Texas Comptroller *of* Public Accounts

Susan Combs

February 4, 2009

Ladies and Gentlemen:

As Texas' chief fiscal officer, I am committed to creating an environment that encourages the Texas economy to grow and thrive. One of my responsibilities is to analyze factors affecting the state's economy. Access to reliable sources of abundant clean water plays a key role in determining the future success of Texas' economy and the health of our citizens.

Our office presents the *Liquid Assets: The State of Texas' Water Resources*, which discusses the current and future water resources in Texas, the practical and policy barriers faced by local and state water planners and the possible funding mechanisms that could be tapped to develop our water resources. The report also provides information on the current status of water management strategies in the 16 water planning regions in the state. State and regional decision makers will be able to use this report as a tool to drive sound and prudent water policy in the state.

This report evaluates the progress Texas is making in securing water resources for the future. Texas' water resources are diverse and ever changing, since they are based upon climatic and demographic fluctuations. Drought is an ever-present concern in many parts of the state, leading to pressure on our water infrastructure. Texas' population is growing at nearly twice the national rate and it is estimated that by 2060 there will be more than 46 million people living in Texas, and the state will need ample water supplies to serve them. According to the Texas Water Development Board demand for water will increase 27 percent by 2060 and if demand is not met it could cost businesses and workers in the state approximately $9.1 billion per year by 2010 and $98.4 billion per year by 2060.

Our economy always has and always will rely on clean and abundant water supplies. In addition, state and local leaders must recognize that how they define ownership of groundwater could have enormous economic consequences for property owners statewide. Important financial decisions have been based on the belief by landowners that the water under their land is in fact their "property." A change in this system could have very significant and adverse financial consequences for individuals as well as for the economic vitality of the state. *Liquid Assets: The State of Texas' Water Resources* will help all Texas citizens understand the importance of reliable water resources and what is being done now and in the future to ensure those resources.

Our office stands ready to assist communities, businesses and lawmakers in their efforts to ensure our state has the necessary water resources to continue our way of life. Together we can guarantee that Texas' water resources remain plentiful for future generations.

Sincerely,

Susan Combs

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Introduction

Water is not only essential to life, it is essential to our way of life. Moreover, it has no substitute. Without it, our bodies won't function, food crops won't grow, livestock and wildlife won't thrive, electricity can't be generated, and industries and communities can't grow.

The lack of water is costly. Each of the several one- or two-year droughts in Texas in the past decade has cost agricultural producers and businesses impacted by them between $1 billion and $4 billion annually.[1] The infamous eight-year drought in the 1950s, the drought of record against which all droughts in Texas are measured, is estimated to have cost the Texas economy about $3.5 billion in 2008 dollars each year from 1950 to 1957.[2]

In 2002, an agency of the United Nations (U.N.) estimated that 5 billion people in the world would face severe water shortages by 2025 if demand continues at current rates. The resulting effects of these shortages could be crop failure, increased likelihood of disease and, in the extreme, threatened stability of affected governments.[3] While Texas may avoid some of the most severe consequences anticipated by the U.N., water shortages in Texas could still threaten the economy and public health of the Lone Star State.

Historically, more people across the world have lived in rural areas than urban ones, and they depend on more diffuse sources of water. By 2020, however, urban dwellers worldwide will outnumber those living in rural areas.[4] As

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Blanco River near Luckenbach, Texas.

people concentrate, so does their need for water, making it increasingly difficult for communities worldwide to provide sufficient amounts of water for their residents.

Texans face the same challenges as the global community. The state's population is expected to nearly double by 2060 and will also become more urban.[5] Total statewide demand for water in Texas is projected to grow 27 percent, from nearly 17 million acre-feet in 2000 to 21.6 million acre-feet in 2060. From 2010 through 2060, water supplies from existing sources are expected to decrease by 18 percent, from 17.9 million acre-feet to 14.6 million acre-feet.[6] Without a significant, persistent climatological change that brings increased moisture, this growth is likely to mean that more people will live with less water. Ensuring reliable water supplies for the future, and balancing those supplies appropriately between rural and urban areas, and among agricultural, municipal, industrial and electricity-generating users is the challenge of our day.

To meet that challenge, Texas legislators established a comprehensive water planning process in 1997 which assesses current and future needs in each of the state's 16 Regional Water Planning Groups (RWPGs), identifies potential solutions

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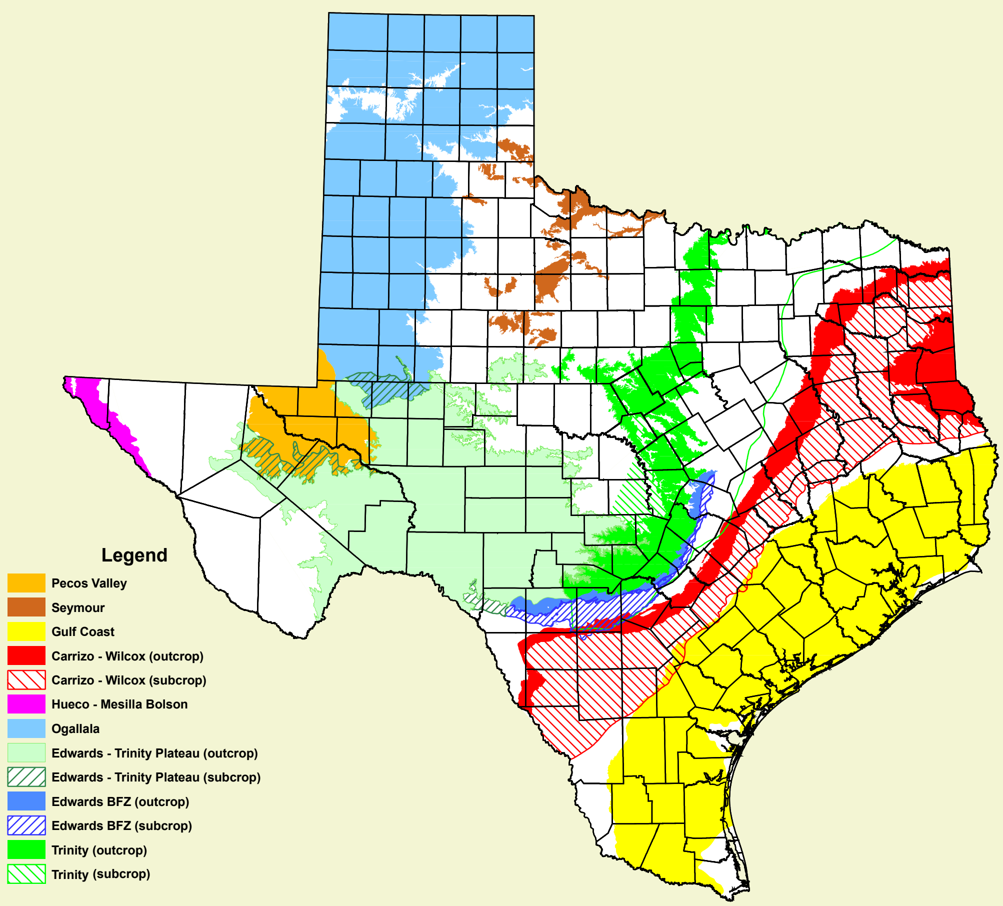
Exhibit 1

Major Texas Aquifers



Sources: Texas Water Development Board.

Exhibit 2

Major River Basins of Texas

Source: Texas Water Development Board.

and estimates their cost, culminating in a State Water Plan updated every five years.[7] *Liquid Assets: The State of Texas' Water Resources* evaluates the progress that Texas has made toward developing sustainable water supplies since the issuance of the 2007 State Water Plan, with particular emphasis on identifying policy and funding barriers impeding that progress.

Water Supply and Demand in Texas

The Texas Water Development Board (TWDB), the state agency responsible for providing "leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas," estimates that groundwater provides 59 percent of all available fresh water in the state, with surface water providing the nearly 40 percent, and the remaining 1 percent coming from both ground water and surface water reuse projects. Unfortunately, both water sources are decreasing — the former due to pumping in excess of recharge, and the latter primarily because of sediment accumulation in reservoirs.[8] **Exhibits 1** and **2** show the major aquifers and river basins in Texas.

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Exhibit 3

Estimated Per Capita Water Use, 2000-2060

40 Largest Texas Cities Ranked by Gallons Used Per Day Per Person in 2060

City	2000	2020 (est.)	2040 (est.)	2060 (est.)
Richardson	282	278	274	272
Dallas	262	262	257	256
Plano	256	253	250	249
Tyler	261	255	249	248
Midland	262	254	248	247
McKinney	220	244	242	242
Irving	220	223	218	217
Brownsville	229	221	217	216
College Station	225	217	213	212
Sugar Land	221	214	211	211
Fort Worth	215	207	203	202
Amarillo	256	201	201	201
Beaumont	216	209	203	201
Lubbock	181	202	196	195
Odessa	208	202	195	194
McAllen	205	197	193	192
Round Rock	201	194	191	191
Laredo	200	192	189	188
San Angelo	162	193	187	186
Waco	183	183	183	183
Carrollton	189	188	184	183
Denton	189	179	176	176
Arlington	165	179	175	174
El Paso	184	176	171	170
Lewisville	167	173	171	170
Austin	175	173	171	169
Wichita Falls	188	172	170	168
Killeen	132	179	174	167
Corpus Christi	179	171	166	165
Garland	159	160	156	155
Abilene	304	161	155	154
Mesquite	160	157	153	152
Houston	159	152	147	146
Harlingen	156	149	144	143
Grand Prairie	153	145	142	141
Bryan	147	140	135	134
San Antonio	147	139	135	134
Baytown	147	140	134	133
Longview	127	120	115	115
Pasadena	117	110	105	104
Average	195.2	189.1	185	183.9

Note: Water use projections from 2020 through 2060 rely on per capita use in 2000 as a baseline. According to TWDB, 2000 was a hot and dry year when much of the state was experiencing a drought. Consequently, year 2000 water use tended to be relatively high across the state.
Source: Texas Water Development Board.

Based on current conditions, TWDB models suggest existing groundwater supplies provide 8.5 million acre-feet. As the state's major aquifers are used increasingly for irrigation, municipal and industrial use, TWDB projects a 32 percent decline in supply from 8.5 to 5.8 million acre-feet by 2060.[9]

As of 2010, Texas is projected to have approximately 13.3 million acre-feet of total surface water available during times of drought, although some 20 million acre-feet are permitted for consumption annually. According to TWDB, only 9 million acre-feet of this amount can be considered existing supply due to legal and other constraints. By 2060, in periods of drought surface water sources are expected to decrease 7 percent, from around 9 million acre-feet to 8.4 million acre-feet.[10] This decline in supply will be the result of reservoir sedimentation, a process in which eroded sediments accumulate in reservoirs, eventually making the reservoirs shallower. In 2060, the total amount of surface water is projected to decrease to approximately 13.1 million acre-feet in non-drought conditions.[11]

While water supplies decrease, demand is expected to increase due largely to population growth. Per capita use among the 40 largest cities in Texas in 2000 averaged just over 195 gallons per day per person, while conservation recommendations aim to reduce demand by 1 percent annually to reach a future statewide average of 140 gallons per capita per day.[12] However, TWDB's projections based on the 40 largest Texas cities suggest that conservation efforts will be far short of that mark. It should also be noted that basic projections of per capita water use do not take into account water conservation strategies, which are anticipated for most cities in 15 of the 16 regions **(Exhibit 3)**.[13]

In addition to conservation, increased efficiency in delivery of water, especially for agricultural uses, is critical to the future of Texas.

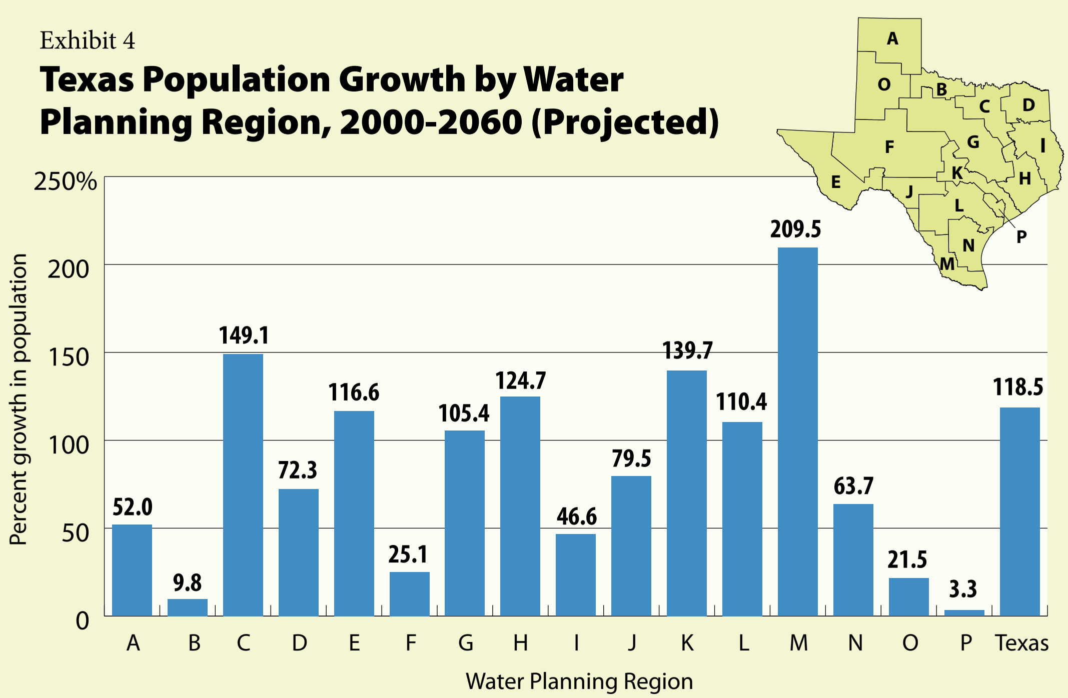
Demographics and Future Water Needs

According to projections from TWDB and the Texas State Data Center, the Texas population will more than double between 2000 and 2060,

The Texas population will more than double between 2000 and 2060, from 21 million to 46 million people.

Exhibit 4

Texas Population Growth by Water Planning Region, 2000-2060 (Projected)



Source: Texas Water Development Board.

from 21 million to 46 million people. This growth will vary widely across the state. **Exhibit 4** shows population growth across the 16 water planning regions. Eight regions, which include most of the state's metropolitan areas, are expected to at least double in population during this period. The population in Region M, which includes Brownsville-Harlingen, Laredo and McAllen, is expected to triple during this period.

Demand for water will not increase as rapidly as population growth, largely due to decreases in irrigation. Demand growth for water will come from the municipal sector (which is made up primarily of household and commercial uses), doubling from 4 million acre-feet to 8.3 million acre-feet **(Exhibit 5)**. Water use for irrigation is expected to decline from 10.2 to 8.6 million acre-feet during this period due to more efficient irrigation systems, reduced groundwater supplies and transfer of water rights from agriculture to municipal uses, according to TWDB.[14] Overall existing water supplies are projected to decrease from 17.9 million acre-feet in 2010 to 14.6 million acre-feet in 2060, an 18 percent drop. The overall existing water supplies consist of the amount that can be produced with current permits, current contracts and the existing infrastructure during droughts.[15]

Texas does not have enough water now to fulfill all of its estimated future needs. If new management and conservation strategies are not implemented, water needs will increase from 3.7 million acre-feet in 2010 to 8.8 million acre-feet in 2060 (**Exhibit 6**). These water shortages would leave 85 percent of the Texas population in 2060 with insufficient supplies.

Insufficient water supplies can harm the Texas economy in a number of ways. According to TWDB, "without water, farmers cannot irrigate, refineries cannot produce gasoline, and paper mills cannot make paper." Economically, insufficient water supplies could cost Texans $9.1 billion in 2010 and $98.4 billion in 2060. State

If new management and conservation strategies are not implemented, water shortages would leave 85 percent of the Texas population in 2060 with insufficient supplies.

San Antonio and the Edwards Aquifer: Striking a Groundwater Balance

Dependent upon the abundant Edwards Aquifer for more than a century, the growing city of San Antonio and neighboring cities and rural areas have made a concerted effort in recent years to lessen their use of water from the Edwards.

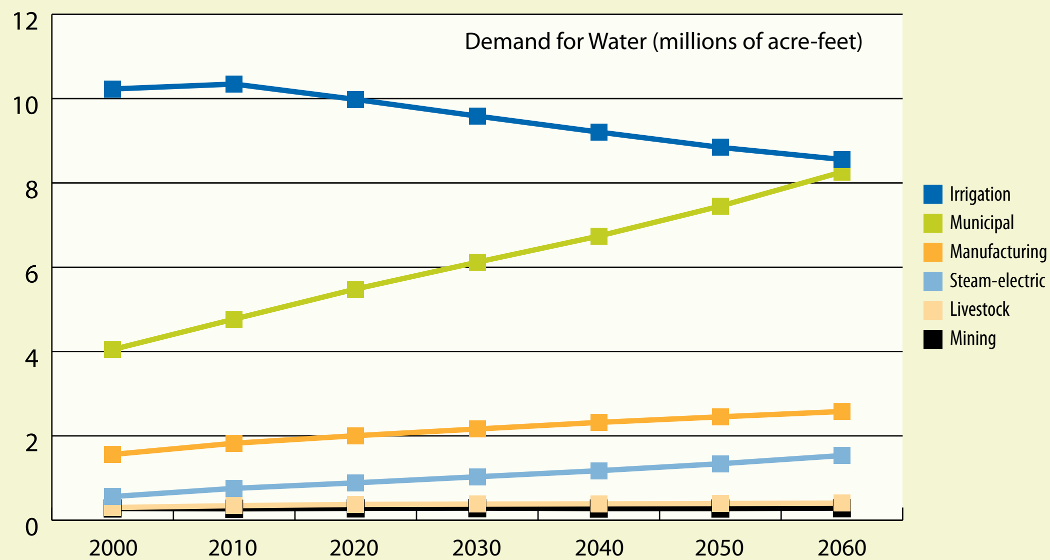
The Edwards Aquifer provides water to many people throughout the Hill Country, not just San Antonio. The area has experienced tremendous growth in recent years, and water use has been apportioned carefully. After many legal proceedings, the Edwards Aquifer Authority, operating since 1996 as a successor to the Edwards Underground Water District established in 1949, was created to regulate water withdrawals from the aquifer, protect endangered species and preserve the aquifer for future generations.[17]

Adding to the management issues of the Edwards are concerns with hydrogeology. Even though the aquifer recharges readily, it cannot recharge without rain, sometimes a rare commodity in Central Texas. Continued pumping from the Edwards has exacerbated droughts in previous years. San Antonio city leaders realized that the city's long-term viability could not be assured with a water source that fluctuated dramatically. As a result, the city, the San Antonio Water System and others have focused on conservation and are considering obtaining rights to more reliable surface waters from the Lower Colorado River Authority and the Guadalupe-Blanco River Authority.

San Antonio's efforts to use water from outside its metropolitan area have had some interesting policy and political consequences. In 1997, the "junior water rights provision" of Senate Bill 1 strongly limited future efforts to export surface water from outside its basin of origin, a management tool known as interbasin transfer, or IBT (see Section 3). At the same time, neighboring counties feared the city would pump and export groundwater from their county, so several created groundwater conservation districts to restrict such activity. Although the city continues to wean itself from the Edwards Aquifer, it faces several formidable challenges in its pursuit of replacement water sources.

Exhibit 5

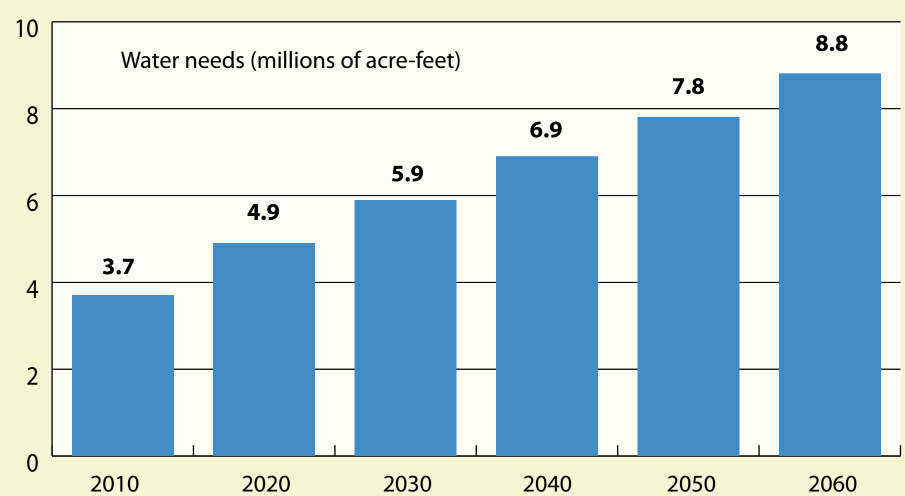
Texas Projected Water Demand by Category, 2000-2060



Sources: Texas Water Development Board.

Exhibit 6

Texas Projected Water Needs in Times of Drought, 2010-2060



Sources: Texas Water Development Board.

Georgia's Drought Crisis

Georgia has been experiencing a severe drought that has caused significant harm to that state's economy. In testimony before a Congressional field hearing in March 2008, the General of the area U.S. Corps of Engineers stated that lakes in Georgia, Alabama and Florida were for the first time experiencing "negative inflows," meaning that "there was more water leaving the system through evaporation than was…coming into the system" through rainfall.[18]

Water management in Georgia is very different than in Texas because the management of certain lake waters include laws that require water releases to protect endangered species downstream in Alabama and Florida. Business interests affiliated with West Point Lake in northwest Georgia estimated that diminished economic activity resulting from the low water level at West Point Lake cost between $800 million and $1.1 billion for 2006-07.[19] Of the state's 159 counties, 40 were in moderate to extreme drought as of October 2008.[20] The cities of Atlanta, Athens, Augusta, Columbus and Macon are engaged in significant water conservation efforts.[21]

A report published in 1959 cited an estimated cumulative agricultural loss in Texas from 1950 to 1956 to be in excess of $3 billion per year in 2008 dollars.

government could lose $466 million in tax revenue in 2010 and up to $5.4 billion by 2060 due to decreased business activity as a direct result of insufficient supply.[16]

New management and conservation strategies identified by the regional planning groups in the State Water Plan could add 9 million acre-feet of water supply by 2060. However, even with these new water supplies, while some regions will have their projected demands met, other regions in Texas will have unmet needs because cost-effective strategies to increase supply could not be identified.[22]

The Economic Consequences of Drought

The American Meteorological Society defines drought as "a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area."[23] Droughts can be *meteorological* (less than normal precipitation), *agricultural* (soil moisture insufficient to grow crops), *hydrological* (below normal surface and subsurface water supplies) and/or *socioeconomic* (when water shortages begin to affect daily life).[24]

Policymakers look to the "drought of record" as a yardstick for estimating water needs during future droughts. The first drought of record was the Dust Bowl of the 1930s, which covered 70 percent of the U.S. An even more severe drought during the mid- 1950s hit Texas particularly hard.[25] This one was called "the worst drought in recorded history" by the former Texas Water Commission.[26] Today this drought of record is used as a model for the worst-case scenario in most regional and state water plans.

Climatologists studying tree rings and other indicators of past rainfall have discovered that a Dust Bowl-scale drought is likely once or twice a century, continuing a 400-year-old pattern. In the past 800 years, two North American droughts of 20 to 25 years in length occurred.[27] So not only are droughts likely to be frequent in the future, they could also persist long enough to cause severe socioeconomic repercussions. Should global climate change reduce rainfall and increases surface water evaporation as many experts fear, the impact could be even worse.

