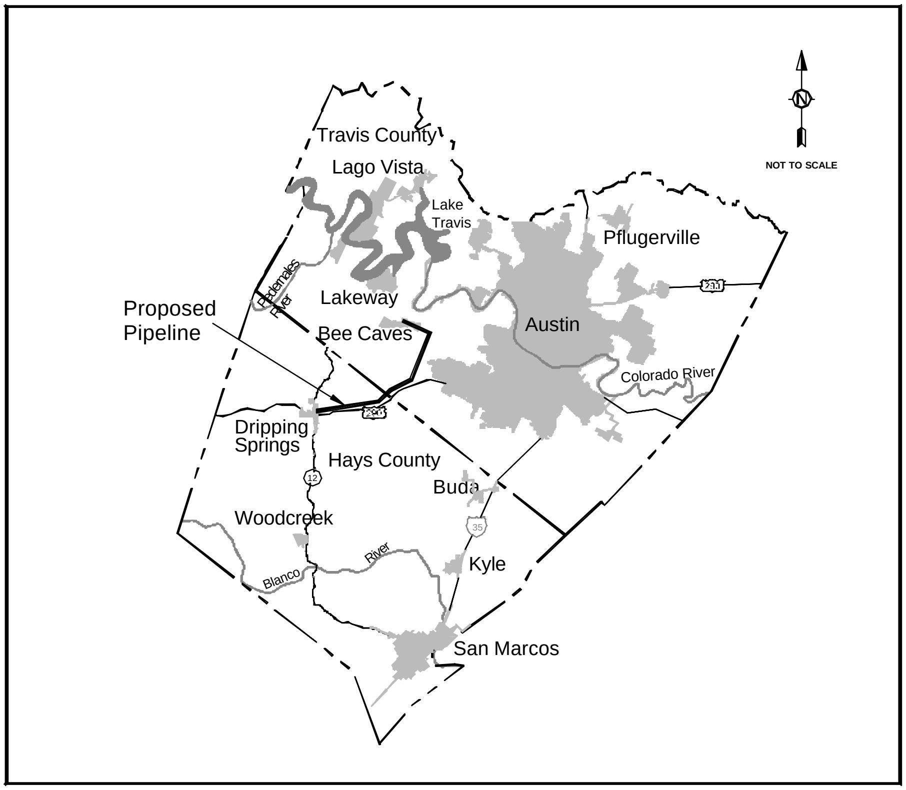
5.9.2 Hays County-Other Shortage Water Management Strategies - Other Alternatives

Northern Hays County has begun to experience rapid growth as the nearby Austin Metropolitan Area continues to expand its population base. Currently, groundwater is the primary source of water for residents in this area. The groundwater supplies in the area are presently showing signs of stress as a result of this intense growth. The following sections present alternative water management strategies, to meet the needs of this rapidly growing area, which has been designated as Hays County-Other by the TWDB.

5.9.2.1 Alternative H1 – Obtain Surface Water Through LCRA System

The LCRA is currently in the first phase design of a project to bring treated surface water to Northern Hays County along the U.S. 290 corridor. The project would allow the LCRA to deliver water from its West Travis County Regional Water System (WTCRWS) to areas of Northern Hays County that are along the U.S. 290 corridor. A schematic layout of this alternative is presented on Figure 5.9. The LCRA would commit a portion of its firm yield water from the Highland Lakes System to customers in the Hays County-Other WUG. Existing development in these areas are generally dependent on the Trinity aquifer for their water supply. Individual wells in these areas have gone dry during the recent drought conditions.

Figure 5.9: Alternative H1 – Obtain Surface Water Through LCRA System



The first phase of the proposed project will include three booster pump stations, approximately 14 miles of water transmission main, and two elevated storage tanks. This initial phase of the project would have the capacity to provide up to a maximum estimated 4.4 mgd to Hays County-Other. on a maximum day. The anticipated average day demand associated with this maximum day demand is 2.0 mgd 2,240 ac-ft/yr. The LCRA anticipates beginning construction on these facilities later this year.

In addition, the LCRA has plans to expand the WTCRWS by constructing a second water treatment plant and installing additional transmission mains to form a looped system. The ultimate plan would be to have the capacity to provide up to 6.6 mgd on a maximum day to Hays County-Other. This would be the equivalent of 3 mgd on an average day, or approximately 3,360 ac-ft/yr.

Opinion of Probable Costs

The opinion of probable costs for the first phase of this project is presented in Table 5.30. For the purposes of this plan, it is assumed that the additional capacity would be provided at a similar unit cost.

Table 5.30: Alternative H1 (LCRA Waterline) Opinion of Probable Cost [1]

Phase	Cost Opinion
Capital Costs	
Pump Station Costs (3 booster pump stations)	$6,300,000
Transmission Main Costs (13.8 miles)	$6,600,000
Reservoir Construction	$1,500,000
Total Capital Costs	**$14,400,000**
Engineering, Contingencies and Legal Services (35%)	$5,040,000
Environmental and Archeological Studies, Mitigation, and Permitting	$2,160,000
Site Acquisition	$320,000
Interest Accrued During Construction	$2,600,000
Interest Earned on Unused Principal	($910,000)
Total Project Costs	**$23,610,000**
Annual Costs	
Debt Service (6 % for 30 years)	$1,720,000
Operation and Maintenance [2]	$1,100,000
Total Annual Costs	**$2,820,000**
Unit Cost of Water ($/ac-ft)	**$1,259**
Unit Cost of Water ($/1000 gallons)	**3.87**

[1] Opinion of probable costs taken from report entitled "Northern Hays and Southwestern Travis County Supply Study, Phase One of the Stage I Loop, Preliminary Engineering Report" by PBS&J, April 1998.

[2] Opinion of O&M costs includes raw water, treatment, and system operations. Opinion taken from report entitled "Northern Hays County and Southwest Travis County Regional Surface Water System Feasibility Study" by Espey, Huston & Associates, Inc., May 1996.

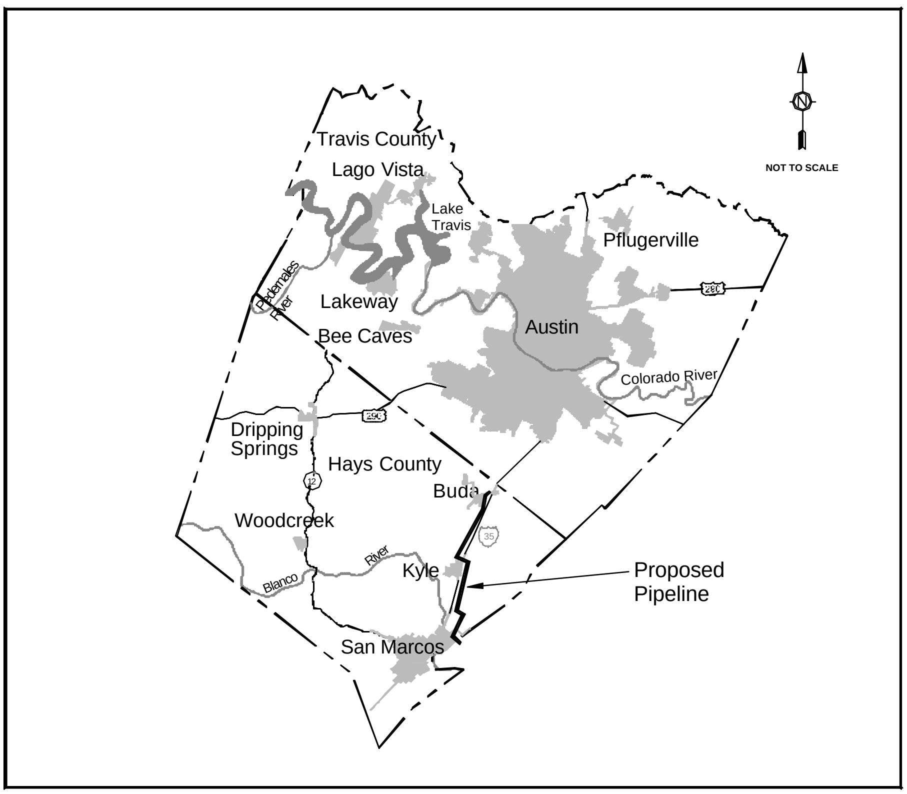
Environmental Impact

In addition to the typical environmental impacts associated with construction activities, concerns have been raised about the potential impact that the proposed project might have on encouraging increased development in an environmentally sensitive area. In particular, there is concern that the implementation of this project will allow more and denser development to take place in the contributing zone for Barton Springs segment of the Edwards aquifer has been raised. The LCRA has agreed to conduct an environmental impact study to determine the potential secondary impact that the transmission line might have. However, the LCRA is proceeding with the project in the interim to provide immediate relief to area residents that are currently experiencing groundwater supply shortages. The LCRA has agreed to only connect existing residences to the line until the environmental study has been completed.

5.9.2.2 Alternative H2 – Obtain Surface Water Through the GBRA System

The GBRA and the City of San Marcos have joined together to construct a regional raw water transmission system and a regional water treatment plant near San Marcos. The GBRA is currently considering the construction of a treated water transmission system to provide water to customers in portions of Hays and Caldwell counties. A schematic layout of this alternative is presented on Figure 5.10. A portion of the potential service area is within the LCRWPA. This portion generally includes the City of Buda and the Creedmoor-Maha Water Supply Corporation, which is within the Hays County-Other WUG.

Figure 5.10: Alternative H2 - Obtain Surface Water Through the GBRA System



The transmission system would be designed to provide an average day demand of 4.0 mgd. This would include approximately 1.5 mgd for areas inside the LCRWPA. Customers of the system would use existing well capacity for peaking purposes. Therefore, the total yield of water to the LCRWPA would be approximately 1,680 ac-ft/yr.

System participants would be required to assume their pro-rata share of the debt retirement obligations for the raw water delivery system. Additional capacity would be required at the existing regional water treatment plant. In addition, a booster pump station at the plant would need to be constructed.

Approximately 20 miles of treated water transmission main ranging in size from 14- to 24-inches would also need to be constructed. The transmission main alignment would generally run parallel to IH 35.

Opinion of Probable Costs

The opinion of probable costs for this project is presented in Table 5.31. This opinion is for the entire project, which has a total yield of approximately 4,480 ac-ft/yr.

Table 5.31: Alternative H2 (GBRA Waterline) Opinion of Probable Cost [1]

Phase	Cost Opinion
Capital Costs	
Pump Station Costs	$950,000
Transmission Main Costs (20 miles)	$3,000,000
Treatment Plant Expansion	$5,700,000
Total Capital Costs	**$9,650,000**
Engineering, Contingencies and Legal Services (35%)	$3,380,000
Environmental and Archeological Studies, Mitigation, and Permitting	$150,000
Site Acquisition	$800,000
Interest Accrued During Construction	$1,700,000
Interest Earned on Unused Principal	($570,000)
Total Project Costs	**$15,110,000**
Annual Costs[2]	
Debt Service (6 % for 30 years)	$1,100,000
Operation and Maintenance	$1,800,000
Total Annual Costs	**$2, 900,000**
Unit Cost of Water ($/ac-ft)	**$647**
Unit Cost of Water ($/1000 gallons)	**$1.99**

1 Opinion of probable costs taken from draft report entitled "IH 35 Water Supply Study" , June 2000.
2 Annual costs based on total capacity of 4.0 mgd being utilized. The O&M cost includes debt service for the existing raw water delivery system at $87/ac-ft and raw water charge of $69/ac-ft.

Environmental Impact

An assessment of the potential environmental impact of this project has not yet been completed. An environmental impact assessment would be required before this alternative could be implemented. Beyond the short-term impact associated with typical construction projects and the potential long-term impacts of decreasing recharge to the Barton Springs segment of the Edwards aquifer, it is anticipated that implementation of this project would have the positive benefit of reducing the demand on the Barton Springs portion of the Edwards aquifer.

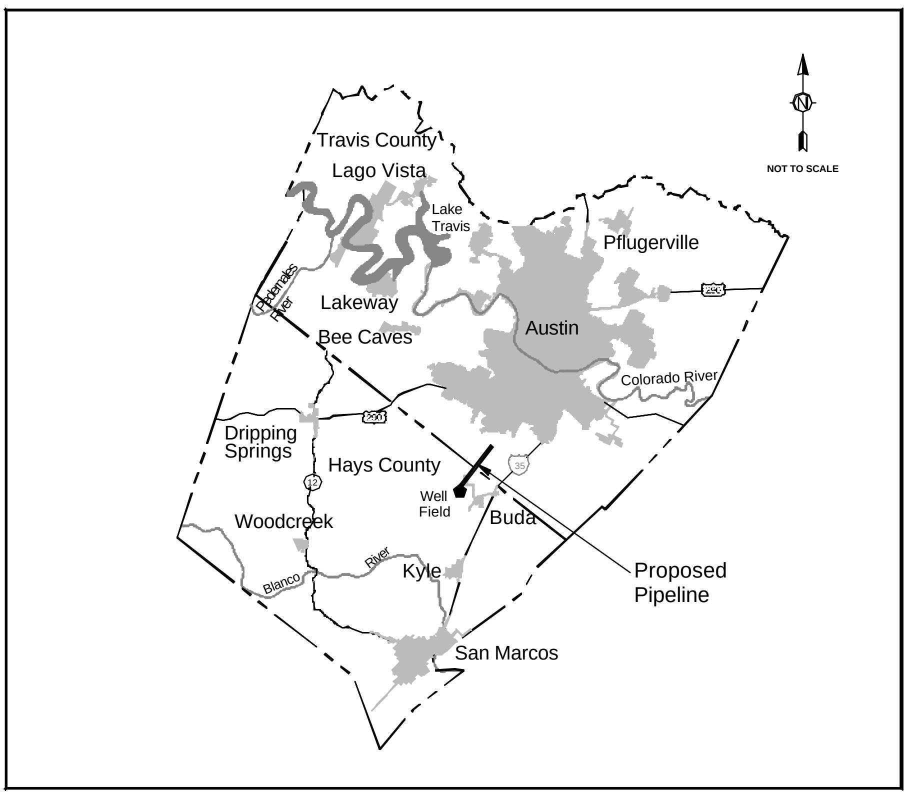
Regulatory Considerations

This alternative would involve an interbasin transfer of water from the Guadalupe River Basin to the Colorado River Basin. This project would need to be approved through the TNRCC is process for interbasin transfers. However, since Hays County is split between two basins, it is anticipated that approval of the project could be achieved.

5.9.2.3 Alternative H3 – Obtain Surface Water from the City of Austin

This alternative would involve the construction of transmission facilities to transport water from the City of Austin's distribution system into Northern Hays County. Water provided by the City of Austin would be specifically designated for the Spillar Ranch and Pfluger Ranch developments. A schematic layout of this alternative is presented on Figure 5.11.

Figure 5.11: Alternative H3 – Obtain Surface Water from the City of Austin



The improvements necessary to move water from the City of Austin to the proposed developments would involve a looped 16-inch transmission main. These facilities would have the capacity to provide approximately 1,100 ac-ft/yr to the proposed developments.

Opinion of Probable Cost

The opinion of probable cost for this alternative is presented in Table 5.32. The costs presented include the transmission main from the City of Austin and are based on information provided by City staff.

Table 5.32: Alternative H3 (COA Waterline) Opinion of Probable Cost

Phase	Cost Opinion
Total Project Costs[1]	**$2,200,000**
Annual Costs	
Debt Service (6 % for 30 years)	$160,000
Operation and Maintenance	$20,000
Purchase of Treated Water from COA[2]	$720,000
Total Annual Costs	**$900,000**
Unit Cost of Water ($/ac-ft)	**$818**
Unit Cost of Water ($/1000 gallons)	**$2.51**

[1] Opinion of probable costs provided through personnel communication with City of Austin staff 8/3/00.
[2] The purchase of treated water from City of Austin is assumed to be an average cost of $2.01/1000 gallons.

Environmental Impact

An assessment of the potential environmental impact of this project has not been completed. An assessment would need to be completed before this alternative is implemented. Beyond the short-term impact associated with typical construction projects, it is anticipated that implementation of this project would have the positive benefit of limiting the demand on the Barton Springs segment of the Edwards aquifer.

5.9.2.4 Alternative H4 – Dripping Springs Reservoir

Another alternative to provide water to the Hays County-Other WUG would involve the construction of a dam across Onion Creek approximately five miles south-southeast of Dripping Springs. This site was studied most recently in 1989 by HDR Engineering, Inc. Detailed information concerning the reservoir was not readily available. However, opinions of probable cost for the project were reported in the document entitled "Regional Water Plan for the Barton Springs Segment of the Edwards Aquifer" by Donald G. Rauschuber & Associates, Inc., September 1990. The capital cost of facilities necessary to supply 3,100 ac-ft/yr of treated water to the Dripping Springs area was reported to be $23 million (updated to 1999 dollars). It was assumed that these costs only included capital expenditures and did not include engineering, land acquisition, or financing costs. Based on similar projects, the opinion of probable total project costs is $39 million. The annual operations and maintenance costs were reported to be $400,000 (updated to 1999 dollars). Based on these opinions, the probable cost of water for this alternative would be $965 per ac-ft, or $2.96 per 1000 gallons.

Information concerning the environmental impact of this alternative was not readily available. An environmental assessment would need to be completed before this alternative was implemented.

5.9.2.5 Alternative H5 – Driftwood Reservoir

This Hays County-Other alternative would involve the construction of a rockfill dam about 100 feet in height and approximately 2,500 feet in length. The dam would be constructed across Onion Creek approximately four miles southeast of the town of Driftwood. The dam would impound 55,000 acre-feet of water and would have a surface area of 1,750 acres. This project has been evaluated as a potential recharge enhancement project. That is, water stored in the reservoir would be released at a controlled rate to maximize the amount of recharge to the Edwards aquifer downstream along Onion Creek. This reservoir has been projected to increase recharge to the aquifer by 9,300 ac-ft/yr during the recurrence of a seven-year critical drought. The enhanced recharge would be available to groundwater users within the Edwards aquifer area.

Detailed information concerning the probable costs for this project was not available. However, an opinion of the total probable project costs was presented in the report entitled “Regional Water Plan for the Barton Springs Segment of the Edwards Aquifer” by Donald G. Rauschuber & Associates, Inc., September 1990. The probable cost for this project was estimated to be $44.3 million (updated to 1999 dollars). The opinion of probable operations and maintenance costs for the project was presented as $125,000 (updated to 1999 costs).

Based on this information, the total annual cost for this alternative water management strategy, which would be $3.1 million, which results in a unit cost of water of $333 per ac-ft, or $1.02 per 1000 gallons.

Environmental Impacts

This alternative was particularly controversial when it was first introduced due to local landowner opposition and environmental concerns. Ultimately, an agreement was reached to prohibit any involuntary acquisition of land for the project for at least 10 years and could only resume after thorough and appropriate cost/benefit, geological, hydrological, archeological, and environmental analyses were completed. This 10-year period has expired, although the studies identified have not been completed.

5.9.2.6 Alternative H6 – Onion Creek Recharge Dams

Another Hays County-Other alternative that has been evaluated to enhance recharge to the Edwards aquifer is the construction of a series of small channel dams along Onion Creek. These dams would impound water that could later be released at controlled rates to downstream recharge features. A total of four sites have been evaluated in the past. A summary of the information for each of the sites is presented in Table 5.33.

Table 5.33: Alternative H6 (Onion Creek Recharge Dams) Opinion of Probable Costs

Phase	Centex Reservoir	Ruby Reservoir	Rutherford Reservoir	Centex Quarry
Capital Costs				
Dam Construction	$560,000	$895,000	$2,675,000	$998,000
Total Capital Costs	**$560,000**	**$895,000**	**$2,675,000**	**$998,000**
Engineering, Contingencies, and Legal Services (35%)	$196,000	$315,000	$935,000	$350,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$85,000	$135,000	$400,000	$150,000
Site Acquisition	$35,000	$45,000	$190,000	$95,000
Interest Accrued During Construction	$105,000	$165,000	$505,000	$190,000
Interest Earned on Unused Principal	($30,000)	($50,000)	($150,000)	($55,000)
Total Project Costs	**$951,000**	**$1,505,000**	**$4,555,000**	**$1,728,000**
Annual Costs				
Debt Service (6 % for 30 years)	$69,000	$109,000	$331,000	$125,000
Operation and Maintenance	$18,000	$18,000	$61,000	$73,000
Total Annual Costs	**$85,000**	**$127,000**	**$392,000**	**$198,000**
Firm Annual Recharge (af)	**768**	**1152**	**4000**	**5718**
Unit Cost of Water ($/ac-ft)	**$111**	**$110**	**$98**	**$35**
Unit Cost of Water ($/1000 gal.)	**$0.34**	**$0.34**	**$0.30**	**$0.11**

[1] Opinion of probable costs taken from report entitled "Engineering Assessment and Environmental Inventory and Issues Report Artificial Recharge Enhancement Onion Creek, Hays County, Texas" , by Donald G. Rauschuber & Associates, Inc., April 1992.

Environmental Impact

Construction of these channel dams would tend to change the ecology in the vicinity from an ephemeral riverine system to a palustrine system upstream of the dams. This activity would require a Section 404 Permit from the U.S. Army Corps of Engineers. A review of available literature indicates that there are no known occurrences of endangered species within the Onion Creek watershed.

5.9.2.7 Summary of Hays County-Other Water Management Strategy Alternatives

A total of six alternative water management strategies have been evaluated to meet the identified demand deficits for the Hays County-Other Municipal WUG. The summary information for these alternatives is presented in Table 5.34

Table 5.34: Summary of Alternative Strategies Evaluated to Meet the Hays County-Other Water Supply Shortages

Water Management Strategy	Strategy Description	Capital Cost ($)	Debt Service ($)	O&M Cost ($)	Total Annual Cost ($)	2050 Firm Yield (ac-ft/yr)	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gallons)	Summary of Environmental Impacts
H1	Obtain surface water through LCRA West Travis County Regional Water System	$ 23,610,000	$ 1,720,000	$ 1,100,000	$ 2,820,000	2,240	$ 1,259	$ 3.86	Pipeline construction impacts, possible secondary impacts of development over the contributing zone
H2	Obtain surface water through GBRA/San Marcos system [1]	$ 15,110,000	$ 1,100,000	$ 1,800,000	$ 2,900,000	4,480	$ 647	$ 1.99	Pipeline construction impacts
H3	Obtain surface water through City of Austin system	$ 2,200,000	$ 160,000	$ 20,000	$ 900,000	1,100	$ 818	$ 2.51	Pipeline construction impacts
H4	Dripping Springs Reservoir	$ 39,000,000	$ 2,592,000	$ 400,000	$ 2,992,000	3,100	$ 965	$ 2.96	Impacts of dam construction, inundation of riparian habitat
H5	Driftwood Reservoir	$ 44,300,000	$ 2,944,246	$ 125,000	$ 3,069,246	9,300	$ 330	$ 1.01	Impacts of dam construction, inundation of large areas, limited information available
H6	Onion Creek Rutherford Recharge Dam	$ 4,555,000	$ 331,000	$ 61,000	$ 392,000	4,000	$ 98	$ 0.30	Impacts of dam construction, inundation of riparian habitat

[1] Only 1,680 ac-ft/yr of this yield would be available to WUGs in the Lower Colorado Region.

5.9.3 City of Dripping Springs Water Management Strategy Alternatives

The City of Dripping Springs is the focal point for much of the anticipated growth in Northern Hays County that was discussed in the previous section. As a result, several of the water management strategies evaluated in the previous section would also be appropriate for the City of Dripping Springs. In particular, Alternatives H1, H4, H5, and H6 have been considered for the City of Dripping Springs.

5.9.4 City of Pflugerville Water Management Strategy Alternatives

Currently, the City of Pflugerville obtains its water from local groundwater resources. The continued growth of the City is expected to exceed the availability of groundwater in the area. In order to secure a future supply of water, the City of Pflugerville executed a contract with the City of Austin for the purchase of up to 10 mgd of treated water. However, Pflugerville has not yet exercised this option because it has not constructed the infrastructure needed to obtain the water. The City of Pflugerville is currently constructing a small pump station and pipeline that will allow it to take a portion of the contracted water from the City of Austin.

While the City of Pflugerville has contracted with the COA for enough water to meet its projected needs through 2050, Pflugerville is not certain that it will rely on this water supply for its long-term needs. The City of Pflugerville is currently evaluating alternative supplies of water. Information concerning two of these options is presented in the following sections.

5.9.4.1 Alternative PF1 - Aquifer Storage and Recovery

The City of Pflugerville, in cooperation with the LCRA and two local utilities, recently completed a Phase 1 study of the feasibility of developing an aquifer storage and recovery (ASR) system. Several systems were evaluated as part of the Phase 1 study. The study indicated that ASR wells could be used to address seasonal variations in peak demand. However, since the source of water for the ASR system was limited to either the Edwards Aquifer or the City of Austin, the use of ASR wells in this context did not generate any additional, long-term supply of water for the City of Pflugerville. In order to generate an additional supply of water, the long-term supply of water would need to be evaluated so that water could be stored in the ground for later retrieval. Assuming that this alternative is implemented to manage peak demands, the opinion of probable costs for the ASR wells is presented in Table 5.35.

Table 5.35: Alternative PF1 (ASR) Opinion of Probable Cost[1]

Phase	Cost Opinion
Capital Costs	
ASR Wells (5)	$3,040,000
Total Capital Costs	**$3,040,000**
Engineering, Contingencies and Legal Services (35%)	$1,064,000
Environmental and Archeological Studies, Mitigation, and Permitting	$75,000
Site Acquisition	$150,000
Interest Accrued During Construction	$520,000
Interest Earned on Unused Principal	($182,000)
Total Project Costs	**$4,667,000**
Annual Costs[2]	
Debt Service (6 % for 30 years)	$340,000
Operation and Maintenance	$100,000
Treated Water Purchase[2]	$4,966,000
Total Annual Costs	**$5,406,000**
Unit Cost of Water ($/ac-ft)	**$710**
Unit Cost of Water ($/1000 gallons)	**$2.18**

1 Capital costs, operations and maintenance costs, and yield information obtained from "Pflugerville Area Phase 1 Aquifer Storage and Recovery Feasibility Study", June 2000, as prepared by CH2MHILL, Inc.

2 Unit cost of treated water assumes a uniform rate of delivery from the City of Austin at $652/ac-ft.

5.9.4.2 Alternative PF2 – Colorado River Supply

This alternative involves the construction of a raw water intake, pump station, and transmission main to convey raw water from the Colorado River to the City of Pflugerville. The City would purchase the raw water from LCRA at the firm supply rate of $105 per ac-ft. In order to minimize the cost of the raw water conveyance system, a raw water storage reservoir would be constructed near a new water treatment facility at the City of Pflugerville to accommodate seasonal variations in the daily demand for water. The raw water conveyance system would be designed to meet an annual average daily demand of 10.3 mgd and the treatment system would be designed to meet the peak-day demand. As a result, it is anticipated that this alternative would produce a supply of 11,540 ac-ft/yr. The opinion of probable costs for this alternative is presented in Table 5.36.

Table 5.36: Alternative PF2 (Colorado River Supply) Opinion of Probable Cost [1]

Phase	Cost Opinion
Capital Costs	
Raw Water Intake and Pump Station	$3,025,000
Raw Water Transmission Main Costs (24-in. 13 miles)	$4,310,000
Raw Water Storage Reservoir	$1,675,000
Water Treatment Plant (22 mgd)	$18,160,000
Total Capital Costs	**$27,170,000**
Engineering, Contingencies and Legal Services (35%)	$9,510,000
Environmental and Archeological Studies, Mitigation, and Permitting	$150,000
Site Acquisition	$4,600,000
Interest Accrued During Construction	$4,975,000
Interest Earned on Unused Principal	($1,490,000)
Total Project Costs	**$44,915,000**
Annual Costs[2]	
Debt Service (6 % for 30 years)	$3,260,000
Operation and Maintenance	$1,556,000
Raw Water Purchase	$1,390,000
Total Annual Costs	**$6, 206,000**
Unit Cost of Water ($/ac-ft)	**$538**
Unit Cost of Water ($/1000 gallons)[2]	**$1.65**

1 Capital costs, operations and maintenance costs, and yield information obtained from "Colorado River Water Supply Feasibility Study", May 2000, as prepared by HDR Engineering, Inc. for the City of Pflugerville.

2 Unit cost of treated water at the water treatment plant site. Does not include delivery to City's distribution system.

5.9.4.3 Alternative PF3 – Carrizo-Wilcox Water Supply

This alternative would involve the construction of a well field in the Carrizo-Wilcox Aquifer east of town and pumping groundwater back to town. The City of Pflugerville is currently investigating this alternative but has not completed the evaluation. A preliminary evaluation of this alternative was completed for this study. It included developing well capacity and a pipeline necessary to convey 7,000 ac-ft/yr from Milam County near Rockdale to the City of Pflugerville. An opinion of probable costs for this alternative is presented in Table 5.37.

Table 5.37: Alternative PF3 (Carrizo-Wilcox Supply) Opinion of Probable Cost[1]

Phase	Cost Opinion
Capital Costs	
Well Sites	$2,500,000
Raw Water Transmission Main Costs (16-in. 45 miles)	$12,000,000
Booster Pump Station	$1,500,000
Total Capital Costs	**$16,000,000**
Engineering, Contingencies and Legal Services (35%)	$5,600,000
Environmental and Archeological Studies, Mitigation, and Permitting	$750,000
Site Acquisition	$1,500,000
Interest Accrued During Construction	$2,860,000
Interest Earned on Unused Principal	($1,000,000)
Total Project Costs	**$25,710,000**
Annual Costs[2]	
Debt Service (6 % for 30 years)	$1,875,000
Operation and Maintenance	$1,200,000
Total Annual Costs	**$3, 075,000**
Unit Cost of Water ($/ac-ft)	**$439**
Unit Cost of Water ($/1000 gallons)[2]	**$1.35**

5.10 EVALUATION OF WATER MANAGEMENT STRATEGIES TO MEET HILL COUNTRY MUNICIPAL DEMAND/DEFICITS

As previously discussed, there are four areas in the Hill Country where the demands for municipal water are expected to exceed the available water supply. In each case, the identified needs are immediate. The demand deficits actually decline over time due to the benefits associated with planned water conservation efforts. The alternative water management strategies for these areas are addressed in the following sections.

5.10.1 City of Blanco Water Management Strategy Alternatives

The City of Blanco receives the majority of its water supply from the Blanco River. The city has the right to divert more water than it currently needs from the river, however, the water may not always be available in the river when the City needs it. The City pumps water from a system of channel dams on the river to its water treatment plant. During normal conditions, the flow in the river exceeds the City's demand for water and produces flow over the dams. However, during drought conditions, the river can cease to flow. During these times, the City of Blanco must withdraw water from its reservoirs, reducing their levels. If drought conditions were extended, it is possible that the City would deplete its reservoir water stores before the river begins to flow again.

Hydrologic data sufficient to quantify the firm yield of the City's reservoirs is not currently available. Based on anecdotal information, it has been estimated that the City may have as much as a 52 ac-ft/yr demand deficit if a critical drought were to occur today. The estimated needs decrease over time due to the anticipated benefits of water conservation efforts and a flat growth projection. However, the City of Blanco has indicated a desire to plan for future growth of its city beyond the existing corporate boundaries as a result of annexation. The following alternatives for meeting the existing water supply shortages were evaluated.

5.10.1.1 Alternative BL1 – Dredge Existing Reservoirs

It is possible that the City of Blanco's potential water supply shortage could be eliminated by dredging existing reservoirs and restoring them to their original capacities. If the amount of water available in storage is increased, the City will be able to sustain its water demands for a longer period while the flow in the river is down.

The amount of material that could be removed from the reservoirs is not currently known. In order to make a comparison of this water management strategy alternative to other alternatives, its was assumed that 52 acre-feet of material could be removed to meet the projected deficit. This material would be removed immediately under a capital expenditure, and in the future, routine maintenance would be required to keep the reservoirs clean and ready for the beginning of a drought. The opinion of probable costs for this alternative is presented in Table 5.38.

Table 5.38: Alternative BL1 (Dredge Existing Reservoirs) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Initial Dredging (52 ac-tt)	$170,000
Total Capital Costs	**$170,000**
Engineering, Contingencies and Legal Services (35%)	$60,000
Environmental and Archeological Studies, Mitigation, and Permitting	$15,000
Site Acquisition	$0
Interest Accrued During Construction	$0
Interest Earned on Unused Principal	($0)
Total Project Costs	**$245,000**
Annual Costs	
Debt Service (6 % for 30 years)	$17,800
Annual Dredging (10 ac-ft/yr)	$33,500
Treatment at existing plant	$12,000
Total Annual Costs	**$63,300**
Unit Cost of Water ($/ac-ft)	**$1,217**
Unit Cost of Water ($/1000 gallons)	**$3.73**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Least cost alternative;
- Implementation by the City would not require contract negotiations with outside entities; and,
- Near-term implementation of this alternative is possible.

Disadvantages

- It is uncertain whether enough material can be removed to eliminate the projected water supply shortage.
- Intensive ongoing maintenance would be required for the existing reservoirs to keep them free from sediment build up;
- A dredging permit would be required and disposal of the dredged material may be an issue; and,
- This alternative would likely not provide a source of water for additional growth of the City.

5.10.1.2 Alternative BL2 – Construct an Additional Blanco River Channel Dam

Additional storage could also be developed by creating another storage reservoir upstream of the existing reservoirs on the Blanco River. The additional storage would allow the City of Blanco to provide water for a longer period while the river was not flowing. The dam would be very similar to the existing dams and would inundate water within the channel banks of the river. A specific location for the damn has not yet been selected. The opinion of probable cost has been developed based on typical costs for similar facilities and is presented in Table 5.39.

Table 5.39: Alternative BL2 (Additional Channel Dam) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Reservoir Construction	$1,300,000
Total Capital Costs	**$1,300,000**
Engineering, Contingencies and Legal Services (35%)	$455,000
Environmental and Archeological Studies, Mitigation, and Permitting	$150,000
Site Acquisition	$80,000
Interest Accrued During Construction	$470,000
Interest Earned on Unused Principal	($190,000)
Total Project Costs	**$2,265,000**
Annual Costs	
Debt Service (6 % for 40 years)	$150,000
Operation and Maintenance	$50,000
Treatment at Existing Plant	$22,800
Total Annual Costs	**$222,800**
Unit Cost of Water ($/ac-ft)	**$2,228**
Unit Cost of Water ($/1000 gallons)	**$6.84**

[1] Capital costs based on unit costs presented in LCRA report "Cost Estimation and Location of a Channel Dam on the Colorado River Near Goldthwaite, Texas", May 1998.

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Operation of the City's water system would remain the same; and,
- Depending upon the size of the reservoir, it may be possible to develop sufficient supply to allow some growth in the City.

Disadvantages

- Relatively expensive alternative.
- Construction of the dam would require acquisition of land or the rights to inundate land.
- Construction of a channel dam would require a water rights permit amendment if the total storage exceeded the 168 ac-ft in the City's existing water rights permits.
- Construction of a channel dam may have environmental impacts;
- Future sedimentation of the reservoir may become an issue; and,
- Implementation of this alternative may take several years (3-5).

5.10.1.3 Alternative BL3 Construction of an Off-Channel Dam

Construction of a reservoir at a location along one of the tributaries of the Blanco River could also provide the City of Blanco with additional storage capacity. The additional storage capacity would allow the City to continue providing water for a longer period while the flow in the river was down. An actual site for an off-channel dam has not been selected, although a site on Koch Creek has been investigated in the past. This project would require an intake structure on the Blanco River and a raw water pump station to get the water to the off-channel reservoir. When the water was needed, it would flow back into the existing Blanco River reservoirs to keep them full. The opinion of probable cost for this alternative is presented in Table 5.40.

Table 5.40: Alternative BL3 (Off-Channel Dam) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs [1]	
Intake/Pump Station at River	$100,000
Transmission Pipe to Reservoir	$280,000
Reservoir Construction	$1,800,000
Total Capital Costs	**$2,180,000**
Engineering, Contingencies and Legal Services (35%)	$765,000
Environmental and Archeological Studies, Mitigation, and Permitting	$200,000
Site Acquisition	$400,000
Interest Accrued During Construction	$420,000
Interest Earned on Unused Principal	($125,000)
Total Project Costs	**$3,840,000**
Annual Costs	
Debt Service (6 % for 40 years)	$255,000
Operations and Maintenance	$100,000
Treatment at Existing Plant	$45,600
Total Annual Costs	**$400,600**
Unit Cost of Water ($/ac-ft)	**$2,003**
Unit Cost of Water ($/1000 gallons)	**$6.15**

[1] Capital cost information updated from LCRA report "Water Supply and Demand Assessment for Blanco County", June 1988.

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Additional water supplies would be provided for future growth.

Disadvantages

- Expensive alternative;
- Construction of the dam would require acquisition of land;
- Construction of the dam would require a water rights permit;
- Construction of a dam could have environmental impacts;
- System operation would require careful attention to maximize the benefit of the storage capacity; and,
- Implementation of this alternative may take several years (4-6).

5.10.1.4 Alternative BL4 - Purchase Treated Water from the GBRA West Comal County System

The City of Blanco could purchase treated water from the GBRA West Comal County Water System. This alternative would involve the construction of a pipeline from US 281 and Highway 46 to the City of Blanco. The project would also include a booster pump station and storage tank. A schematic layout of this alternative is presented on Figure 5.12. The City would provide the capital expense and then pay $ 1.96 per 1000 gallons of treated water. The opinion of probable cost for this alternative is presented in Table 5.41.

Figure 5.12: Alternative BL-4 - Purchase Treated Water from the GBRA West Comal County System

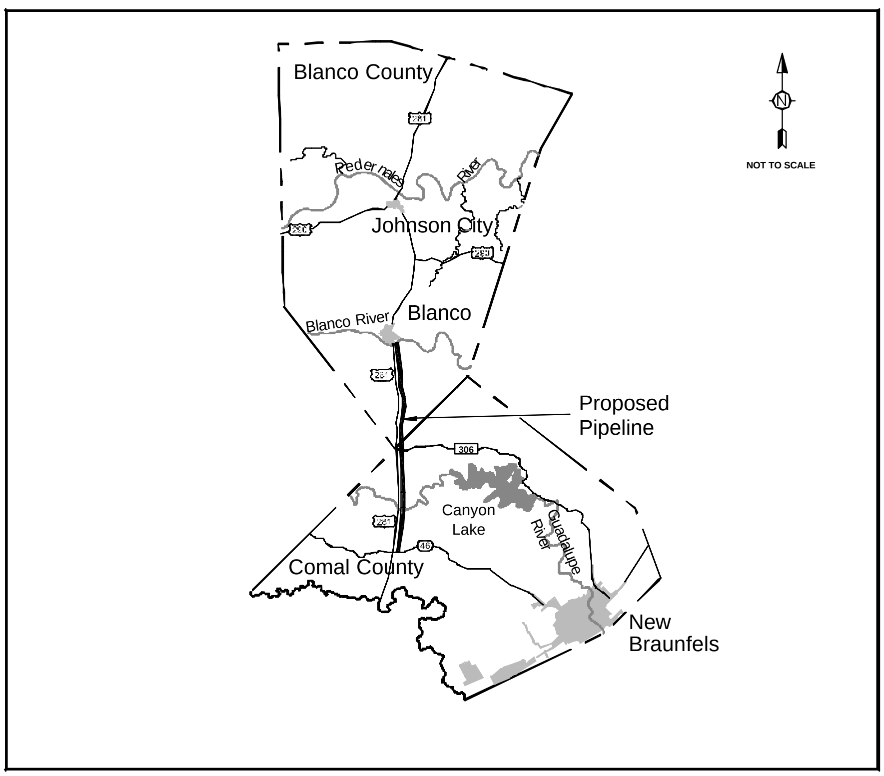


Table 5.41: Alternative BL4 (GBRA Water Supply) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Booster Pump Station	$100,000
Transmission Main (22 miles)	$3,060,000
Highway Crossings	$650,000
Storage Tank	$500,000
Total Capital Costs	**$4,310,000**
Engineering, Contingencies and Legal Services (35%)	$1,510,000
Environmental and Archeological Studies, Mitigation, and Permitting	$150,000
Site Acquisition	$250,000
Interest Accrued During Construction	$750,000
Interest Earned on Unused Principal	($220,000)
Total Project Costs	**$6,750,000**
Annual Costs	
Debt Service (6 % for 30 years)	$490,000
Operations and Maintenance	$40,000
Treatment at Existing Plant	$190,000
Total Annual Costs	**$720,000**
Unit Cost of Water ($/ac-ft)	**$2,400**
Unit Cost of Water ($/1000 gallons)	**$7.37**

[1] Capital cost information updated from HDR memorandum dated August 18, 1998.

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- A firm supply of water would be developed;
- Future growth of the City would be possible;
- System reliability would be provided in the event the City's water treatment plant experienced difficulties;
- The proposed water line along US 281 could provide the opportunity to develop additional water customers in the future to help pay for the facilities; and,
- Near-term implementation of this alternative is possible (1-2 years).

Disadvantages

- Relatively expensive alternative;
- Taste and odor problems may result from mixing two different sources and treatment plants; and,
- The unit cost of water is dependent on the City finding someone to purchase the additional water in excess of its needs.

5.10.1.5 Alternative BL5 – Purchase Treated Water from Canyon Lake Water Supply

The City of Blanco could purchase treated water from the Canyon Lake Water Supply Corporation (CLWSC). This alternative would involve the construction of a pipeline from US 281 and Highway 306 to the City of Blanco. The project would also include a booster pump station and a storage tank. A schematic layout of this alternative is presented on Figure 5.13. The City would provide the capital expense and purchase capacity within the existing facilities. The City would purchase treated water for approximately $ 1.69 per 1000 gallons. This rate would include the raw water charge paid to GBRA. The opinion of probable cost for this alternative is presented in Table 5.42.

Figure 5.13: Alternative BL5 - Purchase Treated Water from Canyon Lake Water Supply

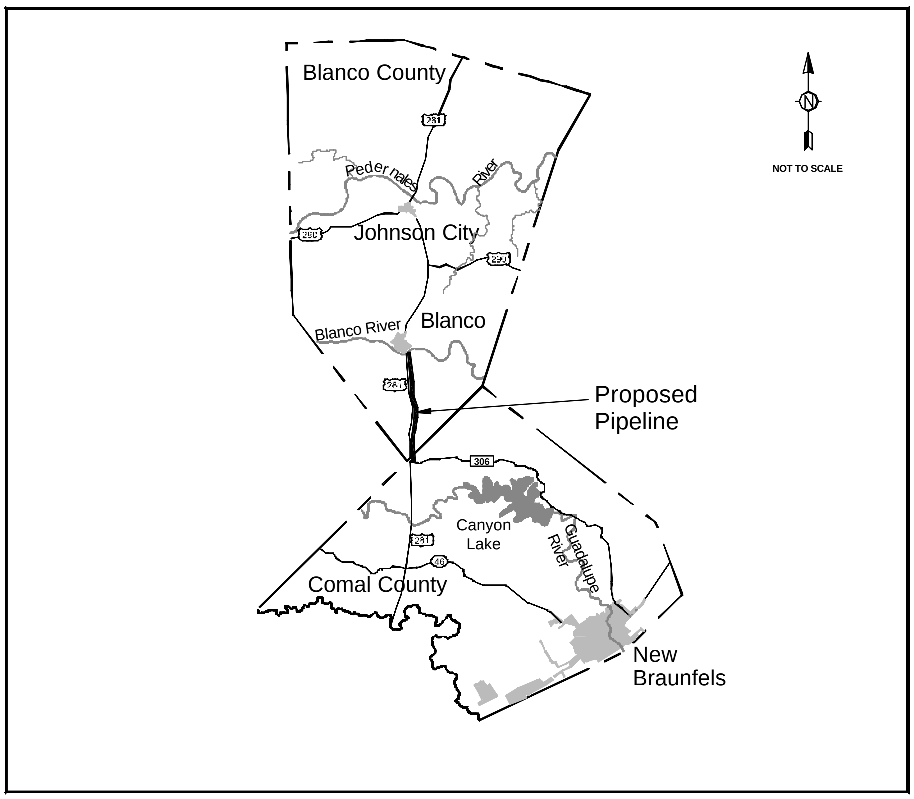


Table 5.42: Alternative BL5 (Canyon Lake Water Supply) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Booster Pump Station	$100,000
Transmission Main (10.5 miles)	$1,300,000
Highway Crossings	$300,000
Storage Tank	$100,000
Total Capital Costs	**$1,800,000**
Engineering, Contingencies and Legal Services (35%)	$630,000
Environmental and Archeological Studies, Mitigation, and Permitting	$50,000
Site Acquisition	$200,000
Interest Accrued During Construction	$320,000
Interest Earned on Unused Principal	($90,000)
Total Project Costs	**$2,910,000**
Annual Costs	
Debt Service (6 % for 30 years)	$210,000
Operations and Maintenance	$20,000
Treatment at CLWSC Plant	$165,000
Total Annual Costs	**$395,000**
Unit Cost of Water ($/ac-ft)	**$1,317**
Unit Cost of Water ($/1000 gallons)	**$4.04**

[1] Cost information based on personal conversation with Mr. Dale Yates June 21, 2000.

The following is a summary of the advantages and disadvantages for this alternative.

Advantages

- A firm supply of water would be developed;
- Future growth of the City would be possible;
- System reliability in the event the City's water treatment plant experienced difficulties would be provided;
- The proposed water line along US 281 could provide the opportunity to develop additional water customers in the future to help pay for the facilities; and,
- Near-term implementation of this alternative is possible (1-2 years).

Disadvantages

- Moderately expensive alternative;
- Taste and odor problems may result from mixing two different treatment plants and sources; and,
- The unit cost of water is dependent on the City finding someone to purchase the additional water in excess of its needs.

5.10.1.6 Alternative BL6 – Purchase Raw Water from the LCRA in the Pedernales River

The City of Blanco could purchase raw water from the LCRA in the Pedernales River near Johnson City. This alternative would require a raw water intake, pump station, and pipeline from Johnson City. A schematic layout of this alternative is presented on Figure 5.14. The pipeline would discharge the raw river water to the City's existing reservoirs and would mix these waters before being treated at the existing water treatment plant. The unit cost of the raw water would be $0.32 per 1000 gallons. The opinion of probable costs for this alternative is presented in Table 5.43.

Figure 5.14: Alternative BL6 - Purchase Raw Water from the LCRA in the Pedernales River

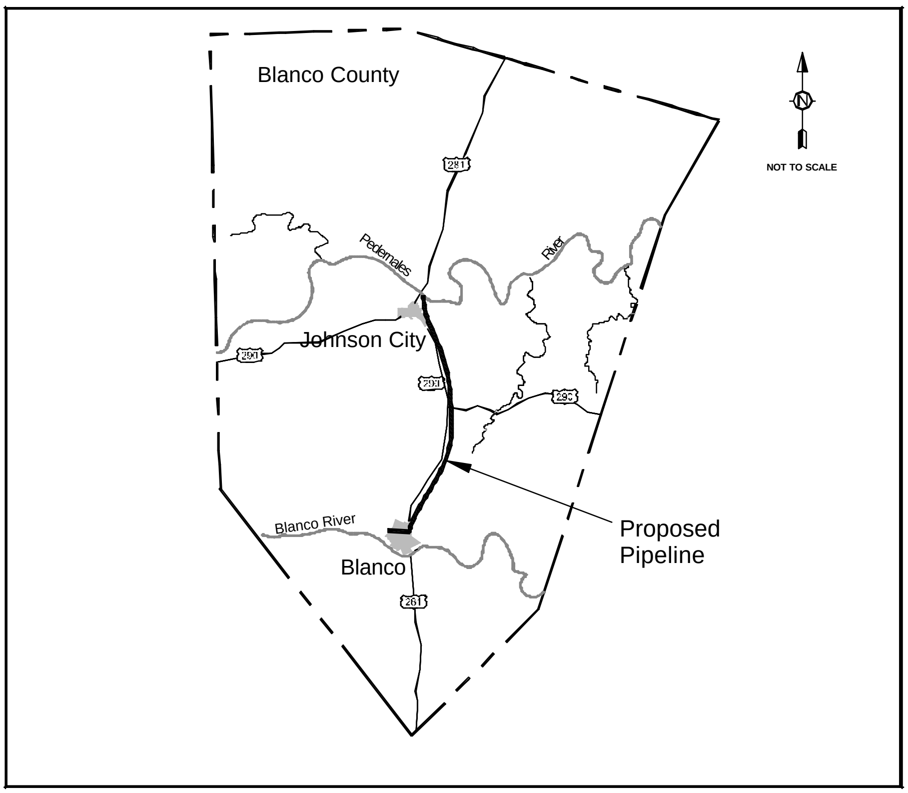


Table 5.43: Alternative BL6 (LCRA Water Supply) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Intake and Pump Station	$200,000
Transmission Main (15.5 miles)	$2,150,000
Highway Crossings	$450,000
Storage Tank	$100,000
Total Capital Costs	**$2,900,000**
Engineering, Contingencies and Legal Services (35%)	$1,015,000
Environmental and Archeological Studies, Mitigation, and Permitting	$200,000
Site Acquisition	$200,000
Interest Accrued During Construction	$520,000
Interest Earned on Unused Principal	($155,000)
Total Project Costs	**$4,680,000**
Annual Costs	
Debt Service (6 % for 30 years)	$340,000
Operations and Maintenance	$30,000
Raw Water Purchase	$31,500
Treatment at Existing Plant	$67,000
Total Annual Costs	**$468,500**
Unit Cost of Water ($/ac-ft)	**$1,562**
Unit Cost of Water ($/1000 gallons)	**$4.80**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages
- A firm supply of water would be developed; and,
- Future growth of the City would be possible.

Disadvantages
- Moderately expensive alternative;
- An interbasin transfer of water would be involved and would require approval;
- Implementation is expected to take several years (3-6) due to interbasin transfer issues;
- The Pedernales River water supply may not be reliable because it may experience dry periods at the same time as the Blanco River; and,
- The unit cost of water is dependent on the City finding someone to purchase the additional water in excess of its needs.

5.10.1.7 Alternative BL7 – Develop Groundwater Resources West of the City of Blanco

This alternative would indicate the development of eight wells to extract water from the Hensell/Cow Creek aquifer west of The City of Blanco. The groundwater would be piped to the city through a small diameter line. A schematic layout of this alternative is presented on Figure 5.15. The opinion of probable costs for this alternative is presented in Table 5.44.

Figure 5.15: Alternative BL7 – Develop Groundwater Resources West of the City of Blanco

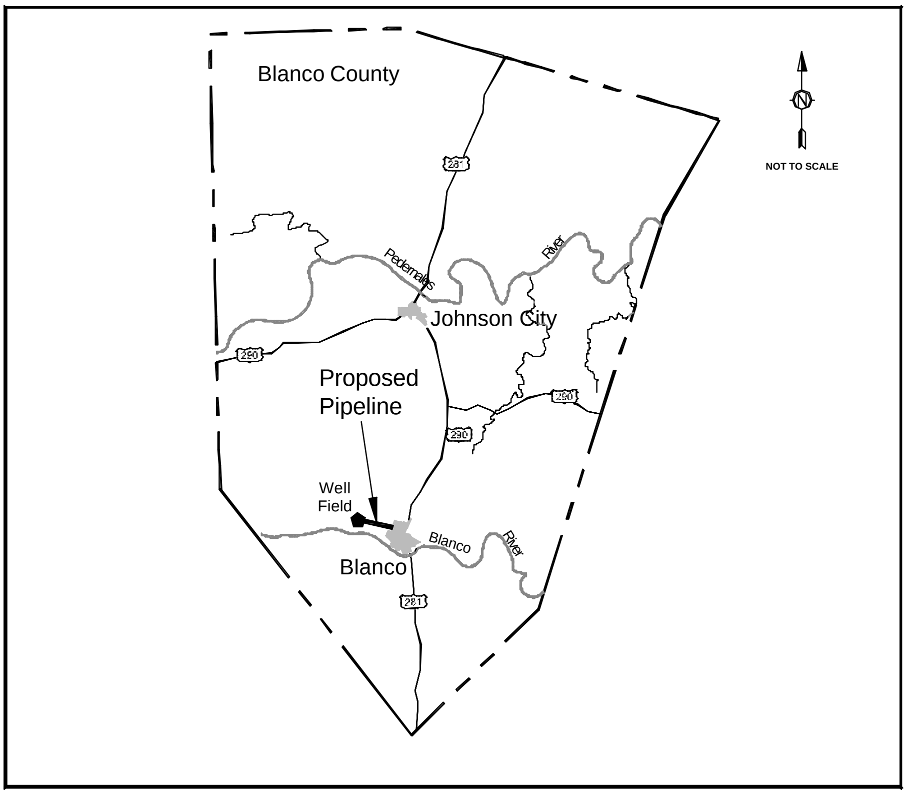


Table 5.44: Alternative BL7 (Hensell Groundwater) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Well Construction and Piping (8 wells)	$785,000
Transmission Main (1.5 miles)	$320,000
Total Capital Costs	**$1,105,000**
Engineering, Contingencies and Legal Services (35%)	$390,000
Environmental and Archeological Studies, Mitigation, and Permitting	$30,000
Site Acquisition	$200,000
Interest Accrued During Construction	$210,000
Interest Earned on Unused Principal	($60,000)
Total Project Costs	**$1,875,000**
Annual Costs	
Debt Service (6 % for 30 years)	$135,000
Operations and Maintenance	$8,500
Total Annual Costs	**$143,500**
Unit Cost of Water ($/ac-ft)	**$2,760**
Unit Cost of Water ($/1000 gallons)	**$8.47**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Near-term implementation of this alterative is possible (1-2 years).

Disadvantages

- Relatively expensive alternative;
- The groundwater production is highly variable and uncertain;
- Land would need to be acquired for the well sites; and,
- It may not be possible to obtain enough water from these wells to support growth of the City beyond its existing boundaries.

5.10.1.8 Alternative BL8 – Develop Groundwater Resources North of the City of Blanco

This alternative would indicate the development of two wells to extract groundwater from the Ellenburger Group north of the City of Blanco. Indications are that wells in this area have the capabilities of producing significant quantities of water. Therefore, a field of two wells would have the capacity to supply 300 ac-ft/yr, which is the equivalent of other alternatives evaluated. The City could use this additional capacity to market water to other entities needing water in the area. The groundwater would be piped back to town through a 12-inch diameter line. A schematic layout of this alternative is presented on Figure 5.16. The opinion of probable cost for this alternative is presented in Table 5.45.

Figure 5.16: Alternative BL8 - Develop Groundwater Resources North of the City of Blanco

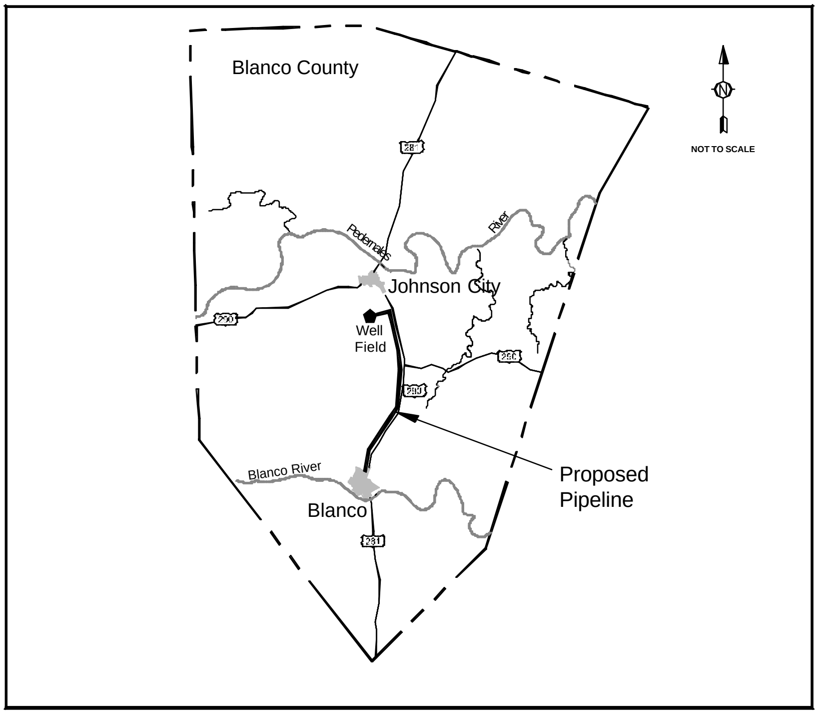


Table 5.45: Alternative BL8 (Ellenburger Groundwater) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Well Construction and Piping (2 wells)	$70,000
Transmission Main (11 miles)	$1,350,000
Highway Crossings	$300,000
Total Capital Costs	**$1,720,000**
Engineering, Contingencies and Legal Services (35%)	$600,000
Environmental and Archeological Studies, Mitigation, and Permitting	$50,000
Site Acquisition	$200,000
Interest Accrued During Construction	$310,000
Interest Earned on Unused Principal	($90,000)
Total Project Costs	**$2,790,000**
Annual Costs	
Debt Service (6 % for 30 years)	$200,000
Operations and Maintenance	$30,000
Total Annual Costs	**$230,000**
Unit Cost of Water ($/ac-ft)	**$767**
Unit Cost of Water ($/1000 gallons)	**$2.35**

The following is a summary of the advantages and disadvantages for alternative BL8:

Advantages

- The least expensive alternative; and,
- This project could be implemented in the near-term (1-2 years).

Disadvantages

- The groundwater production can be variable and uncertain;
- Land would need to be acquired for the well sites; and,
- The unit cost of water is dependent on the City finding someone to purchase the additional water in excess of its needs.

5.10.1.9 Summary of the Alternatives to Meet the City of Blanco Demand Deficits

Eight alternative water management strategies (BL1-BL8) were investigated to meet the projected demand deficits for the City of Blanco. The City's water supply shortage is an immediate concern. The alternatives investigated include groundwater and surface water from both the Guadalupe and Colorado River Basins. Summary information on these alternatives is presented in Table 5.46.

Table 5.46: Summary of Alternative Strategies Evaluated to Meet the City of Blanco Water Supply Shortages

Water Management Strategy	Strategy Description	Capital Cost ($)	Debt Service ($)	O&M Cost ($)	Total Annual Cost ($)	2050 Firm Yield (ac-ft/yr)	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gallons)	Summary of Environmental Impacts
BL1	Dredge existing reservoirs	$ 245,000	$ 17,800	$ 45,500	$ 63,300	52	$ 1,217	$ 3.74	Disposal of dredged material
BL2	Construction of a new channel dam	$ 2,265,000	$ 150,000	$ 72,800	$ 222,800	100	$ 2,228	$ 6.84	Inundation of riverine habitat
BL3	Construction of off-channel reservoir	$ 3,840,000	$ 255,000	$ 145,600	$ 400,600	200	$ 2,003	$ 6.15	River intake structure impacts, inundation of large area
BL4	Construction of pipeline from West Comal County Water System	$ 6,750,000	$ 490,000	$ 230,000	$ 720,000	300	$ 2,400	$ 7.37	Pipeline construction impacts
BL5	Construction of pipeline from Canyon Lake Water Supply Corporation	$ 2,910,000	$ 210,000	$ 185,000	$ 395,000	300	$ 1,317	$ 4.04	Pipeline construction impacts
BL6	Construction of pipeline from Pedernales River & purchase of water from LCRA.	$ 4,680,000	$ 340,000	$ 128,500	$ 468,500	300	$ 1,562	$ 4.79	Pipeline construction impacts, interbasin transfer issues
BL7	Construct 8 wells in the Hensell/Cow Creek Aquifer ~ 2 miles west of town	$ 1,875,000	$ 135,000	$ 8,500	$ 143,500	52	$ 2,760	$ 8.47	Pipeline construction impacts
BL8	Construct 2 wells in the Ellenburger approximately 10 miles north of town	$ 2,790,000	$ 200,000	$ 30,000	$ 230,000	300	$ 767	$ 2.35	Pipeline construction impacts

5.10.2 Blanco County-Other Water Management Strategy Alternatives

The rural area surrounding the City of Blanco, primarily to the south, is projected to experience significant growth in the future. Currently, this area of the County is dependent on the Trinity Aquifer for water. The projections indicate that during the drought of record, the rural area of Blanco County in the Guadalupe River Basin would have a shortage of 24 ac-ft/yr in the year 2000. This shortage increases to 163 ac-ft/yr in 2030 and 215 ac-ft/yr in 2050.

Due to the location of the projected demands, Alternatives BL4 and BL5 have been considered for the Blanco County-Other demands. The construction of the waterlines along US Highway 281 will allow developers in this portion of the County to connect to the system.

5.10.3 City of Llano Water Management Strategy Alternatives

The City of Llano receives the majority of its water supply from the Llano River. The City has the right to divert more water than it currently needs from the river; however, the water may not always be available in the river when it needed it. The City pumps water from a system of channel dams along the river to its water treatment plant. During normal conditions, the flow in the river exceeds the City's demand for water and produces flow over the dams. However, during drought conditions, the river can cease to flow. During these times, the City of Llano must withdraw water from its reservoirs, reducing their levels. If drought conditions were extended, it is possible that the City would deplete its water stores before the river begins to flow again.

Based on previous studies, it has been estimated that the City of Llano may have as much as a 660 ac-ft/yr demand deficit if a critical drought were to occur today. The demand deficits decrease over time due to the anticipated benefits of water conservation efforts and a relatively flat growth projection. The following alternatives for meeting the existing water supply shortages were evaluated.

5.10.3.1Alternative L1 – Dredge Existing Reservoir

The combined firm yield of the City of Llano reservoirs was estimated to be 400 ac-ft/yr according to a 1988 study. The City has recently removed sediment from these reservoirs. The amount of material removed during that operation was not readily available. Nor is it known how much additional material would still be able to be removed. For comparison purposes, it was assumed that the firm yield could be increased by 100 ac-ft/yr through an ongoing maintenance program to remove sediment as it is deposited. This would involve annual maintenance to keep the reservoirs clean and ready for the beginning of a drought. An opinion of probable costs for this alternative is presented in Table 5.47.

Table 5.47: Alternative L1 (Dredge Existing Reservoirs) Opinion of Probable Cost

Phase	Cost Opinion
Annual Dredging	$48,400
Treatment Cost at Existing Plant	$22,600
Total Annual Costs	**$71,000**
Unit Cost of Water ($/ac-ft)	**$710**
Unit Cost of Water ($/1000 gallons)	**$2.18**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Implementation by the City would not require contract negotiations with outside entities; and,
- Near-term implementation of this alternative is possible.

Disadvantages

- It is unlikely that enough material can be removed to eliminate the projected water supply shortage;
- Intensive, ongoing maintenance requirements would be required for the existing reservoirs to keep them free from sediment buildup;
- A dredging permit would be required and disposal of the dredged material may be an issue; and,
- This alternative would not provide a source of water for additional growth of the City.

5.10.3.2 Alternative L2 – Construct Additional Channel Dam

This alternative would involve the construction of a third channel dam structure across the Llano River. The structure would be located downstream of the two existing reservoirs. The dam would have a height of 25 feet above the existing bedrock in the area. The spillway for the dam would be 650 feet wide to pass flood flows without impacting upstream water surface elevations. Water would need to be pumped from the new reservoir into City Lake, where the City of Llano's water treatment plant intake structure is located. The projected firm yield from the addition of this reservoir is 1,300 ac-ft/yr. The opinion of probable costs for this project is presented in Table 5.48.

Table 5.48: Alternative L2 (Additional Channel Dam) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Pump Station/Transfer Pipeline	$55,000
Reservoir Construction	$1,350,000
Total Capital Costs	**$1,405,000**
Engineering, Contingencies and Legal Services (35%)	$490,000
Environmental and Archeological Studies, Mitigation, and Permitting	$300,000
Site Acquisition	$140,000
Interest Accrued During Construction	$280,000
Interest Earned on Unused Principal	($85,000)
Total Project Costs	**$2,530,000**
Annual Costs	
Debt Service (6 % for 40 years)	$170,000
Operations and Maintenance	$135,000
Treatment at Existing Plant	$295,000
Total Annual Costs	**$600,000**
Unit Cost of Water ($/ac-ft)	**$461**
Unit Cost of Water ($/1000 gallons)	**$1.42**

[1] Cost information updated from Freese & Nichols report "Engineering Report on the Llano River Channel Dam Project", February 1988.

The following is a summary of the advantages and disadvantages for this alternative:

Advantages
- The operation of the City's water system would remain the same;
- It would be possible to develop sufficient supply to allow growth in the City; and,
- Development of a sufficient supply of water to allow growth in the City would be possible.

Disadvantages
- Construction of the dam would require acquisition of land or the rights to inundate land;
- Construction of a channel dam would require a water rights permit amendment;
- Construction of a channel dam may have environmental impacts;
- Future sedimentation of the reservoir may become an issue; and,
- Implementation of this alternative may take several years (3-5).

5.10.3.3 Alternative L3 – Construct an Off-Channel Dam

This alternative would include the construction of an off-channel dam to store water for later use during drought conditions. A site for an off-channel reservoir has not been determined. It is anticipated that the reservoir would be located upstream from one of the existing channel reservoirs. Water would be pumped from the river, or existing channel reservoir, to the new off-channel reservoir. The new off-channel reservoir would be kept full during normal conditions. This would require the addition of periodic "make-up" water from the Llano River to account for evaporation and infiltration.

During a critical drought period, when flow in the river has ceased, water would be released from the additional off-channel reservoir back to the river to replenish the levels in City Lake. This additional storage would allow the City of Llano to continue operations for a longer period of time when there was no natural flow in the river. An opinion of probable costs for a typical off-channel reservoir project is presented in Table 5.49.

Table 5.49: Alternative L3 (Off-Channel Reservoir) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Pump Station/Transfer Pipeline	$380,000
Reservoir Construction	$1,800,000
Total Capital Costs	**$2,180,000**
Engineering, Contingencies and Legal Services (35%)	$765,000
Environmental and Archeological Studies, Mitigation, and Permitting	$165,000
Site Acquisition	$380,000
Interest Accrued During Construction	$420,000
Interest Earned on Unused Principal	($125,000)
Total Project Costs	**$3,785,000**
Annual Costs	
Debt Service (6 % for 40 years)	$250,000
Operations and Maintenance	$100,000
Treatment at Existing Plant	$45,000
Total Annual Costs	**$395,000**
Unit Cost of Water ($/ac-ft)	**$1,975**
Unit Cost of Water ($/1000 gallons)	**$6.07**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- An off-channel reservoir is less likely to experience significant sedimentation.