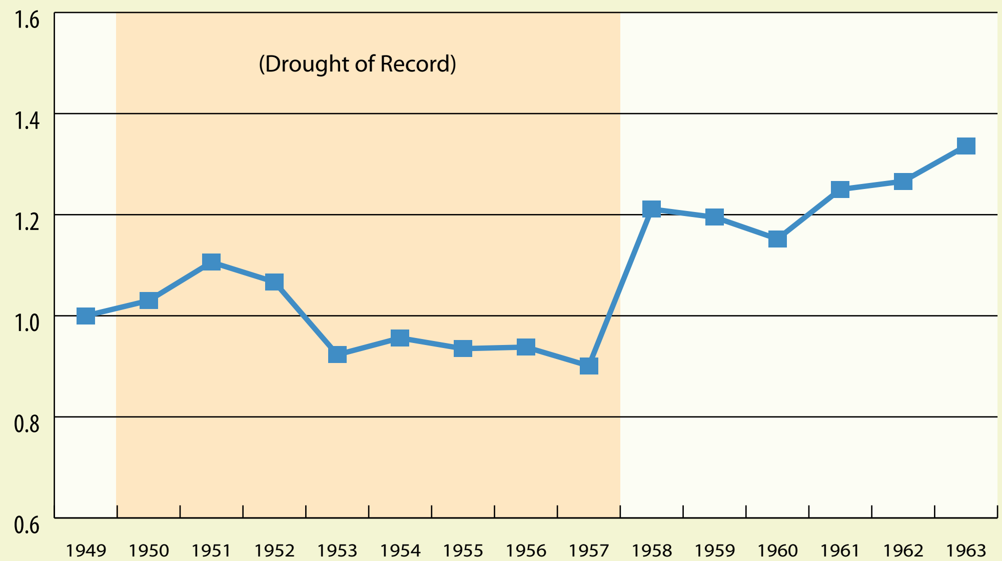
While water planners throughout the state prepare for a future drought of record, history has demonstrated repeatedly that many droughts end, rather ironically, with the appearance of hurricanes, tropical storms and other flood events.[28] So, while we plan for too little water, we must also plan for too much.

Drought losses are felt first, most often and most severely in the agricultural sector. The economic impact of the 1950s drought can be drawn indirectly by studying meteorological or agricultural production data of the time. A report by the Texas Board of Water Engineers, published in 1959,

Exhibit 7

Texas Farm Gross Cash Income Index 1949-1963

1.0 = $1 in 1949



Note: Annual values are indexed to 1949 dollars.

Sources: U.S. Bureau of Economic Analysis and Comptroller of Public Accounts.

cited an estimated cumulative agricultural loss in Texas from 1950 to 1956 to be in excess of $3 billion,[29] the equivalent of more than $24 billion, or almost $3.5 billion annually, in 2008 dollars.[30]

Exhibit 7 shows the effect that the drought of the 1950s had on net cash farm income in Texas, which excludes most governmental sources of income for farmers. Drought swept across the state starting in 1950. Within three years annual farm income decreased below 1949 levels and remained low until the drought lifted. This indicates that this severe drought had a pronounced negative impact on the agricultural sector of the Texas economy.

Data from Texas A&M University's Department of Agricultural Economics indicate that recent, less severe droughts have had significant economic effects on the state's agricultural sector. **Exhibit 8** shows the estimated losses suffered by producers during several one-year droughts in the past 12 years. Losses of $1 billion or more occurred in five separate years between 1996 and 2008.

Regional Water Planning Process

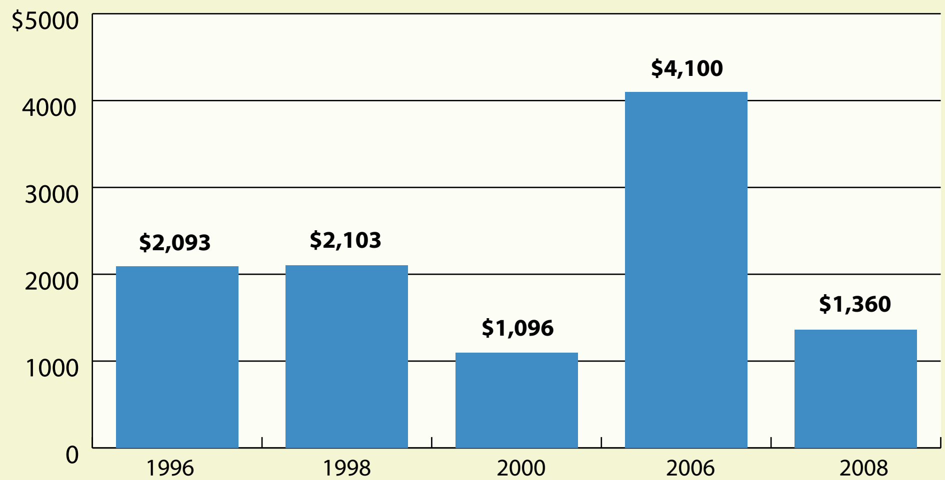
According to TWDB, the goal of the water planning process is to ensure "that Texas will have enough water in the future to sustain our cities and rural communities, our farms and ranches, our businesses and industries, and the environment."[31] Based on the state's growing population and vulnerability to drought, water planning in Texas takes on an important dimension.

In 1997, the Texas Legislature enacted Senate Bill 1, which directed TWDB to designate the areas for which regional water plans should be developed — in essence, creating 16 regional water planning groups and established a water planning process that occurs in 5-year increments and is based on a 50-year planning horizon. Under the bill, water planning in Texas is a collaborative, statewide initiative. Texas uses a "bottom-up" approach to water planning rooted in local, consensus-based decision-making. Each regional water planning group includes members representing various stakeholders, including agriculture,

Exhibit 8

Texas Agriculture Producer Losses Due to Drought, 1996-2008

(in millions)



Sources: Texas A&M University.

Providing adequate freshwater supplies for the future is a critical task that Texas must confront head-on.

industry, the environment, cities, water utilities, power companies and other interests.[32]

Using data from the Texas State Data Center and TWDB, each planning group evaluates population, water demand and water supply projections, along with potential strategies to meet demands over a 50-year planning horizon. After this process is complete, TWDB compiles regional plans from each of the 16 areas into the State Water Plan. These strategies and projects are submitted to the Legislature, along with policy recommendations needed to implement the plan. After the plan is published, the planning process repeats. **Exhibit** 9 shows the water planning regions in the state.

Conclusion

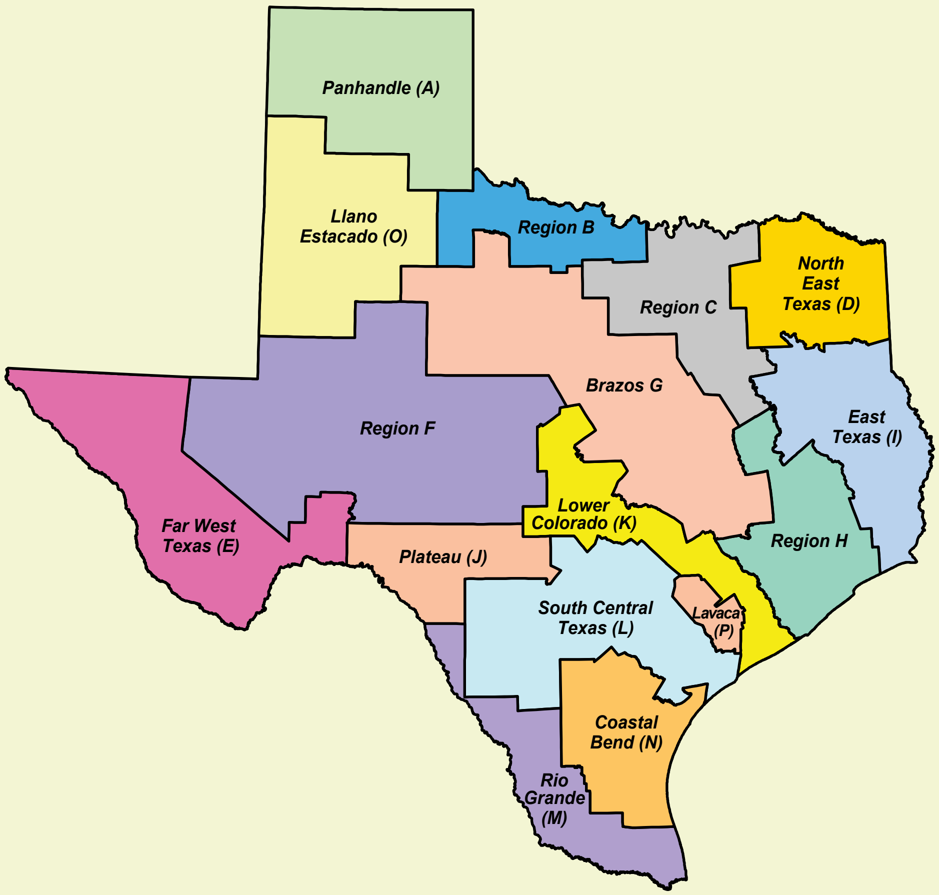
Providing adequate freshwater supplies for the future is a critical task that Texas must confront head-on. The needs are great and varied, and meeting them will be both daunting and expensive. State and local water management entities must evaluate the need for developing new water resources while at the same time determine what effect conservation efforts will have on local and statewide water supplies. In addition, these entities also must consider the impact their actions could have on a landowner's private property rights in the water on or under their land, as well as any potential economic impact.

The following sections will take a more in-depth look at the challenges facing Texas regarding water policy. *Regional Water Planning* of the report reviews the challenges faced by each of the state's 16 regional water planning groups, and provides an update on the progress each group has made in addressing its water needs.

State Water Plan: Issues and Funding looks at several of the water policy issues that need to be confronted to ensure that Texas has sufficient water in the future. This includes a look at various proposals to create a dedicated funding mechanism for water projects and an examination of water infrastructure funding mechanisms in other states.

Exhibit 9

Water Planning Regions



Sources: Texas Water Development Board.

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[9] Texas Water Development Board, *Water for Texas 2007*, Volume II, p. 176.

[10] Texas Water Development Board, *Water for Texas 2007*, Volume II, p. 138.

[11] Texas Water Development Board, *Water for Texas 2007*, Volume II, p. 172. http://www.twdb.state.tx.us/publications/reports/State_Water_Plan/2007/2007StateWaterPlan/CHAPTER%206%20FINAL_112906.pdf. (Last visited December 29, 2008.)

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[24] National Weather Service Forecast Office, "What is Meant by the Term Drought?" p. 1, http://www.wrh.noaa.gov/fgz/science/drought.php?wfo=fgz. (Last visited December 30, 2008.)

[25] Sources vary in estimating the duration of the drought of the 1950s. Some argue that the drought began in 1949, not 1950, while others say it ended in 1956, not 1957. Because droughts by their very nature are transitory and do not affect every area of the state equally, it is likely that all these dates are accurate, depending upon locally available data. For purposes of this report, the drought will be defined as beginning in 1950 and ending in mid-1957 so that it lasted a full seven years. All sources agree, however, that the drought was most severe in 1956.

[26] Texas Water Commission, *Texas Drought: Its Recent History (1931-1985)* (Austin, Texas, September 1987), p. 1.

[27] Connie A. Woodhouse and David Rind, "A 2,000-Year Record of Drought Variability in the Central United States," in *History of Drought Variability in the Central United States: Implications for the Future, United States Global Change Research Program Seminar, 25*

January 1999, (Washington, D.C. 2003) p. 3, http://www.usgcrp.gov/usgcrp/seminars/990120FO.html. (Last visited December 30, 3008.)

28 Texas Water Commission, *Texas Drought: Its Recent History (1931-1985)*, p. 1.

29 Robert L. Lowry, Jr., *Bulletin 5914: A Study of Droughts in Texas*, p. 1.

30 U.S. Bureau of Labor Statistics, "Inflation Calculator."

31 Texas Water Development Board, *Water for Texas 2007*, Volume I, p. 2.

32 Texas Water Development Board, *Water for Texas 2007*, Volume II, pp. 2-4.

Regional Water Planning

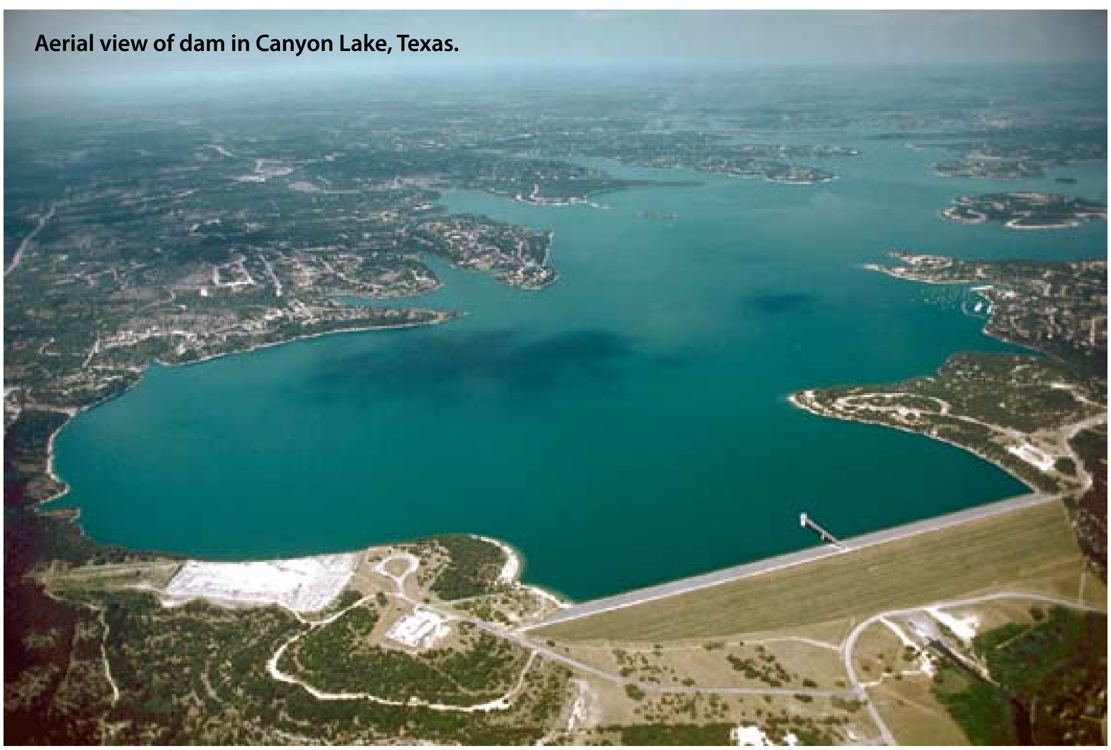
The Texas Water Development Board's (TWDB's) 2007 State Water Plan identifies 330 water management strategies from around the state that could add about 9 million acre-feet annually to the Texas water supply by 2060. Some of these strategies require significant upfront capital costs while others require users to pay fees or provide incentives for users to change their usage.

TWDB estimates that these projects — which involve new reservoirs, desalination plants and conveyance/distribution infrastructure conservation measures and increased transfers between river basins — would cost the state $30.7 billion in current dollars by 2060. To put that figure in perspective, the total fiscal 2008 state budget, including federal funds, was $85.7 billion.

TWDB also estimates that the cost of *not* implementing these strategies, assuming widespread drought conditions, would be about $9.1 billion in current dollars in 2010 and $98.4 billion in 2060. According to TWDB, if Texas fails to implement the State Water Plan, drought in 2060 could mean that up to 85 percent of Texans would not have enough water to sustain their current levels of use during a report of drought of record conditions.[1]

The economic impacts listed above are estimates based on a variety of assumptions made by TWDB and should only be considered as an approximation of what these costs could be. To generate the estimates above, TWDB assumed a drought of record occurring in every part of the state simultaneously. While not without precedent, this is an unlikely proposition. The analysis

The 2007 State Water Plan identifies 330 individual water management strategies from around the state that could add about 9 million acre-feet annually to the Texas water supply by 2060.


Aerial view of dam in Canyon Lake, Texas.

does not estimate the likelihood of a drought of record occurring or discount costs based on the likelihood of drought.

The analysis also assumes stability in water usage patterns and does not consider the effect that increasing costs for water during times of shortage may have on water usage by commercial, agricultural, residential and other users. The model used by TWDB assumes that the structure of the Texas economy will remain constant over the next 50 years, and does not predict migration of Texas citizens out of economically inefficient industries.

Finally, the analysis assumes that economic inputs such as labor move in "lockstep" with changes in output. As acknowledged by TWDB, however, there may be economic, contractual and practical reasons why a business that was negatively affected by drought likely would not layoff its employees if the drought conditions were expected to pass. Further, some employees who are laid off likely would find jobs in other sectors that were not harmed by drought, or would find employment in different part of the state. Thus, according to TWDB, "direct losses for employment and secondary losses in sales and employment should be considered an upper bound."[2]

Water Management Strategies

Each of the more than 320 water management strategies in the State Water Plan can be categorized in one of six general areas: conjunctive use, conservation, desalination, groundwater, surface water and water reuse.

Conjunctive Use

Conjunctive use water management strategies involve combining the use of groundwater and surface water in a way that optimizes the benefits of each. An example of conjunctive use is when water providers use surface water as their primary water supply and use groundwater only to meet peak needs or to supplement supplies in times of drought.

Conservation

Conservation generally involves the management of existing water supplies to reduce demand and increase efficiencies in use. The water plan contains two key types of conservation: municipal water conservation and irrigation water conservation.

Municipal water conservation strategies attempt to reduce water use in urban areas through a variety of social or technological approaches.

Social approaches include changing water pricing structures to encourage more efficient water use and increasing awareness of the importance of conservation through promotional and educational campaigns. Programs that explain water bills, offer plant tours and school programs and provide other educational and outreach activities have proven beneficial in increasing water conservation. Technological approaches include installing more efficient plumbing fixtures in homes and businesses.

Specific municipal conservation strategies in the 2007 State Water Plan include aggressive water-wasting fixture replacement programs; water-efficient landscaping codes; water loss and leak detection programs; educational and public awareness programs; rainwater harvesting; and changes in water rate structures.

Irrigation water conservation involves increasing the efficiency of water use in agricultural operations. Approaches recommended in the 2007 water plan include:

- irrigation water use management, such as irrigation scheduling, volumetric measurement of water use, crop management (leaving sufficient residue on the soil surface by eliminating plowing to reduce wind and/or water erosion) and on-farm irrigation water audits;
- land management systems, including furrow dikes (small earthen dams), land leveling, conversion from irrigated to dryland farming, and brush control/management;
- on-farm delivery systems, such as lining of farm ditches to catch rainfall and run off,

low-pressure sprinkler systems, drip/micro irrigation systems; and

- water district delivery systems, including lining of district irrigation canals to reduce water leakage and replacing irrigation district and lateral canals with pipelines.

In addition to municipal and irrigation water conservation, water consumption by manufacturing, mining and steam electrical generation interests is a growing concern for the state. Some regions have engaged in conservation efforts in these areas, but such strategies tend to be restricted to areas of the state with significant concentrations of these industries.

Examples of conservation techniques used for manufacturing, mining and steam electrical generation include using water that has a low mineral content for cooling and stabilizing or minimizing variations in water levels to prevent the need for large surges of water. For mining and steam electrical generation, the primary conservation technique is to develop more groundwater and surface water supplies at or near the operation, thereby reducing water lost during transportation or evaporation.

Desalination

Desalination is the process of converting salty seawater or brackish (semi-saline) groundwater into usable water.

Groundwater

Recommended water management strategies for groundwater involve:

- drilling new wells and increasing pumping from existing wells;
- temporarily overdrafting aquifers (that is extracting more water than can be recharged), during drought conditions to supplement water supplies;
- expanding the capacity and number of water treatment plants so that more groundwater supplies can meet water quality standards; and
- supplementing water supplies in dry areas with water from an area with a water surplus.

In August 2007, Fort Bliss and the City of El Paso opened the second largest inland desalination water plant in the world. The Kay Bailey Hutchison Desalination Plant produces 27.5 million gallons of fresh water daily using reverse osmosis (RO).

El Paso: New Water Sources

Nestled against the Rio Grande, the Franklin Mountains and the state of New Mexico in the Chihuahuan Desert, the city of El Paso's natural beauty has attracted settlers and tourists for centuries. But El Paso's location in the arid western part of the state creates a significant challenge — water supply.

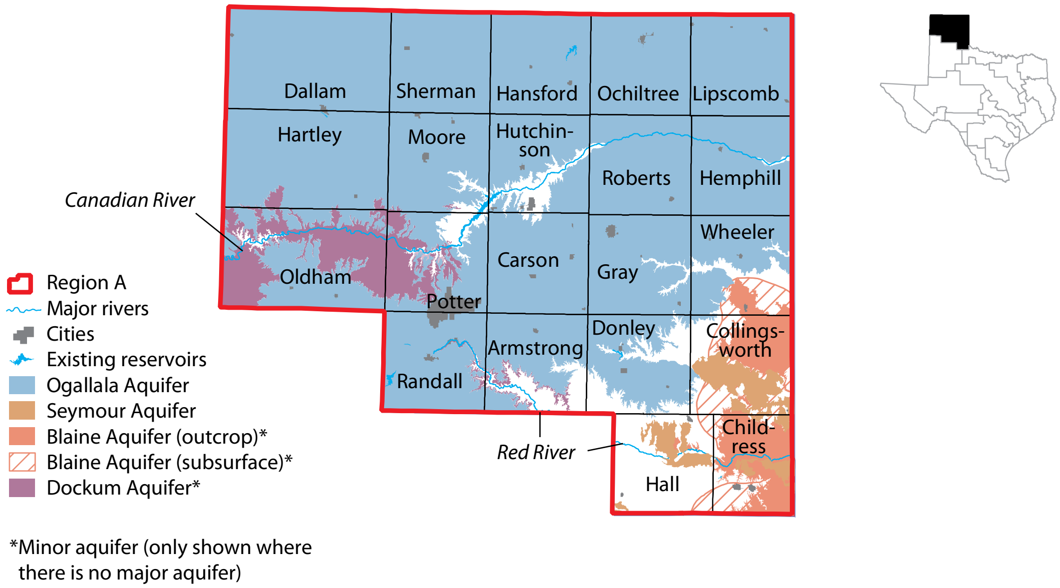
El Paso receives an average of less than ten inches of rainfall annually, has no reservoirs and shares its only surface water source — the Rio Grande — with both New Mexico and Mexico. As a result, the Rio Grande is constrained by the U.S. Bureau of Reclamation and by an international treaty downstream.[3]

Just a few years ago, officials worried that El Paso would run out of water by 2020. However, aggressive water conservation efforts coupled with the discovery of abundant, if brackish, groundwater in the Hueco-Mesilla Bolson have provided the city with sufficient water supplies decades into the future.[4] ("Bolson" means "basin"—the Hueco and Mesilla aquifers are separate aquifers that overlay each other but have little interconnection.)[5]

In August 2007, Fort Bliss and the City of El Paso opened the second largest inland desalination water plant in the world. The Kay Bailey Hutchison Desalination Plant produces 27.5 million gallons of fresh water daily using reverse osmosis (RO). RO filters resemble thick rolls of wax paper through which saline or semi-saline water is forced under high pressure, filtering out salt and other impurities. El Paso Water Utilities estimates that about 83 percent of the brackish water put into the system is recovered as potable water. The resulting concentrate is disposed of carefully in a disposal facility or underground injection well.[6]

Exhibit 10

Panhandle Region (A)



Source: Texas Water Development Board.

Even with full implementation of all these strategies, Region A expects a shortfall in irrigation water of more than 300,000 acre-feet in 2060.