Disadvantages

- Expensive alternative;
- Construction of the off-channel reservoir would require acquisition of land;
- Construction of the off-channel reservoir would likely require a water rights permit amendment;
- Construction of an off-channel reservoir may have significant environmental impacts; and,
- System operation would require careful attention to maximize the benefit of the storage capacity.

5.10.3.4 Alternative L4 – Develop Groundwater Resources Southeast of the City of Llano

This alternative would include the development of a well field southeast of the City of Llano. The wells would be completed into the Ellenburger-San Saba aquifer. Information concerning wells recently drilled in the Riley Mountain area indicates wells that are 600 feet deep and 6 inches in diameter produce 70-100 gpm. Based on this information, a well field of seven wells is proposed to supply water to the City of Llano. Water would be pumped from the well field directly to the City's distribution system. A schematic layout of this alternative is presented on Figure 5.17. The opinion of probable costs for this alternative is presented in Table 5.50.

Figure 5.17: Alternative L4 – Develop Groundwater Resources Southeast of the City of Llano

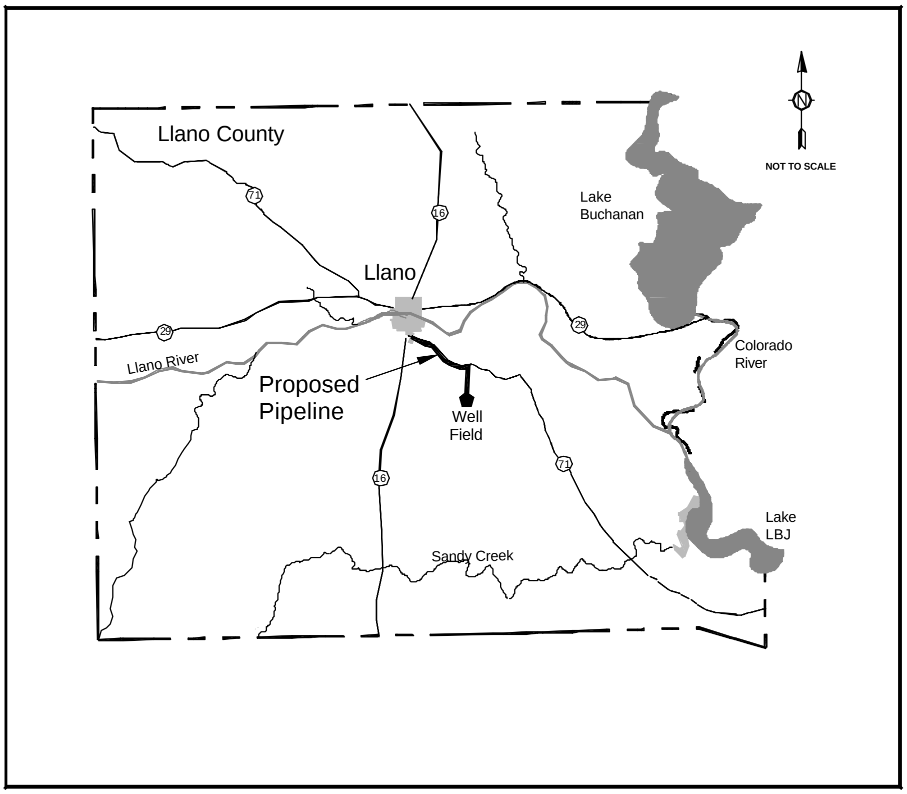


Table 5.50: Alternative L4 (Ellenburger Groundwater) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Well Construction and Piping (7 wells)	$680,000
Transmission Main (7 miles)	$1,500,000
Total Capital Costs	**$2,180,000**
Engineering, Contingencies and Legal Services (35%)	$765,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$75,000
Site Acquisition	$250,000
Interest Accrued During Construction	$390,000
Interest Earned on Unused Principal	($120,000)
Total Project Costs	**$3,540,000**
Annual Costs	
Debt Service (6 % for 30 years)	$260,000
Operations and Maintenance	$15,000
Total Annual Costs	**$275,000**
Unit Cost of Water ($/ac-ft)	**$416**
Unit Cost of Water ($/1000 gallons)	**$1.28**

The following is a summary of the advantages and disadvantages for this alternative.

Advantages

- Lowest cost alternative;
- Near-term implementation of this alternative is possible (1-2 years);
- Secondary source of water would provide system redundancy in case of system failure at the plant or dam; and,
- Additional wells could be evaluated to meet potential growth of the City.

Disadvantages

- The groundwater production is variable and would need to be confirmed; and,
- Land would need to be acquired for the well sites.

5.10.3.5 Summary of the Alternatives to Meet the City of Llano Demand Deficits

Four alternative water management strategies were investigated to meet the projected demand deficits for the City of Llano. The City's water supply shortage is an immediate need. It is anticipated that any solution implemented to meet the immediate demand deficits will also address the long-term needs of the City. The alternatives investigated include both groundwater and surface water sources and summary information is presented in Table 5.51.

Table 5.51: Summary of Alternative Strategies Evaluated to Meet the City of Llano Water Supply Shortage

Water Management Strategy	Strategy Description	Capital Cost ($)	Debt Service ($)	O&M Cost ($)	Total Annual Cost ($)	2050 Firm Yield (ac-ft/yr)	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gallons)	Summary of Environmental Impacts
L1	Dredge existing reservoirs	$ -	$ -	$ 71,000	$ 71,000	100	$ 710	$ 2.18	Disposal of dredge material
L2	Construction of a new channel dam	$ 2,530,000	$ 170,000	$ 430,000	$ 600,000	1,300	$ 462	$ 1.42	Inundation of riverine and riparian habitat, impacts of dam construction
L3	Construction of off-channel reservoir	$ 3,785,000	$ 250,000	$ 145,000	$ 395,000	200	$ 1,975	$ 6.06	River intake structure impacts, inundation of uplands area
L4	Construct 7 wells in the Ellenberger-San Saba Aquifer ~ 7 miles southeast of town	$ 3,540,000	$ 260,000	$ 15,000	$ 275,000	660	$ 417	$ 1.28	Pipeline construction impacts

5.10.4 City of Goldthwaite Water Management Strategy Alternatives

The City of Goldthwaite receives the majority of its water supply from the Colorado River in Mills County. The City has the right to divert more water than it currently needs from the river, however, the water may not always be available in the river when its needed. The City pumps water from the river to off-channel storage where water can be withdrawn for treatment at the plant and distribution into the City's water system. During normal conditions, the flow in the river exceeds the city's demand for water. The City is able to pump enough water to meet its demand and keep the off-channel reservoirs completely full. However, during drought conditions, the river can cease to flow. During these times, the City must withdraw water from its reservoirs, reducing the levels. If drought conditions were extended, it possible that the city would deplete its stores before the river begins to flow again.

Hydrologic data sufficient to quantify the firm yield of the City's reservoirs is not currently available. Based on anecdotal information, it has been estimated that the City of Goldthwaite may have as much as a 117 ac-ft/yr demand deficit if a critical drought were to occur today. The estimated demand deficits decrease over time due to the anticipated benefits of water conservation efforts and a flat growth projection. However, the City of Goldthwaite has indicated a desire to work with the Fox Crossing Water District to develop a reliable water supply for all residents in Mills County. The following alternatives to meeting the existing water supply shortages were evaluated.

5.10.4.1 Alternative G1 – Dredge Existing Reservoirs

It is possible that the potential water supply shortage could be reduced by dredging the existing reservoirs in Mills County and restoring them to their original capacities. If the amount of water available in storage is increased, the City of Goldthwaite will be able to sustain its water demands for a longer period while the flow in the river is down.

The amount of material that could be removed from the reservoirs is not currently known. In order to make a comparison of this alternative water management strategy to other alternatives, its was assumed that 52 acre-feet of material could be removed to meet the projected water supply shortage. This material would be removed immediately under a capital expenditure. In the future, routine maintenance would be required to keep the reservoirs clean and ready for the beginning of a drought.

The opinion of probable costs for this alternative is presented in Table 5.52.

Table 5.52: Alternative G1 (Dredge Existing Reservoirs) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Initial Dredging (52 ac-ft)	$100,000
Total Capital Costs	**$100,000**
Engineering, Contingencies and Legal Services (35%)	$35,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$15,000
Site Acquisition	$0
Interest Accrued During Construction	$0
Interest Earned on Unused Principal	($0)
Total Project Costs	**$150,000**
Annual Costs	
Debt Service (6 % for 30 years)	$11,000
Annual Dredging (8 ac-ft/yr)	$26,000
Treatment at Existing Plant	$9,000
Total Annual Costs	**$46,000**
Unit Cost of Water ($/ac-ft)	**$1,150**
Unit Cost of Water ($/1000 gallons)	**$3.53**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Implementation by the City would not require contract regulations with outside entities; and,
- Near-term implementation of the alternative is possible.

Disadvantages

- Moderately expensive alternative;
- It is uncertain whether enough material can be removed to eliminate the projected water supply shortage;
- This alternative would involve intensive, ongoing maintenance requirements for the existing reservoirs to keep them free from sediment buildup;
- A dredging permit would be required and disposal of the dredged material may be an issue; and,
- This alternative would likely not provide a source of water for additional growth of the City's system.

5.10.4.2 Alternative G2 – Construct a New Channel Dam

This alternative would include the construction of a low dam approximately 300 feet downstream of the City of Goldthwaite's existing intake structure on the Colorado River. The channel dam would be 10 feet in height. The reservoir formed would have a firm yield of 510 ac-ft/yr. The construction of this dam would provide a reliable source of water for the City's diversion pumps and would allow the City to continue providing service for a longer period without flow in the river. The opinion of probable project costs is presented in Table 5.53.

Table 5.53: Alternative G2 (New Channel Dam) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Reservoir Construction	$1,300,000
Total Capital Costs	**$1,300,000**
Engineering, Contingencies and Legal Services (35%)	$455,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$400,000
Site Acquisition	$65,000
Interest Accrued During Construction	$265,000
Interest Earned on Unused Principal	($80,000)
Total Project Costs	**$2,405,000**
Annual Costs	
Debt Service (6 % for 40 years)	$160,000
Operations and Maintenance	$50,000
Treatment at Existing Plant	$90,000
Total Annual Costs	**$300,000**
Unit Cost of Water ($/ac-ft)	**$750**
Unit Cost of Water ($/1000 gallons)	**$2.30**

[1] Cost information taken from LCRA report "Cost Estimation and Location of a Channel Dam on the Colorado River Near Goldthwaite, Texas", May 1998.

The following is a summary of the advantages and disadvantages for this alternative.

Advantages

- Operation of the City's water system would remain the same; and,
- Development of a sufficient supply of water to allow some growth in the City's system, would be possible.

Disadvantages

- Construction of the dam would require acquisition of land or the rights to inundate land;
- Construction of a channel dam would require a water rights permit amendment;
- Construction of a channel dam may have environmental impacts;
- Future sedimentation of the reservoir may become an issue; and,
- Implementation of this alternative could take several years (3-5).

5.10.4.3 Alternative G3 – Construct an Additional Off-Channel Dam

This alternative would involve the construction of an additional off-channel dam adjacent to the City of Goldthwaite's existing off-channel reservoir near the water treatment plant. An additional 200 ac-ft of storage could be added at this site to increase the city's total storage capacity, and therefore its ability to survive extended dry periods. The opinion of probable project costs for this alternative is presented in Table 5.54.

Table 5.54: Alternative G3 (Additional Off-Channel Reservoir) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Reservoir Construction	$1,900,000
Total Capital Costs	**$1,900,000**
Engineering, Contingencies and Legal Services (35%)	$665,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$100,000
Site Acquisition	$0
Interest Accrued During Construction	$320,000
Interest Earned on Unused Principal	($95,000)
Total Project Costs	**$2,890,000**
Annual Costs	
Debt Service (6 % for 40 years)	$190,000
Operations and Maintenance	$50,000
Treatment at Existing Plant	$45,000
Total Annual Costs	**$285,000**
Unit Cost of Water ($/ac-ft)	**$1,425**
Unit Cost of Water ($/1000 gallons)	**$4.38**

[1] Cost information taken from reference in LCRA report "Cost Estimation and Location of a Channel Dam on the Colorado River Near Goldthwaite, Texas", May 1998.

The following is a summary of the advantages and disadvantages for this alternative:

Advantages
- Operation of the City's water system would remain the same;
- Development of a sufficient supply of water to allow some growth in the City' system, would be possible; and,
- Near-term implementation of this alternative is possible (2-3 years).

Disadvantages
- Relatively expensive alternative;
- Construction of an off-channel reservoir may require a water rights permit amendment; and,
- Construction of an off-channel reservoir may have environmental impacts.

5.10.4.4 Alternative G4 – Participate in Mills County Reservoir

Fox Crossing Water District is currently in the planning stage for the construction of a surface water reservoir in Mills County. The District is expected to begin a two-year feasibility in Fiscal Year 2001, which will identify and evaluate potential reservoir sites in the county from a water supply perspective. The City of Goldthwaite has expressed interest in this study and is looking forward to its initiation. Once the study has been completed, it is anticipated that the City of Goldthwaite would have enough information to determine whether it should participate in the reservoir project as part of its long-term water management strategies. For the purposes of the Lower Colorado Regional Water Plan, information that has been developed for the Blanket Creek Reservoir site will be used for this alternative as a planning comparison tool.

The Blanket Creek project would involve the construction of a dam across Blanket Creek in Mills County. The conservation pool would be at an elevation of 1,300 feet above mean sea level. The reservoir would impound approximately 11,000 acre-feet of water with a surface area of about 500 acres. The drainage area for the reservoir would be approximately 130 square miles. The anticipated firm yield for the reservoir is estimated to be 1,120 ac-ft/yr. However, it has not yet been determined to what extent, if any, the construction of this reservoir might decrease the firm yield of the Highland Lakes System. If it negatively impacts the Highland Lakes, compensation would need to be made to the LCRA for the water lost.

In order to provide water to the City of Goldthwaite, water could be released from the new off-channel reservoir and allowed to flow down Blanket Creek, Pecan Bayou, and the Colorado River to the City's intake structure. The amount of water that would be lost due to transportation losses has not been determined. It is anticipated that this would represent a significant volume of water since the only time the City would need water from the Blanket Creek Reservoir is when the rivers in the area are all dry. The City of Goldthwaite would need to include these transportation losses before contracting for any given amount of water from the off-channel reservoir.

The opinion of probable costs for this alternative is presented in Table 5.55.

Table 5.55: Alternative G4 (Mills County Reservoir) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Reservoir Construction	$2,750,000
Total Capital Costs	**$2,750,000**
Engineering, Contingencies and Legal Services (35%)	$965,000
Environmental and Archaeological Studies, Mitigation, and Permitting	$250,000
Site Acquisition	$175,000
Interest Accrued During Construction	$500,000
Interest Earned on Unused Principal	($15,000)
Total Project Costs	**$4,490,000**
Annual Costs	
Debt Service (6 % for 40 years)	$300,000
Operations and Maintenance	$100,000
Treatment at Existing Plant	$30,000
Total Annual Costs	**$430,000**
Unit Cost of Water ($/ac-ft)	**$384**
Unit Cost of Water ($/1000 gallons)	**$1.18**

1 Cost information taken from unpublished studies provided by Fox Crossing Water District.

The following is a summary of the advantages and disadvantages for alternative G4:

Advantages

- The operation of the City's water system would remain the same;
- Development of a sufficient supply of water to allow some growth in the City's system would be possible;
- Relatively affordable alternative; and,
- Would also provide water for the region.

Disadvantages

- Construction of a reservoir would require a water rights permit;
- Construction of a reservoir would have environmental impact;
- A significant amount of land would need to be acquired;
- Transportation losses of water may significantly increase costs;
- Cost of water is dependent on obtaining commitments from others for the rest of the reservoir capacity; and,
- Implementation of this project could take 5-10 years.

5.10.4.5 Alternative G5 – Participate in the Fox Crossing Reservoir

The Fox Crossing Reservoir was previously discussed in Section 5.5.5 of this chapter. Water for the City of Goldthwaite could be released from Fox Crossing Reservoir to the City's existing intake structure. It is anticipated that the water loss associated with this delivery would be manageable due to the relatively short travel distance. Information concerning the opinion of probable cost for this project, including treating the water at the City's existing treatment plant, is presented in Table 5.56.

Table 5.56: Alternative G5 (Fox Crossing Reservoir) Opinion of Probable Cost

Phase	Cost Opinion
Annual Costs[1]	
Raw Water Cost for 117 ac-ft at $421/ac-ft	$49,000
Cost of Treating 117 ac-ft at Existing Plant at $0.70/1000 gallons	$27,000
Total Annual Costs	**$76,000**
Unit Cost of Raw Water ($/ac-ft)	**$650**
Unit Cost of Water ($/1000 gallons)	**$1.99**

[1] Cost information as presented on Table 5.18.

The following is a summary advantages and disadvantages for this alternative.

Advantages

- Operation of the City's water system would remain;
- Development of a sufficient supply to allow some growth in the City's system, would be possible;
- Relatively affordable alternative; and,
- Would also provide water for the region.

Disadvantages

- Construction of a reservoir would require a water rights permit;
- Construction of a reservoir would have environmental impact;
- A significant amount of land would need to be acquired; and,
- Cost of water is dependent on obtaining commitments from others for the rest of the reservoir capacity.

5.10.4.6 Alternative G6 – Develop Groundwater Resources Southwest of the City of Goldthwaite

This alternative would involve the development of a well field approximately 1 mile southwest of the City of Goldthwaite. A total of three wells would be completed into the Travis Peak Formation of the Trinity Group. Based on available information, it appears as though the wells would be approximately 550 feet deep and would produce 30 gpm each. The groundwater would be pumped back to town through a small diameter line. A schematic layout of this alternative is presented on Figure 5.18. The opinion of probable costs for this alternative is presented in Table 5.57.

Figure 5.18: Alternative G6 – Develop Groundwater Resources Southwest of the City of Goldthwaite

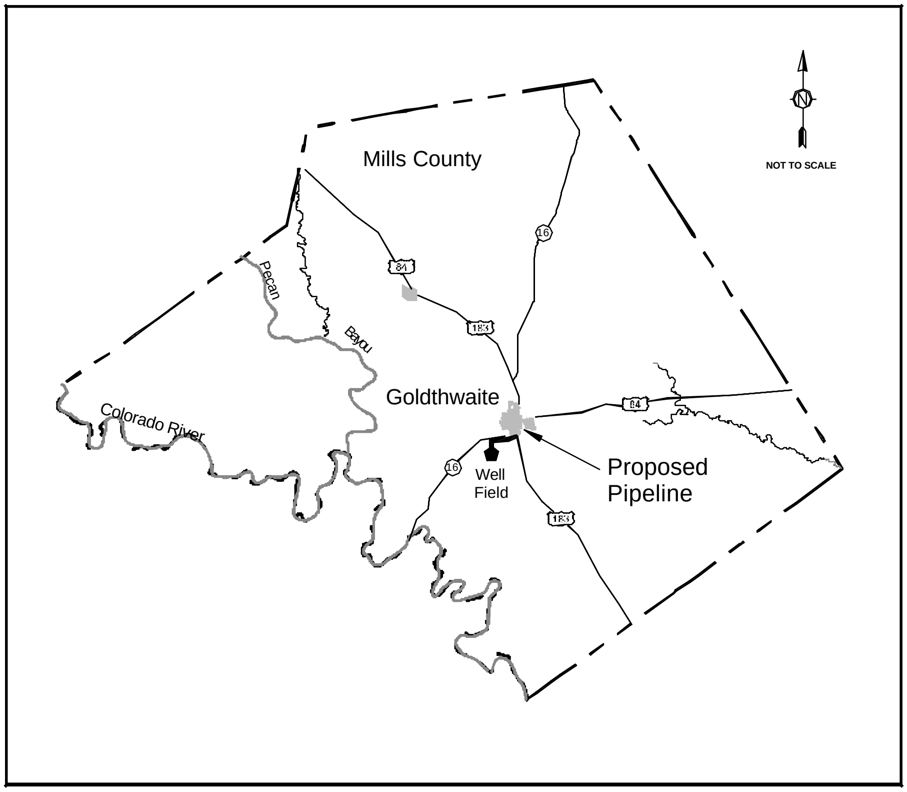


Table 5.57: Alternative G6 (Trinity Groundwater) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs	
Well Construction and Piping (3 wells)	$385,000
Transmission Main (1.5 miles)	$245,000
Total Capital Costs	**$630,000**
Engineering, Contingencies and Legal Services (35%)	$220,000
Environmental and Archeological Studies, Mitigation, and Permitting	$30,000
Site Acquisition	$100,000
Interest Accrued During Construction	$115,000
Interest Earned on Unused Principal	($35,000)
Total Project Costs	**$1,060,000**
Annual Costs	
Debt Service (6 % for 30 years)	$75,000
Operations and Maintenance	$11,000
Total Annual Costs	**$86,000**
Unit Cost of Water ($/ac-ft)	**$735**
Unit Cost of Water ($/1000 gallons)	**$2.26**

The following is a summary of the advantages and disadvantages for this alternative:

Advantages

- Near-term implementation of this alternative is possible (1-2 years).

Disadvantages

- Moderately expensive alternative;
- The groundwater production is highly variable and uncertain;
- Land acquisition would be required for the well field; and,
- It may not be possible to obtain enough water from wells to support growth of the City beyond its existing boundaries.

5.10.4.7 Summary of the Alternatives to Meet the City of Goldthwaite Demand Deficits

Six alternative management supply strategies were investigated to meet the projected demand deficits for the City of Goldthwaite. The City's water supply shortage is an immediate concern. It is anticipated that any solution implemented to meet the immediate needs will also address the long-term needs of the City. The alternatives investigated include groundwater and surface water from both the Guadalupe and Colorado River Basins. Summary information for these alternatives is presented in Table 5.58.

Table 5.58: Summary of Alternative Strategies Evaluated to Meet the City of Goldthwaite Water Supply Shortages

Water Management Strategy	Strategy Description	Capital Cost ($)	Debt Service ($)	O&M Cost ($)	Total Annual Cost ($)	2050 Firm Yield (ac-ft/yr)	Unit Cost ($/ac-ft)	Unit Cost ($/1000 gallons)	Summary of Environmental Impacts
G1	Dredge existing reservoirs	$ 150,000	$ 11,000	$ 35,000	$ 46,000	40	$ 1,150	$ 3.53	Disposal of dredge material
G2	Construction of a new channel dam	$ 2,405,000	$ 160,000	$ 140,000	$ 300,000	400	$ 750	$ 2.30	Impacts of dam construction, inundation of riparian habitat
G3	Construction of off-channel reservoir	$ 2,890,000	$ 190,000	$ 95,000	$ 285,000	200	$ 1,425	$ 4.37	Impacts of berm construction, inundation of uplands area
G4	Mills County reservoir	$ 4,490,000	$ 300,000	$ 130,000	$ 430,000	1,120	$ 384	$ 1.18	Impacts of dam construction, inundation of riparian habitat
G5	Construction of Fox Crossing Reservoir [1]	$ -	$ -	$ 76,000	$ 76,000	117	$ 650	$ 1.99	Major dam construction impacts, inundation of large areas, limited information available
G6	Construct 3 wells in the Trinity Group ~ 1 mile southwest of town	$ 1,060,000	$ 75,000	$ 11,000	$ 86,000	117	$ 735	$ 2.26	Pipeline construction impacts

[1] Annual operations and maintenance costs include raw water cost based on pro-rata share of full reservoir commitments.

5.10.5 Mills County-Other Water Management Strategy Alternatives

The rural portions of Mills County are dependent on groundwater resources to meet their water demands. The aquifers in this area are very inconsistent. As a result, isolated areas within the County have difficulty obtaining water. Due to the isolated nature of these shortages, it was not possible to quantify the shortage. However, Alternative G5 has been evaluated to meet these isolated needs in the County.

5.10.6 Gillespie County-Other Water Management Strategy Alternatives

An immediate municipal water demand deficit for Gillespie County-Other was identified in Chapter 4 of this report. The identified water supply shortages are expected to increase in the future as the population in the county continues to grow. The development of specific water management strategies for the County-Other WUG is difficult since the location of future development in the county is not known. However, it is generally expected that the majority of the growth will occur in the area surrounding the City of Fredericksburg.

The City of Fredericksburg was not identified as having a water supply shortage since its existing wells have the capacity to meet the projected demands. However, if the majority of the growth surrounding the City relies on groundwater as its water supply, it is possible that the competing interests for water might impact the City's long-term ability to continue getting the groundwater it needs.

Two alternative water management strategies have been investigated. The first alternative would involve a regional approach to water supplies in and around the City of Fredericksburg. The second alternative would involve a continuation of the City's existing dependence on groundwater.

5.10.6.1 Alternative GL1 – Aquifer Storage and Recovery

The LCRA has completed an initial, Phase 1 evaluation of the potential to increase water supplies in the general vicinity of the City of Fredericksburg by developing a surface water supply system with an aquifer storage and recovery (ASR) component. The project would involve the construction of a raw water intake structure and pump station on the Pedernales River (an alternative of using shallow alluvial wells at the river is also being evaluated), a surface water treatment plant, transmission pipelines, and an ASR well.

The LCRA's Phase 1 evaluation was based on meeting the projected demands for 2010. However, system capacities could also be evaluated to meet additional future demands. Based on the LCRA analysis, the water treatment plant would have a capacity of 1.75 mgd. When water is available in the Pedernales River for diversion (it is anticipated that minimum flow maintenance requirements may be placed on the diversion right), it would be treated through the plant and either used in the distribution system or pumped into the aquifer through the ASR well. The use of surface water to meet a portion of the demand, and the injection of treated water into the aquifer would combine to keep the aquifer at higher levels prior to the beginning of drought conditions. Once the drought began, and water would not be available in the river, water would be withdrawn from the increased groundwater supply. It is anticipated that the combined system would increase the average supply of water during drought conditions by approximately 1 mgd or 1,120 ac-ft/yr. The opinion of probable costs for this alternative is presented in Table 5.59.

Table 5.59: Alternative GL1 (Aquifer Storage and Recovery) Opinion of Probable Cost

Phase	Cost Opinion
Capital Costs[1]	
Intake Structure/Pump Station	$2,385,000
Water Treatment Plant	$1,835,000
Transmission Lines	$200,000
ASR Well Construction	$325,000
Total Capital Costs	**$4,745,000**
Engineering, Contingencies and Legal Services (35%)	$1,660,000
Environmental and Archeological Studies, Mitigation, and Permitting	$475,000
Site Acquisition	$525,000
Interest Accrued During Construction	$890,000
Interest Earned on Unused Principal	($265,000)
Total Project Costs	**$8,030,000**
Annual Costs	
Debt Service (6 % for 30 years)	$580,000
Operations and Maintenance	$350,000
Total Annual Costs	**$940,000**
Unit Cost of Water ($/ac-ft)	**$839**
Unit Cost of Water ($/1000 gallons)	**$2.58**

[1] Cost information taken from LCRA Memorandum dated January 6, 1998.

5.10.6.2 Alternative GL2 – Develop Additional Groundwater Resources

This alternative would involve the development of additional groundwater resources for Gillespie County-Other. As additional subdivisions are developed in the county, these subdivisions would drill additional wells to meet their demands. Depending upon where the subdivisions are developed, the aquifer may be depleted in certain areas of the county. When this occurs, it is anticipated that new development would shift to areas of the county with remaining groundwater, or groundwater from other areas of the county will be piped to the location of the new subdivisions. Since the location, size, and number of these subdivisions and their relative densities are not known, it is not possible to develop a detailed opinion of probable costs for the development and distribution of additional groundwater resources to serve these needs. However, for the purposes of the regional water planning process, it is assumed that 180 ac-ft/yr could be developed at a capital cost of $300,000. The cost of water produced from these wells is assumed to be $350 per ac-ft.

5.11 DROUGHT CONTINGENCY PLANNING

The regional water supply plan has been developed based on estimates of water supply availability during a repeat of the historical drought of record. This is intended to provide a conservative estimate of water availability during times other than extreme drought conditions. It is possible that drought conditions in the future could exceed severity of the historical drought of record conditions. Developing contingency plans to address this potential condition is an important aspect of the overall Regional Water Planning process.

Provisions in SB 1 require that water utilities within the State develop specific drought contingency plans for their systems. Large utilities, those serving more than 3,300 connections, were required to submit their plans in September 1999. Smaller utilities are required to submit plans by September 2000. Specific drought contingency planning for surface water and groundwater supplies are addressed in the following sections.

5.11.1 Surface Water Drought Contingency Plans

The majority of the surface water supplies in the region are provided through the two Major Water Providers (LCRA and the City of Austin). In addition, several smaller WUGs rely on other surface water supplies to meet their demands. Drought contingency planning for these entities are discussed in the following sections.

5.11.1.1 Lower Colorado River Authority

The LCRA originally developed a Water Management Plan for the use its surface water rights in 1989 in response to requirements imposed through the adjudication of water rights within the Lower Colorado Basin. The Water Management Plan establishes procedures used to determine how water is allocated to users of interruptible water and firm water customers and is a drought contingency plan. The following are specific requirements contained in the Water Management Plan.

- The Water Management Plan is established for a 10-year period to reflect the projected demands in that decade, and is reviewed on an annual basis.
- The LCRA requires each of its firm water customers and the four irrigation districts to develop a legally enforceable local drought management plan.
- Interruptible water supplies are curtailed based on the projected combined storage in Lakes Buchanan and Travis as of January 1 of each year. The curtailment is gradual as indicated in Table 5.60.
- If at anytime during the year, the combined storage in the lakes drops below 200,000 ac-ft, all interruptible water supplies will be cut off.
- If the combined storage is projected to be equal to or greater than 1.1 million ac-ft at any time during July in a year where curtailments were announced, these curtailments can be lifted.
- The irrigation operators receiving interruptible water will have the option to curtail the total amount of interruptible water delivered or the total number of acres cultivated.

- LCRA will request voluntary curtailment of firm water demands when there is a curtailment of interruptible water supplies and/or the total combined storage in Lakes Buchanan and Travis is less than 1.6 million ac-ft.
- LCRA will request that firm water customers reduce water use by their end users when the combined storage is at or below 900,000 ac-ft.
- During a drought more severe than the drought of record, the LCRA will curtail and distribute firm water on a pro rata basis according to the demands for stored water. All interruptible water supplies will be cut off prior to any mandatory curtailment of firm water supplies.

Table 5.60: LCRA Water Management Plan for Curtailment of Interruptible Water Supplies

Projected Storage on January 1 (ac-ft)	Percent Curtailment of Interruptible Water Supplies
>1,100,000	0
1,000,000	4
900,000	8
800,000	12
700,000	16
600,000	20
500,000	24
400,000	28
325,000	100

5.11.1.2 City of Austin

The City of Austin has enacted a Water Waste Ordinance to control the peak day use of water during high demand periods. The ordinance identified three separate stages to reduce the peak day demands. The trigger levels for each stage are currently based on the City's capacity to treat and distribute water as opposed to the availability of raw water supplies. It is anticipated that the trigger levels will be revised as the City's demand and capacity increases. As the demand approaches the available water supply, it is anticipated that the trigger levels will be contingent on drought supply levels. In addition, it is anticipated that the restrictions contained in the ordinance would also be implemented in response to projected curtailments in water deliveries by the LCRA. The three stages of the Water Waste Ordinance are as follows:

Stage I – Peak Day Water Use Management

This stage is effective every year between May 1 and September 30. The goal is to reduce the overall peak day demand for water during the heavy demand period associated with summer irrigation activities. Under this stage, the timing of outdoor irrigation at commercial establishments is regulated and all customers are requested to limit the frequency of irrigation. City departments are required to adhere to a five-day irrigation cycle. Finally, all customers are prohibited from wasting water by failing to repair leaking or faulty irrigation systems.

Stage II – Mandatory Water Use Management

This stage is implemented when the water use in the system exceeds 210 mgd for three days or 215 mgd for one day. Under this stage, restrictions on the timing and frequency of outdoor water use are imposed.

Stage III – Emergency Water Use Management

This stage is implemented when the system demand exceeds 215 mgd for three days or 220 mgd for one day. Under this stage, irrigation is prohibited except by hand-held hose during prescribed times and frequencies. Other uses of outdoor water are prohibited.

5.11.1.3 City of Blanco

The City of Blanco has a four-stage Emergency Water Management Plant. This plan includes the following:

Stage I – Voluntary Conservation

This stage is triggered when the City has been without appreciable rainfall and more dry weather is forecast, or when the flow over the dam at the plant is 10 percent of the average flow. The goal of this stage is a reduction in water use of 10 to 15 percent through voluntary water conservation.

Stage II – Mandatory Conservation

This stage is triggered when water is no longer flowing over the dam at the water plant, continued weeks without rain, and forecast of continued drought. The goal of this stage is a reduction in water use of 15 to 20 percent through mandatory restrictions on the timing and frequency of water use for outside purposes.

Stage III – Mandatory Compliance, Water Warning

This stage is triggered when the Director of Public Works determines that a severe drought condition is present. The goal of this stage is to reduce water consumption by 25 to 30 percent through the prohibition of all outside irrigation, except vegetable gardens. In addition, customer water quotas can be imposed by the City Council.

Stage IV – Mandatory Compliance, Water Emergency

This stage is triggered when the water system fails or becomes contaminated. The goal in this stage is to reduce water consumption by 50 percent through additional water use restrictions.

5.11.1.4 City of Llano

The City of Llano is currently developing its Drought Management Plan for submittal by September 2000. The following is a summary of the current proposal, which is subject to revision pending City Council action.

The proposed plan will have three stages with increasing restrictions placed on the use of water. The restrictions will be voluntary under Stage I. Mandatory restrictions will be implemented under Stage II, and additional, mandatory restrictions will be imposed under Stage III. The proposed trigger mechanisms for the various stages will be a combination of spring flows at the City of Junction, river flows at the City of Llano, and treatment plant/system capacities.

5.11.1.5 City of Goldthwaite

The City of Goldthwaite has a three-stage Drought Contingency Plan. The stages are triggered by the levels in the City's storage reservoir. The following is summary of the plan:

Stage I – Drought Watch

> Customers are requested to voluntarily conserve water when the reservoir level is equal to or less than 85 percent of capacity and drought conditions exist.

Stage II – Drought Warning

> Mandatory water management controls are enacted when the reservoir level is equal to or less than 60 percent of capacity and drought conditions exist. The measures include mandatory lawn watering schedules, and the elimination of non-essential water uses such as street washing, fire hydrant flushing, filling of swimming pools, and golf course watering.

Stage III – Drought Emergency

> Should the reservoir level reach 50 percent of its capacity and drought conditions exist, the following management controls will be enacted: a) all outdoor water use is prohibited, b) a user surcharge in excess of a specified number of gallons will be charged, and c) persons violating the mandatory water prohibitions are subject to citation.

5.11.2 Groundwater Drought Contingency Plans

The LCRWPG has indicated that the management of groundwater resources is an important component of the Regional Water Planning Process. The group has further indicated (see Chapter 6) that the preferred method of managing groundwater resources is at the local level through appropriate, local groundwater districts. There are currently four active groundwater districts within the region. These Districts have various rules and powers concerning drought management. In areas where groundwater districts have not been developed, drought management is left to the individual water user. The following is a summary of drought contingency planning for groundwater resources.

5.11.2.1 Barton Springs/Edwards Aquifer Conservation District

The Barton Springs/Edwards Aquifer Conservation District requires all of its users with permitted wells to develop User Drought Contingency Plans (UDCP), approved by the District, to achieve specified goals in the reduction of water use for a three-stage drought contingency plan. The stages are triggered by water levels in five monitor wells within the District. The trigger levels for each well are shown on Table 5.61.

Table 5.61: BSEACD Drought Trigger Levels

Monitor Well	Alert Status Level (Feet above MSL)	Alarm Status Level (Feet above MSL)	Critical Status Level (Feet above MSL)
MOUNTAIN CITY AREA: 58-57-903	596.8	584.4	554.0
BUDA AREA 58-58-101	599.8	580.2	550.7
SAN LEANNA AREA 58-50-801	564.6	541.2	505.9
SOUTH AUSTIN AREA 58-50-301	463.4	452.8	431.0
BARTON CREEK/ BARTON SPRINGS AREA 58-42-903	431.9	430.0	426.7

Stage I – Alert Status

An Alert Status signifies that the District is in a local or regional drought. A local drought Alert Status commences when the water level elevation in one (1) or more of the District's monitor wells declines below a historical median level elevation for fourteen (14) consecutive days and the District's General Manager determines that conditions warrant the execution of this stage. A regional drought Alert Status commences when the water level elevation in two (2) or more of the District's monitor wells declines below a historical median level elevation for fourteen (14) consecutive days and the District's General Manager determines that conditions warrant the execution of this stage. Under this stage, users must reduce water consumption by 10 percent.

Stage II – Alarm Status

An Alarm Status signifies that the District is in a local or regional drought. This stage commences when the water level elevation in two (2) or more of the District's monitor wells declines below the historical lower quartile level elevation for 14 (fourteen) consecutive days and the District's Board of Directors determines that conditions warrant the execution of this stage. Under this stage, users must reduce water consumption by 20 percent.

Stage III – Critical Status

A Critical Status signifies that the District is in a local or regional drought. This stage commences when the water level elevation in two (2) or more of the District's monitor wells declines below the lowest historical observed / established level for 14 (fourteen) consecutive days and the District's Board of Directors determines that conditions warrant the execution of this stage. Under this stage, water users must reduce consumption by 30 percent.

5.11.2.2 Hill Country Underground Water Conservation District

The District periodically reviews the water level data obtained from its various water level monitoring programs across the District. If evidence of drawdown of the water table or reduction of artesian pressure in an area of an aquifer indicates an aquifer-mining situation, the Board will consider the need to declare the area a Depletion Study Area (DSA). The purpose for designating a DSA is to collect hydrological information on as many wells in the area as is reasonably possible together with other data that may explain the extent of and reasons for the drawdown of the water table or reduction of artesian pressure. The size of the DSA will be based on the data obtained from the District's water monitoring programs.

If during the evaluation of a DSA, the Board concludes that the data suggests that the regulation of production of water from Permitted Wells within the DSA may reduce the rate of the drawdown of the water table or the reduction of the artesian pressure in an area of an aquifer due to an aquifer mining situation within the DSA, then the Board may designate the area a Critical Groundwater Depletion Area (CGWDA). Once designated, the District will develop regulations controlling the production of Permitted Wells within the CGWDA.

5.11.2.3 Hickory Underground Water Conservation District

The District undertakes a study of the rate of depletion of water from the outcrop areas of the Hickory Aquifer at least once every five years, to evaluate the rate of decline and the impact of such decline on outcrop wells ("Outcrop Decline Study"). Based upon the results of the Outcrop Decline Study, the District shall evaluate methods to limit or reduce the rate of water level decline in the outcrop areas, including enacting groundwater production restrictions.

5.11.2.4 Lost Pines Underground Water Conservation District

The Lost Pines Underground Water Conservation District was created in the last legislative session. The District is currently developing its rules and has not adopted a drought management plan to date. It is anticipated that the District will develop one in the near future.

5.11.2.5 Aqua Water Supply Corporation

Aqua Water Supply Corporation has a four-stage water-rationing plan to reduce water consumption. Individual trigger mechanisms for the stages have not been identified. Stages are implemented by the General Manager when the system demand threatens to exceed production or storage capacity.

Stage I – Voluntary Conservation

This stage includes a request to reduce the amount of water used through limits on the times, frequencies, and amount of outdoor irrigation.

Stage II – Mild Rationing Conditions

This stage includes mandatory restrictions on the outside use of water.

<u>Stage III – Moderate Rationing Restriction</u>

All outside water use is prohibited under this stage, with the exception of livestock usage.

<u>Stage IV – Severe Rationing Restriction</u>

Under this stage, all outside water use is prohibited, with the exception of livestock usage. In addition, total quantity limits on all uses of water for individual users will also be implemented.

5.11.2.6 City of Pflugerville

The City of Pflugerville has a four-stage drought contingency plan. The following is a summary of the plan:

<u>Stage I – Mild Water Shortage Condition</u>

This stage is in effect every year between May 1 and September 30. Customers are requested to voluntarily conserve water. In addition, the waste of water is prohibited.

<u>Stage II – Moderate Water Shortage Condition</u>

This stage is triggered when the average daily consumption reaches 80 percent of production/distribution capacity for a period of three consecutive days, the aquifer level drops to 350 feet below ground level, or the City Manager determines that it is necessary. Under this stage, the goal is to reduce overall demand by 10 percent through mandatory restrictions on the time, frequency, and method of outdoor water use.

<u>Stage III – Severe Water Shortage Condition</u>

This stage is triggered when the average daily consumption reaches 90 percent of production/distribution capacity for a period of three consecutive days, the aquifer level drops to 380 feet below ground level, or the City Manager determines that it is necessary. Under this stage, the goal is to reduce overall demand by 25 percent through additional, mandatory restrictions on the method and use of outdoor water use.

<u>Stage IV – Emergency Water Shortage Condition</u>

This stage is triggered when the City Manager determines that a water emergency exists due to system failure or contamination. Under this stage, the goal is to reduce overall demand by 75 percent by prohibiting all outdoor water use.

5.11.2.7 Other Groundwater Users

For groundwater users in areas without an groundwater district or specific drought contingency plan, the LCRWPG would offer the following as a guideline for the development of individual drought contingency plans by each user, for each water supply.

Each individual water user group should develop a trigger mechanism to determine when drought contingency measures should be employed. The trigger mechanism should be based on a comparison of the users water demands with the capacities of their wells, transmission lines, pumping equipment, and distribution system. When the water demands exceed a set percentages of the available capacity, established by the individual water user group, then drought contingency measures should be undertaken in stages as the drought condition worsens. In defining the capacity of the wells, the individual water user groups should evaluate and monitor the impact that declines in static water levels have on the capacity of wells as a result of increased pumping requirements and decreased saturated thickness at the well screens.

When a drought contingency trigger condition is identified, the individual water user group should consider implementing one or more of the following measures in stages.

1. Initial Stage (Suggested trigger level is demands greater than 80 percent of available capacity.)
   a. Reduction in outdoor watering uses by water user group personnel, including vehicle and equipment washing, except for necessary repairs.
   b. Elimination of any washing of driveways or vehicle containment areas.
   c. Reduction in outdoor watering of landscapes owned by the water user group.
   d. Reduction in water for sprinkling roadways and/or roadway construction.
   e. Requests for voluntary reductions in outdoor watering and washing of vehicles at individual residences.

2. Moderate Stage (Suggested trigger level is demands greater than 85 percent of available capacity.)
   a. Prohibition of outdoor washdown of slabs, vehicles, for water user group personnel and private residents.
   b. Mandatory outdoor irrigation watering restrictions for no more than two days per week, with watering occurring outside peak system demand hours.
   c. Request voluntary conservation by public in both indoor and outdoor uses.
   d. Elimination of water consumption by manufacturers not directly related to output.
   e. Implementation of an increasing step water rate structure to encourage conservation.

3. Severe Stage (Suggested trigger level is demands greater than 90 percent of available capacity.)
   a. Prohibition of outdoor watering.
   b. Closing of public swimming pools.
   c. Prohibition on filling private swimming pools.
   d. Implementation of penalties for consuming water in excess of set amount.

As previously indicated, this list of possible water conservation measures is not intended to be exhaustive or a requirement. Each individual water user group should adopt measures and trigger levels appropriate for its water system and demand conditions.

5.12 INTER-REGIONAL COORDINATION

The regional plans developed for each of the regional water planning areas must be consistent with each other. The plans must reflect the anticipated demands placed on each region by other regions. If these inter-regional demands cannot be accommodated, then a conflict exists that must be resolved. The following is a summary of new inter-regional demands that have been identified and a status as to whether the demands constitute a conflict. With the exception of the potential conflicts identified, these inter-regional transfers will not affect the region's ability to meet the 50-year projected demands within the region as required by TAC 357.7(a)(7)(G).

- **Region F Demands -** Region F has indicated that its regional water plan will include a project to transport approximately 800 ac-ft/yr of groundwater from the Ellenburger aquifer in western San Saba County to the Brady area. It is believed that this demand can be accommodated in the regional plan, although additional evaluations are necessary.

- **Region G Demands -** Region G has indicated that an additional 16,000 ac-ft/yr will be sought from the Colorado River to serve demands in Williamson County through the year 2030. The demand may increase to 25,000 ac-ft/yr beyond 2030. While the sale of water outside the basin has been approved, a source of new water to replace the water leaving the basin must be found in accordance with HB 1437. If this new source of water can be found from Region G, then it is believed that this demand can be accommodated. The identification of this source will be subject to additional studies and negotiations between the two regions.

- **Region L Demands -** Region L has indicated that up to 22,882 ac-ft/yr of groundwater is sought from Bastrop County. This water includes the SAWS-ALCOA project to withdraw water from the Simsboro aquifer. In addition, it also includes approximately 12,500 ac-ft/yr from the Carrizo-Wilcox in southern Bastrop County. Based on the water availability adopted by the RWPG for Bastrop County, sufficient water is available to meet the 5,450 ac-ft/yr pumping demands associated with the SAWS-ALCOA project through the year 2020. However, Region L has indicated that the demand would increase to 10,000 ac-ft/yr in 2030 and this increase would be inconsistent with the Lower Colorado Regional Water Plan. The additional 12,500 ac-ft/yr from southern Bastrop County is also above the adopted water availability for Bastrop County.

  In addition, Region L has indicated that up to 150,000 ac-ft/yr of water from the Colorado River will be sought. It is currently believed that 122,000 ac-ft/yr would be taken from Matagorda County by constructing four off-channel reservoirs and diverting excess river flows. The remainder of the water would be diverted directly from the river somewhere between Austin and Bastrop. The LCRWPG has indicated that this transfer of water would be consistent as long as the transfer meets the ***nine-point policy*** presented in Chapter 6 of this plan and the costs of the improvements are born entirely by Region L. In addition, this project would only be considered consistent if the results of environmental evaluations of the impact of these diversions on the flows to the bays and estuaries indicate that the impacts can be mitigated.

- **Region N Demands -** The City of Corpus Christi currently possess the right to transfer up to 35,000 ac-ft/yr from the Colorado River. Since this is an existing right, it has been included in the water availability analysis and is consistent with the Regional Plan.

The LCRWP includes several specific demands for water from another region. These demands are summarized below.

- **City of Blanco/Blanco County-Other Demand -** The City of Blanco has indicated a desire to obtain 300 ac-ft/yr from Canyon Lake in Region L. The water would be transported to the City of Blanco through a pipeline. It is believed that the Region L plan will include this inter-regional transfer.
- **Hays County-Other Demand -** The LCRWP includes the construction of a pipeline along IH-35 from San Marcos to northern Hays County. The pipeline would be constructed by GBRA to serve demands in the Buda and Kyle areas. A portion of the proposed service area would be in the LCRWPA. It is believed that the Region L plan will include this inter-regional transfer.
- **City of Pflugerville -** The City of Pflugerville is considering the use of groundwater from the Carrizo-Wilcox Aquifer as part of its water management strategy. As currently envisioned, this groundwater would be imported from areas within Region G. The City of Pflugerville has not defined the amount of water sought through this transfer of groundwater.
- **Irrigation Demand -** As previously discussed, the transfer of up to 25,000 ac-ft/yr of Colorado River water to Williamson County users can only be considered consistent if a source of water from Region G is found to replace this water in accordance with HB 1437. The replacement water will be made available to irrigation customers.

5.13 Water Management Summaries by WUG and MWP

Summaries of the water management strategies necessary to meet projected shortages for each major water provider (MWP) and water user group (WUG) are presented in Appendices 5C and 5D as required by the TWDB.

APPENDIX 5A

TWDB-REQUIRED TABLES
(Exhibit B Data Tables 9, 10, 11, 12, and 13)

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 5B

Technical Memorandum:
Rice Irrigation Economics and an Agriculture-to-Agriculture Transfer Option

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 5C

Summary of the water management strategies necessary to meet projected shortages for each MWP in Region K

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 5D

Summary of the water management strategies necessary to meet projected shortages for each WUG in Region K

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

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6.1 SUMMARY OF TWDB RULES

6.1.1 Policy Recommendation Rules

Texas Water Development Board (TWDB) rules for SB 1 regional water planning [31 TAC Chapter 357.7(a)(9)] provide that the regional water planning groups (RWPG) may include in their regional water plans:

> "…regulatory, administrative, or legislative recommendations 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."

The approved scope-of-work for the development of the water plan for the Lower Colorado Region also includes a subtask to "prepare possible legislative, regulatory, and administrative recommendations." In this regard, the Lower Colorado Regional Water Planning Group (LCRWPG) established a Policy Committee and charged it with the responsibility for coordinating a three-step process to:

- Identify, define, and screen policy issues;
- Evaluate issues and policy options; and,
- Develop recommendations for consideration by the LCRWPG.

This recommendation process will be applied to the following five water policy issue areas:

- Groundwater management;
- Interbasin transfers of surface water;
- Impacts of water management strategies on return flows and ecological values;
- Sustainability; and,
- Agricultural land preservation.

In addition, the LCRWPG has adopted policy recommendations on various issues either by resolution or motion. These recommendations are incorporated into the policy issue briefs or otherwise included below. Finally, the LCRWPG has identified a number of areas in which the SB 1 regional water planning process might be improved for subsequent regional water plan updates. These recommendations are also presented.

6.1.2 Unique Ecological Stream Segment Recommendation Rules

In accordance with the Texas Administrative Code 31 §357.8, LCRWPGs:

> "…may include in adopted regional water plans recommendations for all or parts of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment, and a site characterization of the stream segment documented by supporting literature and data."

The following criteria are to be used when identifying a river or stream segment as being of unique ecological value:

- Biological Function: Segments that display significant overall habitat value including both quantity and quality considering the degree of biodiversity, age, and uniqueness observed and including terrestrial, wetland, aquatic, or estuarine habitats;
- Hydrologic Function: Segments which are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization, or groundwater recharge and discharge;
- Riparian Conservation Areas: Segments that are fringed by significant areas in public ownership including state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations for conservation purposes under a governmentally approved conservation plan;
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: Segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses dependent on or associated with high water quality; or
- Threatened or Endangered Species/Unique Communities: Sites along segments where water development projects would have significant detrimental effects on state or federally listed threatened and endangered species, and sites along segments that are significant due to the presence of unique, exemplary, or unusually extensive natural communities.

The recommendation package will be forwarded to the Texas Parks and Wildlife Department (TPWD) for its written evaluation of each recommended river or stream segment, which will also be included in the adopted regional water plan.

6.1.3 Unique Reservoir Site Selection Rules

In accordance with the Texas Administrative Code 31 §357.9, RWPGs:

> "…may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation, and expected beneficiaries of the water supply to be developed at the site."

The following criteria are to be used when identifying a site that is unique for reservoir construction:

- The site-specific reservoir development is recommended as a specific water management strategy or in an alternative long-term scenario in an adopted regional water plan; or,

- The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics, or other pertinent factors that make the site uniquely suited for:
  - a reservoir development to provide water supply for the current planning period; or
  - where a reservoir development might reasonably be needed to meet water supply needs beyond 2050.

6.2 SUMMARY OF POLICY RECOMMENDATIONS

6.2.1 Conceptual Elements of a Regional Water Solution With the South Central Regional Water Planning Group

The LCRWPG has adopted a resolution (Appendix 6A) and the following nine-point policy that identifies the conceptual elements and guidelines for transporting water outside of the lower Colorado River Basin:

1. ***A cooperative regional water solution shall benefit each region.***
2. ***Lower Colorado Regional Planning Area's (LCRPA) water shortages shall be substantially reduced if there is an exchange for an equitable contribution from the LCRPA to meet the municipal water shortages in the South Central Texas Region (or similar transfers to other regions of the state).***
3. ***Proposed actions for interregional water transfers shall have minimal detrimental environmental, social, economic, and cultural impacts.***
4. ***Regional water plans with exports of significant water resources shall provide for the improvement of lake recreation and tourism in the Colorado River basin over what would occur without water exports.***
5. ***Each region shall determine its own water management strategies to meet internal water shortages when those strategies involve internal water supplies and/or water demand management.***
6. ***Cooperative regional solutions shall include consideration of alternatives to resolve conflicts over groundwater availability.***
7. ***Any water export from the Colorado River would not be guaranteed on a permanent basis.***
8. ***Any water export from the Colorado River shall make maximum use of inflows below Austin.***
9. ***Any water export from the Colorado River shall comply with the LCRA's interbasin water transfer policy.***

These nine elements are fundamental considerations for any out-of-basin transfers. This policy specifically addresses potential transfers to the South Central Texas Regional Water Planning Group (SCTRWPG), but would be similarly applied to any request made for a transfer to any other region of the state.

The LCRWPG has completed a planning process to ensure that the Region's water demands are met throughout the prescribed 50-year planning period. In light of that planning process, the LCRWPG would not support a water sales contract that extends beyond this planning period, unless additional planning is completed to identify the potential impact that a longer contract period might have on water users within Region K.

The LCRWPG is charged with preparing the regional water plan. However, that plan does not obligate political subdivisions to implement its provisions. In fact, Section 357.7(b) of the TWDB rules for SB 1 planning prohibits the LCRWPG from recommending water management strategies for political subdivisions if those subdivisions object to the strategies. Any cooperative agreement between LCRWPG and SCTRWPG shall recognize that potential cooperation by the LCRA will be contingent on meeting the LCRA's interbasin transfer policy.

6.2.2 Groundwater Management

Groundwater is a vitally important resource in Texas. It is a major source of the water used by Texans for domestic, municipal, industrial, and agricultural purposes. In 1994, Texans used about 16.5 million acre-feet of water, of which 9.4 million acre-feet (57 %) was derived from groundwater sources. More than 80 percent of groundwater use is for irrigation, with the remainder being utilized for municipal supplies, rural domestic consumption, livestock, electric utility, and industry. About 43 percent of municipal water in Texas is obtained from groundwater sources.

The major and minor aquifers within the state furnish this vast groundwater resource. These aquifers underlie approximately 76 percent of the state's surface area of 266,807 square miles. Major aquifers are defined as being capable of producing large quantities of water over a relatively large area of the state, whereas minor aquifers are capable of producing significant quantities of water over smaller geographical areas or small quantities in large geographic areas. Minor aquifers are very important, as they may constitute the only significant source of water supply in some regions of the state. The major and minor aquifers are composed of many rock types, including limestones, dolomites, sandstones, gypsum, alluvial gravels, and in some parts of the state, igneous rocks. Nine major aquifers and 20 minor aquifers have been delineated within the state. Other undifferentiated, local aquifers also exist and may represent the only source of groundwater where major or minor aquifers are absent. These local aquifers, which provide groundwater that is utilized for all purposes, vary in extent from being very small to encompassing several hundred square miles.

Texas' approach to providing for the water needs of its citizenry, along with the expanding economy and a diverse environment, has undergone a major transformation in the past twenty years. For instance:

- Gone are the days when an almost infinite, low cost supply of water was available to communities upon demand;
- Groundwater supplies, which historically served an entire agricultural region, are now to the point of irreversible depletion while others are experiencing withdrawal rates that exceed aquifer recharge (mining);
- Rapidly growing demand centers for water, namely major urban areas with high population densities, no longer lie in close proximity to the remaining water sources available for development;
- With projections for a doubling of the state's population in the next 50 years, Texas faces increasing challenges of scarce water supplies, regional and inter-regional competition for water, increased infrastructure and regulatory costs, and limited financial resources; and,
- Institutional conditions have remained static, as demonstrated by the statutory authority exempting certain Railroad Commission of Texas activities and failure to require that agency to coordinate its activities with other state and local water resource agencies to protect groundwater resources.

Given the challenges of diminishing groundwater supplies, increasing competition for those supplies, escalating infrastructure and regulatory costs, and limited financial resources for resolution of these matters, the LCRWPG has undertaken a review of existing statutes and programs governing groundwater management. The LCRWPG's goal in so doing has been to identify improved policies, methods, etc., to recommend to the Texas Legislature, the Texas Natural Resource Conservation Commission, and/or the

Texas Water Development Board. Such efforts would help mitigate the effects of the aforementioned challenges while ensuring the efficient use of the groundwater resource for present and future generations.

LCRWPG policy recommendations regarding groundwater issues have been developed with the goals for Groundwater Conservation Districts (GCDs) set forth in 31 TAC 356.5(a)(1) as the guiding framework. The six management goals are:

1. To provide for the most efficient use of groundwater within the District;
2. To control and prevent waste of groundwater within the District;
3. To control and prevent subsidence within the District;
4. To address conjunctive surface water management issues within the District;
5. To address natural resource issues that impact the use and availability of groundwater and which are impacted by the use of groundwater within the District; and,
6. Any additional management goal(s) beyond those specified in and considered specifically applicable to the operations of the District.

6.2.2.1 Creation of Groundwater Conservation Districts

A review of Groundwater Conservation Districts (GCDs) in Texas offers several interesting insights:

- SB 1 establishes GCDs as the preferred entity for management of the resource - see Texas Water Code §36.0015;
- 90% of the land in Texas is privately owned;
- A majority of the water used in Texas is groundwater; supplying 57 percent of the water used statewide as recently as 1994;
- As of 9/1/99, there were 49 confirmed GCDs and 13 provisional districts (created by SB 1911, 76th Legislature);
- There are 103 counties covered in whole or in part by a GCD;
- In total, 37 percent of the state is covered by GCDs;
- 76 percent of the groundwater produced in Texas falls within confirmed GCDs, and 3 percent is under provisional GCDs;
- While 63 percent of the state remains outside the GCDs, 79 percent of the groundwater produced is from within these districts;
- Affordable and accessible supplies of groundwater are crucial to the state's future growth and prosperity;
- SB 1 affirms this natural resource as vital to the health and well being of all interests;
- SB 1 also expressly authorizes more aggressive management of the resource at the local level, provides added resources for management of the resource, and sets forth accountability measures to guide local management efforts;
- GCDs enhance the ability of state agencies to inventory groundwater availability and water quality through each GCD's collection and dissemination of local groundwater data;
- Due to the size and vast diversity within the state, there are varied differences in groundwater management goals, objectives, and needs that may be addressed within the local district. Groundwater management at the local level is preferred over state control, and certainly over federal control; and,

- While groundwater may be "controlled" by GCDs, activities under the Railroad Commission's jurisdiction are exempt from that control, which creates a substantial lapse in ability of GCDs to monitor and protect groundwater supplies.

GCDs are the state's preferred approach to groundwater management. The Lower Colorado Regional Water Planning Group has adopted a resolution regarding the creation of groundwater districts (Appendix 6A), which supports the state's current position that groundwater management is best accomplished through locally controlled, Chapter 36, GCDs due to the variability in the:

- aquifers and aquifer characteristics;
- regional climatic characteristics;
- regional socioeconomic characteristics;
- potential for groundwater quality degradation; and,
- level of dependence of local communities and water users on groundwater resources.

Following analysis and recommendations regarding Groundwater Conservation Districts, a resolution was adopted by the LCRWPG, which addresses groundwater management by GCDs and the State:

> ***"…the Lower Colorado RWPG resolves to recommend the creation of Groundwater Conservation Districts as soon as possible giving consideration to developing multi-county districts, or single-county districts with shared management and costs, and with consideration to adjacent hydrological impacts, consistent with local control and local political considerations in order that they may provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater and to prevent and control subsidence in their areas of the state consistent with the objectives of Section 59, Article XVI, Texas Constitution, or single-county districts with shared management and with consideration to adjacent hydrological impacts."***

The LCRWPG supports consideration of the following four concepts during the creation of locally supported Chapter 36 GCDs:

1. ***Priority Groundwater Management Areas should be encouraged to form GCDs;***
2. ***GCD boundaries should be determined in such a manner that will facilitate the efficient management of the groundwater resources. Where politically achievable, the boundaries should be rationally derived from available scientific data regarding hydrogeologic boundaries of groundwater formations giving due consideration as well to surface characteristics that could affect the management of groundwater;***
3. ***Where a single-county GCD may be considered the only politically achievable form of GCD, care must be given to: 1) be certain that the county can provide adequate funding for a GCD to effectively accomplish its duties, and 2) assure cooperation between neighboring GCDs attempting to manage water from the same source; and,***
4. ***Full Chapter 36 authority, including general powers, regulatory authority, duties, and funding, should be provided for GCDs created through SB 1911, 76th Texas Legislature.***

The LCRWPG also adopted a resolution specifically supporting the creation of a Groundwater Conservation District in Blanco County, Texas, which is located within the Hill Country Priority Groundwater Management Area (Appendix 6A).

6.2.2.2 Rule of Capture

The "right" or "rule of capture" states simply that groundwater is there for the taking, provided the water is used for beneficial purposes and not wasted. The landowner that can get the groundwater to the surface the fastest gets as much as they can pump out of the ground – the biggest pump wins the war, so to speak. The issue of groundwater management, rule of capture, and GCDs has prompted an extraordinary level of interest across the state in the past several years. This high level of attention progressed all the way to the Texas Supreme Court in 1999. During the well-publicized case involving the Sipriano family whose well went dry due to the pumpage of the neighboring drinking water bottler, Ozarka, the Court found that GCDs "…are not just the preferred method of groundwater management, they are the only method presently available." There was not a GCD in place to protect the Sipriano's groundwater interests.

While the merits of the Sipriano litigation makes for artful discussion, the State Supreme Court's opinion highlights the significant responsibility vested with the 60-plus GCDs in Texas. With respect to the LCRWPG, the high court decision underscores the important role that GCDs can play in working with the Lower Colorado RWPG to address this region's groundwater concerns. At present, there are six GCDs operating within the Lower Colorado Region: the Hickory Underground Water Conservation District, the Hill Country Underground Water Conservation District, the Barton Springs/Edwards aquifer Conservation District, the Fox Crossing Water District, and two provisional SB 1911 districts – the Lost Pines Groundwater Conservation District and the Hays Trinity Groundwater Conservation District.

To be sure, the programs administered by the GCDs operating within the Lower Colorado Region represent the remedy under existing law for the management and conservation of a fair percentage of the groundwater resources located in the Lower Colorado Region. For the balance of the region not served by a district, regulatory uncertainties are interwoven with the "rule of capture" doctrine, thereby creating an unstable environment for the regional water planning process.

The LCRWPG has adopted a resolution (Appendix 6A) pertaining to groundwater management. The resolution establishes the LCRWPG's position regarding the over-utilization or mining of groundwater. The resolution states, in part, that the LCRWPG ***"…will not support the mining of groundwater except during limited periods of extreme drought conditions."***

The creation and confirmation of GCDs, while modifying the rule of capture doctrine based on local control, further defines and protects the ownership and production rights of groundwater as a private property right, and fosters improved stewardship of groundwater resources through the equitable distribution of the resource.

6.2.2.3 GCD Exemptions, Exceptions, and Limitations in TWC §36.117

Most GCDs are created by confirmation elections of local citizens who have the expectation that the district will manage the groundwater resources to benefit all of the well users within its jurisdiction. Fulfilling this expectation may not be able to be accomplished because of the exemptions that are provided in §36.117 of the Texas Water Code. §36.117 provides exemptions, exceptions, and limitations related to the GCD's well permitting authority. This section of the Texas Water Code has been repeatedly amended over the years as the powers and duties of GCDs have evolved. The resulting statutory language is often ambiguous, duplicative, and difficult to understand.

GCDs must have the ability to regulate all groundwater withdrawals within their jurisdiction in order to effectively manage their groundwater resources. Section 36.117, Texas Water Code, prevents GCDs from accomplishing that objective and substantial quantities of water could be outside the jurisdiction of the locally created and governed GCDs to regulate pumpage, which could result in significant damage to the aquifers over which they have responsibility. Exemptions from district permitting that are currently allowed generally include:

1. Wells incapable of producing more than 25,000 gallons per day (gpd), or 28 acre-feet per year (ac-ft/yr);
2. Domestic wells supplying 10 or fewer households;
3. Livestock and poultry wells; and,
4. Wells supplying water for exploration, production, and other activities permitted by the Railroad Commission of Texas.

A number of aquifers within the state are not capable of producing 25,000 gpd from a single well and this limitation often prevents application of the protective measures for which local districts have been created. These exemptions have also discouraged the creation of GCDs in some parts of the state, as most of the wells would be outside of a district's authority to protect, conserve, and preserve the groundwater resource. This provision of the Texas Water Code was originally intended to address large capacity irrigation wells in the Texas High Plains. For GCDs that are created to protect urban, suburban, and rural groundwater supplies, the provision has become antiquated. There is no reasonable use associated with domestic water needs that require 25,000 gpd (28 ac-ft/yr). Indeed, in view of the state's emphasis on conservation, the exemption is counter-productive.

Wells supplying water for exploration, production, and other activities regulated by the Texas Railroad Commission are exempt from GCD regulation and are not limited with respect to the size or amount of production from these wells. In some counties of Texas, these wells are the largest water producing wells in the area. Consequently, significant production from aquifers is totally exempt from the GCD regulation. Additionally, in §36.117(e), this exemption starts out as if to only prohibit the district from regulating wells drilled for oil, gas, sulphur, uranium, brine, core tests, injection of gas, saltwater, or other fluids permitted by the Texas Railroad Commission; however, with the term "for any other purpose, under permits issued by the Railroad Commission of Texas", allows for larger production water wells for water flood projects associated with secondary recovery operations and/or any other mineral production, including surface mining, which require large quantities of water. Furthermore, this section of the code is confusing by using phrases such as, "Any well that ceases to be used for these purposes and is then used as an ordinary water well is subject to the rules of the district." What is "an ordinary" water well? Is it one larger than 25,000 gpd or one used to supply water for other activities not exempted by this section?

The LCRWPG supports ***the enactment of legislation to repeal the well-permitting exemptions contained in the Texas Water Code §36.117, and allow local GCDs to adopt their own permitting exemptions through local rule-making processes. Amending Section 36.117 would accomplish this by deleting the permitting exemptions contained in Subsection (a) and the related provisions in Subsections (b) through (h). The remaining language of Section 36.117 would then read as follows: "A district may exempt wells from the requirements to obtain a drilling permit, an operating permit, or any other permit required by this chapter or the district's rules."***

The objective of the modifications to this section accomplishes at least two points: (1) the elimination of confusing language; and, (2) the elimination of exemptions so as to facilitate local management of groundwater resources. Exemptions from a district permitting authority should be set locally through district rule-making procedures based on local aquifer conditions. The district rule-making process allows for public hearings and input in determining district-specific exemption needs based on district-specific groundwater conditions. Furthermore, an additional incidental benefit would be to bring significant wells, existing or prospective, now under the sole jurisdiction of the Texas Railroad Commission within the local district's regulatory authority.