Surface Water

Surface water management strategies generally consist of building new reservoirs; moving water from one area to another through pipelines or natural waterways; purchasing additional water through contracts with major water providers; obtaining additional water rights; and reallocating water in existing reservoirs.

Water Reuse

Water reuse is simply the use of reclaimed water — wastewater that has been treated to remove solids and certain impurities, and then put to a beneficial use. Such water can be used in irrigation, cooling and washing.

Regional Water Plans

Each local planning group evaluates potentially feasible water management strategies based on its projected needs, and identifies the projects needed to meet future water needs. TWDB compiles plans from each of the state's 16 regions into the State Water Plan and submits the plan to the Legislature, along with policy recommendations needed to implement it. A detailed look at the cost and status of each region's plan follows.

Panhandle Region (A)

Region A, also known as the Panhandle region, consists of 21 counties and includes the cities of Amarillo and Pampa (**Exhibit 10**). The region is bisected by the Canadian River and gets nine-tenths of its water from the Ogallala Aquifer.

Region A's ten water management strategies are focused mainly on conserving existing groundwater supplies used by irrigators, developing additional wells and encouraging voluntary transfers among users.

The region also receives small amounts of water from municipal and manufacturing conservation, water reuse projects and the Palo Duro Reservoir. As such, its water management strategies fall into four general categories: conservation, desalination, groundwater and surface water needs (**Exhibit 11**). Even with full implementation of all these strategies, the region expects a shortfall in irrigation water of more than 300,000 acre-feet in 2060. Region A estimates its management strategies will cost $562.4 million through 2060.[7]

Exhibit 11

Panhandle Region (A) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$144,969,383	288,476	$503
Groundwater	343,380,400	117,220	2,929
Surface Water	72,265,600	3,750	19,271
Water Reuse	1,829,300	2,700	678
Total	**$562,444,683**	**412,146**	**$1,365**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Status of Major Water Projects and Strategies

Region A's conservation strategies are having only limited success. Its strategies include municipal conservation measures such as public awareness programs and water audits; manufacturing conservation efforts like using water with lower mineral content; and irrigation conservation efforts such as irrigation scheduling. The regional water planning group has set a long-term goal to deplete no more than 1.25 percent of the Ogallala Aquifer's water supplies per year. However, the planning group reports that this restricted access to the Ogallala Aquifer has made it difficult for the region to produce adequate water supplies in the short-term, and thus conservation measures are having a limited positive impact. Even so, the planning group estimates that its conservation strategies could save the region an estimated 288,476 acre-feet per year.[8]

Well development plans represent the region's most costly strategy. Costs to drill new groundwater wells in Roberts County alone are estimated at $164.3 million. Such cost estimates, combined with the region's limited groundwater supplies, have made the board's drilling strategy difficult to implement thus far. The region has, however, received a commitment of nearly $23 million from the Texas Water Development Board to help fund new well drilling in Potter County. Even with this strategy, the region faces challenges in maintaining an adequate water supply.[9]

According to TWDB, any failure to fully implement Region A's strategies could cost area residents $384 million in income and 5,320 full- and part-time jobs by 2010, and nearly $1.9 billion in income and more than 30,000 jobs by 2060. In addition, state and local governments could lose $24 million in annual tax revenue by 2010 and some $127 million by 2060.[10]

Regional Challenges and Successes

The Panhandle region shares an overriding challenge with Region O, the Llano Estacado region, which borders it to the south; most of the water supply for both regions comes from the Ogallala Aquifer. This aquifer is vast but recharges very slowly, and its water is being used at an unsustainable rate. Unfortunately, the Panhandle region's planning group has been unable to identify water management strategies that can fully address the region's water needs.

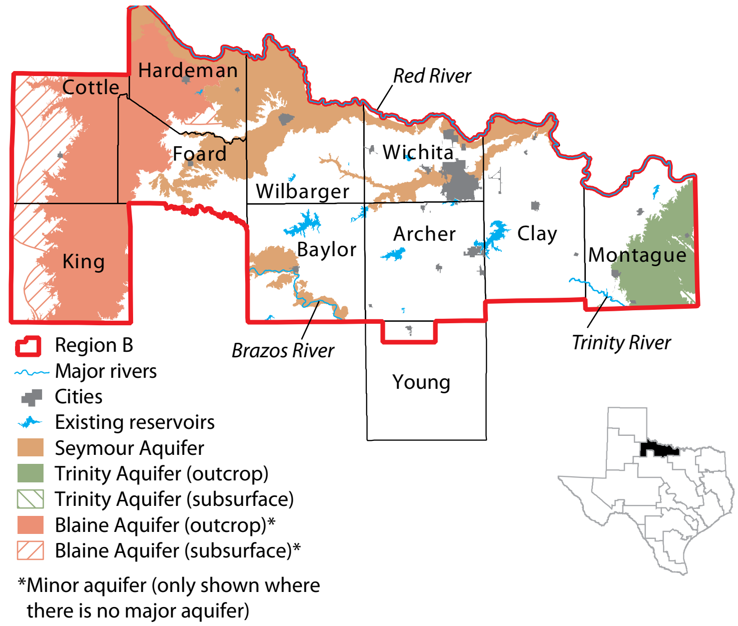
The Panhandle region shares an overriding challenge with Region O… Most of the water supply for both regions comes from the Ogallala Aquifer. This aquifer is vast but recharges very slowly, and its water is being used at an unsustainable rate.

Given its dependence on the Ogallala, following the region's goal of depleting no more than 1.25 percent of its water supplies annually is difficult. This is illustrated by the fact that one of its water management strategies is "temporary overdraft," a strategy to use more than the recommended annual amount of 1.25 percent, to meet the needs of counties with inadequate supplies. These two opposing objectives illustrate the challenges that Region A faces in attempting to balance present and future water requirements. Several counties already lack sufficient water supplies to meet their irrigation needs.

The Region A planning group notes that its report represented a "worst-case" scenario which assumes that, absent the strategies recommended in the water plan, the region would take no actions

Exhibit 12

Region B



Source: Texas Water Development Board.

to address shortages that might occur. Similarly, the planning group observes that the shortage estimates used in the report are fully cumulative. For example, the planning group's report assumes that a shortage that is projected to begin in 2015 continues to exist through 2060. The planning group also stated its estimates did not assume any conversion to dryland farming. As the chairman of the planning group said, "Some conversion to dryland farming is already happening, and some is returning to grass, too."[11]

The Texas Panhandle has been part of the nation's breadbasket for many decades, thanks to irrigation technology that converted dry grasslands to farmlands. How the region responds to shrinking supplies of groundwater may be the largest single factor in determining its future.

Region B

Region B is located in North Central Texas and borders Oklahoma. The region consists of 11 counties and contains a portion of three major river basins. The area's two major cities are Wichita Falls and Vernon (**Exhibit 12**). Its main industries include farming, ranching and mineral production.

Region B's 16 recommended water management strategies include conservation, water reuse and water quality improvements, as drought conditions tend to produce high nitrate and chloride concentrations in its water. Total capital costs for all of Region B's water management strategies are estimated at just over $202.2 million.[12] Although the region's water supplies will fall from 2010 to 2060, a projected decrease in demand will allow the region to meet all its needs if its recommended strategies are followed.

Region B's strategies fall under four major categories: conservation, desalination, groundwater and surface water (**Exhibit 13**).

Status of Water Project and Strategies

Region B's planning group has recommended four water conservation strategies, the largest of which is a canal lining project that aims to prevent water loss by improving the structural integrity of irrigation canals. If fully implemented, the canal lining project will save the region an additional 15,700 acre-feet annually by 2060. This project is long-term, as the region plans to implement it by 2040. To meet more immediate needs, however, Region B must find

Exhibit 13

Region B Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$58,500,000	16,462	$3,554
Groundwater	5,094,500	1,550	3,287
Surface Water	89,077,000	51,875	1,717
Water Reuse	49,595,000	11,134	4,454
Total	**$202,266,500**	**81,021**	**$2,496**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

solutions to its water challenges and manage its current supply more effectively.

Region B's most costly and most vital projects are those that aim to improve water quality. For example, the region plays a role in a chloride control water quality project that was initiated in the 1970's by the Army Corps of Engineers, the Red River Authority and water planners in Texas, Oklahoma, Arkansas and Louisiana. The collaborative project aims to desalinate water in the Wichita Basin, which supplies water to all four of the aforementioned states. Region B's portion of the chloride control project has projected capital costs of $77.5 million. The project, if successful, would provide an additional 26,500 acre-feet of water annually by 2060. In the late 1990's, however, Army Corps of Engineers recommended that a non-federal entity assume maintenance and operation of the project. Since then, the region's planning board has had difficulty obtaining funding for the project and has been forced to suspend it due to a lack of federal appropriations.[13]

Regional Challenges and Successes

Water quality is by far Region B's biggest challenge, due to high concentrations of nitrate and chloride in Lake Kemp. The region is in desperate need of federal funding for its chloride control project, which would help make the lake's water potable. The region's planning group also asserts that the EPA's current nitrate drinking water standard, which specifies a nitrate concentration of no more than 10 milligrams per liter, forces the region to bear unreasonable costs. According to the planning group, the standard should allow for significantly higher nitrate content because water with higher nitrate levels does not present a health hazard to the region's residents. Moreover, the nitrate standard requires that local water management entities conduct costly processing that is unreasonable given their budgetary allowances.[14]

According to TWDB, any failure to implement the region's strategies could cost its residents $4 million in income and 50 to 60 full and part-time jobs from 2010 through 2060. State and local governments could lose $200,000 in annual tax revenue by 2010 and $300,000 by 2060.[15]

Region C

Region C includes 15 counties and part of another (Henderson). Four of these counties contain most of the Dallas-Fort Worth Metroplex (**Exhibit 14**). Other cities in the region include Denton, Garland, Corsicana and Waxahachie. The Red River is the northern border of the region (and the state). The Trinity River runs diagonally across the middle of Region C, and almost the entire region lies within the upper part of the Trinity's basin. The region also contains portions of the Sabine and Sulphur river basins. The area's economy is based in large part on services, trade, manufacturing and government.

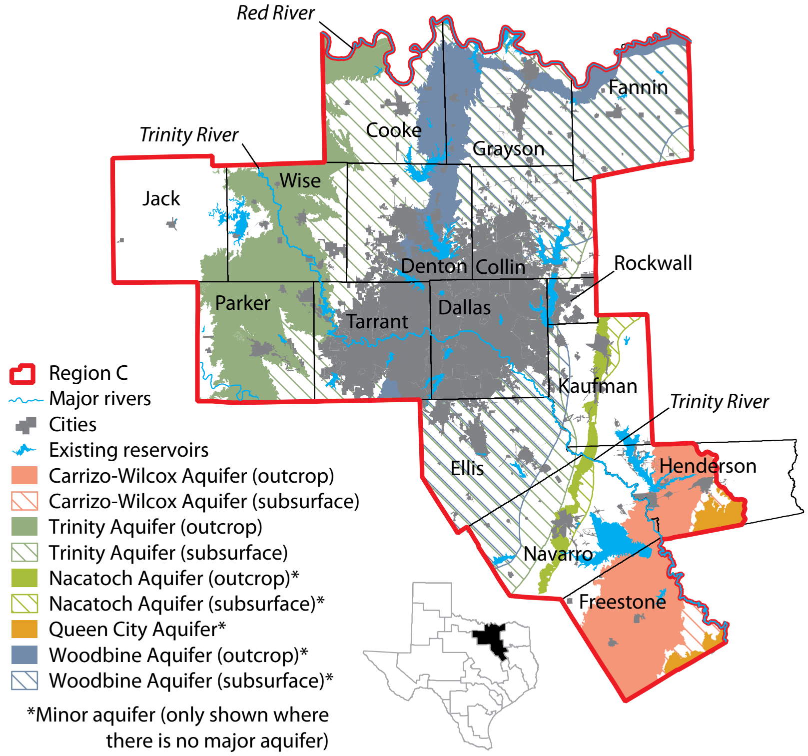
Strategies and Estimated Costs

Region C's planning group has recommended 59 strategies to meet and even exceed the projected water demands through 2060. The strategies include four new major reservoirs, 18 water reuse

Region B's most costly and most vital projects are those that aim to improve water quality. For example, the region plays a role in a chloride control water quality project that was initiated in the 1970's by the Army Corps of Engineers, the Red River Authority and water planners in Texas, Oklahoma, Arkansas and Louisiana.

Exhibit 14

Region C



Source: Texas Water Development Board.

The total estimated capital cost of Region C's strategies is just over $13.2 billion. This amount represents 43 percent of the total capital costs in the State Water Plan.

projects, three levels of municipal conservation strategies, increased water supplies from various existing sources and work on numerous water utility facilities (**Exhibit 15**). The total estimated capital cost for the plan's strategies is just over $13.2 billion. This amount represents 43 percent of the total capital costs in the State Water Plan. These projects would provide Region C with an estimated 2.7 million additional acre-feet of water, for a total of 22 percent more water than the total projected demand in 2060.

The strategies include new connections to Lake Fork and Lake Palestine and additional water from Lake Texoma, blended with more water from Lake Lavon. Several major Metroplex water suppliers are pursuing an option to purchase additional water from Oklahoma in the final decade of the planning period. New reservoirs recommended by the region's planning group include two within Region C, Ralph Hall and Lower Bois d'Arc, and two outside the region, Marvin Nichols and Lake Fastrill. Only four strategies address groundwater supplies, but another involves using an aquifer to store water for later recovery and use.[16]

Status of Major Water Projects and Strategies

The Region C planning group identified 13 of its recommended strategies as "major," due to their large projected yield of additional water or because they are new reservoirs. In addition, there are two strategies, facilities improvements and construction and expansion of water treatment plants, that, while not directly attributed with new water supplies, have a combined capital cost of more than $3.4 billion. TWDB has committed partial funding for six of those 15 strategies, as well as five other of Region C's strategies recommended in the state water plan. All 20 of these projects are surface water or water reuse strategies and together account for 73 percent of Region C's total projected capital costs and 77 percent of its estimated additional water supplies in 2060.

Exhibit 15

Region C Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$1,097,572	297,647	$4
Groundwater	449,530,624	12,639	35,567
Surface Water	9,800,286,546	1,627,213	6,023
Water Reuse	2,952,014,853	722,320	4,087
Total	**$13,202,929,595**	**2,659,819**	**$4,964**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Surface Water Strategies

Sixteen of the region's surface water strategies are considered major projects and/or have received some funding from TWDB. Four of these are proposed new reservoirs. Two of these already have partial funding committed to them and are scheduled to be in service by 2020; Lake Ralph Hall received $20.8 million in March 2008 and Lower Bois d'Arc Creek Reservoir received $23.35 million for permitting and mitigation in November 2008.[17]

The status of the two other new reservoirs is more uncertain. Part of the site for Lake Fastrill has been designated a national wildlife refuge by the U.S. Fish and Wildlife Service, and efforts to overturn that decision have failed thus far. Neighboring Region D actively opposes the proposed Marvin Nichols reservoir on the Sulphur River in its territory. The Legislature has created a study commission to look into and make recommendations on the proposal and other water supply alternatives.[18]

The two strategies involving water facilities and treatment plants received funding for seven different projects in 2007 and 2008. In addition, two pipeline projects have received funds from TWDB. The Collin-Grayson Municipal Alliance Pipeline Project has been underway for several years. It first obtained funding in March 2003 and then again in November 2006. The Terrell/Lawrence Pipeline is a project to bring water taken from Lake Tawakoni on the Sabine River to Lake Lavon on the East Fork of the Trinity, and received TWDB funding in November 2008. This project is in the design phase, with construction expected to begin in mid 2009.[19]

Two recommended surface water strategies for Region C involve obtaining water from distant sources. The first, the Toledo Bend Project, is a strategy to bring water from a reservoir on the Texas-Louisiana border, while the second involves purchasing water supplies from Oklahoma. The Toledo Bend project is being investigated and discussed by Region C water suppliers and the Sabine River Authority; it is not scheduled to be developed until 2040 at the earliest. The Oklahoma water strategy is not scheduled to supply water until 2060 and currently is stymied by a moratorium on water exports imposed by the Oklahoma Legislature.[20]

Three more major surface water strategies involve obtaining additional water supplies from existing reservoirs. One of these is a new connection to Lake Fork Reservoir, most of which is already completed, having also been a recommended strategy in the region's 2001 plan. The final construction and testing of the pumping station is underway. Another new connection, to Lake Palestine, is being designed; the supplier has a contract for the water and the project should be completed by 2015.

The third strategy does not require a new connection, but rather is a plan to obtain additional water from Lake Texoma (which would have to be blended with other water supplies due to its high levels of dissolved salts and minerals). The supplier has the necessary water rights permit and is awaiting a contract with the U.S. Corps of

Engineers for storing the water in Lake Texoma. The project is scheduled to begin supplying water by 2020.[21]

The last of the major surface strategies also involves obtaining more water from an existing supply, in this case by raising the water level and thus increasing the capacity in the Wright Patman Reservoir. The water supplier plans to build the transmission system to get the water to Dallas by 2035 and shows the additional supply in the region's plan by 2040.[22]

Water Reuse Strategies

Region C's plan contains three major reuse strategies, two of which received some funding from TWDB in 2008. In addition, a general reuse strategy, "conveyance with infrastructure," was partially funded in 2007 and 2008. The funding was designated for delivering reuse water to Fort Worth supply facilities.

The rapid growth of the Metroplex cities within Region C poses the biggest challenge to its water planners. Developing sufficient water supplies for the region is difficult, time-consuming and very expensive, as demonstrated by the recommended water strategies.

Dallas Water Utility (DWU) has multiple projects included within its reuse strategy, with a total capital cost of nearly $455 million. One of these is an indirect reuse project that would take water from a DWU wastewater treatment plant and pump it into an artificially constructed wetland. After the water is further cleaned through filtering by the wetland, it will then be pumped into Lake Ray Hubbard. This project was in the region's 2001 plan and is scheduled for 2012; TWDB provided $16.6 million for it in 2008. The wetland construction is already completed. Another DWU project that received $30 million from TWDB is the Cedar Crest Pipeline. This direct reuse project is in operation, delivering effluent for irrigation purposes (mostly on golf courses); the 2008 funding was for pipeline construction to take the water to more golf courses, parks and possibly industrial plants.[23]

The other reuse strategy that received partial funding from TWDB in 2008 is Tarrant Regional Water District's (TRWD) "Third Pipeline and Reuse" project. This project was in an experimental stage starting in the 1990s, demonstrating the use of constructed wetlands for water treatment, and is now is progressing towards completion of stage one of the project. It involves indirect reuse of return flows into the Trinity River; the water will be diverted from the Trinity (the permit for which has been granted to TRWD), piped into constructed wetlands and then to the Richland-Chambers and Cedar Creek reservoirs. The transmission system and wetlands for Richland-Chambers are completed; the Cedar Creek portion and the "third pipeline" are in a later stage of the project, scheduled for 2018.[24]

The last major reuse strategy in Region C is very similar to the Richland-Chambers project described above. The East Fork Reuse Project will divert water from return flows to the East Fork of the Trinity River; this project was added to Region C's 2001 plan by amendment in 2005. The water will be piped to another constructed wetlands for treatment and then transferred to Lake Lavon. East Fork is nearing completion and expected to begin delivering water by the end of 2008.[25]

According to TWDB, if the strategies listed above are not implemented, residents of Region C could face losses of slightly more than $3 billion in income and 27,760 full and part time jobs by 2010, and nearly $58.8 billion in income and more than 691,000 jobs by 2060. In addition, state and local governments could lose $128 million in annual tax revenue by 2010 and more than $2.5 billion by 2060.[26]

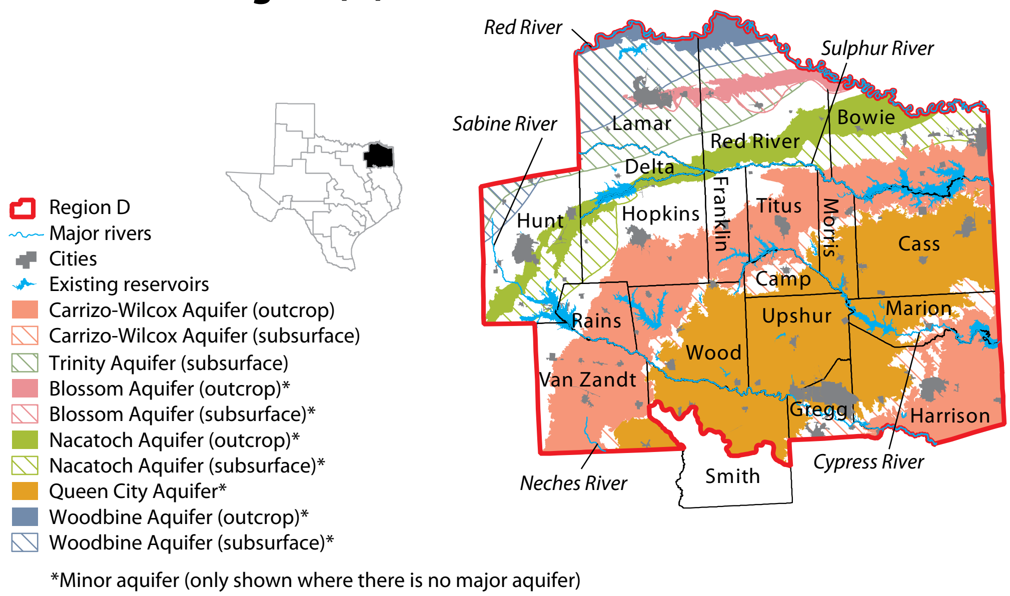
Regional Challenges and Successes

The rapid growth of the Metroplex cities within Region C poses the biggest challenge to its water planners. Developing sufficient water supplies for the region is difficult, time-consuming and very expensive, as demonstrated by the recommended water strategies.

Most of the strategies in the 2006 regional plan, as well as its 2001 predecessor, are being implemented to some extent. Some of the proposed projects, however, pose significant problems, particularly the proposed Lake Fastrill reservoir site to be located in a designated national wildlife refuge, and the Marvin Nichols reservoir site in Region D, which has specifically recommended that the site not be included in the state water plan.

Exhibit 16

North East Texas Region (D)



Source: Texas Water Development Board.

Other obstacles to Region C's plan include state restrictions on transfers of water between river basins; difficulties in obtaining surface water rights for smaller water suppliers that previously relied on groundwater sources that are diminishing; and the high-costs of various anticipated construction projects.

Even so, Region C has made significant progress on several of its water management strategies. Five water reuse projects have been permitted and are projected to provide 540,000 acre-feet of water annually to the region. In addition, six new connections to existing supplies have been completed, and a seventh is nearing completion. These resources should bring 351,100 acre-feet of new supplies to the region annually."[27]

North East Texas Region (D)

Region D, also known as the North East Texas region, comprises 19 counties as well as the cities of Longview, Marshall, Greenville and Texarkana (**Exhibit 16**). Large portions of the Red, Cypress, Sulphur and Sabine river basins and smaller portions of Trinity and Neches river basins are located in the area. The region's major industries are agriculture, oil and natural gas production, forestry and power generation.

To meet the region's projected water demands in 2060, the Region D planning group recommended seven water management strategies that would provide 108,742 acre-feet of additional water supply by 2060. The projected total capital cost for these projects would be approximately $32.5 million. The region's water management strategies fall into two general areas, groundwater and surface water (**Exhibit 17**).[28]

Status of Major Water Projects and Strategies

The most costly strategy in Region D's plan involves new groundwater wells, many of them being drilled by Crooked Creek Water Supply Company over the Carrizo-Wilcox aquifer. Some of these wells have already been completed. A project to drill two additional wells in Wood County, for example, was completed in 2008 at a cost of about $1.5 million. Other projects are in progress and still others are in the planning stages, with additional wells to be drilled as needed.[29]

Exhibit17

North East Texas Region (D) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Groundwater	$27,764,102	7,806	$3,557
Surface Water	4,815,605	100,936	48
Total	**$32,579,707**	**108,742**	**$300**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

The most challenging issue the region faces, however, is the potential development of its own surface water for use by the much more populous Region C. Region D opposes the development of the Marvin Nichols Reservoir as a water management strategy for Region C.