Eliminating these exemptions would enhance the GCD's ability to manage the resource. Currently, the GCD's jurisdiction over water wells is split between those wells exempted because they are under the Railroad Commission's jurisdiction or those wells that are statutorily exempted. This modification would bring all wells under the jurisdiction of the local GCD and allow the district to determine which wells should be exempted based on local conditions. Legislation should emphasize the requirement for registration prior to drilling and the requirement to meet construction standards to protect groundwater resources. The benefit of district oversight regarding spacing and production requirements is to help prevent local well interference and over-drafting of the groundwater resource.

6.2.2.4 Regulation of Groundwater Exports

The LCRWPG resolution pertaining to the mining of groundwater establishes the planning group's position regarding the over-utilization of groundwater. Mining is defined as the withdrawal of groundwater from within each aquifer in the Lower Colorado Region at an annual average rate that exceeds the annual average recharge rate. The resolution states, in part, that the LCRWPG "…will not support the mining of groundwater except during limited periods of extreme drought conditions." In essence, the LCRWPG has recognized that there may be temporary, but not permanent, drawdown of water levels within an aquifer. The concern is that the over-utilization of groundwater could lead to eventual harm in the possible forms of subsidence, drying up of wells, saltwater encroachment into the freshwater zone of aquifers, instream flow losses to alluvial aquifers, and the cessation of springflow. The LCRWPG is also concerned that the transport of groundwater out of Region K does not contribute to mining of local aquifers within Region K.

The LCRWPG supports ***the efforts of the local GCDs within the Lower Colorado Region to control or limit groundwater mining. This can be achieved in part through the regulation of groundwater transports from the region and the issuance of transport permits. The following guidelines are recommended for the issuance of groundwater transport permits. The district shall grant a permit for a groundwater transport at a level of operation that the district determines:***

- ***would have a beneficial use;***
- ***would not cause or contribute to waste;***
- ***would not present the possibility of unreasonable interference with the production of water from exempt, existing, or previously permitted wells;***
- ***would not be otherwise contrary to the public welfare;***
- ***would consider and protect natural resources (TWC §36.1071); and,***
- ***is not contrary to the district's certified management plan or an approved regional water supply plan.***

In determining whether to issue a permit to transport groundwater out of a district and the region, the district shall require the requesting region to provide scientific evidence of the following:

1. ***The location of the proposed receiving area for the water to be transported;***
2. ***a description of the amount and purposes of use in the proposed receiving area for which water is needed;***
3. ***The availability of water in the district and region of origin and in the proposed receiving area during the period for which the water supply is requested;***
4. ***Information describing alternate sources of supply that might be utilized, and the feasibility and practicability of utilizing such supplies;***
5. ***The projected effect of the proposed transfer on aquifer conditions, including springflow, depletion, subsidence, or effects on existing permit holders or other groundwater users within the district and region of origin;***
6. ***The indirect costs, economic and social impacts, and cost of resource replacement associated with the proposed transporting of water from the district and region;***
7. ***Any proposed plan of the adjacent region to mitigate adverse hydrogeological, social, or economic impacts of the proposed transporting of water from the district and region, including a comprehensive hydrogeological well report;***
8. ***A technical description of the facilities to be used for transportation of water and a time schedule for construction thereof;***
9. ***A description of how the proposed transport is addressed in any approved regional water plan(s) and the certified district management plan of the district of origin and how that the transport complies with these plans; and,***
10. ***Other facts and considerations deemed necessary by the district for protection of the public health and welfare and conservation and management efforts of natural resources in the district and region of origin.***

The LCRWPG supports ***an amendment of Subsection (b) of §36.205, Texas Water Code, to state that a district may charge a transport fee on water produced from a well within the boundaries of the district, in addition to either taxes or water use fees. Also, a new Subsection (e) should be added allowing a district to set different fee rates for different types of uses, but prohibiting a district from setting different fee rates for similar uses, except that a district may establish a different fee for tax exempt users to make up the lost tax income. And, old Subsection (e) would be renumbered as Subsection (f).***

6.2.2.5 State or Federal Intervention to Mandate Minimum Springflows

Springs are fed by water percolating through the ground after rains. Some ephemeral springs are not associated with aquifers. However most, if not all, permanent and semi-permanent springs are associated with aquifers and derive their flow from hydraulic pressure exerted within the associated aquifer. Springs contribute water to local ecosystems, providing watering places for a multitude of wildlife and sustaining stabilizing vegetation. Within the Lower Colorado Region, spring water often collects in ponds and creeks and eventually contributes water to the Colorado River, its reservoirs, and the aquifers over which spring-fed streams flow. Spring water is used for human and livestock drinking water in the Colorado River Basin. When aquifer water is mined (pumped at a faster rate than recharge replaces the water), some springs will go dry. The deeper the drawdown, the more springs will go dry and the longer they will stay dry. It is possible that the loss of hydraulic pressure for a sustained period will permanently alter the underground hydrology, and springflow may permanently cease, even if water in the aquifer later returns to maximum historic levels.

Several federally listed endangered species are indigenous to the Lower Colorado Region. It is in the best interests of the region to maintain local control of our surface and groundwater resources by effectively managing the aquatic and riparian habitat of these species and preclude state or federal intervention.

SB 1 included provisions requiring the TNRCC to consider potential interrelationships between surface and groundwater in the issuance of water rights permits. Likewise, the LCRWPG should consider the impacts of groundwater withdrawals on any springs associated with an aquifer. The impacts of springflow reduction and loss of water in creeks and ponds, as well as loss of domestic and livestock supplies, should be considered in determining the water supply potential of any aquifer.

Failure to consider the impacts of aquifer mining on springflow could result in water deprivation to rural residents and their livestock. Lack of watering places can cause dramatic reduction in wildlife populations, which contribute significantly to the economy of rural areas of the region. Loss of springflow can contribute significantly to a decrease in tourism and recreational values within the region. Aquifer mining has the potential to reduce springflow into the Colorado River, resulting in lower river volume and more concentrated pollutants. And, reduced springflow may adversely impact endangered species habitat.

The LCRWPG supports ***conjunctive use of surface water and groundwater within the Lower Colorado Region in order to promote conservation and to meet the identified needs of this regional water plan. Conjunctive use of water is defined as the use of multiple sources of water that are available to meet local and/or regional water demands.*** Conjunctive water use can help to either conserve groundwater through the use of supplemental surface water or can help to conserve surface water through the use of supplemental groundwater. Conjunctive water use can also help to address natural resource issues that impact the use and availability of surface water or groundwater and those natural resources which are impacted by the use of these water sources within the region, including the impacts that may occur on existing water rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries.

6.2.3 Interbasin Transfers of Surface Water

Prior to 1997, those sections of the Texas Water Code that dealt with interbasin water transfers (IBTs) included:

- § 15.004 – This section prohibits the use of state funds for IBT projects unless the water is not needed within the donor basin during the next 50 years (this section still exists in the TWC and the Texas Constitution).
- § 11.085 - This section required a special permit for IBTs and prohibited those IBTs, which prejudiced persons or property in the basin of origin. This section was repealed in 1997 and was replaced by specific provisions of Senate Bill 1 (SB 1).

The TWDB, TNRCC, and others requested that the legislature replace the vague wording of §11.085 with specific provisions relating to public notice, hearings, etc.:

- The legislature responded to these requests with Senate Bill 1, which contains several specific safeguards designed to protect the basin of origin in the case of proposed interbasin transfers. These include requirements for notification of local officials and water right owners, and local public hearings; documentation of alternative water sources for the receiving basin; conservation programs in the receiving basin; mitigation and compensation to the donor basin; evaluation of impacts on the environment of the donor basin; a comparison of benefits to the receiving basin versus harm to the donor basin; and, the change in the priority date of the transferred water right to the current date on which the permit is issued (the so-called "junior water right provision"). Of these, the junior water right provision is the strongest protection against the removal of water from an existing source in one basin to another basin.

- The junior water right provision would not affect new water supply projects, which will have junior water rights assigned to them anyway. It is not clear from the wording of the law whether the junior water rights provision applies to water contracts or only water rights.

Those areas of the state in need of new water sources may find that transferring water from an existing source is cheaper and quicker than developing their own supplies locally. The existing law makes some IBTs an expensive alternative because the transferred water would likely be available in wet periods only and unavailable in periods of severe drought when more senior water rights would be drawing on all of the available supplies in the basin of origin. Those regions wishing to use IBTs as a source for new water supplies will likely be lobbying for a repeal of the junior water right provision, as well as some of the other safeguards for the donor basin contained in SB 1. Those regions that have water supplies, which they wish to protect against export, will likely lobby for maintaining the junior water rights provision as it is, or possibly expanding it to include water contracts as well as water rights.

The LCRWPG has adopted the following positions:

1. ***That the junior water rights transfer provision of current state law be preserved;***
2. ***That the junior water rights transfer provision be clarified so that it clearly applies both to water sale contracts as well as water rights transfers; and,***
3. ***That the surcharge on future water sales by LCRA to users in Williamson County, in excess of the 25,000 ac-ft/yr provided for in HB 1437, be adjusted so that it provides for replacement of at least 1.33 acre-feet of water for each 1.0 acre-foot of water transferred.***

As previously discussed, the LCRWPG has adopted a resolution and nine-point policy (Appendix 6A and Section 6.2.2, respectively) that identifies the conceptual elements and guidelines for transporting water outside the lower Colorado River Basin. The nine elements are fundamental considerations for any out-of-basin transfers. This policy specifically addresses potential transfers to the SCTRWPG, but would be similarly applied to any request made for a transfer to any other region of the state.

6.2.4 Impacts on Return Flows and Ecological Values

Historically, measurable volumes of water have been diverted from various locations along the Colorado River for municipal and industrial uses. After consumptive use, the remaining portions have been treated and discharged back into the Colorado River. In some cases, such return flows are required to meet water quality standards set by the TNRCC and contribute to the maintenance of instream river flows necessary for the ecological stability in riparian, riverine, estuarine and hardwood bottomland ecosystems. Failure to look at the return-flow side of water supply could result in degraded ecosystems and diminished aesthetic and recreational values to riparian landowners. Large interbasin transfers, through transfer of water rights, sales from reservoirs, and/or sales of potential return flows of significant volumes could encumber additional reservoir volume, which would be needed to keep in reserve for ecosystem maintenance. Essentially, the historic residents of the basin would lose twice.

Interbasin transfers, conservation and reuse strategies, and/or water marketing can be beneficial; however, the impacts on the amount of return flow into the Colorado River resulting from these strategies must be evaluated. Interbasin transfers could permanently remove water from the Colorado River system, which would permanently deprive downstream users, including the downstream ecosystems, of historical volumes of potential return flows once that water has served its institutional purpose. Reuse of water by current water users within the region may also permanently reduce return flows. Cities, industries, and agricultural practices that extend their water supplies through reuse may deprive downstream ecological systems of maintenance water. In addition, cities, industries, and agricultural entities that capture the potential return flows after their initial use, and sell the water to other users, may also similarly deprive downstream ecological systems. Site-specific flow (volume of water in the river) is considered when the TNRCC grants discharge permits. A reduction in river flows could result in more concentrated pollutants than those anticipated by the TNRCC when current discharge permits were granted. Concentrated pollutants will degrade downstream ecological systems and may require more releases from LCRA storage reservoirs to provide sufficient dilution.

The LCRWPG needs to look at the return-flow side of water use as well as the supply side and be sure that diminishing return flows are not contributing to degraded ecosystems***. The LCRWPG recommends that the LCRA release water from storage to prevent degradation of human and livestock water supplies and sufficient to protect the health of riparian, riverine, estuarine, and hardwood bottomland ecosystems.***

6.2.5 Agricultural Land Preservation

The State of Texas should prepare a study of farmland preservation in order to learn the effect of the loss of rural and agricultural lands on the quantity and quality of state water supplies. Agricultural land is threatened in Texas, the most rapidly urbanizing state in the country. According to an article in the *Dallas Morning News*, agricultural land in Texas is shrinking by about 244,000 acres per year (data source – U.S. Department of Agriculture). From 1992 to 1997, more than 1.2 million acres shifted from farmland, forests, and open spaces to developed property. This loss of agricultural land threatens the state's water supply.

Urbanization results in the loss of agricultural land, which contains water supplies, wetlands, and wildlife habitat. The concomitant population growth threatens water supplies for rural and agricultural areas. Water marketing and the unregulated use of ground water may be serious threats to agricultural lands and the agricultural economy of the lower Colorado River Basin. And the loss of agricultural land threatens a way of life in rural areas. The State Legislature recognized the important link between agricultural planning and water planning by enacting legislation that provided the inclusion of agricultural interests at the policy level of the current water planning effort.

The Texas Department of Agriculture or the Agricultural Extension Service should review and evaluate the status of Texas farmland preservation and report its findings to the Legislature. This review would consist of an analysis of the extent to which farmland has been lost or threatened by urban sprawl, an assessment of the effectiveness of current farmland preservation efforts by state agencies, possible mitigating efforts to reduce farmland loss through changes in state law or current department efforts, and efforts and resources that would be necessary to effectively improve farmland preservation. For example, the U.S. Department of Agriculture's Farmland Protection Program is used to purchase development rights on farmland, which remain in private ownership, but can no longer be built upon.

The review should assess the economic, cultural, and environmental importance of agriculture to the State of Texas, and the interrelationship between agricultural lands and water. Investment in water conservation, the recreational value of waterfowl hunting, the environmental/ecological benefits of water use associated with agricultural lands for waterfowl habitat, water quality, freshwater inflows to the bays and estuaries, and the cost of funding for additional agricultural water supplies, should all be addressed in a comprehensive study of agricultural land preservation.

Lastly, the State Legislature and state agencies need to focus on all of the issues, negative and positive, that surround water marketing and the uncontrolled use of ground water, in order to develop a more complete understanding on the impact of these two activities on rural agricultural Texas.

The State Legislature should establish a process for creating an inventory of state agricultural lands in order to learn the effect of urbanization and the loss of rural and agricultural land on the state's water supply. The intent of SB 1 to create a comprehensive, regional water planning process is handicapped by the lack of information on how the loss of rural agricultural lands affects the state's water supplies.

6.2.6 Agricultural Water Conservation

Irrigation operations, principally for rice production, currently have the greatest demand for water in the Lower Colorado Region. The production of rice and other irrigated crops supports a substantial portion of the economies of the lower three counties. Projections of water availability indicate a significant shortfall of available water during critical drought periods after about 2010. In order to avoid severe reductions of crop production and the resulting economic hardship on the area, strategies must be implemented that will either provide additional water or allow crop production with less water. Efforts to provide additional water are addressed in other policy sections.

The LCRA and the Texas Agriculture Experiment Station (TAES) have researched and developed techniques ("Less Water, More Rice") and management recommendations that have resulted in reduced water use. In 1993, the LCRA, in cooperation with their rice irrigation customers, instituted a new Volumetric Pricing System for water charges. This introduced another incentive to encourage conservation measures. Additional research would enhance the prospects of achieving further water savings for on-farm conservation practices such as precision land leveling, multiple inlets, and levee interval reductions. Other strategies that must be considered include off-channel reservoirs and comprehensive conjunctive groundwater/surface water use.

While these and other efforts will continue to achieve water use reductions, research for high-yielding, low-water-use varieties must be initiated. Previously, the emphasis on developing new varieties has been on increasing yield, improving quality, and shortening the growing cycle (which has also resulted in lowering water use). Agriculture in general, and rice production in particular, has greatly benefited from research and development for new varieties. For example, research at the TAES has resulted in a 300 percent increase in rice yields while reducing costs.

Varietal research has enabled the rice industry to survive in very a competitive environment. Typically, it takes five (5) to seven (7) years to develop a new variety. By initiating a program now to develop a variety specifically requiring less water, while maintaining or improving yield and quality, a new rice variety could be available at a time when lack of water would otherwise limit the rice acreage. The research "tools" to achieve this are available and have been proven. It will only require sufficient funding to develop the new varieties.

The LCRWPG recommends ***that funding be provided through special research efforts to produce a new high-yielding low-water-use variety. This funding could come from special research grants from state agencies and contributions from the rice industry, agri-business interests, the LCRA, and others.***

6.2.7 Brush Control

The LCRWPG adopted the following motion regarding the potential water supply benefits of brush management for the purpose of enhancing water supplies:

> "The LCRWPG recommends and endorses ***studies of brush control projects on a voluntary basis for the Lower Colorado Region, especially west of Interstate Highway 35, and recommends that state and/or federal funds be made available for landowner assistance on a pro-rata basis as needed or requested."***

6.2.8 Recommended Improvements to the Regional Planning Process (SB 1 - 75th Legislature)

The following six recommendations have been developed by the LCRWPG in order to improve the ongoing SB 1 regional water planning process:

1. ***The LCRWPG supports action by the State to provide for the integration of water quantity (supply) and water quality planning. The Texas Water Development Board, and the Texas Natural Resource Conservation Commission should work to coordinate the SB 1 planning process with the Texas Clean Rivers Program, which is a partnership that uses a watershed management approach to identify and evaluate water quality issues. The Regional Water Planning Groups should be considering the effect of their actions on water quality during the development of a regional water plan.***

2. ***The LCRWPG supports action by the State to establish a consistent statewide policy regarding the use of water conservation assumptions in developing municipal water demand projections. The State would need to decide whether these water conservation assumptions should be included in the supply and demand projections, or as water management strategies for conserving/developing water supplies.***

3. ***The LCRWPG supports action by the State to establish a program for the collection of water data and groundwater availability information, which remains a critical need in the planning process. The State should provide adequate, continuous funding in order to improve the collection, development, monitoring, and dissemination of such water data.***

4. ***The LCRWPG supports action by the State to provide assistance to the Regional Water Planning Groups with public information materials and administrative support. This will be particularly important as the RWPGs approach the end of the first planning cycle and enter the second planning phase.***

5. ***The LCRWPG supports action by the State to provide for the continuity of Regional Water Planning Groups between planning cycles. The TWDB and the legislature need to***

consider what role the RWPGs will play, and focus on the guidance and resources that will be needed. For example, the planning groups could focus on public education about the water plan, do research on the need for water facilities/infrastructure in the regions, and/or work on the annual water use survey.

6. ***The LCRWPG supports action by the State to provide for the opportunity to have improved representation of women and minorities on the Regional Water Planning Groups to ensure a true diversity of interests. The TWDB and the legislature must find a way to encourage the RWPGs to improve gender and ethnic representation as new members are appointed to the groups.***

6.2.9 Other Policy Recommendations

6.2.9.1 Implications of Ecologically Unique Stream Segments Designation

The Texas Water Code, Section 16.051, is not clear regarding the long-term ramifications that designating an ecologically unique stream segment or a unique reservoir site would have on land/property owners or local governments. The Unique Stream Segments & Reservoir Sites (USS/RS) Subcommittee, through the LCRWPG Policy Committee, recommends ***the establishment of a policy statement requesting that the State of Texas provide legislative clarification and interpretation of the Texas Water Code §16.051. Section 16.051(e) specifically states that "the plan shall identify river and stream segments of unique ecological value and sites of unique value for the construction of reservoirs that the board recommends for protection under this section." Clarification and interpretation by the State Legislature is requested regarding the meaning of "protection", in order for the RWPGs to make clear informed decisions.*** Section 16.051(g) specifically states that "a state agency or political subdivision may not obtain a fee title or an easement that would: (1) destroy the unique ecological value of a river or stream segment designated by the Legislature under Subsection (f) of this section; or, (2) significantly prevent the construction of a reservoir on a site designated by the Legislature under Subsection (f) of this section." Clarification and interpretation is necessary regarding the meaning of these statements, as well as what the long-term ramifications would be for land/property owners and local governments affected by such designations.

6.2.9.2 Sustainability

The LCRWPG has recommended sacrifices and accepted trade-offs in some areas in order to meet water demands within the region. Sacrifices and trade-offs are seen as necessary to meet a greater common good. In addition, water planning in this state has always assumed that all water demands can and should be met.

The State of Texas has never looked at whether meeting predicted water demands would simply and inevitably generate even higher demands in the future. Will these current planning efforts embrace water supply strategies that cannot be sustained in the future? How many sacrifices should be made to support unsustainable growth in the Lower Colorado Region or to provide for unsustainable growth in another region? If the aquifers that lie within the Lower Colorado Region are mined and the viability of the region's ecosystems are reduced to minimal survival levels, how can assurance be given that the next step will not be destruction of those ecosystems in order to simply support a little more growth?

The LCRWPG supports ***action by the State to augment the standard planning process by developing predictions of what this region's growth limit is, assuming current technologies. That growth limit should address how many people, industries, and agricultural systems the regional water plan will support, regardless of whether those water user groups are developed in the Lower Colorado Region or simply obtain their water from this region. In the development of growth limit predictions, the State should set a minimum standard of maintaining healthy riparian, riverine, estuarine, and hardwood bottomland ecosystem viability. This should include consideration of the conservation of cultural resources, regional economic opportunities, agricultural development, and the preservation of rural communities.***

6.2.9.3 Radionuclides in the Hickory and Marble Falls Aquifers

EPA is revising the current federal radionuclides regulations, which have been in effect since 1977. These revisions include setting a first-time standard for uranium, as required by the 1986 amendments to the Safe Drinking Water Act. The current EPA radionuclides standards are: combined radium (radium isotopes #226 and #228) cannot exceed 5 picocuries/liter (pCI/l); combined beta-radiation emitters' cannot exceed 4 millirems (mrems); and, gross alpha-radiation emitters' cannot exceed 15 pCI/l (not including radon and uranium).

Radionuclides emit ionizing radiation, which can cause various kinds of cancers, depending on the type and concentration of radionuclide a person is exposed to via drinking water. These rules cover man-made and naturally occurring radionuclides in drinking water. The EPA is revising this regulation in accordance with the requirements of the 1986 Amendments to the Safe Drinking Water Act (SDWA) and the 1996 Amendments to SDWA. The statute calls for regulation of radionuclides and a review of regulations every six years. Additionally, according to the Safe Drinking Water Act Amendments, the EPA must maintain or provide for greater protection of the health of persons when revising regulations. The EPA is reviewing the most current health, occurrence, treatment, and analytical methods in revising these regulations to ensure safe drinking water protective of public health.

The Court has issued an order on a stipulated agreement, which calls for the EPA to either finalize the 1991 proposal for revised regulation of radionuclides, or to ratify the existing 1977 standards by November 2000. For uranium, the Court also required that a final standard be established by November 2000.

The major sources of water for individuals living in San Saba County (Region K) are the Hickory and Marble Falls aquifers. In Region F, Mason, Brown, Coleman, Concho, McCulloch, Menard, and Kimble counties obtain the majority of their water from the Hickory aquifer. It is not presently known whether the EPA intends to require treatment of those waters to lower radionuclide contaminates to mandated levels.

There are several water utilities currently providing water to the public from the Hickory and Marble Falls aquifers. This includes San Saba County, within the Lower Colorado Region, as well as seven counties in Region F. The present EPA effort to revise the federal regulations that determine the acceptable levels of radionuclides in drinking water may have an effect on the waters pumped from these two aquifers. Safe drinking water is a concern of these utilities, however, there have been no known radiation-related health problems in the communities historically serviced by these water utilities. These small towns and water utilities have limited financial resources with which to treat the groundwater for municipal uses.

The LCRWPG recommends ***that the state agencies delegated to enforce the proposed revised EPA regulations request thorough scientific data from the EPA to insure that health risks are indeed present in areas serviced by the Hickory and Marble Falls aquifers. If it is determined that compliance with the proposed EPA rules is required for drinking water derived from the affected aquifers, the State should provide adequate funding for water treatment and radioactive waste disposal for those rural communities that may lose their water supply if such financial support is lacking. In addition, state agencies should develop disposal procedures to provide for the safe handling of the radioactive wastes derived from the treatment processes.***

6.3 SUMMARY OF UNIQUE STREAM SEGMENT RECOMMENDATIONS

This section provides background information on the ***nine streams in the Lower Colorado Region identified and recommended by the Subcommittee as warranting further study for consideration of designation as ecologically unique*** (Table 6.1). Additional information resources have also been provided by the TPWD in Appendix 6C.

Table 6.1: Stream Segments Identified for Further Study for Potential Designation as Ecologically Unique.

STREAM SEGMENT	LOCATION
Barton Springs segment of the Edwards Aquifer	Recharge stretches of Barton, Bear, Little Bear, Onion, Slaughter, and Williamson Creeks in Travis and Hays counties.
Bull Creek	From the confluence with Lake Austin upstream to its headwaters in Travis County.
Colorado River	Within TNRCC classified segments 1409 and 1410 including Gorman Creek in Burnet, Lampasas, and Mills counties.
Colorado River	TNRCC classified segments 1428 and 1434 in Travis, Bastrop, and Fayette counties.
Colorado River	TNRCC classified segment 1402 including Shaws Bend in Fayette, Colorado, Wharton, and Matagorda counties.
Cummins Creek	From the confluence with the Colorado River upstream to FM 159 in Fayette County.
Llano River	TNRCC classified segment 1415 from the confluence with Johnson Creek to CR 2768 near Castell in Llano County.
Pedernales River	TNRCC classified segment 1415 in Kimball, Gillespie, Blanco, and Travis counties.
Rocky Creek	From the confluence with the Lampasas River upstream to the union of North Rocky Creek and South Rocky Creek in Burnet County.

6.3.1 Barton Springs Segment of the Edwards Aquifer (including recharge zones of Barton, Bear, Little Bear, Onion, Slaughter, and Williamson Creeks) [1,2,3,4]

Streams within the recharge area of the Barton Springs segment of the Edwards aquifer are generally influenced by the interaction between groundwater and surface water and the physicochemical conditions of the karst Edwards aquifer (Figure 6.1). Water quality is generally good to exceptional, although coliform levels are occasionally elevated after storm events. Nitrite levels can also be high due to the influence of groundwater. Substrate is typically limestone bedrock with rubble, boulders, and gravel. The upper portions of the streams are generally intermittent, except in spring-fed reaches, which limits aquatic habitat. However, these portions of the stream can be important for aquifer recharge.

Barton Creek is the TNRCC classified stream segment 1430 and extends from the confluence with Town Lake in Travis County to FM 12 in Hays County. The creek is in the Central Texas Plateau ecoregion and the watershed lies within the live oak-ashe juniper woods vegetation association. A comprehensive list of literature about the Barton Springs portion of the Edwards aquifer was prepared by the City of Austin in collaboration with the Austin History Center, and is available at http://www.ci.austin.tx.us/aquifer/. Barton Creek meets the following criteria for designation as ecologically unique:

- Riparian Conservation Area: the lower end of the stream is in the City of Austin's Zilker Park;
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: the stream was selected as an ecoregion stream based on its physical attributes, water quality, and biological assemblages; the stream exhibits high dissolved oxygen concentrations and a diverse and complex benthic macroinvertebrate community; and,
- Endangered/Threatened Species: the stream contains the only known population of the Barton Springs salamander (*Eurycea sosorum*), a federally listed endangered species.

6.3.2 Bull Creek From the Confluence With Lake Austin Upstream to its Headwaters [5,6,7]

Bull Creek lies wholly within Travis County in the northwest portion of the City of Austin (Figure 6.2). The watershed for the stream is approximately 32 square miles in a rapidly developing area. The watershed is located on the eastern edge of the Texas Hill Country and immediately west of the Balcones Fault Zone. Numerous seeps and springs provide baseflow to Bull Creek. Water quality is generally good, although some degradation has occurred due to development. The Bull Creek watershed contains

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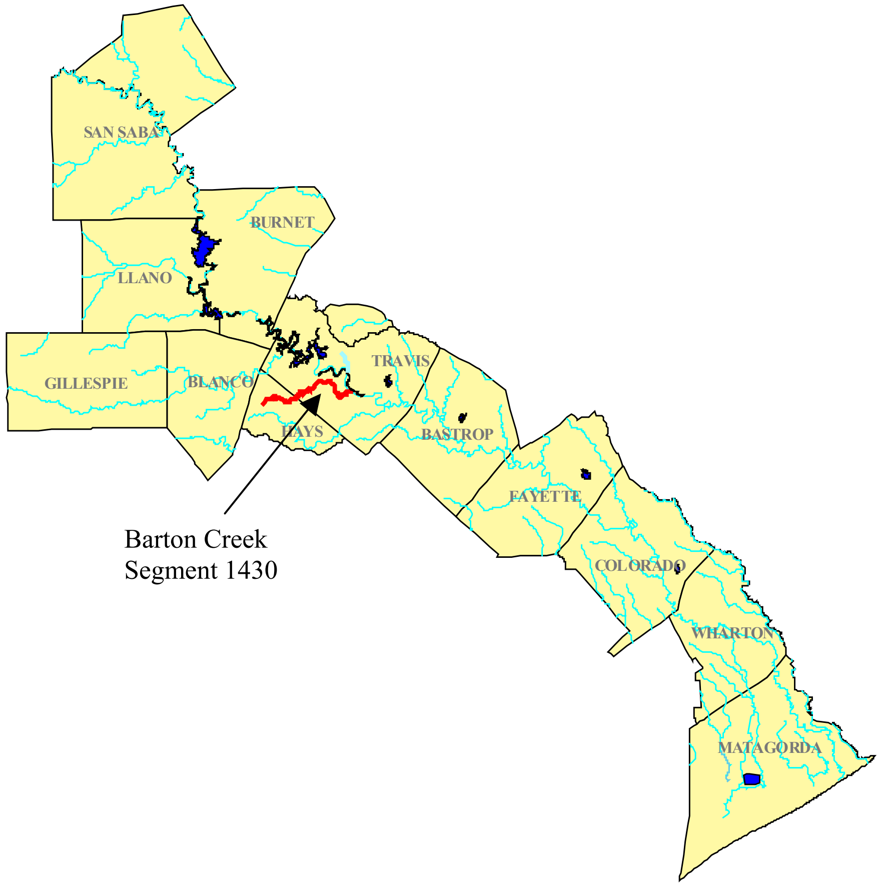
[1] Texas Natural Resource Conservation Commission, 1995. Texas Surface Water Quality Standards, Texas Natural Resource Conservation Commission, Austin, Texas.
[2] McMahan, C. A., R. G. Frye, and K. L. Brown, 1984. The Vegetation Types of Texas Including Cropland, Texas Parks and Wildlife Department, Austin, Texas.
[3] Austin, City of, 2000. Barton Springs Edwards Aquifer Resource Management Knowledge Base, (Available online at http://www.ci.austin.tx.us/aquifer).
[4] Bayer, C.W., J.R. Davis, S.R. Twidwell, R. Kleinsasser, G. Linam, K. Mayes, and E. Hornig, 1992. Texas Aquatic Ecoregion Project: An Assessment of Least Disturbed Streams (draft), Texas Water Commission, Austin, Texas.
[5] Austin, City of, 1993. Cumulative Impacts of Development on Water Quality and Endangered Species in the Bull and West Bull Creek Watersheds, City of Austin Environmental and Conservation Services Department, Austin, Texas.
[6] Bayer, et.al. Op. Cit., 1992.
[7] Austin, City of, 1999. Jollyville Plateau Water Quality and Salamander Assessment, City of Austin Watershed Protection Department, Austin, Texas.