Region D has five surface water strategies to obtain new surface water contracts and extend and increase existing contracts. Most of these strategies move water from Toledo Bend Reservoir to Lake Tawakoni or Lake Fork in Hunt County for agricultural needs. Region D will establish new surface water contracts as needed starting in 2010 and continuing through 2050. Some new contract procurement projects are already under way; Brightstar-Salem Utility District recently obtained a surface water contract from Sabine River Authority that will provide 9,000 acre-feet of water for the city of Marshall.[30]

According to TWDB, failure to implement these strategies could cost residents of Region D $135 million in income and 1,060 full- and part-time jobs by 2010 and more than $320 million in income and nearly 2,600 jobs by 2060. State and local governments could lose $23 million in annual tax revenue by 2010 and some $50 million by 2060.[31]

Regional Challenges and Successes

Region D has significant water quality and distribution problems. Due to high levels of naturally occurring iron and manganese ore deposits, groundwater in parts of the region must be treated to remove these elements. In addition, because the region's is primarily rural in nature there is very little water distribution infrastructure. Building pipelines could be very costly to obtain available surface water.

The most challenging issue the region faces, however, is the potential development of its own surface water for use by the much more populous Region C. As noted above, Region D opposes the development of the Marvin Nichols Reservoir as a water management strategy for Region C.

According to the Region D water planning group, Region C's strategy to develop a reservoir in Region D as a future water source does not follow state law because it inadequately protects the area's water, agriculture and natural resources. In addition, Region D planners believe that Region D's concerns were overlooked by Region C and TWDB alike through the inclusion of the Marvin Nichols Reservoir water management strategy in the State Water Plan.[32]

Far West Texas Region (E)

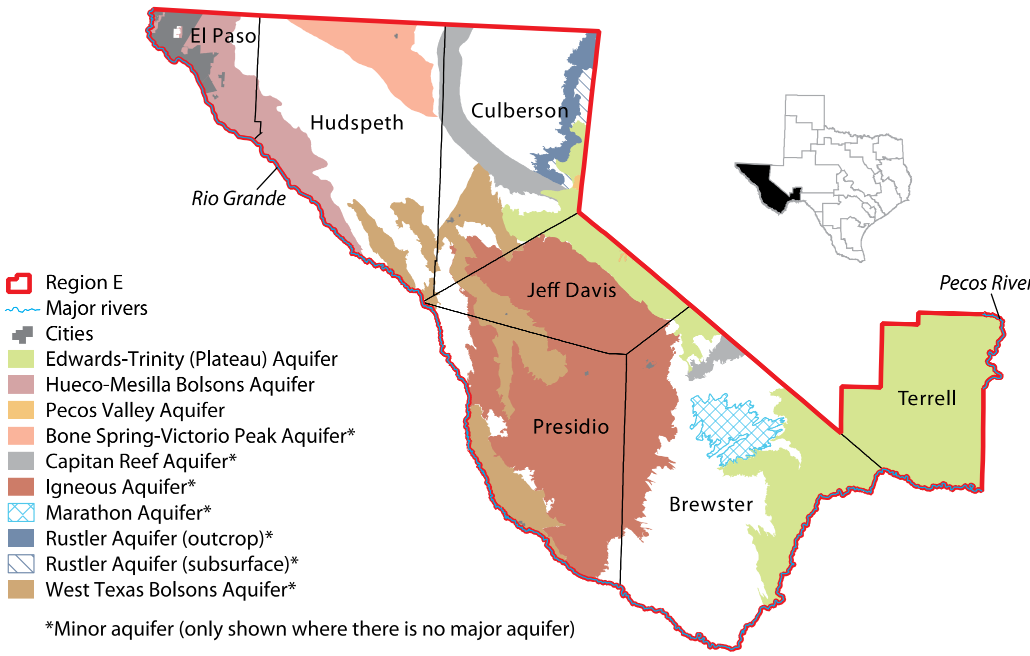
Region E, also known as the Far West region, is located in West Texas adjacent to New Mexico and Mexico. El Paso is located in the western tip of the region, which includes seven counties situated within the Rio Grande River basin (**Exhibit 18**). The region depends on a variety of economic sectors, including agriculture, agribusiness, manufacturing and tourism. Ninety-six percent of the area's residents live in El Paso County, which has a population density of 760 persons per square mile, compared to an average density of 1.1 persons per square mile in the other six counties.[33]

Strategies Used and Estimated Costs

Region E has developed 16 water management strategies to meet its future needs. These are expected to provide 166,097 acre-feet of water annually by 2060 at a capital cost of $688.8 million. The El Paso Water Utilities (EPWU) will implement most of these strategies.

Exhibit 18

Far West Texas Region (E)



Source: Texas Water Development Board.

The majority of the capital cost, $502.7 million, will be used for pumping and treating additional groundwater from the Bone Spring-Victorio Peak Aquifer near Dell City. Other EPWU projects, such as the importation of water, the direct reuse of wastewater effluent, and the increased use of surface water from the Rio Grande will account for another $172.4 million in capital costs. These four strategies alone will create an additional 98,109 acre-feet of water annually by 2060. EPWU's conservation program, with an annual operating cost of $4 million, is expected to provide an additional 23,437 acre-feet per year by 2060 (**Exhibit 19**).[34]

Exhibit 19

Far West Texas Region (E) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$0	23,437	$0
Desalination	502,743,000	50,000	10,055
Groundwater	36,779,000	26,191	1,404
Surface Water	103,494,000	20,000	5,175
Water Reuse	45,842,000	18,109	2,531
Total	**$688,858,000**	**137,737**	**$5,001**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Since 1993, El Paso Water Utility has operated an aggressive water conservation program that imposes restrictions on residential watering and includes a rate structure that penalizes high consumption. Through such conservation efforts, El Paso's daily water use has decreased from 200 gallons per capita in 1990 to 151 in 2006. The per capita goal for the city is 140, which would be the lowest level of use among Texas' large cities.

Status of Major Water Projects and Strategies

The region's largest project involves pumping additional groundwater from Bone Spring-Victorio Peak Aquifer. The brackish water of this aquifer does not meet municipal water quality standards, so most of the $502.7 million in costs are for treating and desalinating the water.[35]

In 2003, EPWU purchased 28,000 acres of land, a tract called Diablo Farms, which overlays the Capitan Reef Aquifer. EPWU intends to convert Diablo Farms into a well field. This project will provide an estimated 10,000 additional acre-feet annually by 2060.[36] The Lower Valley Water District has received $10.2 million in state funds from TWDB to replace a water main as part of this project.[37]

Drilling for the Diablo Farms project is scheduled to begin in 2040. Like the Bone Spring-Victorio Peak project, this is a long-term strategy to meet future water demand driven by regional population growth. Because water demand has not been as high as projected in the 2006 regional water plan, the region is likely to push back the scheduled start dates for the Diablo Farms and the Bone Spring-Victorio Peak Aquifer projects.[38]

According to TWDB, if the strategies listed above are not implemented, Region E residents could lose $160 million in income and 4,570 full- and part-time jobs by 2010, rising to nearly $1.1 billion in income and more than 13,000 jobs by 2060. In addition, state and local governments could lose $8 million in annual tax revenue by 2010 and about $105 million by 2060.[39]

Regional Challenges and Successes

Since 1993, EPWU has operated an aggressive water conservation program that imposes restrictions on residential watering and includes a rate structure that penalizes high consumption. The utility also offers several rebate programs for replacing appliances and bathroom fixtures with low-consumption units and using native landscaping to reduce the need for irrigation.[40] Through such conservation efforts, El Paso's daily water use has decreased from 200 gallons per capita in 1990 to 151 in 2006.[41] The per capita goal for the city is 140, which would be the lowest level of use among Texas' large cities.[42]

EPWU's Kay Bailey Hutchison Desalination Plant, completed in 2007, is the world's second largest inland desalination plant, producing 27.5 million gallons of fresh water per day from brackish groundwater supplies. The facility has increased El Paso's water production by 25 percent, and also includes a learning center, groundwater wells, transmission pipelines and storage and pumping facilities.[43]

Region F

Region F is located in the Edwards Plateau in West Texas. It consists of 32 counties and includes the cities of Midland, Odessa and San Angelo (**Exhibit 20**). The Pecos River is located in the West of the region and the Colorado River is situated in the Northeast. A large portion of Region F lies in the upper portion of the Colorado River basin and the Pecos area of the Rio Grande basin. The region's major industries are health care and social assistance, manufacturing and oil and gas.

Strategies Used and Estimated Cost

In its 2007 water plan, Region F recommended 15 water management strategies at a projected total capital cost of $557 million. The new management strategies would provide 239,250 acre-feet of additional water by 2060, slightly more than will be needed **(Exhibit 21)**.

Region F could not, however, identify economically feasible strategies to meet some of its irrigation needs or any of its steam-electric needs. The region's unmet needs include 115,523 acre-feet a year for irrigation and 24,306 acre-feet annually for steam-electric power generation in 2060.[44]

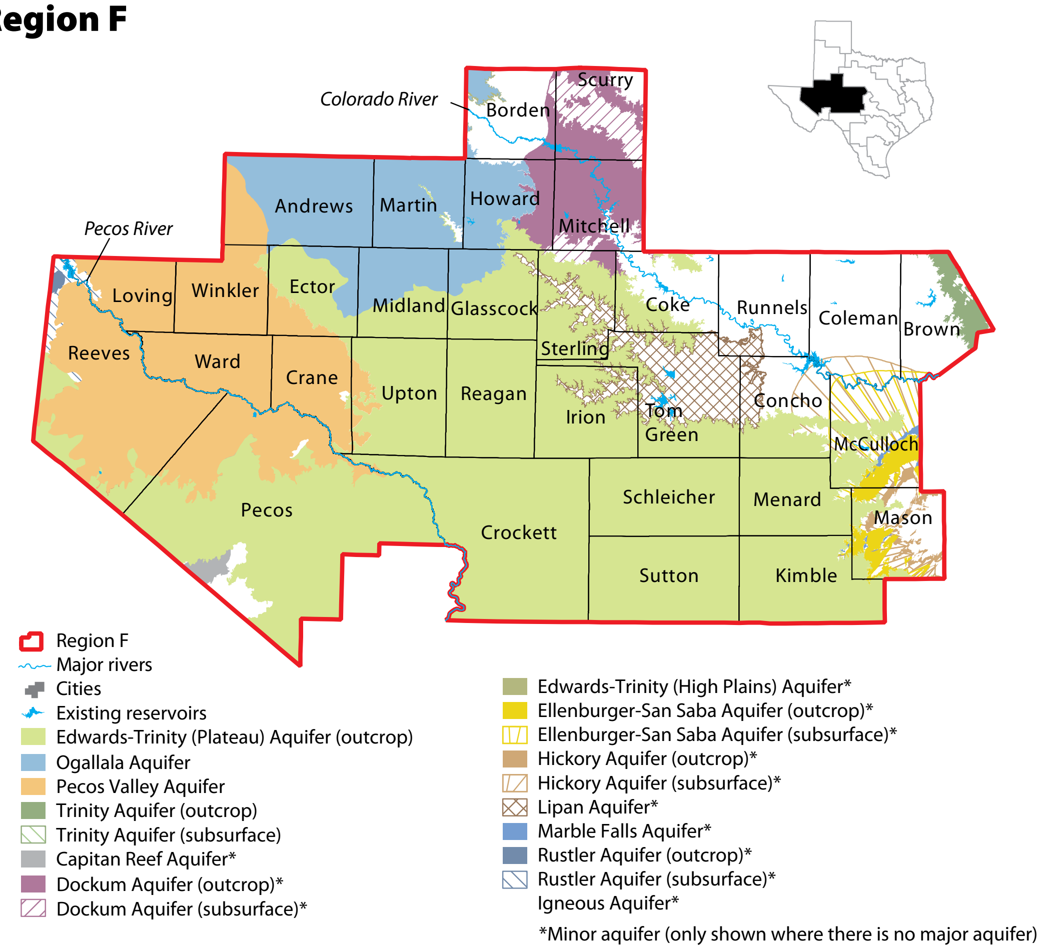
Status of Major Water Projects and Strategies

Because 78 percent of the region's water comes from groundwater, most of the region's projects are focused on reusing, cleaning and enhancing these resources.[45]

Region F has been a leader in weather modification (seeding clouds with rain-inducing chemicals) and brush management for many years. Areas within the region have been seeding prom-

Exhibit 20

Region F



Source: Texas Water Development Board.

Region F has been a leader in weather modification (seeding clouds with rain-inducing chemicals) and brush management for many years. Areas within the region have been seeding promising cloud formations since the early 1970s.

ising cloud formations since the early 1970s.[46] The North Concho River watershed was the site of a state-funded brush management program in the early 2000s to restore grassland and reduce large areas of water-hogging juniper and mesquite trees, thus allowing rainfall to penetrate the soil and flow into underground supplies.[47] Both technologies are included in the region's plan to enhance surface and groundwater supplies.

The Hickory Aquifer supplies the city of Eden with sufficient fresh water, but the area's low number of wells has impeded the city's ability to access much of the aquifer's supplies. Drilling more wells could cost more than $1.5 million, more than the city could afford by itself. Eden is working with TWDB to find funding.

Furthermore, San Angelo recently built a pipeline to its well field south of Melvin to supply it with adequate water. The pipeline passes near Eden and the city could link to it. Plans to do so are still developing.[48]

According to TWDB, any failure to implement Region F's strategies could cost its residents $475 million in income and 8,020 full- and part-time jobs by 2010, and $962 million in income and 15,600 jobs by 2060. In addition, state and local governments could lose $35

Exhibit 21

Region F Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$43,152,601	81,974	$526
Desalination	131,451,830	16,221	8,104
Groundwater	251,825,812	38,270	6,580
Surface Water	30,115,300	90,075	334
Water Reuse	100,889,000	12,710	7,938
Total	**$557,434,543**	**239,250**	**$2,330**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

million in annual tax revenue by 2010 and $82 million by 2060.[49]

Regional Challenges and Successes

Region F faces challenges in meeting drinking water standards as well as with disposing of waste from desalination and radionuclide treatment, which is, respectively, the removal of salts and naturally-occurring, low level radioactive particles from groundwater. A few small, rural communities in the region rely solely on water sources that exceed U.S. Environmental Protection Agency (EPA) regulations on some of these contaminants, but they cannot afford expensive water treatment costs, nor do they have clear guidance on how to dispose of the residual waste. Some regional representatives contend that the cost of treatment in order to meet federal drinking water standards is not justified by the health risks from the presence of radionuclide in the water. The region therefore recommends that the TCEQ help these communities receive exemptions from EPA's radionuclide regulations so that they do not face either strict enforcement or costly water treatment costs. Further, the region also has recommended that TCEQ create rules for disposing of radionuclide waste residuals so that these communities can estimate treatment costs more accurately.[50]

Brazos Region (G)

Region G, also known as the Brazos region, stretches from Grimes County northwest to Kent County and includes all or parts of 37 counties (**Exhibit 22**). Major cities in the region include Abilene, Bryan, College Station, Killeen, Round Rock, Temple and Waco. More than 90 percent of the region is located within the Brazos River Basin, which is also its primary water source. Industries with the largest economic impact on the region are service, manufacturing and retail trade.

The Brazos Planning Group has recommended a variety of management strategies that could provide more water than it needs to meet future needs. In all, these strategies would provide 736,032 acre-feet of additional water annually by 2060. The projected total capital cost for providing this additional water is just over $1 billion.

To achieve the water goals set forth by its planning group, Region G will implement strategies in the areas of conservation, groundwater, surface water and water reuse (**Exhibit 23**).[51]

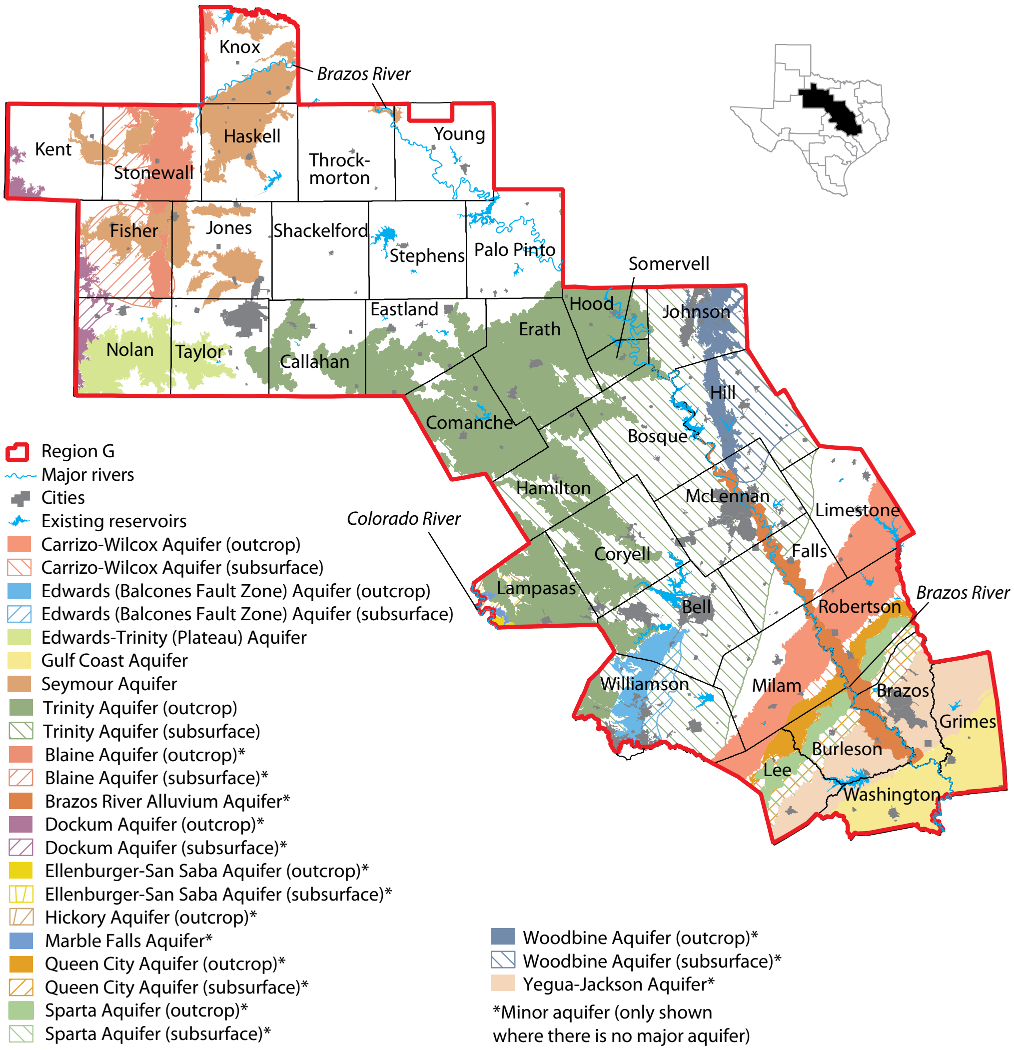
Status of Major Water Projects and Strategies

Region G's conservation strategies would provide 6 percent of all water associated with its strategies. The region has recommended water conservation for every municipal water user group that had both a need and a gallons-per-capita-per-day use greater than 140 gallons.[52] The region will meet with local and municipal groups to develop timelines and reuse systems and closely monitor well and reservoir levels.[53]

Region G also has several groundwater strategies including building additional wells, water treatment facilities and voluntary redistribution.

Exhibit 22

Brazos Region (G)



Source: Texas Water Development Board.

Region G, in partnership with TWDB, HDR Engineering and the city of Sweetwater, began a study in April 2008 to assess the water levels and quality in the Champion Well Field. Sweetwater currently receives all of its water from these wells. Lakes in the area, however, have returned to full capacity after several years of drought so the city can reduce its dependence on groundwater. Sweetwater would like to begin using surface water taken from lakes located 30 miles from the population center along with the well field to supply the residents.

Sweetwater plans to complete a study about water levels and quality with information from the surface water and the well field. The city's wastewater treatment plant, online since 2004, and other infrastructure, including pipelines, will be updated to supply the city with surface water beginning 2009.[54] If the study finds excessive use from citizens using the well field before it

Exhibit 23

Brazos Region (G) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conjunctive Use	303,288,000	54,390	5,576
Conservation	$0	45,218	$0
Groundwater	86,713,541	41,075	2,111
Surface Water	582,639,746	513,621	1,134
Water Reuse	103,681,747	81,728	1,269
Total	**$1,076,323,034**	**736,032**	**$1,462**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Cedar Park, Leander and Round Rock all need additional water in the future. Rather than building three water treatment plants and excess infrastructure, the cities are building one regional water treatment plant and pipes that connect all of them together. A $300 million loan from TWDB will fund the project.

can be replenished, the region may explore other groundwater management strategies such as using supplies purchased from the city of Abilene, other groundwater supplies, or an off-channel alternative to Double Mountain Fork Reservoir. Region G continues to work with other regions to cultivate safe and sufficient water supplies.[55]

The Brazos Region plans include construction of new reservoirs and enhancing existing reservoirs. The region plans to identify specific small public water systems where problems with organization and resources might occur and study regionalization. The Brazos Group hopes to create larger regions that could share resources and pull together with larger water utilities. When counties within the region require more water than they have, the regional groups can distribute water from lakes, reservoirs and treatment plants needing water or to other entities outside the region.

According to TWDB, Somervell County has received $31 million in funding for a water treatment plant, storage and transmission lines. The Brazos River Authority received $22 million to develop a strategy using groundwater to firm up current supplies in Lake Granger, Palo Pinto Water District recieved $8 million for the acquisition of Lake Turkey Peak and the City of Cleburne received nearly $4.8 million for development of Lake Whitney.[56]

Three cities within Region G have joined together to complete the Lake Travis Regional Water System management strategy representing themselves as the Brushy Creek Regional Authority. The cities of Cedar Park, Leander and Round Rock all need additional water in the future. Rather than building three water treatment plants and excess infrastructure, the cities are building one regional water treatment plant and pipes that connect all of them together. A $300 million loan from TWDB will fund the majority of the project, which will begin with improvements to the already present floating intake in Lake Travis, a raw water line with water from the lake to the regional water treatment plant in Cedar Park, and a treated water line with take points for the communities.