Figure 6.1: Location and Map of Barton Creek Segment 1430



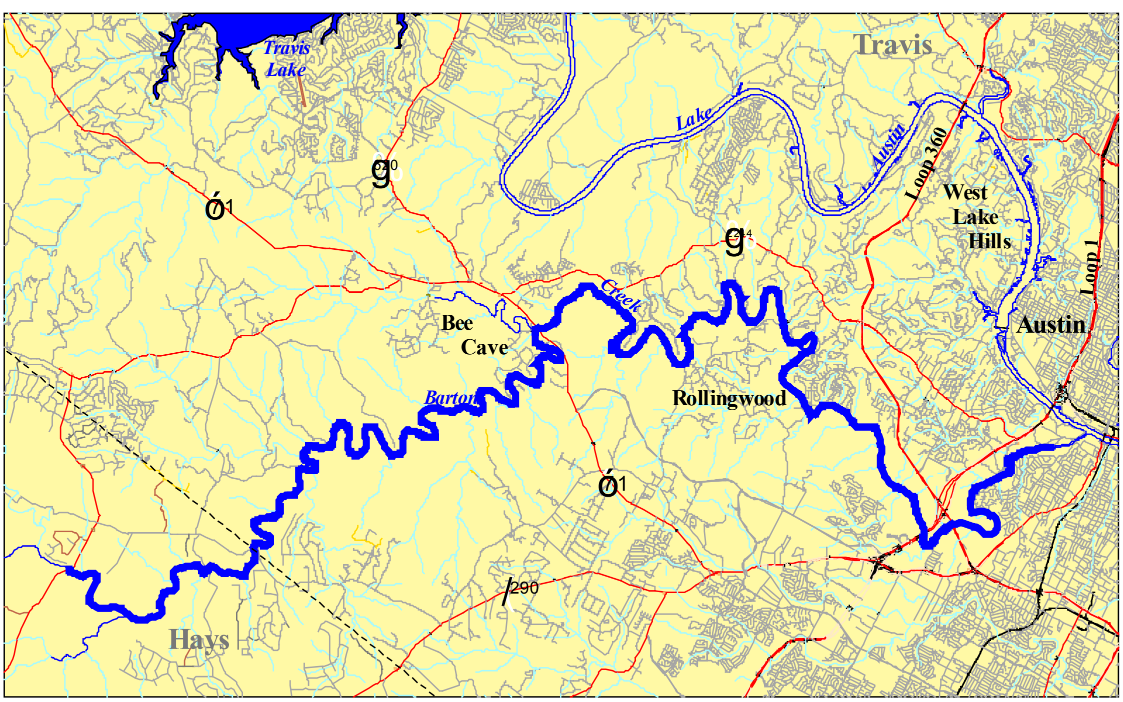
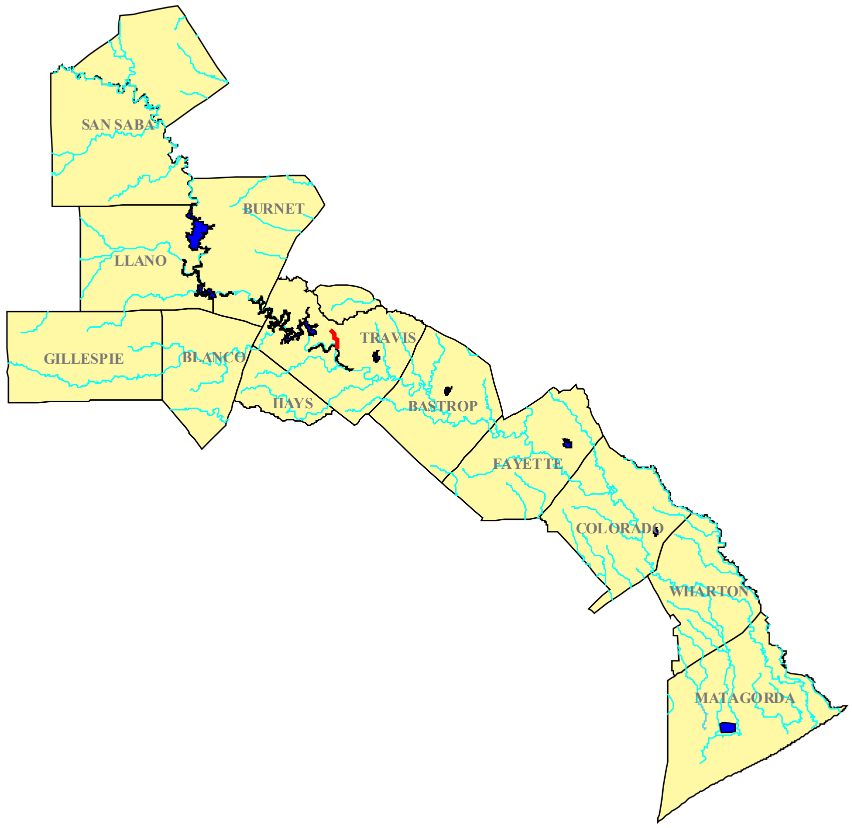
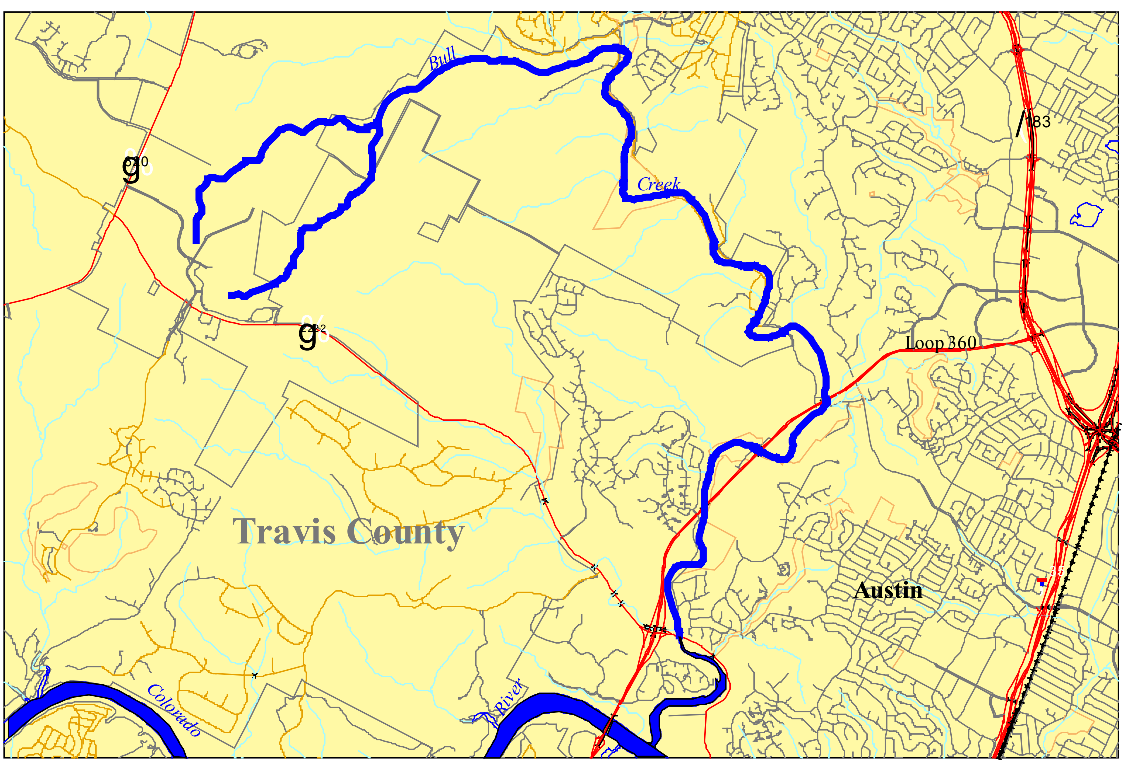


Figure 6.2: Location of Bull Creek





suitable habitat for a variety of rare and endangered species including the golden-cheeked warbler (*Dendroica chrysoparia*), black-capped vireo (*Vireo atricapillus*), Tooth Cave spider (*Neoleptoneta myopica*), Tooth Cave pseudoscorpion (*Tartarocreagris texana*), Bee Creek Cave harvestman (*Texella redelli*), Bone Cave harvestman (*Texella redelli*), Tooth Cave ground beetle (*Rhadine persephone*), Kretshcmarr Cave mold beetle (*Texamaurops reddeli*), and Jollyville Plateau salamander (*Eurycea* sp.). In addition, the watershed contains a very diverse flora. Bull Creek meets the following criteria for designation as ecologically unique:

- Biologic Function: nearly pristine stream with a largely intact riparian area;
- Hydrologic Function: pervious cover and intact riparian zone reduce downstream flooding;
- Riparian Conservation Area: Bull Creek Preserve;
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: overall pristine nature gives the stream a high aesthetic value; stream has a diverse and complex benthic macroinvertebrate community, and an abundance and diversity of amphibians; and,
- Endangered/Threatened Species: the stream contains a population of the Jollyville Plateau salamander (*Eurycea sp.*), a federally listed endangered species.

6.3.3 Colorado River Within TNRCC Classified Segments 1409 and 1410 Including Gorman Creek in Burnet, Lampasas, and Mills Counties [8,9,10,11,12,13]

This segment consists primarily of the Colorado River upstream of Lake Buchanan to the Brown/San Saba/Mills county line, but also includes the Gorman Creek tributary (Figure 6.3). The stream segment is within the Central Texas Plateau ecoregion. Vegetation types common along the stream are mostly live oak-juniper parks. The river itself is wide and relatively shallow, flowing over a bed of limestone and gravel. A few stretches of small rapids exist on the upper part of this section down to the point where the backwaters of Lake Buchanan deepen the river and slow its flow.

Among the segment's scenic attributes are high limestone bluffs, vistas of rugged cedar-covered hills, and the existence of one of the most spectacular waterfalls in Texas. Gorman Falls is formed at the point where Gorman Creek tumbles into the Colorado over a 75-foot tall limestone bluff. The water coming from the creek is clear and cold, and many ferns and mosses grow on the slippery rocks and travertine deposits below the falls. The TNRCC identifies the segment as having a high aquatic life use. The National Park Service identified the segment for inclusion in the National Rivers Inventory based on the degree to which the river is free-flowing, the degree to which the river and corridor is undeveloped, and the outstanding natural and cultural characteristics of the river and its immediate environment. The segment meets the following criteria for designation as ecologically unique:

- Biologic Function: white bass spawning area;
- Riparian Conservation Area: Colorado Bend State Park;

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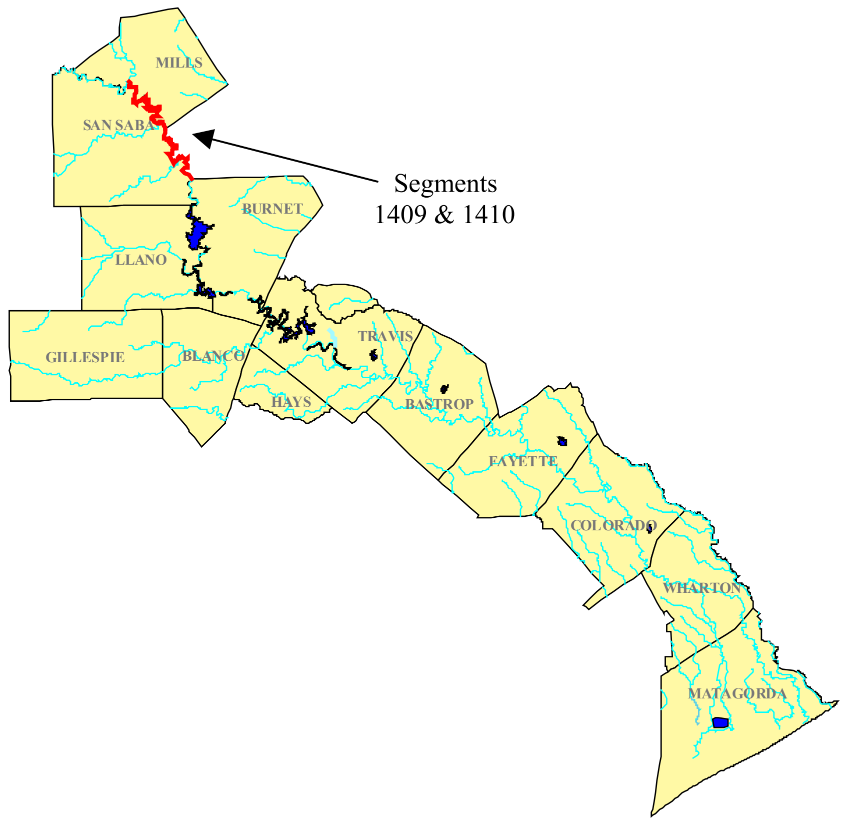
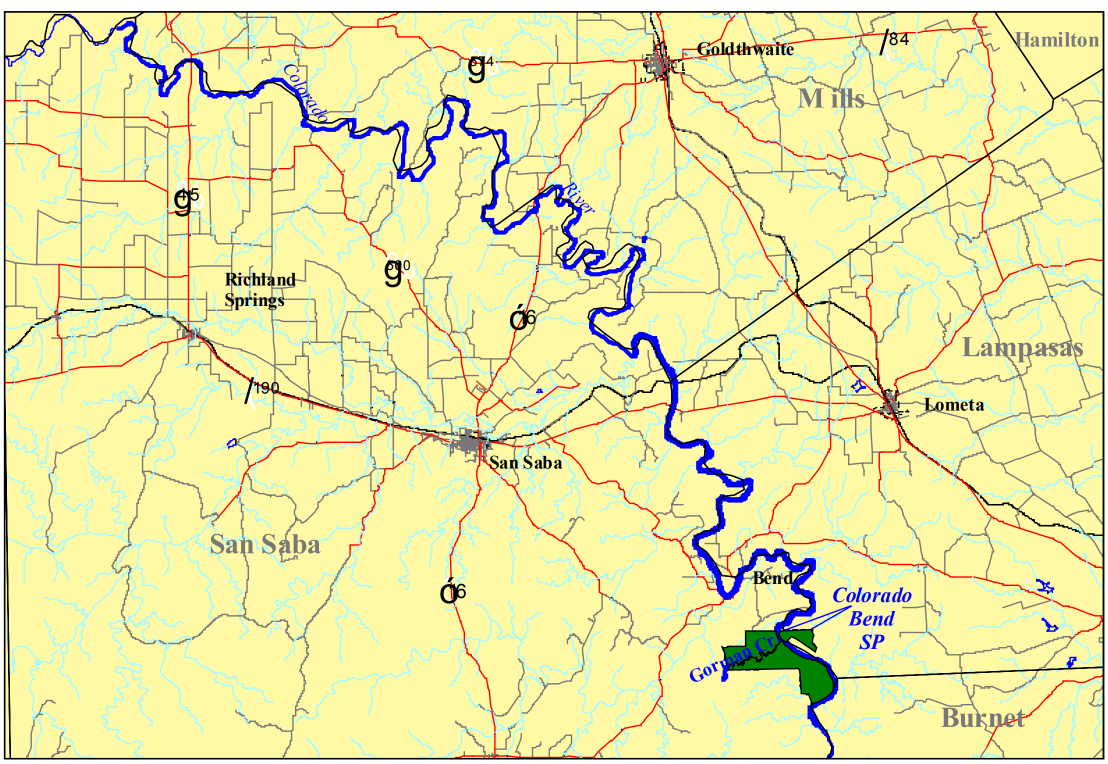
[8] McMahan, et.al., Op. Cit., 1984.
[9] Texas Parks and Wildlife Department, 1979. An Analysis of Texas Waterways, Texas Parks and Wildlife Department, Austin, Texas.
[10] TNRCC, Op. Cit., 1995.
[11] National Park Service, 1995. The Nationwide Rivers Inventory, United States Department of the Interior, Washington, DC.
[12] Bauer, J., R. Frye, B. Spain, 1991. A Natural Resource Survey for Proposed Reservoir Sites and Selected Stream Segments in Texas, Texas Parks and Wildlife Department, Austin, Texas.
[13] Howells, B., 1999. Personal communication, Texas Parks and Wildlife Department, Ingram, Texas.

Figure 6.3: Location of the Colorado River Within TNRCC Classified Stream Segments 1409 and 1410





- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: exceptional aesthetic value; and,
- Endangered/Threatened Species: Concho water snake (*Nerodia paucimaculata*), a federal and state listed endangered species, as well as the rare and endemic mollusks Texas fawnfoot and Texas pimpleback.

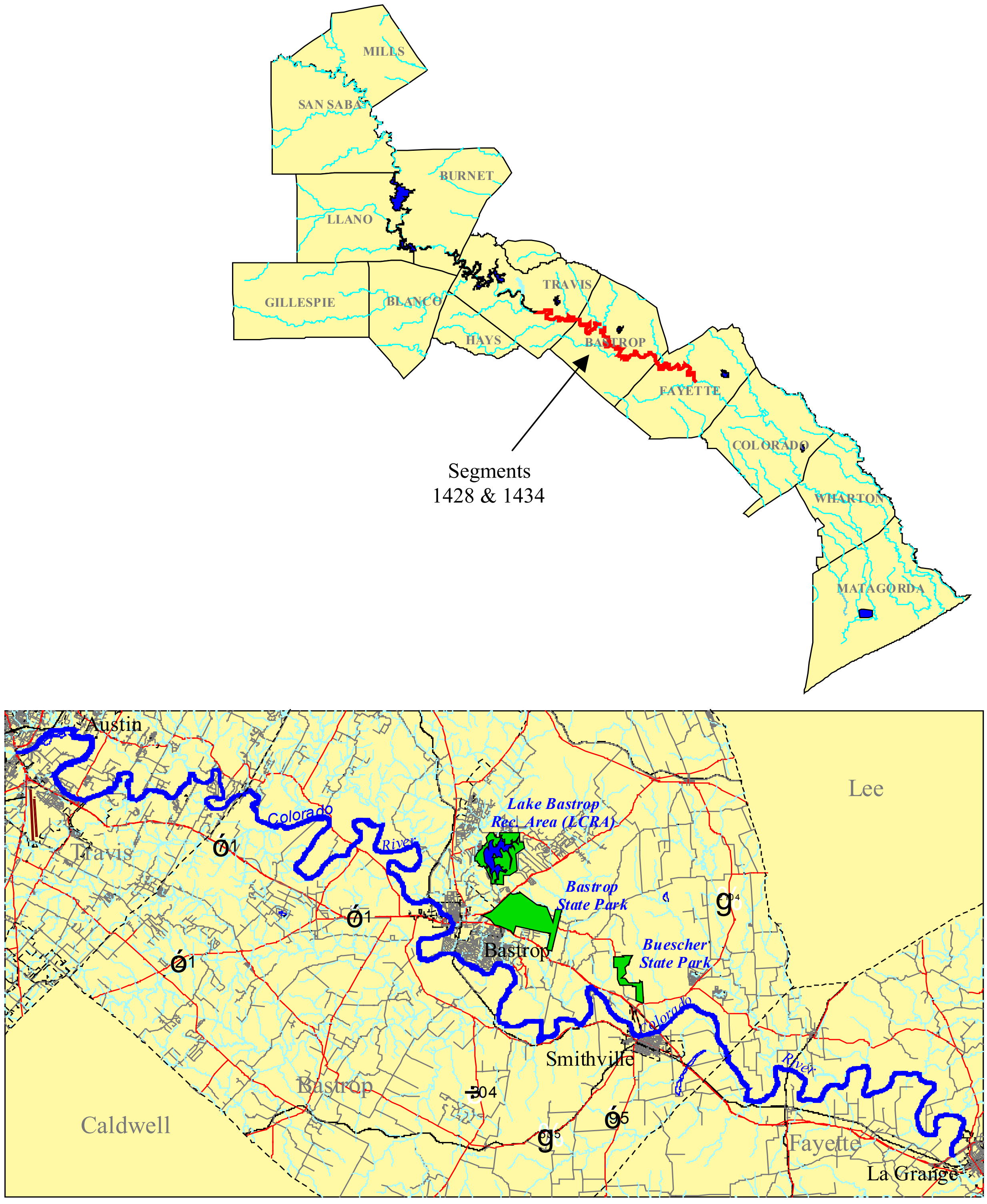
6.3.4 Colorado River Within TNRCC Classified Segments 1428 and 1434 in Travis, Bastrop, and Fayette Counties [14,15]

The segment includes the Colorado River from a point 100 meters downstream of SH 71 in La Grange to Longhorn Dam in Austin and portions of Wilbarger, Big Sandy, Alum, and Cedar creeks in Bastrop County (Figure 6.4). Extensive information about the segment in Bastrop County, submitted by the Bastrop County Environmental Network (BCEN), is presented in Appendix 6B. In general, water levels in the Colorado River are controlled by releases from Lake Travis and Lake Buchanan. The occurrences of low instream flows often depend on the discharge rate of return flows from the City of Austin. Instream flows in the smaller creeks within Bastrop County originate from diffuse surface water runoff, groundwater contributions, and springs. The segment lies within the Texas Blackland Prairies ecoregion. Substrate in the streams is typically sand and/or gravel. Several reaches of the segment are characterized by rubble and boulder fields. The TNRCC has classified the mainstem river as supportive of exceptional aquatic life uses. Water quality is generally good, although nutrient levels are often elevated. Water quality in the creeks is typically good, but influenced by flow levels, land use patterns, and wastewater discharges. Cedar Creek contains an exceptional macroinvertebrate community and, based on the ichthyofauna, a high Index of Biotic Integrity rating. This portion of the Colorado River has a diverse fish community, including the state-listed threatened Blue Sucker (*Cycleptus elongatus*). In addition, the state and federally listed endangered Houston toad (*Bufo houstonensis*) occurs in the area. The segment meets the following criteria for designation as ecologically unique:

- Biologic Function: undeveloped riverine habitat, part of the Central Flyway of migratory birds;
- Hydrologic Function: extensive riparian zone attenuates flooding and improves water quality via filtration and soil stabilization; riparian and stream channels hydrologically connected to an alluvial aquifer and the Carrizo-Wilcox aquifer;
- Riparian Conservation Area: McKinney Roughs Environmental Learning Center;
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: exceptional aquatic life use; and,
- Endangered/Threatened Species: Blue sucker (*Cyclepus elongatus*), a state-listed endangered species; and the federal and state-listed endangered Houston toad (*Bufo houstonensis).*

[14] TNRCC, Op. Cit., 1995.
[15] Lower Colorado River Authority, 2000. Aquatic Resource Characterization Report, (Available online at http://www.lcra.org/lands/wrp/wq/wq_arcprog.htm March 2000).

Figure 6.4: Location of the Colorado River Within TNRCC Classified Segments 1428 and 1434



6.3.5 Colorado River Within the TNRCC Classified Segment 1402 Including Shaws Bend in Fayette, Colorado, Wharton, and Matagorda Counties [16,17,18]

The segment extends from just downstream of the Missouri-Pacific railroad trestle in Matagorda County to a point 100 meters downstream of SH 71 in La Grange, a distance of 150 miles (Figure 6.5). The segment lies within the Texas Blackland Prairies ecoregion and flows into the East Central Texas Plains ecoregion. Substrate varies from primarily gravel in the upper reaches of the segment to gravel/cobble riffles and extensive sand-dominated reaches downstream. Instream flow is largely dependent on upstream releases for rice irrigation, but also receives contributions from the intervening watershed. The water quality of the segment is typically good, and supports a high aquatic life use designation. Nutrient levels are elevated, but dissolved oxygen concentrations are typically higher than the minimum required to maintain a high aquatic life use designation. The fish community is generally diverse and includes the Blue sucker (Cycleptus elongatus), a state-listed endangered species. Although not contained in this report, additional information about the segment is available in feasibility studies performed by ECS Technical Services for the U.S. Department of the Interior, which includes the Shaw's Bend Reservoir site. The segment meets the following criteria for designation as ecologically unique:

- Biologic Function: undeveloped riverine habitat, part of the Central Flyway of migratory birds; and,
- Endangered/Threatened Species: Blue sucker (Cyclepus elongatus), a state-listed endangered species.

6.3.6 Cummins Creek From the Confluence With the Colorado River in Colorado County Upstream to FM 159 in Fayette County [19,20,21,22]

Cummins Creek lies within the Texas Blacklands Prairie ecoregion in Colorado and Fayette counties (Figure 6.6). The stream is characterized by shallow to moderately deep pools, riffles, and occasional shallow runs. Substrate is predominantly fine sands with gravel and rubble in riffles and runs. Cummins Creek is within the post oak savannah vegetation region. The surrounding land use is mostly agricultural. Water quality is generally good, and the stream supports diverse macroinvertebrate and fish communities. The LCRA rated the creek, which has at least 27 species of fish, as suitable for a high aquatic life use for fish. Among the fish species that have been collected in the stream is the Guadalupe bass (*Micropterus treculi*). Cummins Creek supports at least 28 species of aquatic macroinvertebrates. Several varieties of mayflies and caddisflies, which are considered intolerant of pollution, are present. Cummins Creek rated

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[16] Mosier, D.T. and R.T. Ray, 1992. Instream Flows for the Lower Colorado River: Reconciling Traditional Beneficial Uses With the Ecological Requirements of the Native Aquatic Community, Lower Colorado River Authority, Austin, Texas.
[17] TNRCC, Op. Cit., 1995.
[18] ECS Technical Services, April 1985. Colorado Coastal Plains Project, Texas: Environmental Inventory and Impact Assessment (U.S. Department of the Interior, Bureau of Reclamation, Southwest Region Contract # 3-CS-50-01650).
[19] McMahan, et.al., Op. Cit., 1984.
[20] LCRA, Op. Cit., 2000.
[21] Bayer, et.al. Op. Cit., 1992.
[22] Members of the local community have voiced strong opposition to giving a USS designation to Cummins Creek due to the uncertainties that exists regarding the impacts to property rights that such a designation may have. Also, there is concern in the local community that such a designation may infringe upon the Cummins Creek WCID's mandate.

an excellent aquatic life use category for macroinvertebrates based on work by the LCRA. The segment meets the following criteria for designation as ecologically unique:

Figure 6.5: Location of the Colorado River Within the TNRCC Classified Segment 1402

Figure 6.6: Location of Cummins Creek

an excellent aquatic life use category for macroinvertebrates based on work by the LCRA. The segment meets the following criteria for designation as ecologically unique:

- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: the stream was selected as an ecoregion stream based on its physical attributes, water quality, and biological assemblages; the stream
- Exhibits high dissolved oxygen concentrations and a diverse and complex benthic macroinvertebrate community.

6.3.7 Llano River Within the TNRCC Classified Segment 1415 From the Confluence With Johnson Creek to CR 2768 Near Castell in Llano County [23,24,25]

The Llano River between the confluence with Johnson Creek and County Road 2768 in Llano County is part of TNRCC classified stream segment 1415 (Figure 6.7). The Llano River is a spring-fed stream of the Edwards Plateau and is widely known for its scenic beauty. It is in the Central Texas Plateau ecoregion and is characterized by the live oak-mesquite parks vegetation type. Riparian vegetation includes elm, willow, sycamore, and salt-cedar. The stream has designated water uses for contact recreation, as a public water supply, and for high aquatic life uses. Among the fish found in the stream is the Guadalupe bass (*Micropterus treculi*). The substrate is composed of limestone bedrock and gravel. In addition, large boulders and slabs of granite and gneiss occur in the river. This section of the Llano River is widely known for the one billion year old igneous and metamorphic rocks, which form the riverbed. The area is a part of the Llano Uplift, which is one of the most unique geologic features in Texas. Land use along the stream is generally rural and includes ranching and agriculture. The segment meets the following criteria for designation as ecologically unique:

- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: exceptional aesthetic value.

6.3.8 Pedernales River Within the TNRCC Classified Segment 1415 in Kimball, Gillespie, Blanco, and Travis Counties [26,27,28,29]

The Pedernales River from a point immediately upstream of the confluence of Fall Creek in Travis County upstream to FM 385 in Kimble County makes up the TNRCC classified stream segment 1415 (Figure 6.8). Most of this segment lies within the Lower Colorado Regional Water Planning Area. The Pedernales River in general has high water quality and supports a high aquatic life use. The stream is within the Central Texas Plateau ecoregion. Surrounding vegetation is characteristic of the live oak-ashe juniper parks and live oak-mesquite-ashe juniper parks vegetation regions. The river is spring-fed and free flowing, with many limestone outcroppings. The National Park Service identified the segment for inclusion in the National Rivers Inventory based on the degree to which the river is free flowing, the degree to which the river and corridor is undeveloped, and the outstanding natural and cultural

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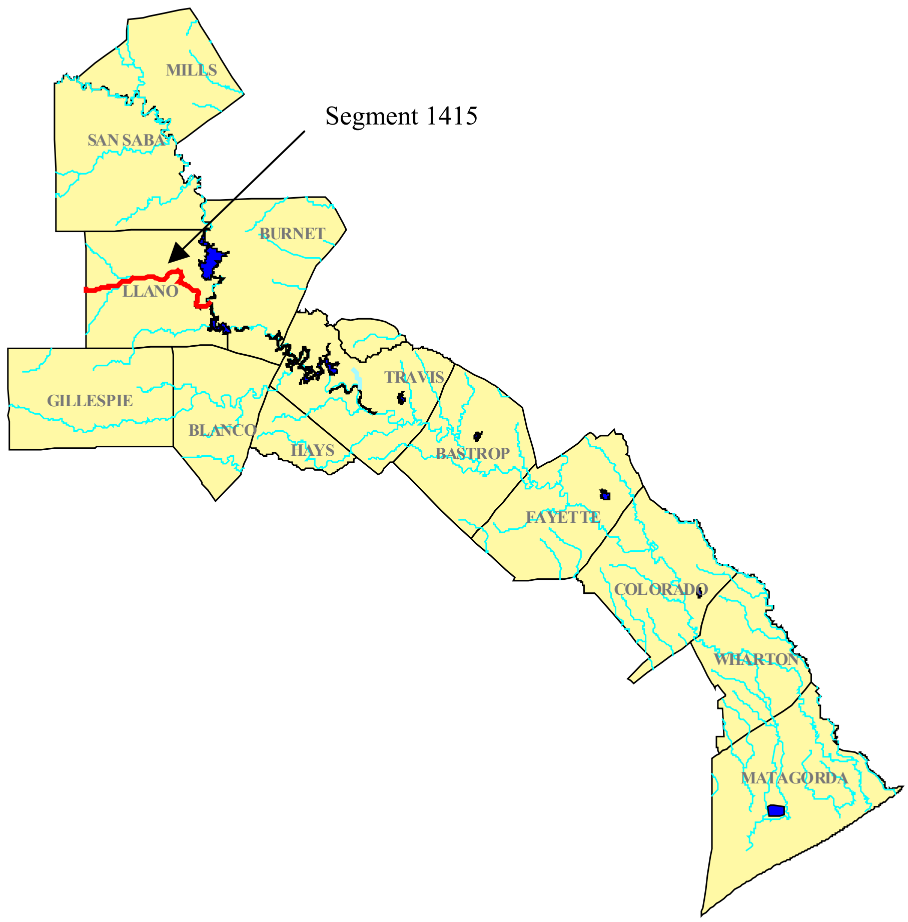
[23] McMahan, et.al., Op. Cit., 1984.
[24] TNRCC, Op. Cit., 1995.
[25] TPWD, Op. Cit., 1979.
[26] TNRCC, Op. Cit., 1995.
[27] McMahan, et.al., Op. Cit., 1984.
[28] National Park Service, 1995. The Nationwide Rivers Inventory, United States Department of the Interior, Washington, DC.
[29] TPWD, Op. Cit., 1979.