Cedar Park has the most immediate need for water at the present and will be online with the water treatment plant in 2012. In the interim, Round Rock will supply the city with water as part of their partnership. The bulk of the work for the project will be completed in the first phase, which includes building of pipes and the water treatment plant, at a cost of $180 million. Four local engineering firms are on working on the project, with the prospect for more consultants as construction begins. Once the project is completed, other cities in the area, including Georgetown, will be free to use local surface water supplies for their own needs rather than sharing with Round Rock, which will receive the bulk of its water from the Lake Travis Regional Water System.[57]

Region G utilizes water reuse strategies with new technology including pipes, discharge mechanisms, and more efficient cleaning techniques for irrigation and manufacturing purposes. The area also plans to purchase water from providers for irrigation. The region will monitor drought conditions and purchase additional water as needed, possibly from Region C. In partnership with Region C, the region will develop a study of the water supplies in Ellis County, Southwest Dallas County, Southeast Tarrant County and Johnson County to check on water levels for possible use in the Brazos Region during drought. Once water levels are assessed, infrastructure may be needed to serve the counties.[58]

According to TWDB, if Region G's strategies are not implemented, its residents could lose nearly $1.1 billion in income and 19,260 full- and part-time jobs by 2010, and nearly $2.8 billion in income and more than 46,000 jobs by 2060. In addition, state and local governments could lose $39 million in annual tax revenue by 2010 and about $141 million by 2060.[59]

Regional Challenges and Successes

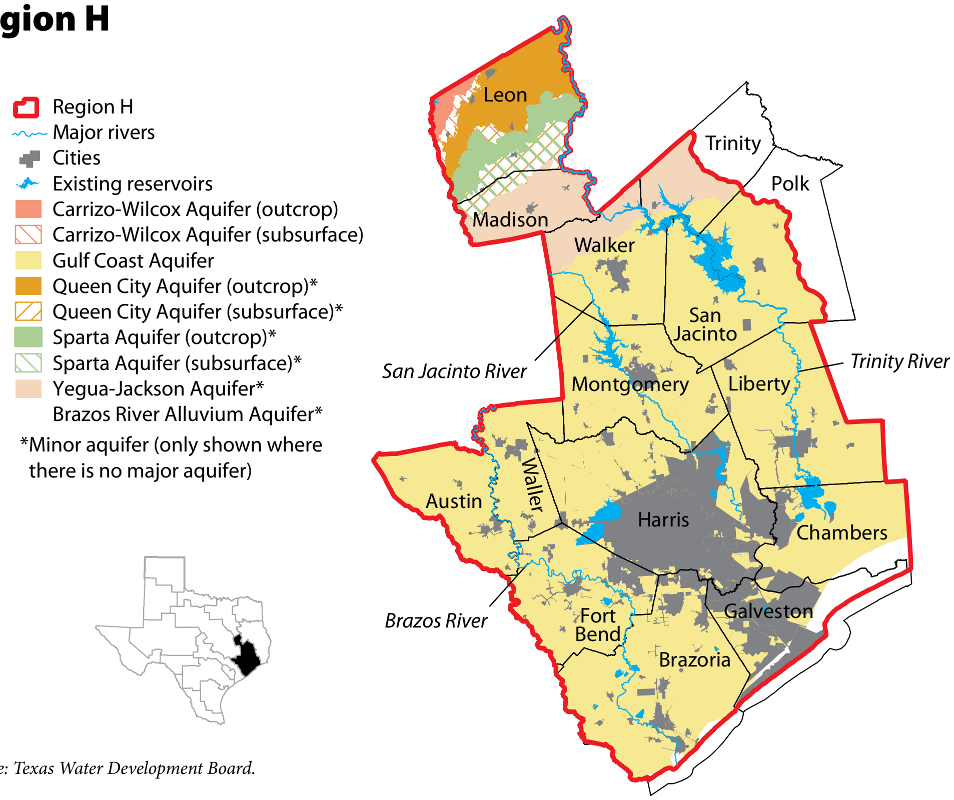
According to the Brazos Planning Group, the regional planning process has become much more inclusive and there is much better communication now between the planning group, entities providing water and entities needing water. This has led to greater understanding of the water issues that the region faces in the future. Specifically, the planning group indicated that the long-term planning horizon for the region is now 50 years, as opposed to previous planning efforts where the region only evaluated 10- to 15-year water needs. Also, the region established a formal method to communicate between competing users for a common resource and among regional water providers that manage the resources. Lastly, grassroots-level water planning with local stakeholders has created greater water literacy on the part of more local people.[60]

Region H

Region H, located in eastern Texas, comprises 15 counties including the Houston metropolitan area (**Exhibit 24**). The region includes portions of the Trinity, San Jacinto and Brazos river basins. Its predominant economic sector is the petrochemical industry; the region is

Exhibit 24

Region H



Source: Texas Water Development Board.

responsible for two-thirds of the nation's total petrochemical production. Other significant industries include medical services, tourism, construction, banking, transportation, government, fisheries and agriculture.

Strategies Used and Estimated Cost

The 23 strategies identified by Region H encompass $5.5 billion in capital costs and would provide 1,300,639 acre-feet of water annually by 2060. About half ($2.7 billion) of this cost is for the city of Houston's purchase of water from the Trinity River Authority. Other costs include the construction of a new desalination plant, wastewater treatment plants, reservoirs and pipelines, at a cost of $1.5 billion. The remaining capital costs are primarily for the renewal of existing water contracts or for new contracts for additional water (**Exhibit 25**).[61]

Status of Major Water Projects and Strategies

In fiscal 2008, Region H received $71.6 million from the Water Infrastructure Fund from TWDB to implement three strategies that create or utilize more surface water. One of the projects in Region H, the Luce Bayou Interbasin Project, has received $28 million in water infrastructure funding from TWDB. This project will provide 400 million gallons per day to users in Harris, Fort Bend and Montgomery counties. These funds will be used for planning, permitting and design. The Region H Planning Group anticipates $250 million from TWDB's State Participation Program to fund future construction.[62]

The San Jacinto River Authority and the Central Harris County Regional Water Authority have received $21.5 million and $22.1 million respectively for the planning, permitting and infrastructure development to implement surface water conversion programs.[63] The Region H Planning Group expects the North Fort Bend Water Authority to apply for $145 million in Water Development Funds from TWDB for the planning and construction of a similar program.[64]

According to the TWDB, if the strategies listed above are not implemented it could cost residents of Region H $2.5 billion in income and 27,970 full- and part-time jobs by 2010 and nearly $15.4 billion in income and about 188,000 jobs by 2060. In addition, state and local governments could lose $133 million in annual tax revenue by 2010 and nearly $1.2 billion by 2060.[65]

Regional Challenges and Successes

Region H faces the challenge of subsidence, which is the settling or sinking of land caused by excessive groundwater pumping. As a result, the region is continuing to convert from groundwater to new surface water sources.[66] The regional planning group estimates that this conversion to surface water will cost $1 billion between now and 2020. The planning group anticipates that local municipalities and water agencies will seek

Exhibit 25

Region H Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$615,740	178,868	$3
Desalination	255,699,000	28,000	9,132
Groundwater	173,153,800	90,993	1,903
Surface Water	4,774,598,260	836,913	5,705
Water Reuse	256,453,592	165,865	1,546
Total	**$5,460,520,392**	**1,300,639**	**$4,198**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

state funds through the Water Infrastructure Fund and State Participation Program to cover part of the cost of conversion.[67]

East Texas Region (I)

Region I, also known as the East Texas region, is located along the Louisiana border extending between Beaumont, Tyler, and the Trinity River, and comprises 20 counties (**Exhibit 26**). Large portions of the Sabine and Neches rivers and a smaller portion of the Trinity River are located in the area. Major industries in the region include petrochemical, timber and agriculture.

Status of Major Water Projects and Strategies

In order to meet the region's projected water demands in 2060, the East Texas Planning Group recommended 19 water management strategies that would provide more water than required to meet future needs. In all, the strategies would provide 324,756 acre-feet of additional water supply by 2060. The total projected capital cost of providing additional water in the region exceeds $613.4 million. The region's water management strategies fall into four general categories: conservation, groundwater, surface water and water reuse (**Exhibit 27**).[68]

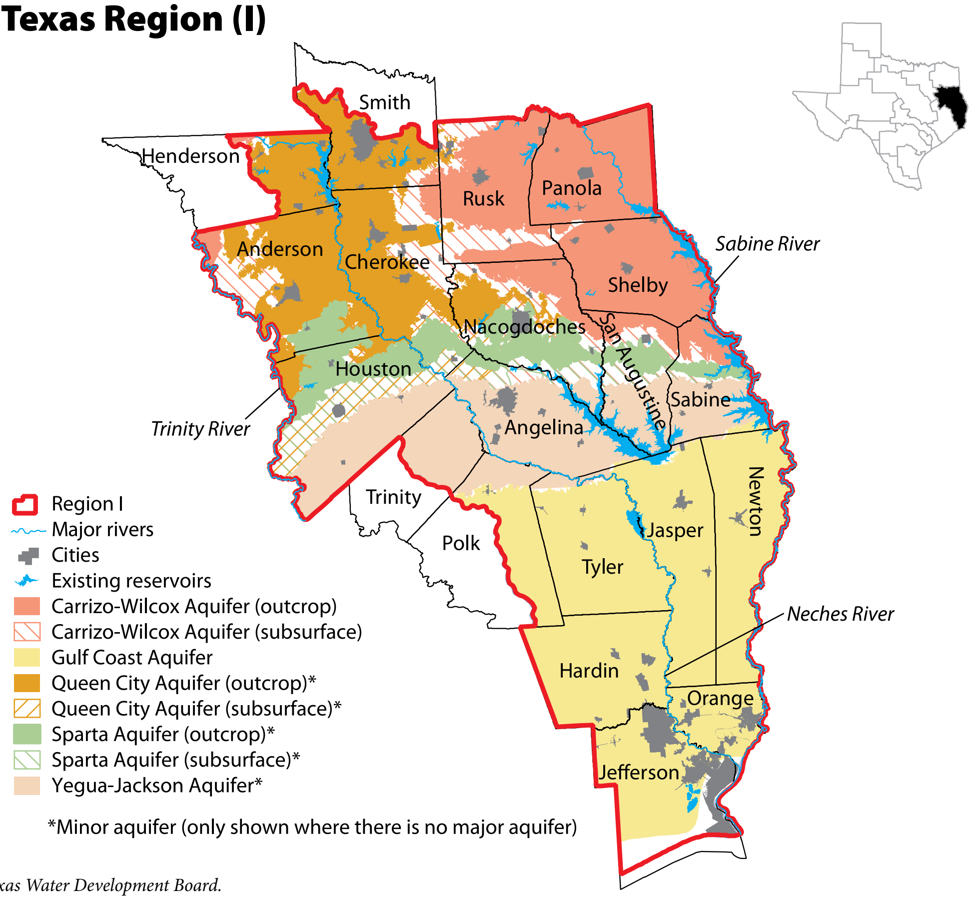
Status of Major Water Projects and Strategies

The state has committed about $15.6 million for the development costs of the Lake Columbia reservoir, currently in the pre-construction phase. Before starting construction, the project must gain a 404 permit, a permit certifying that the region meets governmental standards restricting wastewater discharge into bodies of water, from the U.S. Army Corps of Engineers. Project planners are working with the Angelina & Neches

Region H faces the challenge of subsidence, which is the settling or sinking of land caused by excessive groundwater pumping. As a result, the region is continuing to convert from groundwater to new surface water sources.

Exhibit 26

East Texas Region (I)



Source: Texas Water Development Board.

Exhibit 27

East Texas Region (I) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$0	1,916	$0
Groundwater	32,364,727	21,589	1,499
Surface Water	577,468,276	298,575	1,934
Water Reuse	3,601,700	2,676	1,346
Total	**$613,434,703**	**324,756**	**$1,889**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

River Authority and a private consultant to review comments and address all concerns related to the 404 permit. The region will request an additional $48 million from the state in January, contingent on obtaining the 404 permit.[69]

According to the TWDB, if the strategies listed above are not implemented it could cost residents of Region I $141 million in income and 1,860 full- and part-time jobs by 2010 and nearly $1.7 billion in income and almost 23,000 jobs by 2060. In addition, state and local governments could lose $17 million in annual tax revenue by 2010 and some $236 million by 2060.[70]

Regional Challenges and Successes

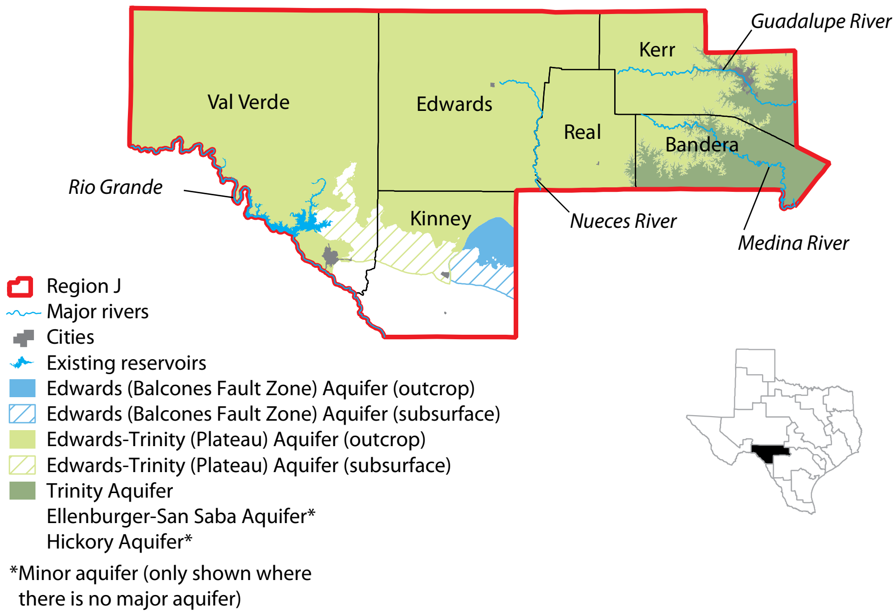
The East Texas region continues to face and overcome challenges associated with water strategy implementation. Designation of unique stream segments presents a problem for the region as water planners must balance future needs of land rights owners with the interests of developers, future public works projects and environmental concerns. Regional planners also face challenges associated with implementing environmental flow, the amount of water necessary for a river, estuary or other freshwater system to maintain its health and productivity, mandates from Senate Bill 3. Environmental flow planners must consider a range of competing interests, from national security to economic development and environmental welfare.[71] For instance, efforts to deepen and widen Sabine Lake require creative ways of mitigating saltwater and brackish water inflows from the Gulf of Mexico. Possible solutions include pumping freshwater into the lake or construction of marshes.

In addition to these issues, the region's chairman identified solutions for two planning and regulatory issues. Water demand projections are based on Texas State Data Center population projections in conjunction with TWDB. According to the East Texas Region's Chairman regional planners must adhere to these projections even if regional planners have better insight on local population trends. Water planning could improve if local consultants became responsible for population projections. According to TWDB, regional planners can amend population projections if they have more accurate demographic data to support these charges.

Also, levels of water consumption used for regional planning differ from levels specified in TCEQ statutes. The region's planning group chairman prefers TCEQ levels, since they more closely align with needs of the region during a drought of record. These two levels could be reconciled based on scientific criteria to create one standard that accommodates both regional planning and TCEQ needs. Funding presents another obstacle for the region. To meet water demand in the northern and southern areas, the region must develop a costly water transportation infrastructure. In addition, rural areas of the region lack the customer base to support large water projects. The East Texas region's greatest success is the designation of Lake Columbia as a unique reservoir site. Several participants from the surrounding area of the future reservoir site continue making progress toward project construction.[72]

Exhibit 28

Plateau Region (J)



Source: Texas Water Development Board.

Plateau Region (J)

Region J, also known as the Plateau region, is located on the southern edge of the Edwards Plateau and consists of six counties (**Exhibit 28**). The major cities in the area are Del Rio and Kerrville. The area extends from the Texas – Mexico border eastward through the Texas Hill Country. Portions of the Guadalupe, Nueces, Colorado, San Antonio and Rio Grande River Basins are included in the area. The major industries in the region are tourism, ranching, hunting and government operations associated with Laughlin Air Force Base in Del Rio.

Strategies Used and Estimated Costs

The Plateau Planning Group recommended 12 water management strategies for the region that can be classified into three general categories: conservation, groundwater and surface water. The strategies recommended in the region have a total capital cost of $14.4 million and would result in an additional 14,869 acre-feet of water supply available by 2060 (**Exhibit 29**).[73]

Eight of the 12 water management strategies in the region deal with conservation efforts in Kerr and Bandera counties and comprise just more than 10 percent, or 1,507 acre-feet, of the additional water needed in the region by 2060. The capital costs associated with these strategies is relatively low, just $3,600, and the region has already begun implementation of these strategies. Specifically, the region is auditing municipal water use in Kerr and Bandera counties to identify wasteful practices. The region is educating the public about wasteful practices and efficient use. In addition, the region is making a concerted effort to conserve water used for irrigation systems through more efficient crop management, time sensitive irrigation schedules and the use of low-pressure sprinkler systems.

Approximately half of the capital costs, $7.7 million, will fund new groundwater wells in Kerr and Bandera counties. These new groundwater wells will provide more than one-third, or 5,672 acre-feet, of the additional water needed in the region by 2060. This strategy is currently being studied, with no plans implement it until at least 2010. The regional planning group is unclear

Exhibit 29

Plateau Region (J) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$3,600	1,507	$2
Groundwater	7,718,000	5,672	1,361
Surface Water	6,650,000	7,690	865
Total	**$14,371,600**	**14,869**	**$967**

Note: Four of the region's conservation strategies do not have any acre-foot cost because they involve crop management and changing irrigation schedules. These strategies can be implemented without any acre-foot cost to water users. Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

at this point exactly how much groundwater is available in the Edwards-Trinity Aquifer because there are some concerns about the accuracy of the current modeling system used by TWDB to calculate the water resources in the aquifer. In addition, the regional planning group has some concerns about the demographic growth data used for the area. Until the region can more accurately project its future demographic changes, as well as the available groundwater resources in the area, these strategies will be on hold.

More than $6.5 million of the capital costs listed in the region's plan deal with increasing the City of Kerrville's water treatment capacity. By doing so, the region will be able to increase the amount of potable water available to the area by 2,240 acre-feet without any additional groundwater or surface water contracts. As part of this strategy, the city of Kerrville plans to increase the amount of water that is treated from 5 million gallons per day to 10 million gallons per day over the course of five years, beginning at the end of 2007. Kerrville initiated the project in November of 2007 and has already expanded the water treatment rate from 5 million gallons per day to 6 million gallons per day.[74] However, the region can also foresee the need for additional surface water supplies and has included in its plan a strategy to obtain additional water from the Upper Guadalupe River Authority (UGRA) in 2030, an additional 3,840 acre-feet, and by 2050, an additional 5,450 acre-feet, to meet its future needs[75]

According to the TWDB, if the strategies listed above are not implemented, residents of Region J stand to lose $6 million in income and 50 full- and part-time jobs by 2010 and nearly $9 million in income and about 70 jobs could be lost by 2060. In addition, state and local governments could lose $140,000 in annual tax revenue by 2010 and about $180,000 by 2060.[76]

Regional Challenges and Successes

The region needs better groundwater modeling to provide more accurate data to the regional and sub-regional planning groups. Improved groundwater modeling data would not only provide a better picture of how much groundwater is available, it would also provide a better idea of seasonal influxes in water needs due to tourists, hunters and weekend home owners. Many residents are very concerned about the possible export of the region's groundwater to neighboring regions.[77]

Lower Colorado Region (K)

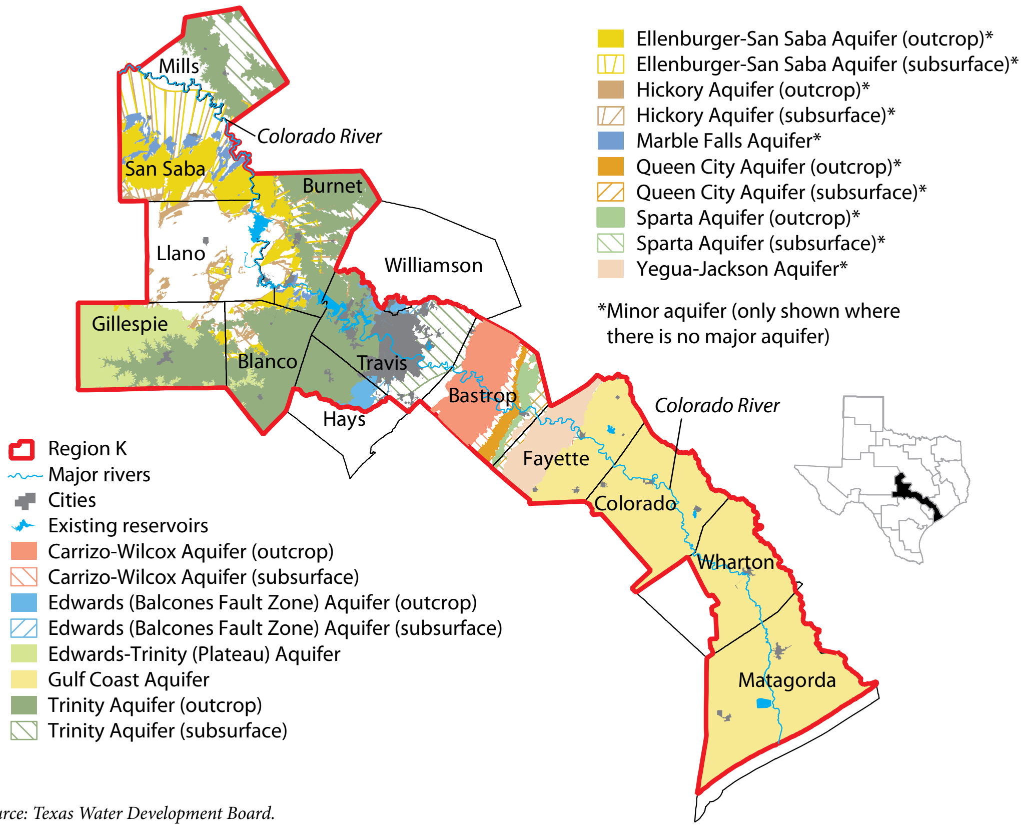
Region K, also known as the Lower Colorado region, begins in Mills and San Saba counties in the Texas Hill Country and makes its way southeastward toward the Gulf of Mexico. The region serves much of the Hill Country, including Llano, Fredericksburg, Austin and Pflugerville, as well as Bay City and other coastal communities (**Exhibit 30**). Agriculture, government, manufacturing (primarily semiconductor and other technological industries), retail and service industries are the region's economic mainstays.[78]

Strategies Used and Estimated Costs

Total capital costs for all of Region K's water management strategies are estimated at $358.2 million. The region's water management strategies are projected to produce 861,930 acre-feet by

Exhibit 30

Lower Colorado Region (K)



Source: Texas Water Development Board.

2060 and fall into four major categories of strategies: conservation, groundwater, surface water, and water reuse (**Exhibit31**).[79]

Status of Major Water Projects and Strategies

Some strategies in the Lower Colorado Region may be changed or substituted with a new strategy based on the regional assessments. The Onion Creek recharge strategy originally would build two dams to provide water to Hays County. The retained water would then be released as needed to meet water needs downstream. However, the recharge strategy will need revisions based on reviews with the Barton Springs/Edwards Aquifer Conservation District and City of Austin. Once new strategy decisions have been made, Region K will host at least one public meeting to discuss them.

Region K's groundwater strategies, which require the bulk of its capital costs, include projects to maintain adequate groundwater supplies through expansion of the Carrizo-Wilcox and Trinity Aquifers, as well as other aquifers throughout the region. Expansion of the Carrizo-Wilcox is estimated at $13 million and the Trinity Aquifer expansion project has an estimated cost of $12.2 million. Overall, the region's groundwater projects are on target to meet projected water demand levels.[80]

Region K is also working on a groundwater strategy in partnership with the Fox Crossing Water District to replace Lake Goldthwaite, which could include freshwater and brackish water from the Trinity and Hickory Aquifers in Mills County and the Ellenburger-San Saba Aquifer in Lampasas and Llano Counties.[81]

Exhibit 31

Lower Colorado Region (K) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$2,903,692	194,315	$15
Desalination	96,537,717	29,568	3,265
Groundwater	65,445,175	95,742	684
Surface Water	15,227,525	398,215	38
Water Reuse	178,059,959	144,090	1,236
Total	**$358,174,068**	**861,930**	**$416**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Population growth in the Austin metro region, surrounding suburban districts, and in the outlying retirement communities has greatly altered the population and water needs estimates.