Figure 6.7: Location of the Llano River from Johnson Creek Confluence to CR 2768



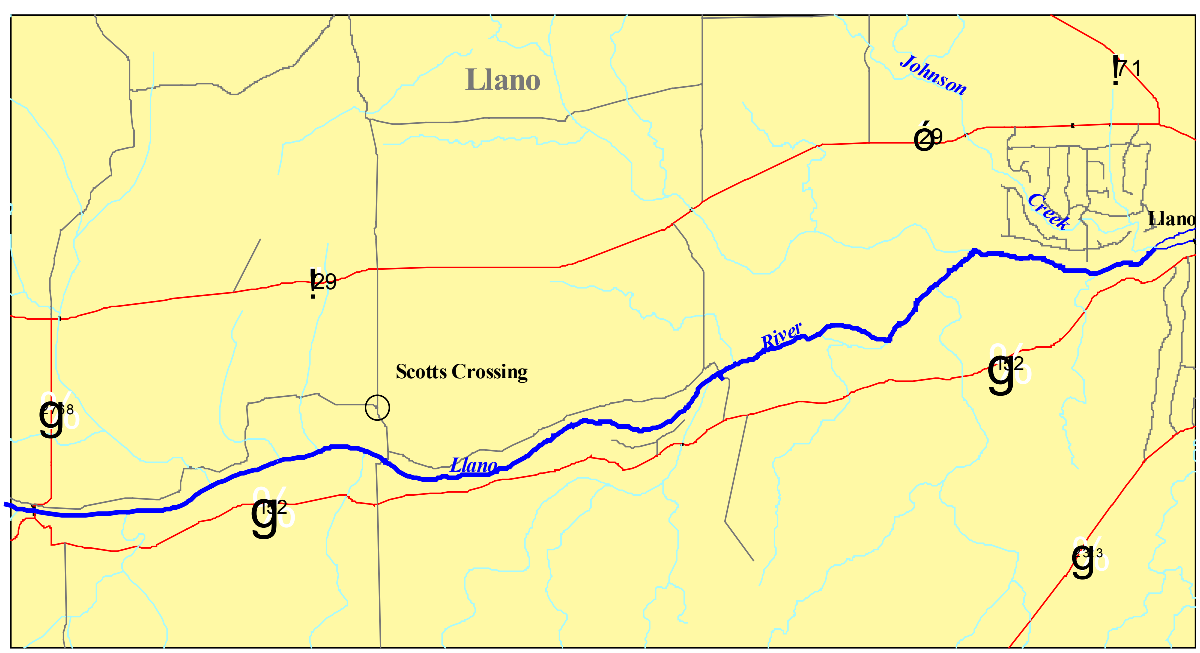
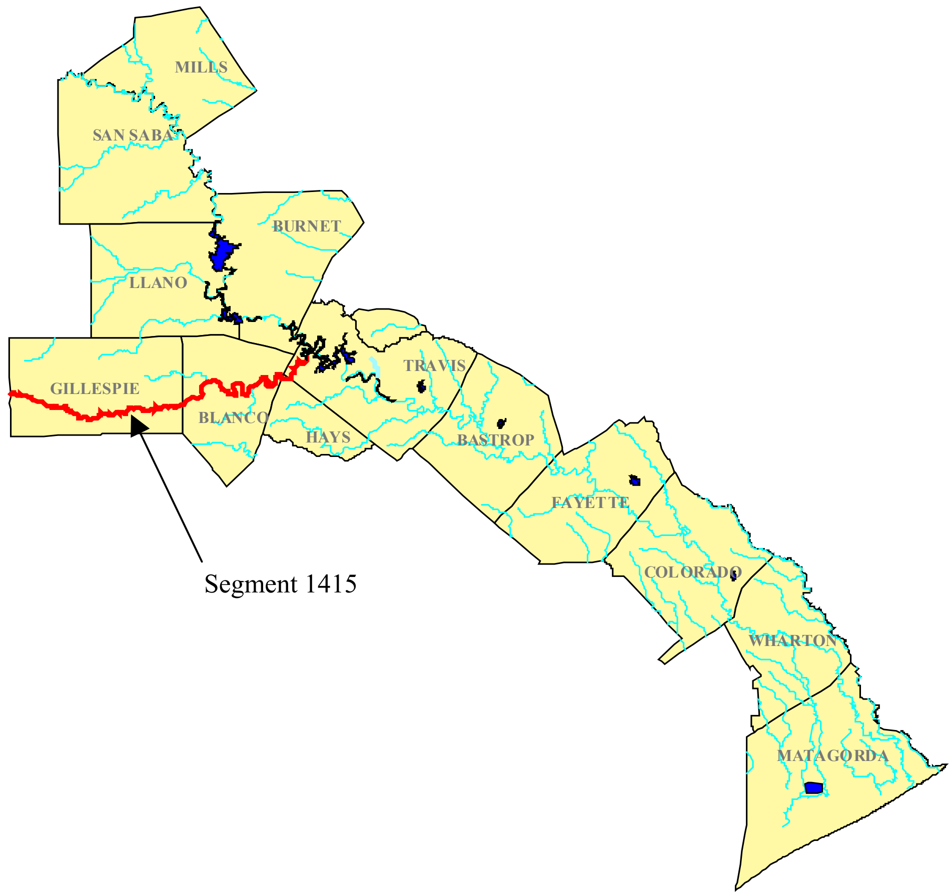
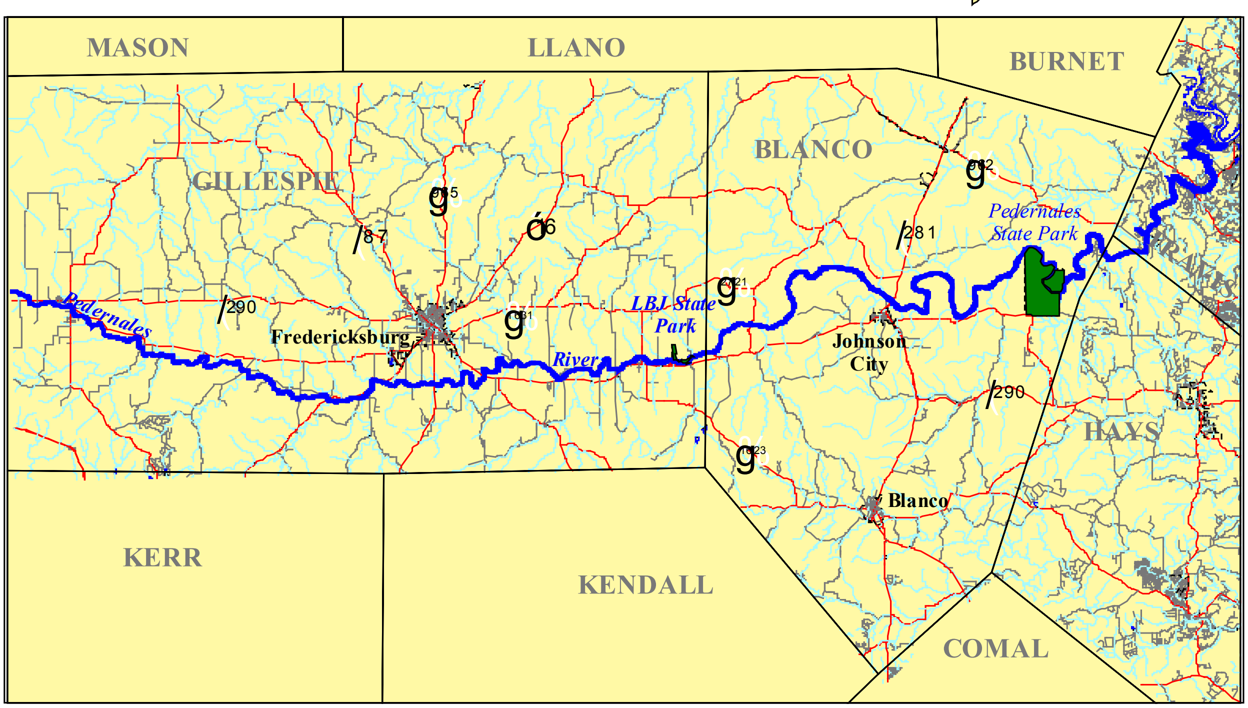


Figure 6.8: Location of the Pedernales River Within the LCRWPA





characteristics of the river and its immediate environment. Bald cypress, red columbine, and native orchids are found adjacent to the river. Among the fish species that occur in the stream is the Guadalupe bass (*Micropterus treculi*). Other aquatic species typical of Hill Country spring-fed streams also inhabit the Pedernales River. Along the river are several state and national parks including Pedernales Falls State Park, LBJ State Park, and LBJ National Park. The segment meets the following criteria for designation as ecologically unique:

- Biologic Function: significant natural area;
- Riparian Conservation Area: Pedernales Falls State Park, LBJ State Park, LBJ National Park, and Stonewall Park; and,
- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: exceptional aesthetic value.

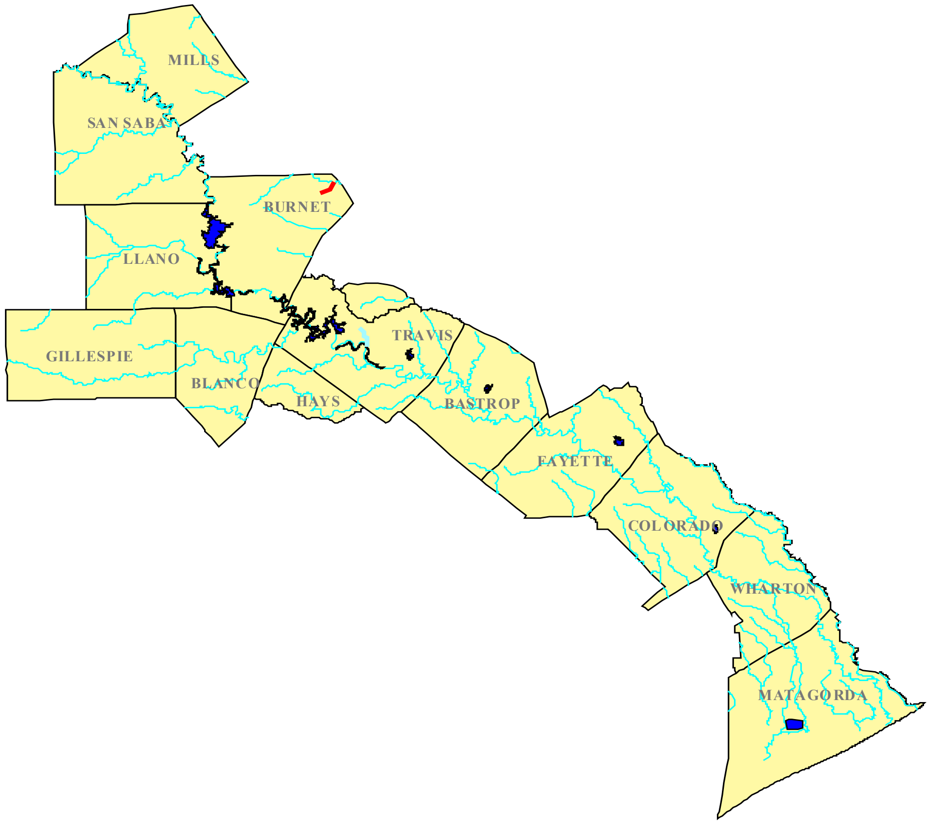
6.3.9 Rocky Creek From the Confluence With the Lampasas River Upstream to the Union of North Rocky Creek and South Rocky Creek in Burnet County [30,31]

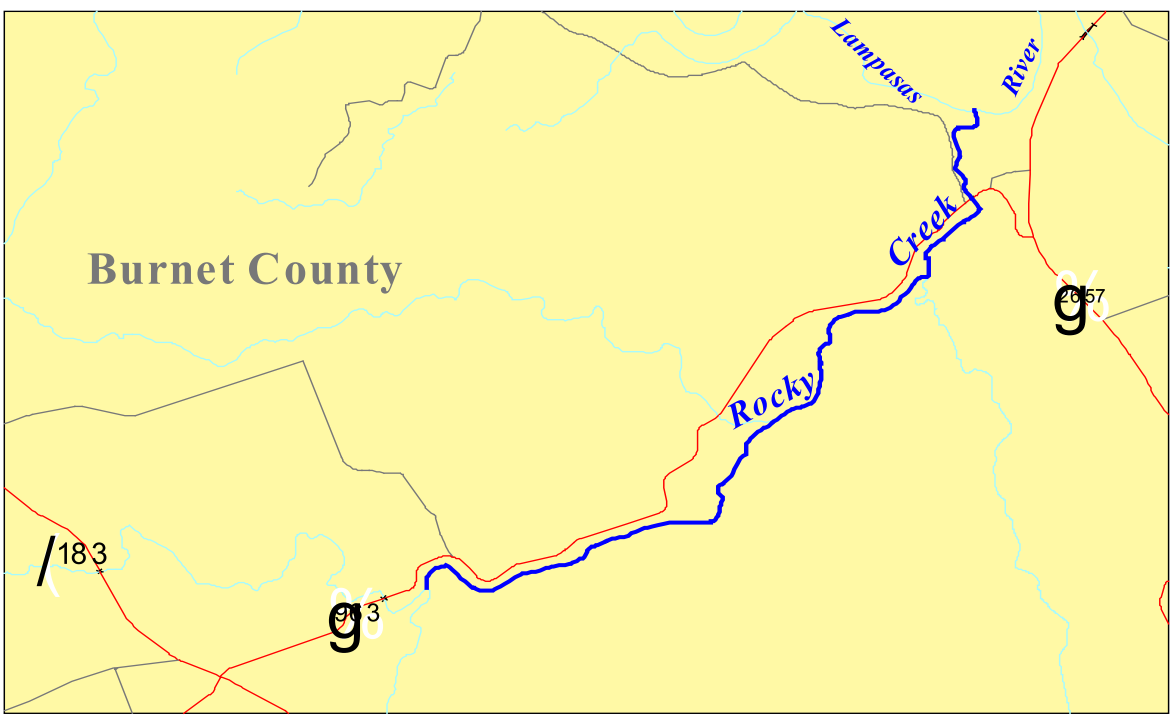
Rocky Creek lies within the Brazos River Basin in northeast Burnet County (Figure 6.9). The stream is approximately six miles long with a drainage area of 94 square miles. The stream is in the Central Texas Plateau ecoregion and within the oak-mesquite-juniper parks/woods vegetation association. The upper reach flows through the live oak-ashe juniper parks association. Long deep runs with numerous short riffles and occasional deep glides characterize the creek morphology. Limestone bedrock, gravel, and rubble are the dominant substrate types. In sampling for the Texas Aquatic Ecoregion Project, 54 species of aquatic invertebrates and 15 species of fish were collected. The segment meets the following criteria for designation as ecologically unique:

- High Water Quality/Exceptional Aquatic Life/High Aesthetic Value: the stream was selected as an ecoregion stream based on its physical attributes, water quality, and biological assemblages; the stream exhibits high dissolved oxygen concentrations and a diverse and complex fish and benthic macroinvertebrate community.

[30] McMahan, et.al., Op. Cit., 1984.
[31] Bayer, et.al. Op. Cit., 1992.

Figure 6.9: Location of Rocky Creek in Burnet County





6.4 SUMMARY OF POTENTIAL SITES UNIQUELY SUITED FOR RESERVOIRS

This section provides background information and recommendations on eight specific reservoir sites, one specific reservoir enhancement project, and several non-specific reservoir sites in the Lower Colorado Region considered by the USS/RS Subcommittee as possible candidates for designation as reservoir sites. The recommendations include support of certain potential projects, opposition to certain potential reservoir sites, and support for further study of certain projects. It should be noted that the TWDB SB 1 guidelines state that public support and acceptance can be considered under "other criteria" for evaluating water supply management strategies.

6.4.1 Mills County Potential Reservoir Projects

The LCRWPG passed a resolution *"supporting the efforts of residents in Mills County and adjoining areas to construct water supply projects involving dams and reservoirs for water supply and the construction of pipelines and other facilities related thereto"* (Appendix 6A). Support of these Mills County proposed reservoir sites is recommended by the USS/RS Subcommittee. Currently, there are five projects under development by the Fox Crossing Water District and the DGRA. These sites include off-channel reservoir alternatives for Blanket Creek, Pompey Creek, Browns Creek, Bennett Creek, and an in-channel reservoir alternative on the Colorado River. To date, there are no engineering technical reports evaluating these locations other than a site map created by the Soil Conservation Service. The Lower Colorado Regional Water Plan's Chapter 4 states that Mills County has projected municipal and irrigation water supply needs for every decade from 2000 through 2050 (deficits of 129 – 165 acre-feet). Table 6.2 below contains the preliminary data currently available from the DGRA on the four off-channel and the one on-channel reservoir sites. Please note this information is extremely preliminary and has not yet been adjusted to meet TWDB SB 1 standards for drought of record conditions or the ENR Second Quarter Cost Index.

Table 6.2: Projected Cost For Selected Mills County Surface Water Reservoir Projects

Reservoir Alternative	Reservoir Area (acres)	Average Reservoir Depth (feet)	Reservoir Conservation Pool (acre-feet)	Drainage Area (sq.miles)	Reservoir Yield (mgd)	Creek Elevation at Dam (ft msl)	Dam Top Elevation (ft msl)
Blanket Ck.	500	22	11,000	129	1 - 1.5	1,245	1,300
Pompey Ck.	240	42	10,080	53	0.4 - 0.75	1,245	1,350
Browns Ck.	530	22	11,660	94	0.8 - 1.2	1,195	1,250
Bennett Ck.	525	16	8,400	100	0.8 - 1	1,260	1,300
Colorado R.		10 or 16	510 or 3,400			1,130	

Reservoir Alternative	Dam Height (feet)	Dam Length (feet)	Estimated Cost ($)	Annual Debt Service* ($)	Annual O&M Cost ($)	Total Projected Annual Cost ($)	Unit Water Cost ($/1,000 gal)
Blanket Ck.	55	780	2,829,200	246,663	15,600	262,263	0.57
Pompey Ck.	105	1,500	3,938,000	343,333	30,000	373,333	1.78
Browns Ck.	55	1,200	3,234,000	281,955	24,000	305,955	0.84
Bennett Ck.	40	5,000	5,188,333	452,343	100,000	552,343	1.68
Colorado R.	10 or 20		3.5-6.9 million				

* annual debt service is calculated at 6% for 20 years

6.4.2 Shaws Bend Potential Reservoir Project [32]

Reservoir Project Opposition is recommended for the potential Shaws Bend Reservoir site in Colorado and Fayette counties. This potential reservoir site is currently a water supply option (C-18) under consideration by the South Central Texas Regional Water Planning Group. This site is within the boundaries of the Lower Colorado Planning Region, and would involve an in-channel dam on the Colorado River approximately five miles west of the City of Columbus. Large local opposition to this project has been demonstrated at the various LCRWPG public meetings and correspondences. In addition, this site has many attributes that may qualify it to be considered for designation as a Unique Stream Segment (USS) (see Section 6.3.5). However, to date, no USS designations have been made by the LCRWPG.

A U.S. Bureau of Reclamation Environmental Inventory and Impact Assessment Study was conducted on the Colorado Coastal Plains, which includes the Shaws Bend Reservoir site, and the results and analyses were compiled in an April 1985 report. This report states that construction and conservation pool operations (220 feet mean sea level, msl) would adversely impact various natural and man-made resources. The reservoir would inundate 12,400 acres and directly impact a total of 12,913 acres of forest, pasture, cultivated, and other lands. Impacts from 100-year and 500-yr flood events would be even greater. Vegetation resources impacted would include pecan orchards, woodlands, bottomland forests, riverine habitat, pastures, and native grasslands/prairies. Five threatened or endangered species could possibly be located within the Shaws Bend Reservoir area. Five unique areas have been identified within the 210,000-acre project area and it has been determined that three of them would definitely be adversely affected. Unique areas are defined as sites that provide an unusual setting with regards to vegetation resources or habitat; or, are of social, historical, recreational, or aesthetic value. A 1.4-mile stretch up-channel containing pristine bottomlands with pools and riffles at Harvey Creek Woodlands would be inundated by approximately 10 feet of water. Approximately 70 percent of Horseshoe Bend Woodlands would be inundated under normal conservation pool operations, and during flood events the entire woodland would be inundated. The third site with vegetative/habitat value is the Fern Hollows and Bluffs, which contain secluded canopies of large trees, natural springs, and unusual hydrophilic plant species. Most of the historical Burnam's Ferry Crossing would be inundated by conservation pool reservoir waters and it has already been determined that mitigation would be required if the reservoir was constructed. This area was part of the La Bahia Road from southwestern Louisiana to San Antonio and is currently privately owned and used annually by the Boy Scouts for camping. Camp Lone Star is located near La Grange and its 125 acres of dense upland forest is of recreational value for camping year-round. In addition, preliminary identification of many potential archeological sites has been made in the Shaws Bend Reservoir project area. Man-made resources that would be adversely affected include roadways, electrical line right-of-ways, oil/gas wells, and petroleum pipelines.

6.4.3 Cummins Creek Potential Reservoir Project

Reservoir Project Opposition is recommended for the potential Cummins Creek Reservoir site in Colorado County. This potential reservoir site is currently a water supply option (SCTN-15) under consideration by the South Central Texas Regional Water Planning Group. This site is within the boundaries of the Lower Colorado Planning Region near the City of Columbus and the confluence with

[32] ECS Technical Services, Op. Cit., 1985.

the Colorado River, and would involve an off-channel dam on Cummins Creek. This reservoir would utilize flows from Cummins Creek plus diversion of unappropriated Colorado River flows. Large local opposition to this project has been demonstrated at the various LCRWPG public meetings and correspondences. Cummins Creek has a Water Control and Improvement District (WCID), and there are already 15 dams along the creek. There are more than 7,200 acres of bottomland along the creek within the proposed reservoir project area as well as spring-fed sections of the creek. It has already been determined by the South Central Texas Regional Water Planning Group that mitigation would be required for inundation of 6,600 acres, which includes riparian woodlands. Portions of the Colorado River and Cummins Creek that would be affected by the reservoir project area have been listed as "ecologically significant" stream segments by the Texas Parks and Wildlife Department (TPWD).

6.4.4 Potential Llano County Small In-Channel Check Dams Project

Support is recommended for further study and potential development of small in-channel check dams within existing floodplains in Llano County. Specific locations need to be identified and further analyses are needed for these projects. The USS/RS Subcommittee is interested in gauging local public support and determining actual need for this project before the recommendation process moves forward. The Subcommittee needs additional information for this project.

6.4.5 Potential Llano County Diversion of the Llano River to Lake Buchanan Project

Support is recommended for further study of the Llano County diversion of the Llano River to Lake Buchanan. Benefits of this reservoir enhancement project include the potential enhancement of lake levels in the Highland Lakes System, and potential flood control in Llano County. The original study conducted in the 1950s (which was updated in the early 1990s) indicated this project would not be cost effective. However, recent engineering technology improvements (specifically mentioned were the methods to excavate dolomite), and decreasing the pipeline path length can improve the unit cost of this option. Specific information on local support is also needed for the consideration of this option. The LCRA provided the LCRWPG with a technical memorandum**,** which describes the LCRA's 1999 Water Management Plan evaluation of increased Highland Lakes water supply available with diversion of water from the Llano River to Lake Buchanan. In this plan, the LCRA determined the firm maximum annual water supply from the Highland Lakes (Combined Firm Yield or CFY) during a repeat of the drought of record to be 445,266 ac-ft/yr. The impact of the proposed Llano River diversion canal was determined by recalculating the CFY, as well as the economic merits of the diversion that largely depend on how much additional water supply is made available. However, this analysis did not consider potential water supply improvements. The new CFY of the Highland Lakes, incorporating the Llano River diversion was determined to be 444,695 ac-ft/yr, which is an annual decrease of 571 ac-ft. The net loss of water due to the diversion canal occurs in Lake Buchanan because this lake has more evaporative surface area than Lake Travis, where all of the Llano River water would have been stored without the diversion canal.

6.4.6 Clear Creek Potential Reservoir Project

Reservoir Project Opposition is recommended for the potential Clear Creek Reservoir site in Fayette County. Clear Creek is an approximately eight-mile long tributary of Cummins Creek, and is a few miles north of Lake Fayette. There are no official reservoir projects currently under consideration for this creek. However, there has been large local opposition to any reservoir projects in this area at the various LCRWPG public meetings and correspondences.

6.4.7 Potential LCRA Off-Channel Flood Storage Facilities

Support is recommended for a "No Action" stance by the LCRWPG regarding the LCRA permits for unspecified numbers and locations of off-channel flood storage facilities until more information can be supplied to the Subcommittee. The LCRA may have some new information regarding specific flood storage options for their newly acquired Pierce Ranch water rights. Some of these off-channel sites are currently being considered in conjunction with a water management strategy to supply water to address shortages inside and outside Region K.

6.4.8 Further Study and Potential Development of LCRA Off-Channel Flood Storage Facilities

Support is recommended for further study and potential development of the LCRA off-channel flood storage facilities for priority use within the lower Colorado River Basin. Specific locations need to be identified and further analysis is needed, especially regarding impacts to recommended upstream reservoir projects.

6.5 UNRESOLVED ISSUES

While the LCRWPG has been able to reach consensus on a number of strategies and related issues regarding future water supplies for the Lower Colorado Region (Region K), not all issues have been able to be resolved. Other issues have certainly not yet been identified and many more cannot be identified, which are all expected occurrences at this stage of the planning process. Many new issues will come to light during the planning, permitting, construction, and operational phases of the identified water management strategies and resulting projects for Region K. Most of these issues will need to be resolved between the various parties responsible for the development and implementation of selected strategies and affected interests.

The following have been identified as unresolved issues by the LCRWPG:

- There is the possibility that policies and or strategies regarding groundwater in adjacent regions could lead to dewatering portions of the aquifers residing in Region K. The portion of the Carrizo-Wilcox aquifer lying under Bastrop County in Region K and Lee County in Region G has the potential for such a conflict. Excess pumpage in Lee County or Bastrop County could lead to dewatering of the aquifer in Region K if such pumpage is permitted.
- Region G has included a demand of 16,000 acre-feet for Williamson County from Region K. According to HB 1437 76th Texas Legislative Session this water must be replaced in Region K with an equivalent new water supply when the transfer occurs. If Region L fully implements Region K's regional cooperation plan, there will be no additional strategies for new water contained in this plan to cover this 16,000 acre-feet transfer to Williamson County. Further work is needed to resolve this potential deficit.

- Much emphasis has been placed on groundwater modeling as the source for reliable data on groundwater availability in the next few years. However, the scientists themselves who will be doing these studies indicate it will be years before reliable data will be available. Once constructed, the models will have to be calibrated over many years in order to provide the level of accuracy needed for water planning on anything other than a region-wide basis. Many of the potential concerns and issues identified are of concern on a more local basis and the impacts of groundwater pumpage on existing wells from future production are undeterminable at this time.
- The environmental impacts that developing additional new Colorado River water supplies in the basin will have on the reductions of instream flows and freshwater inflows to the bays and estuaries may be significant. Methods for mitigating and avoiding these impacts on the estuarine and riparian habitats within lower Colorado Basin will be a fundamental consideration for determining the feasibility of such projects prior to their development and implementation.
- Another unknown that could potentially add balance to the impacts on the bay and estuarine is the contribution of rice irrigation flood-culture runoff to fresh water inflows to the bay and estuary system. This concept needs additional work and quantification with at least three components to be considered: (1) run-off from flooded fields during rain events; (2) irrigation water drained from flooded fields prior to harvest; and, (3) leakage from irrigation delivery systems.
- Concerns have also been expressed regarding the Plan's dependency on conservation to make up much of the available supplies in the future. Region K is dependent upon the success of the implementation of many of the conservation activities that are in turn dependent upon funds being made available from the sale of the developed new water supplies. These funds would be used to pay for implementation of additional on-farm and canal system improvements and water-use efficiencies, as well as research aimed at developing rice varieties that use less water and improve yield relative to water use.

APPENDIX 6A

RESOLUTIONS ADOPTED BY THE LCRWPG

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 6B

INFORMATION PROVIDED BY THE TPWD, LCRA, BCEN, AND REGION G FOR THE IDENTIFICATION OF ECOLOGICALLY UNIQUE STREAM SEGMENTS IN THE LOWER COLORADO REGIONAL WATER PLANNING AREA

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 6C

TPWD SUPPLEMENTAL INFORMATION RESOURCES FOR SECTION 6.3

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

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CHAPTER 7.0: PUBLIC INVOLVEMENT ACTIVITIES

7.1 OVERVIEW

The Lower Colorado Regional Water Planning Group (LCRWPG) made a commitment to conducting public outreach as a part of their duties as Planning Group members. The public involvement effort was led by Planning Group member Dede Armentrout and a five-member Public Involvement Committee that she chaired. Committee members were Richard Macaulay, Julia Marsden, Cole Rowland, and Haskell Simon.

Major aspects of this effort included:

- **Holding more than 35 open meetings of the Planning Group** for presentation of material, discussion, deliberation, voting on specific measures, and public comment between April 1998 and October 2000. Members of the public attended all of these meetings, which were posted on the Internet on the Travis County and LCRA bulletin boards. Every meeting included a scheduled time for public comment and questions. Nine of these meetings were held at the M.D. Anderson Cancer Research Center near Smithville, which is approximately the geographic center of Region K. An additional nine meetings were held at the Lower Colorado River Authority's (LCRA's) McKinney Roughs Environmental Education Center near Bastrop (also near the region's center). Four meetings were held at LCRA facilities in Austin or Bastrop. Three public meetings were also held in Austin, Burnet and Eagle Lake in 1998 near the beginning of the planning process to answer questions from the public regarding Senate Bill 1.

- **Holding 15 of the RWPG's regular monthly meetings at locations throughout the region** to enable a broader spectrum of the public to observe the work of the Planning Group first-hand and to comment or ask questions. These meetings were publicized through phone contact and news releases to the local weekly and daily papers and radio stations in the area that each meeting was to be held in, as well as through mailings of invitations and personal letters to and contacts with interested parties. These meetings and the publicity they generated have reached thousands of people, including the estimated 2,500 people who had personally attended meetings as of 30 November 2000.

    - This included holding meetings open to the public with their counterparts from **Regions L and G** to discuss potential programs that could be pursued in common and potential strategies that cross regional boundaries. In addition, individual Planning Group members served as liaisons to these regions and reported on related developments at the monthly meetings.

- Serving as **speakers at more than 100 civic and interest group meetings** representing the full spectrum of interests and public opinion. These presentations took place throughout the planning period and in all counties of the region.

- Conducting **four surveys** regarding water supply issues and needs throughout the region. The first of these was conducted as part of devising the project scope, while the second survey sought information regarding the boundaries and customers of water utilities. Furthermore, the Planning Group's Unique Stream Segments and Reservoir Sites Committee (USS/RSC) conducted a mail survey on the subject of their deliberations. In the fall of 1999, members of the public attending one of the Planning Group meetings were asked to prioritize the benefits they hoped to gain from a Regional Water Plan.

- Sending a **fund-raising** letter and raising more than $30,000 in cash and in-kind contributions, in addition to those made by Planning Group members, to supplement the project's public involvement budget. Contributors are listed below and include cities, counties, water utilities, and other water user groups that consume more than 1,000 acre-feet of water annually. In addition, LCRWPG members LCRA, the City of Austin and Aqua Water contributed substantial in-kind contributions of labor, technical and administrative support, graphics, postage, printing, and other forms of assistance.

- Maintaining a **web page** with documentation and notices of meetings and discussions, with links from the Lower Colorado River Authority (LCRA) home page and the Texas Water Development Board (TWDB) website.

- Providing **fact sheets** at the beginning and near the end of the planning process to any interested parties. These fact sheets were used as handouts for presentations, at the Planning Group's regular monthly meetings, and as an accompaniment to news releases and in other settings.

- Forming a special **Irrigation Water Supply Working Group** with representatives of farm and recreational interests, among others, to review the potential strategies for meeting identified shortages that were most feasible in their particular setting. Two informal "focus group" meetings were held for interests affected by these identified irrigation shortages. The group also met via conference call and at the Turner, Collie, and Braden, Inc. offices to discuss strategy options.

- Holding **four public meetings, including one required public hearing,** to gain public input on the *Initially Prepared Draft Plan* in addition to that gained through other means. A total of about 400 people attended these meetings, which included a presentation and video describing the Regional Plan as initially drafted.

- Two appearances on the KLRU-TV public affairs program *Austin at Issue*, which airs Fridays at noon and 9:00 p.m. and Sundays at 5:00 p.m. About 90 percent of the Region K population lives within the KLRU viewing area.

    - On August 11, 2000, the RWPG Chair gave a 10-minute interview centered on the availability of the *Initially Prepared Draft Plan* and the upcoming public meetings

    - On September 29, 2000, a 3-minute video (provided by LCRA and the LCRWPG) outlining the proposed plan was aired and the RWPG public interest representative was interviewed with a member of the National Wildlife Federation who opposes the plan regarding pros and cons of what is being proposed and what steps are to follow.

Once the concept of a proposed strategy was endorsed by the Planning Group, a number of additional activities were sponsored and led by the Lower Colorado River Authority, which is the administrative agency for the region, including:

- Holding six public meetings throughout the region, all of which were publicized through news releases and advertisements, and which prompted many media interviews.

- Issuing news releases regarding the proposal to more than 30 media outlets within the region, providing an OpEd column from the LCRA General Manager, and conducting other media relations that resulted in an editorial in the *Austin American-Statesman* and coverage of meetings and the proposal's features in both the print and electronic media.

- Preparing a video on the features of the primary strategies proposed to be used at public meetings.

These activities of the Regional Water Planning Group members are discussed in more detail below.

7.2 PLANNING GROUP MEETINGS THROUGHOUT THE REGION

The first meeting - designated as the Initial Coordinating Body Meeting - of those appointed to serve as representatives on the Regional Water Planning Group was held on 19 March 1998 and was attended by about 14 members of the public. The Planning Group met a total of 12 times during 1998. As with all Planning Group meetings, these meetings were posted on the Internet and included a period for public comment and questions. In many cases, members of the public in attendance also asked questions and participated in discussions during informational parts of the meetings throughout the planning period. At these early meetings, ground rules and bylaws were established, technical project scoping was conducted, and a consultant team was selected to assist the Planning Group.

Ten monthly meetings were held in 1999, many of which focused on establishing the geophysical and hydrologic characteristics of the region, the projected population growth and distribution, the patterns of water consumption, and future water supply needs. These meetings often included special presentations about the concerns and contribution to the region of a particular interest group, potential strategies for conserving or supplying additional water, or other related topics that helped to establish a common vocabulary and a foundation of understanding shared by all Planning Group members.

Meetings were held twice monthly in 2000 as the Lower Colorado Regional Water Planning Group began deliberating on the policies, strategies, and other types of recommendations that were under consideration. Three meetings were held with the South Central Texas (Region L) Regional Water Planning Group in a largely successful effort to build consensus regarding strategies that crossed regional boundaries.

While all Planning Group meetings were open to the public, beginning in April 1999, the Planning Group began holding many of its regular meetings in locations throughout the region in order to make their deliberations accessible to a wider variety of constituents. Table 7.1 provides an overview of these "local" meetings, most of which were heavily publicized.

All meetings not held in locations shown in Table 7.1 were held at McKinney Roughs near Bastrop, the M.D. Anderson Science Park near Smithville, or LCRA facilities in Austin or Bastrop. These "central" meetings were typically attended by about 25 people in addition to the RWPG members, alternates, and consultants.

Gaining publicity to increase attendance at the "local" meetings was a major focus of activity due to the rural nature of much of the region. For most of the meetings shown in Table 7.1, phone contact was made with six to fifteen media outlets in the area surrounding the meeting location. This contact was followed by a news release and fact sheet, and often by a follow-up call from a RWPG member residing in the area. In several cases, Planning Group members appeared on radio talk shows before the meetings. Local print coverage was obtained for all of these meetings. Several of these meetings attracted more than 100 attendees. The most heavily attended were those dealing with strategies that would cross regional boundaries.

Each of these "local" meetings was sponsored by a Planning Group member, who acted as host and arranged for the meeting location and logistics, as well as serving lunch to all attendees. In some cases this provided an opportunity for involving a broad range of community groups as sponsors. The Cities of Bay City, Wharton, Burnet, and others provided meeting facilities free of charge, for example. More than a dozen local sponsors participated in funding and providing in-kind contributions for the 14 June 2000 meeting in Wharton alone. The meeting held at Bamberger Ranch was co-hosted by LCRWPG member Dede Armentrout and Dr. Curtis Chubb of the Hill Country Aquifers Coalition.

Some of these meetings included special tours and events to acquaint Planning Group members with the issues and needs involved. Tours were provided of the:

- South Texas Electric Project;
- Bamberger Ranch environmental demonstration projects;
- Rice irrigation and farming practices;
- Pierce Ranch irrigation methods and organic farming; potential off-channel reservoir and well development sites;
- Ecotourism, and bird watching areas; and,
- Seco Creek Brush Control Project.