In addition the Lower Colorado River Authority (LCRA) and San Antonio River System (SAWS) are partnering on a project that will produce 150,000 acre feet of water in 2060 at a capital cost of $21 million. This water management strategy originates in Region K but will meet water needs in both Region K and Region L. (For more information on this project see LCRA/SAWS Water Project on pages 41 and 42.)

Not all recommended strategies are being implemented. For example, Region K's recommended strategy to desalinate brackish groundwater, estimated at $96.5 million, is not being pursued. Rather, municipalities are considering implementing this strategy in the future. However, a water reuse project for the city of Austin is currently under way and on target, and is projected to provide the region with 33,537 additional acre-feet per year by 2060.

According to the Texas Water Development Board, if the strategies listed above are not implemented, residents of Region K stand to lose $335 million in income and 4,480 full- and part-time jobs by 2010, and more than $4.3 billion in income and nearly 50,000 jobs by 2060. In addition, state and local governments could lose $8 million in annual tax revenue by 2010 and about $248 million by 2060.[82]

Regional Challenges and Successes

Population growth in the Austin metro region, surrounding suburban districts, and in the outlying retirement communities has greatly altered the population and water needs estimates. Region K will work with local entities, TWDB and others to produce new projections based on findings within the area.

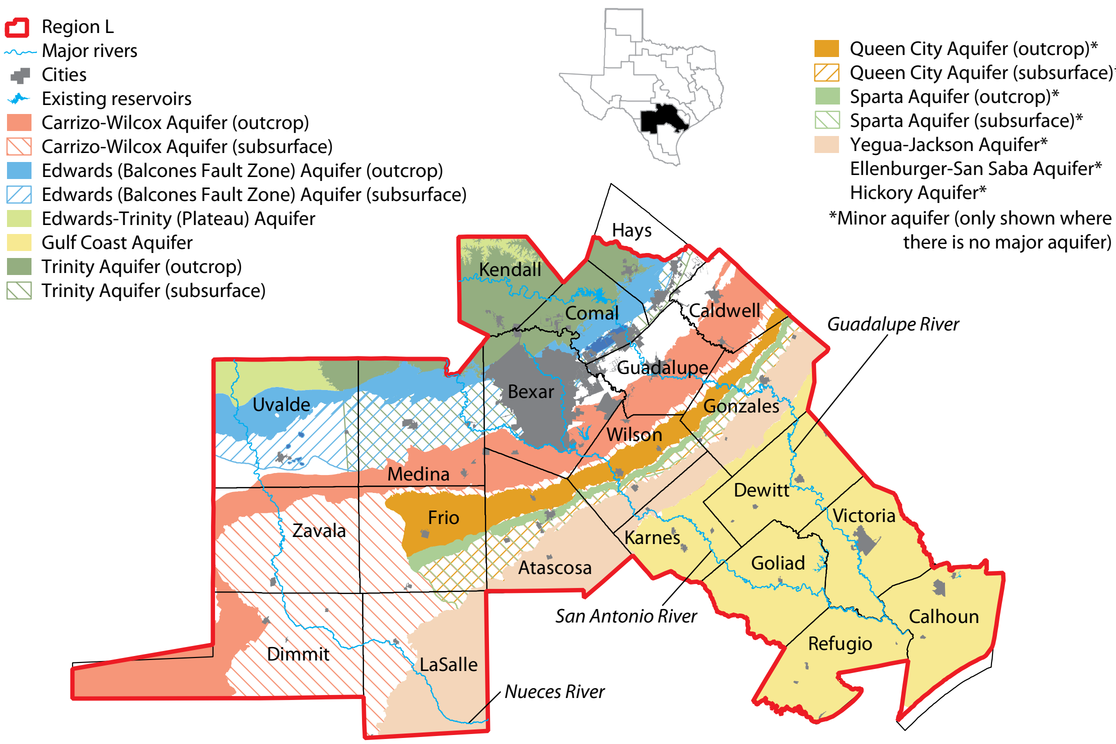
Cities and districts in Region K have indicated that they know little of the conservation measures required of them. In response, the region will re-evaluate conservation and drought contingency strategies for each water user groups (WUG). In addition, there will be a review of significant climate changes to the area.

Because of the changes Region K will be making to its water strategies, additional study is suggested on water availability, quality and cost. Additionally, the region will continue to encourage public participation in the planning process.[83]

Finally, the region has repeatedly recommended the following water segments be studied to potentially identify them as ecologically unique: the Barton Springs segment of the Edwards Aquifer, Bull Creek, the Colorado River (including Gorman Creek and Shaws Bend), Cummins Creek, the Llano River, the Pedernales River, Rocky Creek and Hamilton Creek.[84] Region K members have indicated frustration with the lack of policy action in response to their recommendations for these studies. Until the Legislature makes a decision, no further work will be performed on studies on these areas.[85]

Exhibit 32

South Central Texas Region (L)



Source: Texas Water Development Board.

South Central Texas Region (L)

Region L, also known as the South Central Texas region, stretches from the Gulf Coast in Calhoun County and westward through South Central Texas. The region comprises 21 counties and the cities of San Antonio, Victoria, San Marcos and New Braunfels (**Exhibit 32**). The area includes segments of nine rivers, the Guadalupe Estuary and San Antonio Bay. The Comal and San Marcos Springs, the two largest springs in Texas, are located in the region. The main economic sectors in the area are tourism, medical, military, service, manufacturing and retail trade.[86]

Strategies Used and Estimated Costs

The South Central Texas Water Planning Group has recommended 26 water management strategies to meet the water needs of 2060. In all, the strategies would provide 732,779 acre-feet of additional water supply. The projected total capital cost for providing the additional water for the region is more than $5.2 billion (**Exhibit 33**).[87]

Status of Major Water Projects and Strategies

The Lower Colorado River Authority (LCRA)/San Antonio River System (SAWS) Water Project has the largest capital cost in Region L. The project is expected to generate a capital cost of $2.1 million and produce a gain in water by 150,000 acre-feet in 2060.[88] On February 27, 2002, a definitive agreement between SAWS and LCRA was established to purchase up to 150,000 acre-feet per year of surface water from the Lower Colorado River Basin. The agreement was signed by LCRA and SAWS to collaborate on the water supply project. The agreement requires a six-year study period and then project implementation can occur if the project meets all legislative requirement and is financially, technically and environmentally feasible.[89]

Exhibit 33

South Central Texas Region (L) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conjunctive Use	$2,481,042,000	177,177	$14,003
Conservation	0	109,927	0
Desalination	984,726,000	89,674	10,981
Groundwater	713,958,000	206,111	3,464
Surface Water	853,374,000	98,214	8,689
Water Reuse	189,308,000	51,676	3,663
Total	**$5,222,408,000**	**732,779**	**$7,127**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Currently, the LCRA/SAWS Water Project is in the study phase, which started in mid-2004. Specifically, "the majority of the field studies for the off-channel storage facility and intake facilities have been completed."[90] The study phase is expected to be complete by mid-2009, and an implementation plan will be developed by March 2015 once the project meets the requirements in the Definitive Agreement.[91] The studies in progress focus on issues such as climate change analysis and underground water studies. In relation, House Bill 1629 passed by the Texas Legislature in 2001 authorized the LCRA-SAWS Water Project to proceed only in the case that it meets specific requirements to protect the Lower Colorado River basin. Therefore, the study is formed with an emphasis on meeting criteria set by the bill prior to devising a plan to implement the strategy.[92]

The Edwards Aquifer Recharge – type 2 project has a capital cost of $367.2 million and is expected to generate 21,577 acre-feet of water in 2060.[93] Type 2 projects use recharge dams to catch water in dry streams or creek beds so that it can seep into an aquifer. Currently, studies are being conducted on recharge, recirculation and the recovery implementation program. The project has not yet entered the design and implementation phase.

Presentations on previous recharge studies and the Barton Springs recharge project were conducted on October 16, 2008, and November 13, 2008. The presentations on the various recharge projects are expected to enhance the Edwards Aquifer Recharge subcommittee's familiarity with developing better ways to recharge aquifers.[94]

The Regional Carrizo for Bexar County Supply and Regional Carrizo for Schertz-Seguin Local Government Corporation (SSLGC) strategies have been experiencing impediments in proceeding with the project. The Regional Carrizo for Bexar County Supply strategy is defined as being a total of 62,588 acre-feet per year of Carrizo groundwater from four well fields in Gonzales, Wilson and Bexar Counties. The groundwater is delivered to SAWS Twin Oaks facility in southern Bexar County. The project includes 98 miles of raw water pipeline, 37 miles of treated water transmission pipeline, three raw water pump stations and expansion of a water treatment plant at Twin Oaks will accommodate increase in water demand. [95]

However, the project has been unable to proceed due to contestation. The groundwater districts do not want water in their region to be drawn from the Carrizo and used in the City of San Antonio. A mediation process between the Gonzales groundwater district and SAWS was held last year, but no resolution was reached.[96]

The Regional Carrizo for SSLGC Project Expansion is owned and operated by SSLGC and holds permits to pump 12,200 acre-feet per year of groundwater from Gonzales County's Carrizo Aquifer. Schertz and Seguin will be the primary sites to receive the supply of water, and SSLGC has signed contracts to supply 400 acre-feet per year of peaking water to the cities of Selma and Universal City.[97] Currently, the project has not been able to move forward due to contestation. Permit applications have been submitted to the underground districts, but the next process is being delayed by the contested case hearing.[98]

The SAWS Recycled Water Program is hoping to reach additional customers by establishing north and south interconnections between two main legs of the current system and by extending existing lines. SAWS is currently working with legislative representatives in its area on possible legislation for the 81st Legislature to allow better reuse of water.[99]

According to the TWDB, if the strategies listed above are not implemented, residents of Region L face losses of $664 million in income and 10,200 full- and part-time jobs by 2010, nearly $5.5 billion in income and about 100,000 jobs by 2060. In addition, state and local governments could lose $32 million in annual tax revenue by 2010 and about $335 million by 2060.[100]

Regional Challenges and Successes

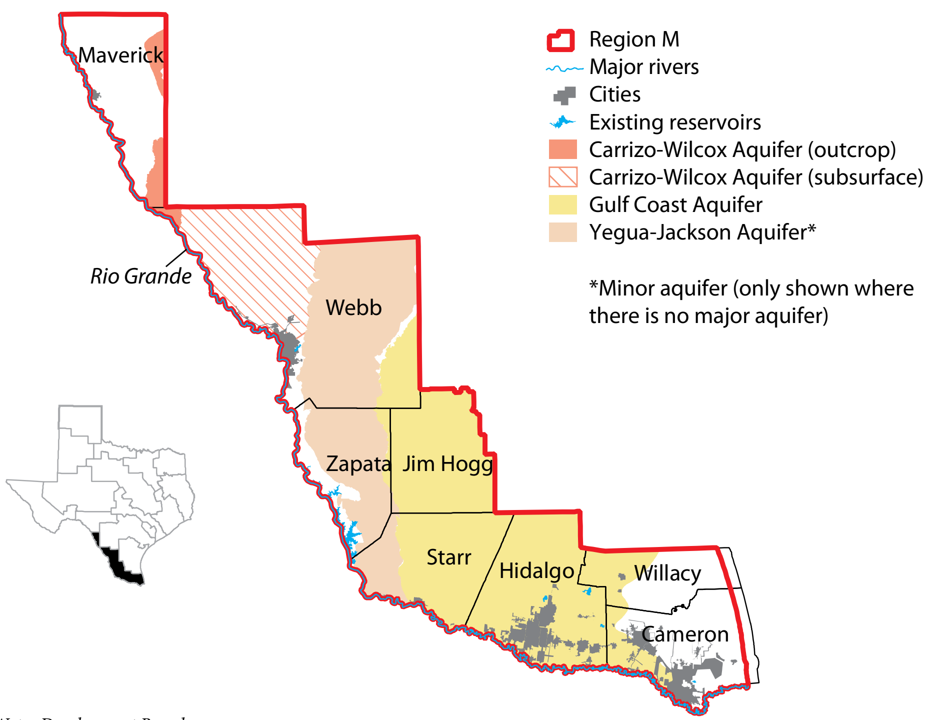
One of the major problems in the region is the lack of water for the growing population. There are ongoing issues such as the exporting of Carrizo-Wilcox Aquifer water from Gonzales and Wilson counties, the potential of temporary overdrafting of the Carrizo-Wilcox Aquifer, the revised Lower Guadalupe Water Supply Project and the over-reliance on the Edwards Aquifer.[101]

Rio Grande Region (M)

Region M, also known as the Rio Grande region, is located along the southern tip of Texas and is adjacent to Mexico. The region includes Maverick, Webb, Zapata, Jim Hogg, Starr, Hidalgo, Willacy and Cameron counties, as well as the major cities of Laredo, Brownsville, Harlingen and McAllen **(Exhibit 34)**. Major economic drivers in the region include agriculture, trade, services, manufacturing and hydrocarbon production.[102]

Exhibit 34

Rio Grande Region (M)



Source: Texas Water Development Board.

The long-term water supply for Region M will be available through operation of an on-channel reservoir and construction. The project will be located approximately four miles southeast of Brownsville and will provide opportunities for water conservation and management improvement in the lower Rio Grande.

Strategies Used and Estimated Costs

To meet projected water demands in 2060, the Rio Grande Planning Group has assessed various water management strategies and their costs. The objective is to provide 807,587 acre-feet of additional water supply by 2060. The projected total capital cost is just more than $1 billion, the fourth largest amount among all regions in Texas. To achieve an increase of 601,127 acre-feet of total water supply by 2060, the region will use a number of strategies including conservation, desalination, groundwater, surface water and water reuse (**Exhibit 35**).[103]

Status of Major Water Projects and Strategies

Brackish groundwater desalination has the largest capital costs in Region M. Reverse osmosis (RO) is the most common method used in desalination of brackish groundwater. A majority of the current or proposed full-scale RO systems will use drainage ditch discharge, which will ultimately discharge into the Gulf of Mexico or Laguna Madre.[104] NRS Consulting Engineers has completed the construction of seven regional brackish groundwater facilities and there are various brackish groundwater desalination projects in progress as well.[105] Some of the regional facilities under construction are in the Valley municipal water district and City of Primera. Plants are also being built for the North Alamo Water Supply Corporation.[106]

The Seawater Desalination project will require a capital cost of nearly $16 million and a water gain of 7,902 acre-feet in 2060.[107] The project has completed a pilot study focusing on the technology associated with seawater desalination. Currently, NRS Engineering is attempting to secure funding to start the demonstration scale project, which will answer questions not addressed in the pilot study in developing and building a full scale seawater desalination plant.[108]

The region is making a concerted effort to reduce water usage in rural areas through several on-farm conservation strategies. Specifically, the region is currently implementing methods such as low energy precision application and metering to help reduce the amount of water used on farms and ranches. In addition, from 2007, manufacturing clothes washers are required to be 35 percent more efficient than current standards.[109]

The Brownsville Weir and Reservoir strategy has a total capital cost of $66.5 million and is expected to produce 20,643 acre-feet of water in 2060.[110] The project is set to capture and store excess river flows as a consistent water supply for lower Rio Grande Valley communities. The water supply for the region will be available through operation of an on-channel reservoir. The project will be located approximately four miles southeast of Brownsville and will provide opportunities for water conservation and management improvement in the lower Rio Grande. Currently, the Brownsville Public Utility Board is collaborating with "the U.S. and Mexican Sections of International Boundary and Water

Exhibit 35

Rio Grande Region (M) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$334,173,100	462,423	$723
Desalination	358,414,525	77,864	4,603
Groundwater	43,982,595	31,416	1,400
Surface Water	297,162,982	190,103	1,563
Water Reuse	52,389,226	45,781	1,144
Total	**$1,086,122,428**	**807,587**	**$1,345**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Commissions, City of Matamoros, Tamaulipas and Comision Nacional del Agua to develop bi-national efforts to construct the Project on the Rio Grande."[111]

According to the TWDB, if the strategies listed above are not implemented, residents of Region M face losses of $164 million in income and 3,610 full- and part-time jobs by 2010, and more than $2 billion in income and nearly 26,900 jobs by 2060. In addition, state and local governments could lose $5 million in annual tax revenue by 2010 and about $76 million by 2060.[112]

Regional Challenges and Successes

There is concern for the reliability of Mexico's inflows into the International Amistad-Falcon Reservoir system and the supply of water that is needed for water rights downstream at points of diversion and usage. Throughout the years, Mexico has often accumulated water debts to the U.S. in violation of the 1944 Treaty.[113] In 1944, Mexico and the US signed a treaty about waters of certain international rivers, including the Colorado River.[114] The lack of surface water from Mexico will decrease the supply available to sustain the area's immense population growth. As of November 2008, however, Mexico had delivered all of the required water under the treaty and no debt currently existed, according to the International Boundary and Water Commission, the international body that manages the agreement.[115]

Overall, water supply in the region is scarce, and more diversity in water sources is needed. Additionally, funds from TWDB and federal programs for irrigation conservation have not been sufficiently available causing difficulty in successfully implementing irrigation conservation strategies.[116]

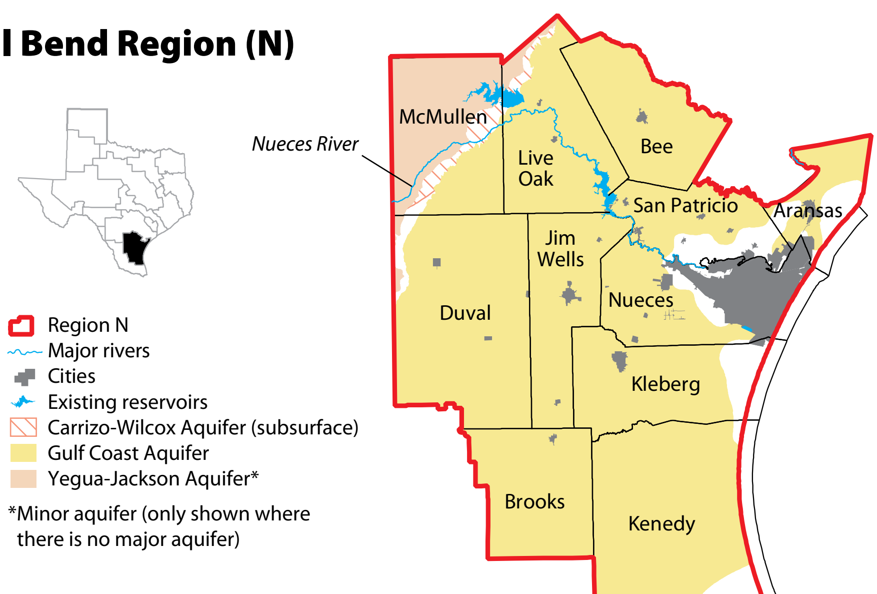
NRS Engineers on behalf of the Brownsville Public Utility Board (PUB) has completed a seawater desalination pilot study that will be published in January of 2009. The purpose of the study is to look at cost effective approaches in developing a full scale seawater desalination plant.[117]

Coastal Bend Region (N)

Located in south Texas, Region N (also known as the Coastal Bend region), covers 11 counties and part of the Nueces River Basin and the Nueces Estuary. The largest cities in the region are Corpus Christi, Portland, Kingsville, Beeville, Alice and Robstown **(Exhibit 36)**.[118] The largest regional water provider, the City of Corpus Christi, sells water to the South Texas Water Authority and San Patricio Municipal Water District.[119] The

Exhibit 36

Coastal Bend Region (N)



Source: Texas Water Development Board.

Exhibit 37

Coastal Bend Region (N) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$0	6,891	$0
Desalination	248,919,000	18,200	13,676
Groundwater	48,338,000	20,535	2,354
Surface Water	490,758,000	103,620	4,736
Water Reuse	1,500,000	250	6,000
Total	**$789,515,000**	**149,496**	**$5,281**

Note: The conservation efforts for mining in Region N that contribute to the region's overall water gain from conservation have highly variable costs per acre-foot and were not included in the overall average cost per acre-foot for that category. Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Region N is working with the U.S. Army Corps of Engineers, the adjoining South Texas Region and other agencies to devise joint water management strategies. The region has been successful in planning for water needs in the region, with available supplies projected to meet water demands through at least 2035.

major industries in the region are service, government, retail trade and petrochemical.

Strategies Used and Estimated Costs

Implementing the recommended water management strategies in the Coastal Bend Region would provide an additional 149,496 acre-feet of water in 2060 at a total capital cost of $789.5 million, most of which would develop surface water sources (**Exhibit 37**).[120]

Status of Major Water Projects and Strategies

To enhance surface supplies, the City of Corpus Christi is planning for a major seawater desalination plant to increase water for municipal users. According to the City of Corpus Christi water department, a feasibility study has been completed on the desalination project. At this time, the project is not economically feasible and will remain on hold until it becomes a necessity.[121] The city also bought 35,000 acre-feet per year from the Colorado River-based Garwood Irrigation Company that will be used for irrigation, as well as industrial and municipal purposes.

Currently, HDR Engineering Inc. is partnering with the Nueces River Authority on a channel loss study on the surface and groundwater moving between the Choke Canyon Reservoir to Lake Corpus Christi. Data revealed that little or no water is actually lost during transport between the reservoir and the lake, eliminating the need to build the $105 million pipeline detailed in the previous plan. The funds can now be redirected to other cost-effective water management strategies. Continued study will include the benefits of an off-channel reservoir, a storage reservoir in a lowland area, to accumulate additional water when supplies exceed capacity. Because the off-channel storage would be smaller and in a lowland area compared to the lake, it would minimize evaporation. HDR continues to assess the cost estimate and benefits of this water management strategy.[122]

Groundwater supplies will be enhanced by a new well field in western Refugio County over the Gulf Coast Aquifer to provide water during peak agricultural times.

According to the TWDB, if the strategies listed above are not implemented, the region could lose $22 million in income and 230 full- and part-time jobs by 2010. By 2060, the cost could be about $3.2 billion in income and nearly 36,800 jobs. In addition, state and local governments could lose $3 million in annual tax revenue by 2010 and about $233 million by 2060.[123]

Regional Challenges and Successes

The region has been a leader in water planning for years. For instance, the Mary Rhodes Pipeline was completed in 1998 to transport water from Lake Texana to the City of Corpus Christi via an interbasin transfer permit. The pipeline can transport twice the volume of water under current supply contracts.[124] The region is working with the U.S. Army Corps of Engineers, the adjoining South Texas Region and other agencies to devise joint water management strategies. The Coastal Bend Region has been successful in planning for water needs in the region, with available supplies projected to meet water demands through at least 2035.[125]

Llano Estacado Region (O)

Located in the Southern High Plains region of the Texas Panhandle, Region O, also known as the Llano Estacado region, includes 21 counties, bounded on the north by Deaf Smith County, Motley and Dickens counties to the east, Gaines and Dawson counties to the south, and New Mexico on the western edge (**Exhibit 38**). Small portions of the Canadian, Red, Brazos and Colorado rivers are located in the area, although almost no surface water leaves the region. Instead, surface water is captured by nearly 14,000 playa basins, which are natural water collecting pools. Major industries in the region include livestock and cotton production. Major cities in the region include Lubbock, Brownfield, Plainview and Hereford.

Strategies Used and Estimated Costs

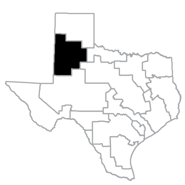
In order to meet the region's projected water demands in 2060, the Llano Estacado Planning Group recommended 13 water management strategies to address most future water needs. In all, the strategies would provide 441,511 acre-feet of additional water supply by 2060, with total projected capital costs exceeding $818.6 million. The region's water management strategies fall into four general categories: irrigation conservation, groundwater development, brackish groundwater desalination, and infrastructure connecting Lubbock to the Alan Henry reservoir (**Exhibit 39**).[126]

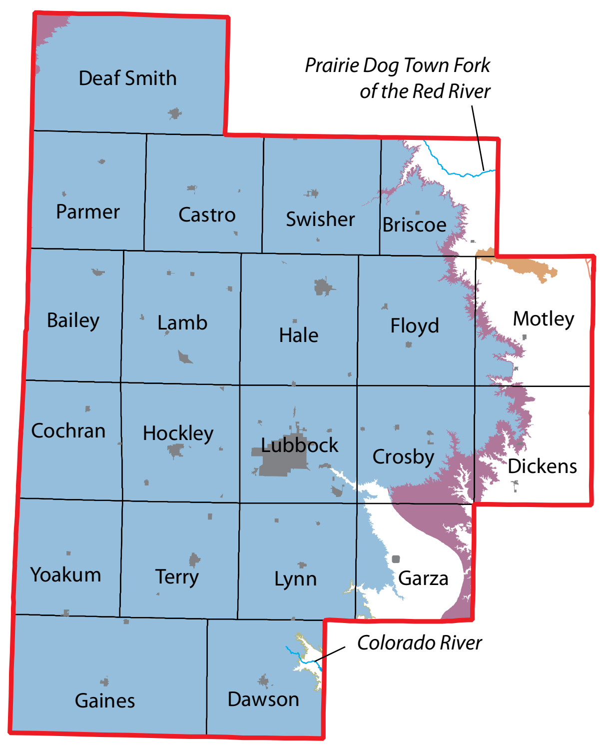
Status of Major Water Projects and Strategies

The state has committed nearly $23 million toward the construction of a pipeline from Lake Alan Henry to the city of Lubbock. Currently, the project is in the design and testing phase, with completion of the pipeline scheduled for 2012. The project includes 50 miles of pipeline, 3 pumping stations, and a treatment plant for distribution within the city of Lubbock.

Exhibit 38

Llano Estacado Region (O)





Source: Texas Water Development Board.

Exhibit 39

Llano Estacado Region (O) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Conservation	$353,510,000	337,790	$1,047
Desalination	10,051,230	3,360	2,991
Groundwater	43,986,161	50,421	872
Reuse	29,746,680	2,240	13,280
Surface Water	381,336,000	47,700	7,995
Total	**$818,630,071**	**441,511**	**$1,854**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

Region O also plans to amend the state water plan with one major reduction and various additions. The region no longer plans to develop the reservoir Canyon Lake 8 and is working with the TWDB to remove the project. Instead, the City of Lubbock plans to purchase and develop Post Reservoir from the City of Post in exchange for water rights. Infrastructure from the Lake Alan Henry pipeline will transport and treat water from this reservoir. Lubbock is also negotiating with the Brazos River Authority to designate water from playa basins as city water. This water would reach Lubbock through the Lake Alan Henry pipeline after a diversion from North Fork. The state plan must be amended to include these additions.[127]

According to the TWDB, if the strategies listed above are not implemented, the region could lose $103 million in income and over 4,400 full- and part-time jobs by 2010. By 2060, the cost could be about $387 million in income and nearly 13,700 jobs. In addition, state and local governments could lose $10 million in annual tax revenue by 2010 and about $32 million by 2060.[128]

Regional Challenges and Successes

Due to heavy reliance on groundwater from the Ogallala Aquifer, the region's main concern is the accurate measurement of groundwater availability. New modeling of the Ogallala's water capacity suggests that the aquifer has greater recharge capacity than was reported for purposes of state and regional water planning. The planning group claims that original modeling was based on incomplete starting volumes of the aquifer in 1995 and 2000, due to drought conditions and unusually high demand. Furthermore, some of the region's counties assumed that up to 80 percent of aquifer capacity in their area will remain in storage through 2060, rather than factoring into supply and demand estimates. The region believes that water supply and demand could be more accurately modeled using more complete data. Also, the region recommends a variety of conservation practices that would contribute to recharge efforts, notably vegetation control efforts in lake watershed districts, as well as efforts to improve irrigation.[129]

Lavaca Region (P)

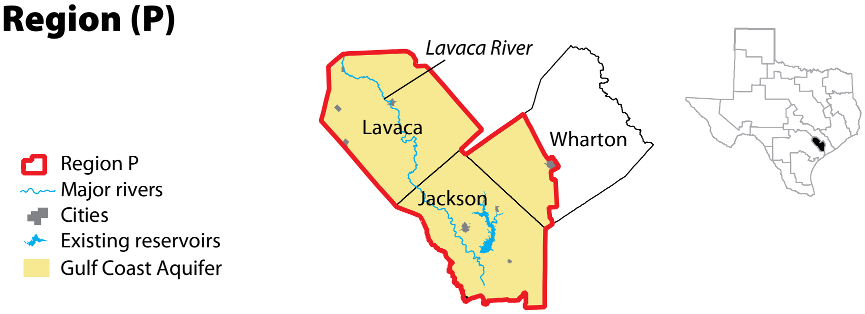
Region P, also known as the Lavaca Region, comprises Jackson and Lavaca counties, as well as the southwest portion of Wharton County. The region contains the cities of Edna, El Campo and Halletsville. The Lavaca River is the region's main source of surface water, while the Gulf Coast Aquifer provides groundwater. Main industries in the region include agribusiness, mineral production, oil and gas production and manufacturing (**Exhibit 40**).[130]

Strategies Used and Estimated Costs

The Lavaca region has only one strategy and it falls under the groundwater category. The strategy would provide 32,468 acre-feet of additional water supply by 2060, with no projected capital costs.[131]

Exhibit 40

Lavaca Region (P)



Source: Texas Water Development Board.

Status of Major Water Projects and Strategies

The Lavaca Region investigated several drought-related strategies for the area. The region's original plan called for three separate strategies. However, since the release of the plan, the region has combined the two over-drafting strategies from Jackson and Wharton counties. Temporary overdrafting of the Gulf Coast Aquifer, which was found to be economically feasible, could provide adequate water for citizens and businesses. While the current implementation schedule of the region's strategy is scheduled to begin in 2010 and provide 32,468 acre-feet by 2060 for agriculture, implementation on the project will not begin until drought conditions exist (**Exhibit 41**).[132]

According to the TWDB, if the strategy listed above is not implemented, Region P residents face losses of $3 million in income and 120 full- and part-time jobs from 2010 through 2060. In addition, state and local governments could lose $300,000 in tax annual revenue from 2010 through 2060.[133]

Regional Challenges and Successes

The Lavaca Region has 76,000 acres of irrigated farmland, with three-fourths solely in rice production. The planning group educates citizens on rice returns and futures. The area is crucial to national rice output. Any increase in production could result in a higher demand for groundwater. The region works to ensure adequate supply for rice farming and has successfully developed its own numbers and methodology to arrive at future plans recognized by the TWDB. Regional planners say they are prepared for drought conditions based on past experience and future planning.[134]

Exhibit 41

Lavaca Region (P) Water Management Strategies

Description	Capital Costs	Water Gained in Acre-Feet	Average Capital Cost per Acre-Feet
Groundwater	$0	31,979	$0
Surface Water	$0	489	0
Total	**$0**	**32,468**	**$0**

Note: Capital cost figures do not include administrative, programmatic or other costs that may be required to implement water management strategies.
Source: Texas Water Development Board.

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State Water Plan: Issues and Funding

In addition to the strategies identified by water planning regions, the 2007 Texas State Water Plan highlighted several policy issues to be addressed in implementing the plan. Some of the recommendations were enacted by the 80th Legislature in 2007, while others have not yet been addressed.

Reservoir Site Designation and Acquisition

Development and construction of new reservoirs remains an ongoing policy issue. An important factor in preserving future reservoir sites for construction is proper designation by the Legislature. Actions by federal, state or local governments to protect ecosystems in or near reservoir sites can sometimes impede development.[1] For example, in 2006 the U.S. Fish and Wildlife Service designated a federal wildlife refuge on 25,000 acres in Anderson and Cherokee counties in East Texas, preventing the construction of Fastrill reservoir, a water supply project which had been sought by the city of Dallas.[2] This designation is being appealed.

Acquisition and protection of future sites is also an issue. To address this, the Texas Water Development Board (TWDB) controls the Storage Acquisition Fund for projects related to the acquisition and development of water storage.[3] In 2007, the 80th Legislature enacted Senate Bill 3. Among its provisions, the bill designated 19 sites identified in the State Water Plan as having unique value for the construction of a dam and reservoir, a designation that will expire in 2015 unless an affirmative vote for a project is made by the project sponsor, such as the governing body of a city. Although the bill did not initiate reservoir construction, it did lay the ground-

Cotton fields near Lubbock, Texas

work for it by designating these sites. To address concerns over the controversial Marvin Nichols reservoir planned along the Sulphur River in Red River and Titus Counties, a study commission will examine water needs in Region C (Dallas-Fort Worth) and recommend, no later than December 1, 2010, whether Marvin Nichols should remain designated as a reservoir site.[4]

Reservoir designation and construction are controversial issues. Development can conflict with the interests of local landowners whose property would be flooded, and environmental concerns such as habitat loss, diminished downstream flows and pollution have also led to opposition.

Rivers need a base level of flow to preserve the fragile ecosystems that surround them. Coastal bays and estuaries need freshwater inflows to maintain the delicate balance between freshwater and seawater that sustains wildlife and supports shrimping, fishing, recreation, and other coastal industries.

Interbasin Transfers of Surface Water

Interbasin transfer of surface water is the practice of moving surface water from one river basin to another. This provides an important source of regional water supply for some, and has been used to meet water demand shortages in various regions. Current state laws, however, substantially restrict the free flow of interbasin transfers.

Prior to the passage of Senate Bill 1 in the 75th Legislative Session (1997), interbasin transfers were significantly more accessible. With Senate Bill 1, the state adopted the "junior water rights provision." This regulation requires any water right that transfers surface water from one river basin to another to be reclassified as "junior." This reclassification means that senior water rights allowing the transfer of surface water outside the basin become junior to other water rights within the basin. For this reason intrabasin water rights have priority over interbasin rights. In drought years when there is not enough surface water to satisfy all water rights, junior interbasin rights may not be satisfied.[5]

Since the passage of Senate Bill 1, only two interbasin transfers have been authorized. Opponents argue that the Legislature should repeal the 1997 provisions to restore the volume of interbasin transfers and facilitate free flows of water throughout the state.[6] Others point out that the process can harm agricultural or historic users in the originating river basin and that these users have a right to be protected.

Groundwater Regulation in Texas

For more than a century, Texas' groundwater has been governed under the "rule of capture," a tenet based in English common law that considers groundwater to be a privately owned resource. Thus in Texas groundwater is treated differently from surface water, which is publicly owned and requires a permit for use.

Under the rule of capture, as adopted by the Texas Supreme Court in 1904, a Texas landowner may pump a virtually unlimited amount of groundwater from below his or her land.[7] The court has established only limited exceptions to this rule, requiring that the water be put to a beneficial use; that a landowner may not withdraw water to maliciously injure a neighbor; and that a landowner cannot cause subsidence to a neighbor's land as a result of groundwater withdrawals.[8]

Since adopting the rule of capture, Texas courts have deferred to the Legislature regarding groundwater regulation. In 1997, Senate Bill 1 took a major step toward altering the state's approach to groundwater regulation by strengthening the role of groundwater conservation districts, specifying that these districts are the preferred method for managing the state's groundwater.[9]

Groundwater districts can be created by local voters or through legislation. At this writing, Texas has 95 groundwater districts.[10] These districts can regulate well spacing and may limit groundwater production.

In some areas, more than one groundwater district manages land over a single aquifer. In these cases, groundwater districts must work together under the framework of a "groundwater management area" that encompasses the aquifer. Districts in a groundwater management area collaborate to ensure that groundwater withdrawals are consistent with their plans for the aquifer.

Parts of the state that are without a groundwater district, however, remain governed by the rule of capture. Because groundwater is less highly regulated than surface water, water marketers have become increasingly interested in groundwater resources as an option for meeting growing demand.

In recent months, several important court rulings have highlighted the contentious nature of groundwater regulation in Texas. In *Guitar Holding Co. L.P. v. Hudspeth County Underground Water Conservation Dist. No. 1, et al.* (December 2007), the Texas Supreme Court found that when using historic usage to permit groundwater withdrawals, a district must consider not only the amount of water historically permitted to a landowner, but also the purpose for which the water had been used. According to the court, "because transferring water out of the district is a new use, it cannot be preserved or 'grandfathered.'" The net effect of the court's ruling was to level the playing field for landowners in the Hudspeth County Underground Water Conservation District, meaning that landowners who do not have a history of irrigating now have a right to export water that is equal to those who have historically drawn from the aquifer, and both must apply for a new permit on an equal basis.

Two recent rulings by the Fourth Court of Appeals in San Antonio clarified the status of a landowner's ownership right to groundwater. In February 2008, the court ruled in *City of Del Rio v. Clayton Sam Colt Hamilton Trust* that groundwater is the property of a landowner whether or not it has yet been captured by the landowner. In August 2008, the Fourth Court of Appeals ruled in *Edwards Aquifer Authority v. Day* that a landowner has a vested ownership right in groundwater, potentially opening the door to compensation for landowners if a groundwater district restricts their ability to withdraw groundwater from their property.

These recent court rulings have affirmed the state's long-held position on ownership of private property, as codified in 1995 by SB 14, the Private Real Property Rights Act, authored by Senator Teel Bivins and then-Representative Susan Combs. Groundwater is the property of the owner of the land overlying the aquifer, and efforts to interfere with this right could result in both uncertainty of ownership and enormous economic consequences for our state.

Environmental Water Needs

Environmental concerns regarding water allocation are a crucial part of state water planning. Rivers need a base level of flow to preserve the fragile ecosystems that surround them. Coastal bays and estuaries need freshwater inflows to maintain the delicate balance between freshwater and seawater that sustains wildlife and supports shrimping, fishing, recreation, and other coastal industries. It is important for state officials to have accurate information on environmental flow requirements when they issue permits for municipal, industrial and agricultural uses. And water rights applicants and permit holders need reliable information from the state to plan adequately for environmental issues. Although state agencies have studied environmental inflow needs since 1977, until recently the results were not widely accepted or incorporated into the water right permitting and planning process.[11]

In 2007, Senate Bill 3 passed by the legislature included a process to determine the environmental needs of Texas rivers, bays and estuaries. This process incorporates a bottom-up planning approach, where basin stakeholder committees and expert science teams submit environmental recommendations to the Environmental Flows Advisory Group and the Texas Commission on Environmental Quality (TCEQ), which then develops environmental flow standards. These flow standards are developed to inform water rights applicants of water to be set aside for the environmental protection of rivers, bays and estuary ecosystems.[12]

Conservation initiatives will help supply nearly 23 percent of the state's water requirements by 2060.

Currently, two river basin/bay stakeholder committees are active: the Sabine and Neches Rivers/Sabine Lake Bay Stakeholder Committee and the Trinity and San Jacinto Rivers/Galveston Bay Stakeholders Committee. These committees have appointed experts to gather research on environmental flow needs specific to these river and bay systems. TCEQ is scheduled to adopt environmental flow standards for these regions by May 2011. As specified by Senate Bill 3, the remaining river basin and bay systems will begin their planning process in the coming months and all will be active by June 2010.[13] In addition, the Environmental

Major challenges affecting each water region include decreased federal assistance, the competition for funding by non-water infrastructure needs and time necessary to complete water projects.

Flows Advisory Group, which will ultimately recommend environmental flow set-aside levels to TCEQ, was appointed by the governor, in December 2007.[14] This group has met several times, as has the Environmental Flows Science Advisory Committee, which advises the Environmental Flows Advisory Group on technical and scientific questions.

Water Conservation

Water conservation is an integral part of the Texas Water Plan. Conservation initiatives will help supply nearly 23 percent of the state's water requirements by 2060. The 78th Legislature established a Water Conservation Implementation Task Force that developed best practices for regional water planners to enhance conservation efforts statewide. The task force made 25 recommendations for conservation initiatives at the state level.

Examples of these recommendations included efforts to raise water conservation awareness, tying state water funding to water conservation requirements, grants to fund innovations in water conservation, and the establishment of a water management resource library. Of the 25 statewide recommendations made by the task force, three need continued funding for existing programs, eight require new or additional funding and 13 require legislation and, in most cases, additional funding.[15]

In addition to these measures, in 2007 the 80th Legislature established a statewide water conservation public awareness program and required public utilities serving at least 3,300 water utility connections to develop a water conservation plan. The Legislature also established the Water Conservation Advisory Council, to provide guidance on water conservation issues.[16]

Expedited Amendment Process

To qualify for state funding assistance, Texas law requires that water supply projects are consistent with the state and regional plans, and receive surface water right permits from TCEQ. If a project does not conform to the state water plan and to the regional water plan, the project's applicant must seek either an amendment to those plans or a waiver from TWDB and from the appropriate regional water planning group. The amendment process can be costly and difficult, requiring such actions as a 60-day notice and comment period; notices to municipalities and river authorities; notices published in local newspapers; and public hearings and comments.

To streamline this process, TWDB has recommended an expedited process for projects that would not result in over-allocation of water resources, was not a reservoir project and would not significantly impact environmental flows. This proposed process would require a two-week public notice of an entity's intent to amend the water plans, followed by a public meeting in which the planning group must consider any public comment before amending the plan.[17] The agency claims that this recommendation would significantly accelerate the amendment process and afford economically disadvantaged areas more opportunities.

Indirect Reuse

Indirect reuse occurs when wastewater treatment plants discharge water into a stream and that water is diverted and reused by the same permit holder downstream creating, in effect, a closed loop system. Under current law, indirect reuse requires a "bed and banks" permit that authorizes a water rights holder to transmit water in a watercourse. This is contrasted with direct reuse, in which water is sent directly from a treatment plant to a location where it is used again without reentering the river or stream.

Conflicts have arisen over indirect reuse because downstream users argue that discharged water falls under the "first come, first served" doctrine of "prior appropriation." Prior appropriation allows the water rights holder with the most senior permit full use of his or her permitted amount before the next most senior permit holder can exercise his or her use. Under this doctrine, any entity interested in reusing water that had been discharged into a river would have to apply for another, more junior permit in order to use that water. Proponents of indirect reuse believe that they should be allowed to reuse discharged effluent downstream in order to meet growing demand for water.

Ultimately, many water users believe that the Legislature should clarify water rights accordingly. Potential issues that could be addressed include: the uniform status of water that is derived from different sources; whether water from future or existing sources is treated uniformly; who can obtain indirect reuse rights; and environmental protection in reuse permitting.[18]

Financing Water Management Strategies

The 2007 State Water Plan's total price tag is $30.7 billion, which represents capital costs associated with supplying water to regional systems. Capital costs do not include funds for water distribution within a water supplier's service area, forcing suppliers to shoulder a variety of investment strategies to meet water needs.

Major challenges affecting each water region include decreased federal assistance, the competition for funding by non-water infrastructure needs and time necessary to complete water projects. Local water groups are receiving less federal support for infrastructure, and are feeling the pinch of higher real interest rates, water scarcity, and rising energy costs, which all erode spending power on water projects. Additionally, water projects must compete with other infrastructure needs brought about by population growth, such as roads and schools.

The length of time needed for large water project construction prevents many local groups from implementing projects without state help. Current legal and regulatory barriers require 10 years for planning, and local sponsors are reluctant to approve projects with little short-term benefit. Economically disadvantaged areas cannot raise necessary capital without sufficient income from residents, adding another barrier to water development without state assistance.

Of the $30.7 billion cost of proposed projects in the 2007 state water plan, municipalities and other jurisdictions indicate that the state will need to provide $2.1 billion by 2060. State funds would aid in initiating essential, large scale projects in communities across the state. TWDB subsequently updated this number to $2.4 billion. In the summer of 2008 TWDB completed a new infrastructure finance survey and the agency now estimates that the state will need to provide $16.6 billion by 2060.[19]

Current Water Project Financing

Water projects in Texas are funded by state and local sources. For the past four years, state funding has made up approximately 2 percent of total water project funding in Texas. In fiscal 2008, TWDB provided $137.9 million, which was 3 percent of the total debt issued in Texas for water projects.[20]

Texas' primary funding mechanism has been the issuance of general obligation (GO) bonds backed by the state. TWDB has authority to issue $4.9 billion in GO bonds. As of August 31, 2008, the agency had issued $2.5 billion in GO bonds with a remaining $2.4 billion in issuance authority.[21] Although TWDB has constitutional authority to issue the bonds, the agency depends upon the Legislature to make an appropriation for debt service (interest and principal payments) on any non-self supporting bonds issued. Therefore, debt service amounts appropriated by the Legislature affect the amount that TWDB can issue in GO bonds each biennium.

Through the State Participation Program (SPP), TWDB provides loans to local governments for the construction of water facilities where local funding is inadequate and the entity cannot assume the necessary debt.

The 80th Legislature authorized TWDB to issue $874.8 million in non-self-supporting GO bonds with debt service payments of $39.8 million for fiscal 2008 and $70.9 million for fiscal 2009.[22] The majority of these debt service amounts will be paid from general revenue. Of the bonds authorized for issuance during the 2008-09 biennium, $762.8 million will be used for projects in the State Water Plan.[23]

TWDB provides grants and loans to local entities for funding the planning, design and construction of water and wastewater projects. Grants are provided primarily through the Economically Distressed Areas Program (EDAP), while loans are provided through the State Participation Program, the Water Infrastructure Fund (WIF), the Clean Water State Revolving Fund, and the Drinking Water State Revolving Fund. Typically, the proceeds from GO bond issuances are used to provide loans to local entities that in turn pledge to pay back the loans. Local entities apply for state financial assistance when they cannot assume enough debt for a project or if they can obtain more favorable terms from a state program. Loans are available to a variety of entities and political subdivisions including:

- cities;
- counties;
- river authorities;
- special law districts;
- water improvement districts;
- water control and improvement districts;
- irrigation districts;
- groundwater districts; and
- nonprofit water supply corporations.

Some of TWDB's loan programs offer local entities the option of deferred payments or a repayment rate below market rates. Deferring payments after the completion of a project lets local entities build the required customer base to generate enough revenue to repay the loan. TWDB also offers loans below the market rate to encourage local entities to begin crucial water projects for the region. In the case of deferred loans, from the State Participation Fund, the state recovers all of the principal and interest. Under the Water Infrastructure Fund, the difference between TWDB's cost for debt service and the amount paid back by the local entities represents a cost to the state.

TWDB administers both self-supporting and non-self-supporting GO bond programs. In self-supporting programs, such as the Water Development Fund, proceeds are used to make loans to communities and loan repayments are used to pay debt service on these bonds and make additional loans. Repayments by local entities are then deposited to the same fund for debt service payments and additional loans. In non-self-supporting programs, proceeds from the sale of bonds are used to make loans to communities. Repayments from the communities are then deposited to the particular program fund. These repayments are insufficient to pay all the debt service required and general revenue pays the remaining amount required to pay debt service.