Special presentations to the RWPG were made by the Save Barton Creek Association, the State Clean Rivers Program, officials from the City of Austin's Rainwater Harvesting Program, and ALCOA, among others; and each member of the Planning Group had the opportunity to make a presentation regarding the concerns and importance of the interest group he or she represents.

Table 7.1: LCRWPG Publicized "Local" Meetings Throughout the Region

Date	Meeting Location	# Attending	Attendee Comments
4/14/99	City of Goldthwaite, Mills Co.	~ 100 * (84)	Concern about supplies during drought; support for capturing more runoff and storing more river flow;
6/16/99	City of La Grange, Fayette Co.	24	Concern about potential local reservoirs (e.g.. Cummins Creek); support for Groundwater District creation;
8/11/99	Bay City, Matagorda Co.	36	Concern about maintaining freshwater inflows to estuaries, water quality concerns, and property rights; concerns with regard to designation of USS/RS**;
9/22/99	City of Burnet, Burnet Co.	139	Need for water storage in Highland Lakes; property rights concerns regarding USS/RS** designation; support for greater emphasis on impacts to recreation and the need to maintain lake levels in the Highland Lakes; support for including flood control considerations;
9/27/00	City of Burnet, Burnet Co.	305	Concerns expressed regarding uncertainties of plan with regard to “temporary” use of water, total amount, willingness of San Antonio to pay, the expanding role of LCRA. Both support and opposition voiced. Praise for pro-active effort. Also concern that the Regional Plan is subject to legislative fiat, or control, regardless of Region K’s recommendations.
11/10/99	City of Columbus, Colorado Co.	~ 200 * (160)	Strong opposition expressed by many opposing potential Shaw's Bend and Cummins Creek area reservoirs;
1/12/00	City of Llano, Llano Co.	75	Support for brush control, rainwater harvesting, conservation incentives; proposal to consider dredging reservoirs as a supply strategy;
2/23/00	City of San Marcos, Hays Co.	~ 400 * (290)	Joint meeting with Region L. Fayette & Colorado Co. Judges opposed interbasin transfers (IBT) to Region L, supported conservation, and emphasis on economic impacts in Region K. *City of Lago Vista and Highland Lakes Group* opposed IBTs due to concern about economic impacts. *Wilson Co. Water Action Project* opposed Cibolo reservoir, presented petition with 2,800 signatures. *Take Back Texas* expressed concerns regarding property rights implications of water planning. *Neighbors for Neighbors* opposed ALCOA project due to concerns about air quality, aquifer drawdown, impact on nearby wells, lack of local control, and endangered species. *BCEN opposed* ALCOA due to aquifer drawdown concerns; several individuals also spoke in opposition to ALCOA. *Grassroots Citizens Group* opposed Shaw’s Bend area reservoir, IBTs, and impacts on property rights. *Burnet Water Council* opposed IBTs, supported conservation and growth controls;

Date	Meeting Location	# Attending	Attendee Comments
3/20/00	City of Belton, Bell Co.	81	Joint meeting with Region G. ALCOA presentation. Concerns expressed about ALCOA project; opposition to large-scale groundwater exports;
4/12/00	Bamberger Ranch, Blanco Co.	52	Groundwater district for Blanco County advocated;
5/10/00	City of Lakeway, Travis Co.	19	Opposition to water pipeline to Dripping Springs;
6/14/00	City of Wharton, Wharton Co.	~ 100 *	Support for reservoirs upstream of Wharton County; strong support for agricultural interests; concern about encroaching development from Houston area; interest in cooperation with flood control efforts;
7/18/00	City of San Marcos, Hays Co.	~ 50 *	Joint meeting with Region L to discuss proposal endorsed by LCRWPG. Opposition to ALCOA project expressed. Proposal for recharge/recirculation as supply strategy for Region L;
8/9/00	McKinney Roughs Complex, Bastrop Co.	~ 15	no public comment received
10/2/00	--	--	Draft Plan was submitted to TWDB. See tables on subsequent pages for reporting on additional meetings.

* *In cases where the number of attendees appeared to be significantly larger than the number of people who signed in, an estimate of total attendance is given, with the actual number of people who signed in indicated in parentheses. All other numbers shown reflect the number of people not directly associated with the Planning Group who signed the sign-in sheets.*

** *USS/RS stands for Ecologically Unique Stream Segments and Reservoir Sites.*

7.3 PRESENTATIONS TO CIVIC AND SPECIAL-INTEREST GROUPS

Using their own materials and a standardized set of presentation materials, Planning Group members gave presentations to more than 100 civic and special-interest groups. Table 7.2 provides a summary of this outreach effort with a listing of the LCRWPG presentations to civic and special interest groups.

These presentations were made to groups composed of individuals from all types of general and special interests that were identified by the Texas Water Development Board (TWDB) in the establishment of the Regional Water Planning Groups.

Table 7.2: LCRWPG Presentations to Civic and Special Interest Groups (3 pages)

LCRWPG PUBLIC OUTREACH RECORD: PRESENTATIONS BY GROUP MEMBERS TO COMMUNITY GROUPS

Presenter *	Date	City	County	Community Group	Type of Group**
M	10/5/98	Georgetown	Williamson	Senior University	1
M	11/15/98	Austin	Travis	Presbyterian Social Issues Class	1
M	11/22/98	Austin	Travis	Presbyterian Social Issues Class	1
M	11/29/98	Austin	Travis	Presbyterian Social Issues Class	1
A	1/6/99	Bastrop	Bastrop	Chamber of Commerce	10,6
A	1/7/99	Giddings	Lee	Kiwanis Club	1
A	1/7/99	Bastrop	Bastrop	City Council	7
A	1/14/99			Manville WSC Board of Directors	11
A	1/26/99	Smithville	Bastrop	Lions' Club	1
A	1/26/99	Elgin	Bastrop	City Council	7
A	2/4/99	Elgin	Bastrop	Chamber of Commerce	10,6
A	2/11/99	Smithville	Bastrop	Chamber of Commerce	10,6
A	2/12/99	Austin	Travis	Central TX Assn of Water Districts	11
A	2/25/99	Giddings	Lee	Rotary Club	1
P	3/4/99	San Saba	San Saba	San Saba Co Soil & Water Conservation Dist	2
M	3/8/99	Austin	Travis	League of Women Voters--Day	1
Q	3/9/99	Austin	Travis	UT Water Environmental Assn	12
M	3/10/99	Austin	Travis	League of Women Voters--Night	1
P	4/12/99	San Saba	San Saba	San Saba Co Commissioners Court	3
P	4/14/99	San Saba	San Saba	San Saba Co Soil & Water Consv. Dist.	2
H	5/11/99	San Antonio	Bexar	Reg L Wtr Planning Group	12
T	6/1/99	Fredericksburg	Gillespie	Hill Country Municipalities' Secretaries	7
A	6/3/99	Giddings	Lee	Public Meeting at High School	1
A	6/8/99	Elgin	Bastrop	Economic Development Commn.	10,6
A	6/16/99	Lexington	Lee	Public Meeting at High School	1
Q	6/18/99	Lago Vista	Travis	City of Lago Vista	7
Q	6/21/99	Village of Hills	Travis	Horst Creek MUD	11
A	6/22/99	Elgin	Bastrop	City Council	7
P	6/22/99	San Saba	San Saba	Property Owners Assn	1
A	6/23/99	Bastrop	Bastrop	Bastrop County Water Council	12
A	6/24/99	Bastrop	Bastrop	Builders Association	10
A	7/6/99	Bastrop	Bastrop	Commissioners Court	3
Q	7/7/99	Lakeway	Travis	Lakeway MUD	11
P	7/13/99	San Saba	San Saba	San Saba Co SWCD	2
Q	7/24/99	Briarcliff	Travis	Village of Briarcliff	7
A	7/29/99	Elgin	Bastrop	Public Meeting	1

Table 7.2: LCRWPG Presentations to Civic and Special Interest Groups (continued)

Presenter *	Date	City	County	Community Group	Type of Group**
Q	7/29/99	Bee Cave	Travis	Village of Bee Cave	7
T	8/1/99	Fredericksburg	Gillespie	Gillespie Co Visioning 20/20	1
A	8/3/99	Austin	Travis	AARO	10,6
A	8/23/99	Giddings	Lee	Commissioners Court	3
S	8/31/99	Llano	Llano	Hill Country Livestock Raisers Assn Bd.	2
E	9/8/99	Buchanan Office	Llano	Buchanan Lake LCRA Advisory Panel	8
K	9/9/99	Eagle Lake	Colorado	Lions' Club	1
Q	9/15/99	Point Venture	Travis	Travis Co WCID Point Venture	11
O	9/16/99	La Grange	Fayette	Fayette Co Water Council	1
O	9/16/99	*	Fayette	Fayette Co Water Council	9
D	9/20/99	Burnet	Burnet	KBAY radio 104.9	1
D	9/20/99	Burnet	Burnet	KBUC radio 92.5	1
D	9/20/99	Burnet	Burnet	KHLB radio 106.9	1
E	9/20/99	Buchanan Office	Llano	Inks Lake LCRA Advisory Panel	8
A	10/25/99		Milam	SWMilam Co.WSC Bd of Directors	11
S	11/1/99	Llano	Llano	Llano Co. Soil & Water Cons. Dist.Bd.	2
M	11/8/99	Austin	Travis	Save Barton Creek Assn	5
M	11/9/99	Austin	Travis	UT LAMP (Sr.Continuing Educ)	1
O	12/2/99	Fayetteville	Fayette	Fayette County Taxpayers Assn.	1
O	1/1/00	La Grange	Fayette	Fayette County Taxpayers Assn.	1
L	1/5/00	Goldthwaite	Mills	Goldthwaite City Council	7
L	1/10/00	Goldthwaite	Mills	Mills Commners Court	3
A	1/11/00		Lee	Lee Co WSC Board of Directors	11
A	1/13/00		Fayette	Public Meeting	1
Q	1/17/00	Lakeway	Travis	Lakeway City Council	7
A	1/18/00		Brazos	Brazos Co COG/County Judges	3
O	1/18/00	La Grange	Fayette	*	*
O	1/19/00	La Grange	Fayette	Fayette County Water Council	9
Q	1/20/00	Lago Vista	Travis	Lago Vista City Council	7
Q	1/22/00	Marble Falls	Burnet	Highland Lakes PAC Directors	1
L	1/24/00	Goldthwaite	Mills	Mills Commissioners Court	3
L	1/24/00	Goldthwaite	Mills	Fox Crossing Water Dist	11
L	1/25/00	Goldthwaite	Mills	Fox Crossing Water Dist	11
Q	2/1/00	Lago Vista	Travis	Lago Vista Lions Club	1
Q	2/2/00	Lakeway	Travis	Lakeway Men's Breakfast Club	1
Q	2/3/00	Lago Vista	Travis	Highland Lakes Group Directors	1
Q	2/8/00	Jonestown	Travis	Jonestown Water Supply Co. Directors	11
H	2/10/00	Austin	Travis	Barton Sprgs/EdAqCD	11
H	2/15/00	San Marcos	Hays	Hays Co. Commissioners	3
H	2/17/00	N.Hays Co.	Hays	Citizens Alliance of N. Hays Co.	1
A	2/24/00		Lincoln	Lincoln Co WSC Annual Meeting	11

Table 7.2: LCRWPG Presentations to Civic and Special Interest Groups (continued)

Presenter *	Date	City	County	Community Group	Type of Group**
A	2/29/00			969 VFD Public Meeting	1
H	3/1/00	Buda	Hays	GBRA I-35 Water Mtg	9
A	3/2/00	Bastrop	Bastrop	Aqua WSC Annual Meeting	11
H	3/2/00	Austin	Travis	City Council of Austin	7
H	3/8/00	Buda	Hays	Buda Citizens Committee	7
Q	3/15/00	Lake Travis	Travis	Lake Travis Chamber of Commerce	10
Q	3/22/00	Lakeway	Travis	Lakeway Homeowners Assn	1
A	3/23/00		Milam	Public Meeting	1
T	4/1/00	Fredericksburg	Gillespie	Leadership Fredericksburg	1
G	4/6/00	Columbus	Colorado	Colorado Co. Republicans	12
Q	4/16/00	Austin	Travis	Radio KJFK "Dockside" Program	1
A	4/24/00		Milam	SW Milam Co.WSC Annual Mtg	11
A	4/28/00		Lee	Lee Co WSC Annual Meeting	11
A	5/3/00	La Grange	Fayette	Public Meeting	1
G	5/3/00	Garwood	Colorado	Garwood Lions Club	1
Q	5/7/00	Austin	Travis	Radio KJFK "Dockside" Program	1
A	5/10/00		Milam	Public Meeting	1
Q	5/30/00	Austin	Travis	Radio KJFK "Dockside" Program	1
Q	6/7/00	Lakeway	Travis	Travis Co Alliance of Cities	7
A	6/29/00	Smithville	Bastrop	Chamber of Commerce	10, 6
A	7/5/00	Bastrop	Bastrop	Chamber of Commerce	10, 6
Q	7/17/00	Lakeway	Travis	City Council	7
A	8/10/00	Bastrop	Bastrop	Bastrop County Realtors Assn.	10, 12
Q	8/17/00	Kingsland	Travis	Neighborhood Association	1
Q	8/22/00	Kingsland	Travis	Hill Country Builders	10
Q	9/12/00	Kingsland	Travis	Lions Club	1
O	9/20/00	Round Top	Fayette	South Central Board of Realtors	10
Q	10/25/00	Kingsland	Travis	Methodist Men' Club	1

** PRESENTERS CODING:*

A	J. Burke	**K**	R. Gertson
B	H. Simon	**L**	D. Henry
C	R. Goss	**M**	J. Marsden
D	J. Barho	**N**	C. Martinez
E	Q. Martin	**O**	R. Macaulay
F	D. Armentrout	**P**	S. Reinhard
G	S. Balas	**Q**	C. Rowland
H	S. Bowlin	**R**	M. Smith
I	R. Dickerson	**S**	B. Stewart
J	R. Gangluff	**T**	P. Tybor

*** GROUP TYPE CODING:*

1	General public	**7**	Municipalities
2	Agricultural interests	**8**	Recreation interests
3	County government	**9**	River Authority contacts
4	Electric power	**10**	Small business
5	Environmental	**11**	Water utilities/districts
6	Industries	**12**	Other

7.4 OPINION SURVEYS

The Planning Group conducted four surveys to gain an overview of the spectrum of opinion regarding issues and problems from a variety of stakeholders. The methodology and findings of each are reported below.

7.4.1 Scoping Phase Survey

One of the initial tasks of the Lower Colorado Regional Water Planning Group was to determine an appropriate scope of services and issues to focus on for its work. Among the tasks undertaken to accomplish this was the use of a mail survey that covered all 14 counties within the region, which prompted a total of 126 responses.

The survey queried stakeholders regarding the types of water supply problems and threats they foresaw, as well as their initial preferences for solutions in their communities. The survey also asked about the existence of conservation, drought management, and water supply plans. Respondents were also asked open-ended questions eliciting opinions of the most pressing issues to be addressed.

While the responses were disproportionately from the northern half of the region, several universal issues were mentioned:

- Population growth placing increasing demands on water supplies—especially on aquifers in areas dependent on groundwater—coupled with concern about the sustainability of these resources. Even in the southern end of the region, development encroaching from the Houston Metropolitan Area has begun to prompt concern.
- Export of Colorado River water outside of the basin has been perceived as a threat by many stakeholders.
- Adequate flows for instream uses and maintaining the health of coastal bays and estuaries.
- Recycling of wastewater flows as a means of making better use of resources; and the associated impact to potentially reduce anticipated instream flows available to downstream users.

Several respondents mentioned support for rainwater harvesting, the difficulties of small systems, areas where no water conservation district has been formed yet, the need to take economic impacts of recreational uses into account, and the importance of conservation (all public water systems are now required to have plans phased in, although when the study was conducted many did not).

Table 7.3 presents the water issues and problems for the RWPG's assessment of the relevant county and regional issues based on the survey summary responses as well as the planning group members' own knowledge of the region.

These issues remained important throughout the planning effort, although they were not always at the forefront of discussion. For example, the population projections prompted strong concerns in many jurisdictions within the region, especially growth in the "County-Other" category within the Hill Country counties.

Table 7.3: LCRWPA Water Issues and Problems

County	City/Area	Issue/Problem
Bastrop	Bastrop	Lack of dependability of alluvium aquifer during severe drought.
	Aqua WSC	Inadequacy of water distribution system to meet high growth.
	County Wide	Over development of Carrizo-Wilcox aquifer by new water users within and outside of county + C23.
Blanco	County Wide	Inadequacy of Trinity Group aquifer to meet water needs of rapidly growing rural population.
	Blanco	Lack of dependability of Blanco River Dams during severe drought.
Burnet	County Wide	Inadequacy of Trinity Group aquifer to meet water needs of rapidly growing population.
Colorado	County Wide	Inadequacy of Colorado River to meet long-term irrigation water needs.
Fayette	County Wide	Local inadequacy of local groundwater to meet domestic water needs.
	County Wide	Poor quality groundwater for some rural water users.
Gillespie	County Wide	Inadequacy of local aquifers to meet water needs of rapidly growing pop.
	County Wide	Groundwater quality deterioration.
	Fredericksburg	Inadequacy of local aquifers to meet water needs of rapidly growing pop.
Hays	Northern	Inadequacy of Trinity Group and Barton Springs /Edwards aquifers to meet water needs of rapidly growing population. Threats to water quality from development in the contributing and recharge zones of the Barton Springs /Edwards aquifer.
Llano	County Wide	Inadequacy of local groundwater to meet water needs.
	Llano	Lack of dependability of Llano River Dams during severe drought.
Matagorda	County Wide	Inadequacy of Colorado River and Gulf Coast aquifer to meet irrigation water needs.
Mills	County Wide	Inadequacy of Colorado River and aquifers to water needs.
	Goldthwaite	Inadequacy of off-channel storage reservoirs to meet water needs.
	County Wide	Periodic high salinity of Colorado River water.
San Saba	County Wide	Inadequacy of groundwater to meet water needs of growing rural population.
	County Wide	Poor quality groundwater for some rural water users.
Travis	Rural Areas	Inadequacy of local groundwater to provide water for growing rural pop.
	All Municipalities	Assured water supply for long-term future growth. Water and Wastewater Infrastructure expansion.
	Southwest	Inadequacy of Barton Springs-Edwards aquifer to provide water for growing suburban/rural population. Threats to water quality from development in the contributing and recharge zones of the Barton Springs /Edwards aquifer.
Wharton	County Wide	Inadequacy of Colorado River and Gulf Coast aquifer to meet irrigation water needs
Williamson	Austin	Assured water supply for long-term future growth. Water and Wastewater Infrastructure expansion.
All Counties	--	Export of Colorado River Water Outside the basin. Adequate flows for instream flow and estuarine inflow needs. Water reuse and return flows.

7.4.2 Unique Stream Segments and Reservoir Sites Survey

In addition to the four public meetings shown below in Table 7.4 Public Meetings and Hearings, the Unique Stream Segments and Reservoir Sites Committee (USS/RSC), led by LCRWPG member Jim Barho, mailed more than 800 surveys to stakeholders throughout the region to obtain public opinion on specific recommendations for potential USS/RS designations. Stakeholders included Lake/River Advisory Panel members, Water Councils, environmental groups, local government officials, and county extension agents.

The survey asked respondents to prioritize the criteria for establishing ecologically unique river and stream segments (criteria: contribution of segment to biological, hydrological, riparian conservation, water quality/exceptional aquatic life/aesthetic, and threatened and endangered species/unique communities factors). The survey also asked for suggestions for specific stream segments to be considered, as well as for sites uniquely suited for reservoirs.

The committee received 57 responses, including several from organizations such as the Bastrop County Environmental Network (BCEN), the Burnet County Water Council, the Bull Creek Foundation, and the Fox Crossing Water District, among others.

Survey respondents identified many of the committee's initial listing of 20 potential stream segments and 29 potential reservoir sites.

The criteria prioritization question elicited a broad range of opinion, but overall the average scores for each of the five criteria (with 1 representing the top priority and 5 representing the lowest priority) were as shown in Table 7.4:

Table 7.4: USS/RS Criteria Prioritization

Criterion	Mean Ranking
Hydrological Function	2.00
Water Quality	2.17
Biological Function	2.92
Riparian Conservation	3.21
Threatened & Endangered Species/Unique Communities	4.46

7.4.3 Benefit Prioritization Survey

The members of the public who attended a monthly RWPG meeting in Columbus on 10 November 1999 were offered the opportunity to complete a feedback form that asked them to prioritize the benefits that might be gained from a new Regional Water Plan or to specify other benefits not yet envisioned by the Planning Group.

Fourteen surveys were returned, with the following results (Table 7.5). Because a "1" indicated first priority, the higher the average number, the higher the priority.

Table 7.5: Regional Water Plan Benefit Prioritization

Benefit	**Mean Ranking**	**Standard Deviation***
Protect water quality	2.8	2.6
Conservation	3.9	2.5
Seek ways to use new technologies to improve water supplies	4.4	3.0
Affordability; low water rates	5.1	2.3
Maintaining a diversity of living options--rural, semi-rural, suburban, and urban	5.7	3.1
Environmental protection	5.7	3.3
Preserve water within the region, rather than sharing the resource or selling water to neighboring regions	6.5	3.0
Water resources for recreation and amenities to enhance our quality of life	6.8	1.8
A reliable, unrestricted water supply to support the economy	7.1	2.9
Address the needs of the hundreds of small water systems	7.4	2.7
Other (please specify: *erosion control in the watershed to prevent silting of lakes and reservoirs*)	*one suggestion*	

* *The standard deviation indicates how far individual rankings were from the average, that is, how much people disagreed about the appropriate ranking. The larger the standard deviation, the broader the disagreement there was regarding what ranking a benefit should have.*

The summary above shows that this group of respondents on average placed the highest priority on protecting water quality, promoting conservation measures, and seeking ways to use new technologies to improve water supplies. By the same token, relatively low average priority ranking was assigned to addressing the needs of small water supply systems, helping to ensure a strong economy, and protecting and enhancing recreational opportunities.

Respondents were in most agreement regarding the relative ranking that protecting recreation and amenities and promoting conservation measures should have. In other words, people generally agreed that conservation merits high priority and that recreational or quality-of-life uses should have relatively low priority.

7.4.4 Water User Group Service Area and Type Survey

In late 1998, the LCRWPG mailed surveys to more than 300 water utilities and large-volume independent water user groups throughout the region requesting that they provide or confirm information regarding the size and boundaries of their service areas, and the types of customers they serve. This gave these core stakeholders an opportunity to communicate directly with the RWPG and to fill in data missing from existing records.

Seventy-three responses were received, many with accompanying maps, as well as verbal descriptions of the nature of the service area or groups served. Reporting and planning information has been updated to reflect these responses.

7.5 STAKEHOLDER FUND-RAISING

To further involve the broad range of stakeholders affected by the regional water planning effort, the LCRWPG mailed a fund-raising letter to all water user groups that consume more than 1,000 acre-feet of water annually, as well as to County Judges and municipalities throughout the region. Planning Group members followed up these letters with personal telephone calls and contacts to increase the interest of these stakeholders in the public process.

In addition to the substantial contributions made by the organizations represented on the Regional Water Planning Group itself, a total of more than $30,000 in cash and in-kind contributions were donated. This money was used to fund public involvement activities such as the additional public meetings the Planning Group hosted (SB 1 guidelines requires a minimum of one hearing).

This fund was used to place display ads for the final public meetings and the public hearing in 26 newspapers and to place 40 spots on two radio stations with wide coverage. Meeting costs for the final meetings were also defrayed by these funds. Some funds remained, which the LCRWPG voted to pass on to the incoming Planning Group.

The list below indicates organizations and individuals who made monetary and/or in-kind contributions to this effort.

County	Contributing Entity
Bastrop	Bastrop County WCID #2
Bastrop	City of Elgin
Bastrop	City of Bastrop
Bastrop	Bastrop County
Bastrop	City of Smithville
Blanco	Blanco County
Burnet	Capitol Aggregates, LTD.
Burnet	City of Bertram - Water Department
Burnet	Cold Spring Granite (Texas Granite Corp.)
Colorado	City of Columbus
Fayette	Fayette Water Supply Corp.
Fayette	City of Schulenburg
Gillespie	City of Fredericksburg
Gillespie	Gillespie County
Gillespie	Tully Currie
Hays	Cimarron Park Water Co., Inc.
Hays	Dripping Springs Water Supply Corp.

County	Contributing Entity
Llano	City of Llano
Matagorda	HL&P (STP Nuclear Operating Company)
Matagorda	Minze Agriculture Partnership
Matagorda	Matagorda County
Matagorda	Celanese, LTD
Matagorda	City of Bay City
Matagorda	Texas Brine Company, LLC
Mills	Don or Martha Burnham
Mills	City of Goldthwaite
Mills	Mills County
San Saba	City of San Saba
San Saba	Waco Creek Ranch
San Saba	Richland Special Utility District
Travis	AquaSource Inc./Central Texas
Travis	Austin White Lime Company
Travis	Arroyo Doble Water System Inc.
Travis	Arlene Bolm Fitzpatrick, et al.
Travis	Creedmoor-Maha Water Supply Corp.
Travis	City of Austin
Travis	City of Rollingwood
Travis	Coca-Cola Enterprises
Travis	Travis County WCID #10
Travis	Travis County WCID #17
Travis	Travis County WCID #19
Travis	Travis County WCID #19
Travis	Travis County WCID # 20
Travis	Lakeway M.U.D.
Travis	Village of Bee Cave
Travis	City of Lago Vista
Travis	City of Lakeway
Travis	University of Texas at Austin
Travis	Hornsby Bend Water Utility Co.
Travis	Jonestown Water Supply Corp.
Travis	Barton Creek Water Supply
Travis	Hurst Creek MUD
Travis	River Place MUD
Travis	Windermere Utility Company
Travis	Onion Creek Country Club
Travis	Travis County WCID
Travis	Lost Creek M.U.D.

County	Contributing Entity
Travis	Glenlake Water Supply Corp.
Travis	Motorola
Wharton	Jochetz Farm, Charlie F. Jochetz, et al.
Wharton	County of Wharton
Wharton	Macha Farms, Leroy Macha, et al.
Wharton	City of Wharton
Wharton	SWK Land Co.
Wharton	Wharton County WCID #2
Williamson	Anderson Mill M.U.D.
Williamson	Williamson County
Williamson	Manville Water Supply Corp.

7.6 INTERNET WEB PAGE AND FACT SHEETS

Internet communications included the listing of meeting locations and times, providing draft chapters of the LCRWPG's Initially Prepared Regional Water Plan, and technical background data that will comprise appendices to the Lower Colorado Regional Water Plan once it is completed. As this report goes to press, LCRA continues to develop web content related the regional and interregional planning process.

A basic fact sheet developed by the TWDB describing the SB 1 planning process and the Lower Colorado Region (Region K) was used in presentations and was available at LCRWPG meetings and hearings. Once outlines of the proposed strategies for meeting many of the region's water supply shortages had been adopted, the LCRA prepared two fact sheets explaining the features of the proposal.

Examples of the initial fact sheet and the proposed strategies fact sheet appear in Appendix 7A.

7.7 IRRIGATION WATER SUPPLY WORKING GROUP

Because irrigated agriculture at the lower end of the Colorado River Basin was identified early on as one of the use groups to suffer water supply shortages that the Lower Colorado Regional Water Plan would need to remedy, a special working group was formed. This group included representatives from the Coastal Plain counties of Matagorda, Wharton, and Colorado.

The RWPG members involved in the working group held their first meeting with irrigators in August 1999 to describe the projected water supply shortfalls during drought-of-record conditions. At this meeting they also began to narrow the range of alternative approaches for devising workable strategies to those that the irrigators felt had a good chance of practical application.

The Planning Group members also invited agricultural experts to participate in the meetings and to work directly with them in seeking solutions. After the initial meeting with irrigators, RWPG members continued to consult with experts to work toward quantifiable means of eliminating the projected shortages.

A second major meeting was held with the Irrigation Water Supply Working Group on 8 May 2000 to review and prioritize strategies and economic data. This enabled both the participating LCRWPG members and the irrigation stakeholders to discuss issues related to the proposed solution and to begin to develop a broader view of its implications.

7.8 PUBLIC HEARINGS AND OTHER PUBLIC MEETINGS

In addition to the meetings shown earlier in Table 7.1, several meetings were held for the primary purpose of gaining public input and answering questions from the public. This included four public hearings (one of which was required by SB 1) and three public meetings for comment on the *Initially Prepared Draft Plan,* and one public hearing as required by SB 1. All of these are summarized in Table 7.6 below.

The public hearings were advertised throughout the region in legal ads as required by SB1. For the public hearing and public meetings for review and comment on the *Initially Prepared Draft Plan,* display advertisements were placed in more than a dozen newspapers throughout the region and 40 radio spots were purchased. In addition, news releases were issued and personal contacts made with publications to garner further coverage. A printed copy of the public hearing presentation appears in Appendix 7A.

LCRA sponsored an additional series of eight meetings throughout the region to explain the concepts and features of the *Initially Prepared Draft Plan* for which it provided its own publicity, a video, and other materials. Reporting from LCRA meetings for which information was available is included in Table 7.6 below.

Table 7.6: Public Hearings and Other Public Meetings

Date	Location	Sponsor	# Attending	Comments
5/27/98	M.D. Anderson Science Park, Bastrop Co.	LCRWPG	44	Attracted participants from throughout the region;
6/3/98	City of Burnet, Burnet Co.	LCRWPG	110	Support for brush control; concern about hidden agendas;
6/17/98	City of Eagle Lake, Colorado Co.	LCRWPG	20	Concern about agricultural water supplies;
8/11/99	Bay City, Matagorda Co.	USS/RSC*/ LCRWPG	36	Concern about how designation as a unique stream segment/reservoir site might affect property rights;
9/22/99	City of Burnet, Burnet Co.	USS/RSC*/ LCRWPG	98	Concern regarding how property rights and taxation would be affected by USS/RS designations; some support for unspecified water storage at the upper end of the region.
11/4/99	Texas Parks & Wildlife HQ, Travis Co.	USS/RSC*/ LCRWPG	15	Suggestions for Barton Creek, portions of Onion Creek as potential USS designations;
11/10/99	City of Columbus, Colorado Co.	USS/RSC*/ LCRWPG	160	Strong opposition voiced to designation as Cummins Creek or Shaw's Bend as potential reservoir sites;
7/18/00	LCRA Western District Complex	LCRA	N/A	N/A
7/20/00	Hinze's Bar-B-Que, Wharton Co.	LCRA	N/A	N/A
7/24/00	City of Burnet, Burnet County	LCRA		Mistrust of San Antonio and durability of a water contract with it. Some support for financing improvements within region.
7/25/00	City of Lakeway Activity Center, Travis Co.	LCRA		Support exists, but conditional on ensuring no environmental damage and on limiting total. Concerns that growth is taken for granted, conservation plans may not work. Lakeway Mayor supports plan.
7/27/00	City of La Grange, Fayette Co.	LCRA	130	General support in hopes of it being "insurance" against development of Shaws Bend. Concerns regarding groundwater mining causing subsidence, other impacts. Prefer Bay City diversion.

Date	Location	Sponsor	# Attending	Comments
7/28/00	Bay City, Matagorda Co.	LCRA	38	Concerned about aquifer mining subsidence. Unsure of ability to limit San Antonio's access to groundwater. Fear serious impact to bays and estuaries.
8/13/00	McKinney Roughs Complex, Bastrop Co.	LCRWPG	28	Question regarding ownership of water and financial gain of those owning land covered by off-channel reservoirs
8/21/00	LCRA Western District Complex	LCRA	N/A	N/A
8/28/00	Travis County Precinct 2	LCRA	N/A	N/A
9/13/00	City of Bastrop, Bastrop Co.	LCRWPG		Support for the plan from most of those commenting. Concerns regarding groundwater production of groundwater in Lee and Bastrop counties and its potential impact on water levels. Concerns about the discrepancies between analyses of models of the Carrizo aquifer and the competing methodologies used.
9/20/00	City of Wharton, Wharton Co.	LCRWPG		Groundwater impact concerns, especially the inability to predict impacts. Concerns regarding groundwater districts and related taxation. Impacts on City of Wharton flood control and groundwater issues. Suggestion to consider constructing reservoirs in Hill County.
9/23/00	City of Lakeway Activity Center, Travis Co.	LCRWPG	30	Questions about how the numbers add up given the combination of "new sources".
9/27/00	City of Burnet, Burnet Co.	LCRWPG	155	Concern for limiting San Antonio's access and the size and permanence of transfers. Concern for property rights, LCRA encroachment and expanding purview.

**Unique Stream Segments and Reservoir Sites Committee of the Planning Group*

Examples of fact sheets, frequently asked questions regarding the proposed strategies, additional detail regarding news coverage, and a printed copy of the public hearing presentation appears in Appendix 7A.

APPENDIX 7A:

EXAMPLE MATERIALS

- Example Web Page
- Initial General Fact Sheet with Frequently Asked Questions
- Proposed Strategy Fact Sheet (Sharing Resources)
- Environmental Protection Fact Sheet
- LCRWPG Survey Letters and Questionnaires
- General Presentation Materials
- Public Hearing Presentation
- Public Hearing Notice

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES

APPENDIX 7B:

PUBLIC COMMENTS AND LCRWPG RESPONSES

LOCATED IN VOLUME II OF THE LCRWPG REGIONAL WATER PLAN - APPENDICES