Non-Self-Supporting GO Bond Programs

Through the State Participation Program (SPP), TWDB provides loans to local governments for the construction of water facilities where local funding is inadequate and the entity cannot assume the necessary debt. To ensure that the project is built with enough capacity to serve future growth, TWDB will defer repayment of the loan until an adequate customer base has been established. In exchange, TWDB may acquire an ownership interest in the water rights or co-ownership in the facility or property.[24] TWDB continues to pay the debt service amounts on the original GO bond issuance while local entities repay the entire loan amount on a deferred timetable. TWDB is authorized to issue $326.1 million in bond authority during the 2008-09 biennium with $276.1 million to be used for projects in the State Water Plan.[25]

EDAP provides loans and grants in economically distressed areas where water or wastewater systems are inadequate and the financial resources to provide services are insufficient. Qualifying systems include *colonias* on the Texas-Mexico border and unincorporated areas across the state. Eligible projects are in areas where the median household income is less than 75 percent of the median state household income. In 1991, voters approved $250 million in bonds for the EDAP program and in 2007 approved an additional $250 million. By the end of fiscal 2007, $238 million had been issued.[26] Out of the authorized issuance of $99.5 million in the 2008-09 biennium, $37.5 million is for projects identified in the State Water Plan. By using GO bond proceeds and federal funds in the Colonia Wastewater Treatment Assistance Program, TWDB has provided $570.9 million to 103 projects in 24 counties, affecting 328,069 residents in 676 colonias.[27]

WIF was created in 2001 for making grants and low-interest loans to communities for water projects, but it did not receive any appropriations until 2007. Currently, TWDB can issue $449.3 million in GO bonds for funding projects in the State Water Plan.[28] Bond proceeds are used to make loans at a subsidized interest rate of 2 percent below the cost for TWDB and no less than zero percent. Since the state offers local entities loans at a lower rate than the state is paying for the debt service, general revenue is used to make up the difference. To advance projects that have significant planning and design stages, locals may defer repayment for up to 10 years or until end of construction for the project.[29]

TWDB has constitutional authority to issue up to $200 million in GO bonds for the Agricultural Water Conservation Fund (AWCF). Through the AWCF, TWDB can provide grants to state agencies and political subdivisions for conservation activities and the purchase and installation of metering devices for irrigation use. Loans are available for projects such as converting irrigated land to dryland farming, more efficient use of precipitation and brush control activities. Local banks and credit systems also can apply to this program for funds. Through linked deposits, banks or farm credit associations are able to offer a lower rate for loans to individuals.[30] In exchange, the lender pays a less-than-market interest rate on state funds deposited with the lender. To date, TWDB has loaned $35.2 million to political subdivisions, individuals, and local lending institutions through the AWCF.[31]

Self -Supporting Bond Programs

The Water Development Fund I was established in 1957 when voters approved a constitutional amendment authorizing $200 million in GO bonds for water projects. In 1997, a new Water Development Fund II was established to update the process used to loan and distribute funds.[32] This constitutionally dedicated fund provides most of TWDB's authority to issue GO bonds for such programs as the SPP, EDAP, WIF and RWAF. The Water Development Fund program offers TWDB flexibility as a wide array of water projects are eligible for funding. The self-supporting component of the Water Development Fund provides loans to entities that need state assistance, are unable to wait for federal funds, and are ineligible for either the Clean or the Drinking Water state revolving funds. Through this initiative, TWDB can make one loan to a municipality for multiple water projects. TWDB funds the 20 percent federally required state match for the Clean and the Drinking Water state revolving funds primarily by using bond proceeds amounts from the Water Development Fund II.[33]

Rural political subdivisions that include municipalities and water districts with a population under 10,000 and counties where no urban area has a population more than 50,000 qualify for Rural Water Assistance Fund loans. The program issues Alternative Minimum Tax (AMT) bonds through the state's private activity bond program and under DFUND authority. The AMT bond allow TWDB to offer loans at rates below taxable market rates to non-profit water supply corporations. Another benefit to the program is that construction purchases by nonprofit water supply corporations may receive a sales tax exemption.[34] Since the program's inception in 2001, $104.8 million has been committed to 34 rural communities through the program.[35]

Federal Financial Assistance

TWDB operates two revolving loan funds that receive federal capitalization grants. The Clean Water State Revolving Fund (CWSRF) was established in 1988 in compliance with the Clean Water Act and the Drinking Water State Revolving Fund (DWSRF) established in 1997 in compliance with the Safe Water Drinking Act.[36] Each of these funds receives a federal grant and the state must provide a match of 20 percent of the federal amount. The state matching amount is provided by bonds issued through the Water Development Fund. CWSRF program funds are used as collateral to issue CWSRF revenue bonds to leverage the program. By leveraging the federal and state match amounts, TWDB is able to make more and larger loans than would be possible using only the amounts in the funds. Repayment of the loan is made by the local entity and these amounts are deposited in the respective fund and used to pay debt service and secure additional bond issuances. TWBD provides these loans at rates of 1 percent to 4 percent below market rates.[37]

The CWSRF provides loans to political subdivisions (except nonprofit water supply corporations) for wastewater treatment facilities and pollution projects that address compliance with the federal Clean Water Act. In addition to providing loans to political subdivisions, banks or farm credit associations may apply for linked deposits to make loans for nonpoint source pollution control projects.[38] TWDB has received $3.0 billion in federal capitalization grants as of 2007 and has provided $5.2 billion in loans to local entities.[39]

Loans provided through the DWSRF ensure public drinking water systems comply with the federal Safe Drinking Water Act regulations and the State Water Plan. In addition to political subdivisions, nonprofit water supply corporations, privately owned water systems, and state agencies are also eligible for funding. Loans can be used for water supply infrastructure upgrades, compliance with federal health standards and the purchase of land or easements in order to prevent contamination of a drinking system water source.[40] TWDB has received $685.2 million in federal capitalization grants as of 2007 and has provided $971 million in loans to local entities.[41]

Proposed Revenue Sources

By adopting a statewide planning process to identify and pursue water development projects, the State of Texas has established water infrastructure as an important public priority. However, Texas also has many other important spending priorities. In coming years, as the Texas population expands, public demand for services provided by state government will grow. State expenditures on health care, public education, higher education, public safety and transportation infrastructure will continue to exert pressure on the state's budget. In addition, given the relatively high levels of property and sales taxation in Texas, it is questionable whether these sources will be available for additional funding. Thus, a dedicated funding source for those projects may need to be established to ensure steady progress toward adequate future water supplies.

Since 1997, the Legislature has considered establishing a dedicated funding mechanism for water programs. Currently, however, no such mechanism exists. Debt service on non-self-supporting general obligation bonds is paid with general revenue from state taxes.

The Water Development Board has identified $2.4 billion in state funding that will be needed to support $30.7 billion in local projects identified in the State Water Plan. Texas needs a funding system for water projects that provides a link between these water development projects and end users. The Texas Legislature is actively exploring the options that are available for funding water projects and may act on the issue in the 2009 legislative session. Although no funding mechanism has been adopted so far, policymakers have considered several proposals. Most recently, the Joint Committee on State Water Funding has held hearings considering several options.

Funding proposals presented by TWDB and the Joint Committee on State Water Funding include:

- a state sales tax increase;
- a water conservation and development fee;
- a water rights fee;
- a water connection fee; and
- a sales tax on bottled water.

Research has shown that the following criteria represent ideal principles by which to evaluate water project funding proposals:

1. Adequacy: The financing mechanism should be sufficient to cover identified costs without excessively burdening those who pay the fees.
2. Balance: The burden for funding water projects should be spread among all water user groups in relative proportion to each group's demand for water, and no group should be favored.
3. Specificity: Funds that are raised should be used for water development projects and not diverted for other budgetary obligations.

4. Equity: The plan should be sensitive to water users' ability to pay, since a certain level of water consumption is nondiscretionary and essential for every individual's health. No plan should unduly burden individuals who might have difficulty paying for it.

5. Efficiency: The plan should be easy to administer, comply with and understand. Such a plan also should avoid distorting economic activity by favoring certain user groups or creating incentives favoring certain types of water projects.

6. Conservation: The financing system should be consistent with the goal of water conservation and discourage inefficient uses.

Policymakers should strive to find the appropriate balance among these criteria.

State Sales Tax Proposal

Under this proposal, the state sales tax rate of 6.25 percent would apply to currently exempt retail sales of water or sewer services by public water supply systems. In addition to a state sales tax, local governments could apply a local tax on retail water sales. Typical exemptions include government entities, education, charitable and nonprofit organizations and chambers of commerce. Residential users would also receive a fixed monthly exemption to account for basic water needs.

Assuming an exemption for the first 5,000 gallons of household residential use per month, state revenues generated from a sales tax on both water and sewer services would be an estimated $243.2 million in fiscal 2008, increasing to $266.6 million in fiscal 2011. This estimate is based on taxable retail sales of water and sewer services of $3.9 billion in fiscal 2008 and $4.3 billion in fiscal 2011.[42] In 2003, average per person-per month water use ranged from approximately 3,750 gallons in Killeen to approximately 8,250 in Richardson.[43]

Taxing industrial users would have been exempt. Industrial users have argued that they should be exempt from this tax because they are taxed on their final product. They point out that manufacturers' inputs typically are exempt from sales tax. Others argue that industrial users should be taxed in proportion to the water that they consume. Assuming an industrial exemption, revenue would decline to an estimated $220.1 million in fiscal 2008 and $242.8 million in fiscal 2011. This is based on estimated taxable retail sales of water and sewer services of $3.5 billion in fiscal 2008 and $3.9 billion in fiscal 2011. The sales tax on water services accounts for 60 percent of the total water/sewer sales tax revenue, with wastewater service accounting for the rest. By applying the 6.25 percent state sales tax to water sales, the average monthly water/sewer bill would increase by approximately $1.66 per month for residential customers and approximately $10.51 for commercial customers.[44]

Proponents of this approach argue that this option generates substantial revenue and would be easy to administer. These amounts could be used to replace general revenue funds for the payment of debt service. Annual amounts for debt service associated with the State Water Plan are expected to increase significantly, but annual revenues generated from this sales tax would exceed that amount. Sales tax revenue could also be used to supplant a portion of GO bond proceeds in the future, providing a savings to the state by avoiding debt service costs. In addition, a tax on water sales would discourage water waste, as taxes increased with increases in water use, which could further be discouraged if higher levels of water use were priced at marginally higher rates. The regressive aspect of this approach would be minimized by providing an allowance for a base level of residential use that would go untaxed.

Critics point out that although this tax is a small portion of a user's residential water bill, sales taxes are regressive, meaning that their burden falls more heavily on lower-income taxpayers than on higher-income taxpayers. Some critics think it would be unfair for industrial users to get an exemption while residents and other commercial users pay the tax. In addition, some argue that it would be problematic for the tax to be a function of both consumption and the price for water that is charged by a utility, rather than exclusively basing it on water use. Finally, unless the revenue stream was established as a dedicated fund, these amounts would be credited to the General Revenue Fund (as is most sales tax) and could be used to pay for other government programs.

Water Funding Mechanisms in Other States

Because of high costs associated with building water infrastructure, many states issue GO or revenue bonds to pay for large water projects. States use additional funding mechanisms to support water quality, conservation and some infrastructure projects.[46]

Arizona

Arizona levies a 5 percent transaction privilege tax on the gross sales or income derived by an entity that furnishes water, including cities and municipalities. The delivery of water by federal or state government entities is exempt generally. The state exempts bottled water (other than water delivered by a retailer to an office or business) and governmental entities. Residential and commercial users pay a water quality fee of $0.0065 per 1,000 gallons of water. The state uses this fee for water quality improvement projects. The state also collects a storm water fee of 50 cents on each utility account.

Arkansas

Arkansas applies a 6 percent state sales tax on residential, commercial and industrial water sales. Large users of water are assessed an annual water use fee in the amount of $10 per registered-surface water diversion and $10 per registered well. The state funds water conservation programs using these fees.[47]

California

In California, water rights holders pay an annual fee of 3 cents per acre-foot of "authorized" water.

Kansas

Kansas assesses a water protection fee of 3 cents per 1,000 gallons of water on the following: 1) water sold at retail by public water supply systems; 2) water appropriated for industrial use; and 3) water appropriated for stock watering. The state charges an inspection fee on each ton of fertilizer offered for sale and deposits $1.40 per ton to the State Water Plan Fund. The state deposits $100 of each pesticide registration fee to the State Water Plan Fund. Kansas also assesses a Clean Water Drinking fee of 3 cents per 1,000 gallons of retail water sold by a public water supply system. The state deposits 95 percent of this in the State Water Plan Fund, using 85 percent of this amount for the renovation and protection of lakes and 15 percent for technical assistance for public water supply systems.[48]

Louisiana

Louisiana applies a 3.8 percent sales tax on water sales to commercial and industrial users. While individual residential consumers are exempt, sales where one meter applies to several residential units, multi-family rentals for example, are subject to the tax.

Michigan

Michigan assesses an annual water use fee on community water supply systems ranging from $372 to $124,791, depending on the number of people served by the water system.[49] The state also charges non-community water suppliers a fee. Facilities with wells serving primarily transient populations, including campgrounds, rest stops, motels and restaurants, are assessed an annual fee of $104. Larger, non-community water systems, such as schools and businesses, that serve the same 25 or more persons on a routine basis, are assessed $442 per year. The state uses the fees to administer Michigan's Clean Drinking Water Act.

Nebraska

Nebraska levies a 5.5 percent sales tax on amounts paid for through sewer and water services. The state exempts water used for agricultural irrigation and manufacturing.

Water Funding Mechanisms in Other States (continued)

Minnesota

Minnesota taxes commercial and industrial water sales at a rate of 7 percent. The state exempts housing authorities, non profits, governmental entities and ice manufacturers. Water permit holders pay a $140 minimum water use fee and a per million gallon fee based on the amount of water appropriated (or used). Maximum allowable fees range from $750 for an agricultural irrigation permit to $250,000 for cities with populations of more 100,000.[50]

Oregon

Oregon charges a fee for water right transfers, permit amendments and exchanges. Water rights users are assessed a minimum fee of $200 or $400 depending on the intended use. The state also charges a fee based on the flow of water measured in cubic feet per second. These fees range from $80 to $200 per cubic feet per second, depending on use.[51]

Tennessee

The state assesses a 7 percent sales tax on residential and commercial water utility accounts and a 1 percent rate on water sold to manufacturers.

Water Conservation and Development Fee Proposal

Legislation introduced, but not passed, in the 79th Legislature in 2005 would have established a water conservation and development fee of $0.13 per 1,000 gallons used by consumers each month. The fee would have been collected by public water supply systems, remitted to the Comptroller and deposited to the Water Infrastructure Fund.

The first 5,000 gallons of water used by a residential customer each month would not be subject to the fee. Exemptions from the fee would have included governmental entities, educational, charitable and nonprofit organizations, and chambers of commerce, and could be expanded to include industrial users.[45]

Using this structure, estimated revenue would be $127.3 million in fiscal 2008 increasing to $130.0 million in fiscal year 2011. This is based on a taxable amount of 978.8 billion gallons in fiscal 2008 and 1 trillion gallons in 2011 of residential, commercial, industrial and irrigation usages.[52]

Assuming exemption for industrial uses (as under the previous sales tax exemption), revenue would decrease by 44 percent to $70.7 million in fiscal 2008 and $72.5 million in fiscal 2011. Taxable gallons for this estimate are 543.8 million in fiscal 2008 and 557.5 million in fiscal 2011.[53] Residential users would see an estimated 48 cents per month average increase to their water bill while commercial customers would see a $4.66 monthly increase.[54]

A change in the number of exempted residential gallons would increase revenue for both the sales tax proposal and the water conservation fee proposal. Reducing the number of gallons exempted by 1,000 would increase average annual revenue amounts by $17.9 million for the sales tax and $9 million for the water conservation fee revenue, based on fiscal 2008. This also would result in a corresponding increase in the monthly water/sewer bill of residential customers of an average of 20 cents for the sales tax and 10 cents for the water conservation fee.

Supporters claim that this option would generate sufficient revenue to replace general revenue funds for expected annual debt service payments associated with the State Water Plan for all but a few years. In the future, these revenues could also supplant some GO bond financing, depending on debt service demands. This fee is a small portion of the average monthly water bill and provides a residential exemption for basic water uses. The fee and exemption could also be changed based on estimated future needs. While costs may be passed on to the consumer, this plan would allow for more accurate pricing of water resources, improving efficiency in the market for this scarce resource. Construction of water infrastructure will pose a significant cost. From the standpoint of economic efficiency it would be most appropriate if those costs were accounted for in the goods that require expanded water supplies.

On the other hand, critics point out that with industrial exemption, the fee would raise insufficient funds, while industrial users would bear a heavy burden without an exemption. Although designed as a conservation measure, increased usage costs residential customers very little. Business interests suggest that it would be unfair for low-use residential customers to avoid paying any fee while industrial users account for the largest share. There is the possibility that industrial users would pass on additional costs to the consumer, potentially reducing demand for some products.

Water Rights Fee Proposal

Surface water in Texas is owned by the state of Texas and requires a permit for use. The Texas Commission for Environmental Quality (TCEQ) administers water rights based on the principle of "prior appropriation," which, in effect, means "first come, first served." A water rights holder could be anyone from an individual landowner to a manufacturing firm, to a municipal water utility that provides water service to thousands of households.[55]

Currently, TCEQ collects an annual fee from water rights holders based on acre-feet of water rights held. In the case of municipal, industrial, agricultural or mining users, the fee is 22 cents per acre-foot up to 20,000 acre-feet, and 8 cents per acre-foot above 20,000 acre-feet. However, many of these entities are exempt under statute if they are paying the Water Quality Fee. As a result, revenues for this fee are low ($416,483 in fiscal 2006).[56] The intent of the fee is to defray TCEQ's costs associated with the water rights permitting program.

Assessing a fee of $1.50 per acre-foot of authorized water on water rights holders would generate an estimated $49.3 million annually. The fee would apply to 7,090 municipal, industrial, irrigation, and mining water rights holders with an estimated 32.9 million acre-feet of authorized water. Water rights for hydroelectric, recreation, storage and environmental needs would be exempt. Average annual costs to water rights holders would increase approximately $10,906 for municipal permit holders and $44,421 for industrial permit holders. Costs to irrigation and mining permit holders would be significantly less, at $1,148 and $1,413 respectively.[57] Increasing revenue from this fee would depend upon increased permitting or raising the fee amount.

Supporters say that this proposal could be used to supplant some general revenue for debt service payments. Although some of the costs to municipal and industrial holders would be passed to residential users, it would not be overly burdensome.

This option generates the least amount of revenue and it may not provide enough money to cover the needs that have been identified.

Water Connection Fee Proposal

A water connection, or "tap fee," would place a monthly charge on each water connection in the state. Applying a $1 monthly fee on residential, commercial, irrigation and industrial users would generate an estimated $94.6 million in fiscal 2008, and increase to $97.3 million in fiscal 2011. This estimate is based on 7.9 million connections in fiscal 2008 and 8.1 million in fiscal 2011.[58] Residential connections could account for 93.5 percent of the total revenue.

This option would generate slightly more revenue than what is required for annual 2008-09 debt service payments. The residential bill charge is slightly less than the sales tax and is a small portion of the water/sewage bill, meaning that it would not be a burdensome levy.

Critics argue that this fee is not tied to water usage, includes no conservation component and is regressive. Residential customers would be the primary contributor of the fee since they make up over 90 percent of water connections in Texas, even though they account for only about 48 percent of water usage.

Sales Tax on Bottled Water Proposal

Removal of the state sales tax exemption for bottled water is estimated to generate $78 million of state sales tax revenue in fiscal 2008 to $101.8 million in fiscal 2011. This estimate is based on Texas bottled water sales of $1.2 billion and $1.6 billion, respectively. The 6.25 percent sales tax would apply to bottled water sold at retail (including gallons or larger), carbonated or seltzer water and cooler water delivered to homes and offices. Local sales and use taxes also would apply. Water delivered by tanker truck to residential wells or cisterns and water sold at community dispensers would be exempt from the sales tax.[59]

As proposed, the bottled water fee would not generate enough revenue supplant all general revenue for debt service payments. Proponents argue, however, that bottled water sales increased significantly in the past few years, providing the possibility of steady revenue growth. Bottled water consumption is typically discretionary, as consumers could purchase other tax-exempt products or drink tap water. In rural areas where tap water is not available, tax exemptions could be structured to avoid taxation of drinking water.

Critics say this fee would not be related to water usage, and bottled water suppliers and consumers likely would object to being singled out. This tax would include no conservation component and would likely be regressive.

Exhibit 42 shows the potential results of the funding mechanisms listed above. Fiscal impact numbers for the proposed funding mechanisms were generated by TWDB with help from TCEQ and the Comptroller's office.

Exhibit 42

Proposed Funding Mechanisms

Proposed Revenue Sources	Fiscal 2008	Fiscal 2011
State Sales Tax	$243,270,000	$266,579,375
State Sales Tax, industrial exemption	$220,112,500	$242,837,500
Water Conservation and Development Fee	$127,250,019	$130,001,766
Water Conservation and Development , industrial exemption	$70,695,486	$72,479,123
Water Rights Fee	$49,339,946	$49,339,946
Water Connection Fee	$94,573,104	$97,280,928
Sales Tax on Bottled Water	$78,000,000	$101,750,000

Source: Texas Water Development Board. and Texas Comptroller of Public Accounts

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Conclusion

Given Texas' growing population, the development and protection of our water resources is one of the most pressing long-term issues facing lawmakers. Ensuring clean and dependable water supplies will be essential to protect the health of Texas citizens and the strength of the state's economy.

With the 1997 initiation of the regional water planning process, Texas took an important step toward coordinating the water needs of communities across the state. This role will continue and may become more prominent as policymakers consider dedicated funding for community water projects.

In evaluating proposals for water project funding, policymakers should seek the appropriate balance among these criteria:

- adequacy — the financing mechanism should be sufficient to cover identified costs without excessively burdening those who pay the fees.
- equity — the financial burden of water projects should be spread among all water user groups in proportion to their demand for water. It should not favor certain user groups or projects.
- specificity — funds raised for water development projects should not be diverted for other budgetary obligations.
- affordability — the plan should be sensitive to water users' ability to pay, since a certain level of water consumption is nondiscretionary and essential for every Texan's health. No plan

Lady Bird Lake in Austin, Texas

should unduly burden individuals who might have difficulty paying for it.

- simplicity — the plan should be easy to administer, understand and follow.
- conservation — the financing system should be consistent with the goal of water conservation and discourage inefficient usage.

If Texas state government continues moving toward greater involvement in financing water projects, a dedicated funding source for water projects may prove useful. However, with this more active state role in regional water planning, policymakers will increasingly look to ensure that the water planning process effectively serves the interests of all Texas citizens.

To do so, two key issues should be explored further.

Conservation

Conservation is often cited as the first goal of any water development plan, since it is the most cost-effective and sustainable water management strategy. One concern is the varying levels of conservation effort made by municipalities across the state. Several cities have already made extensive and successful efforts to reduce their water use, while others plan to rely on increased conservation measures to meet growing demand in the future.

Accountability

Another concern identified by the review team was the manner in which different regional water planning groups are required to report their water needs. The "bottom-up" approach currently employed in Texas allows communities and regions to develop their own estimates for future water needs and project recommendations.

While this system has many benefits, including the ability for local stakeholders to determine the direction of water policy decisions that will affect their communities, it may encourage regions to include marginal projects in their plans.

Many water development projects are extremely expensive, and some projects such as reservoirs can have substantial environmental and social consequences. Policymakers may want to consider strengthening oversight and accountability measures to ensure that they fund only those projects that are truly necessary.

Regional water planning will play an important role in the future of the Lone Star State. Starting with the passage of SB 1 in 1997, policymakers in Texas have shown a willingness to confront this challenging issue head-on. Since the passage of SB 1, Texas has taken many steps to ensure that citizens, businesses and agricultural producers have enough water to serve their needs, while safeguarding environmental needs of our rivers, bays and estuaries. The coming years will require continued attention to this issue, to ensure that all Texans have access to the water they need to thrive.

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