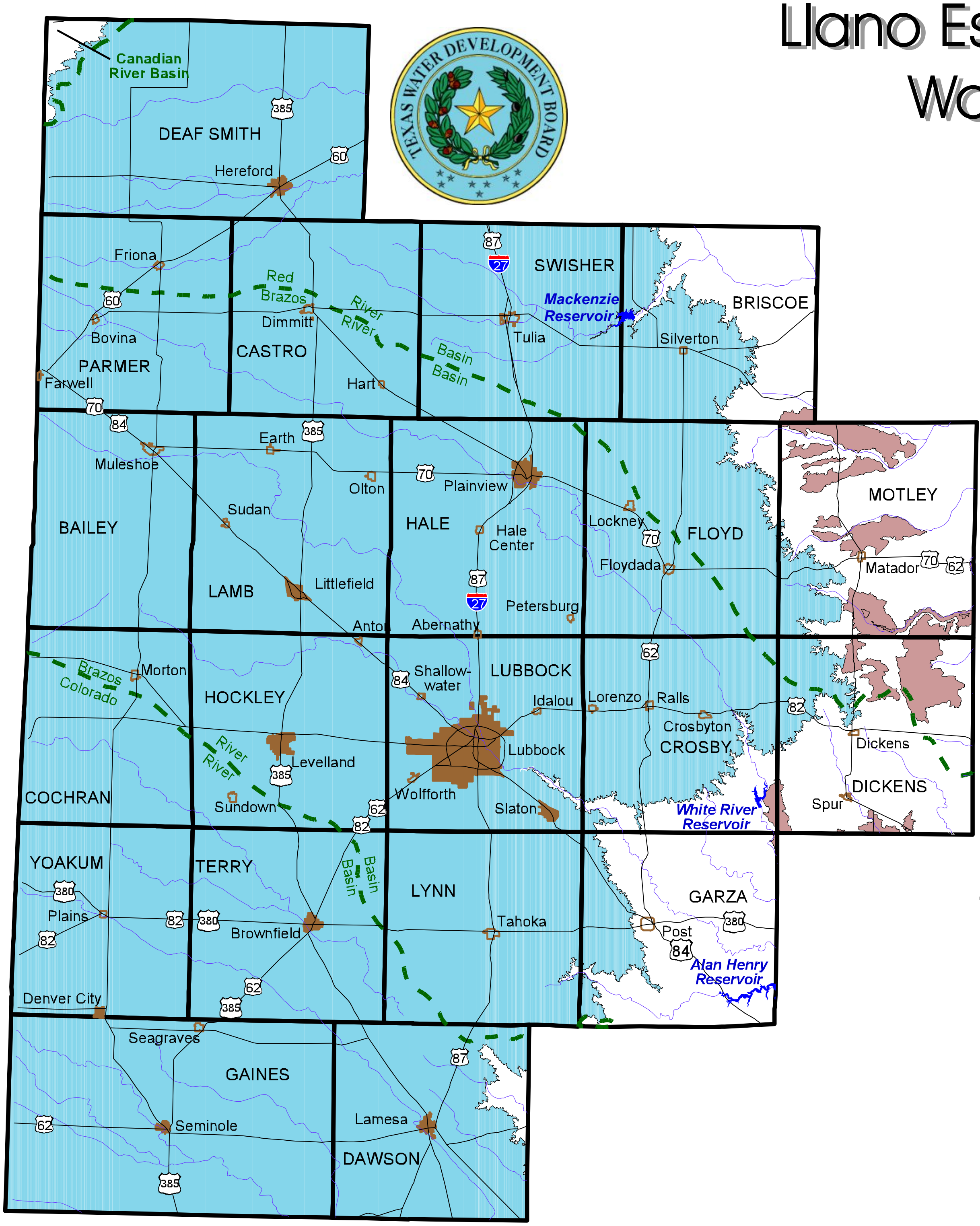

TEXAS WATER DEVELOPMENT BOARD

Llano Estacado Regional Water Planning Area

Regional Water Plan

January 2006
April 2006

Prepared for:

Texas Water Development Board

Prepared by:

Llano Estacado
Regional Water Planning Group

With administration by:

High Plains Underground
Water Conservation District No. 1

With technical assistance by:

HDR Engineering, Inc.

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Llano Estacado Regional Water Plan
Llano Estacado Regional Water Planning Group

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Llano Estacado Regional Water Plan

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Llano Estacado Regional Water Planning Area

Regional Water Plan

Prepared for

Texas Water Development Board

by

Llano Estacado Regional Water Planning Group

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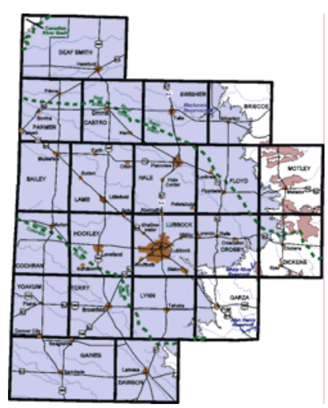

With technical assistance by

HDR Engineering, Inc.
Austin, Texas

January 2006
April 2006

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Llano Estacado Regional Water Plan
Executive Summary

Background

In 1997, Senate Bill 1 was enacted by the 75th Texas Legislature to address experiences of drought and the needs of utilities and water management entities to meet the water supply needs of the State's growing population and economy. The new law emphasized the development of water plans at the regional level with greater local participation and input in order to gain acceptance and commitment to implementation. In addition to requiring the best information possible to guide future water resource decisions, Senate Bill 1 also provided that future regulatory and financing decisions of the Texas Commission on Environmental Quality and the Texas Water Development Board (TWDB) be consistent with approved regional plans. As stated in Senate Bill 1, the purpose of this regional planning effort is to:

> "Provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."

The TWDB is the state agency designated to coordinate the overall statewide planning effort. The TWDB divided the state into 16 planning regions. In the South Plains of Texas, a 21-county area was delineated by the TWDB as Planning Area O, which was subsequently named the Llano Estacado Regional Water Planning Region (herein referred to as the Llano Estacado Region). The counties of the region are:

1. Bailey
2. Briscoe
3. Castro
4. Cochran
5. Crosby
6. Dawson
7. Deaf Smith
8. Dickens
9. Floyd
10. Gaines
11. Garza
12. Hale
13. Hockley
14. Lamb
15. Lubbock
16. Lynn
17. Motley
18. Parmer
19. Swisher
20. Terry
21. Yoakum

The Llano Estacado Regional Water Planning Group (LERWPG) members were appointed by the TWDB to represent 11 stakeholder interests (Public, Counties, Municipalities, Industries, Agricultural, Environmental, Small Businesses, Electric Generating Utilities, River Authorities, Water Districts, and Water Utilities) and act as the steering and decision-making body of the regional planning effort. The planning group members and affiliations are listed below.

Voting Members — Water User Group

H. P. Brown, Jr., Chair, — Agriculture/Cattle

Ches Carthel, Vice Chair — Municipalities (Large)

Jim Conkwright, Secretary/Treasurer — Water Districts

Melanie Barnes, Ph.D. — Public

Delaine Baucum — Agriculture

Bruce Blalack — Municipalities (Large)

Dallas Brewer — County Government

Delmon Ellison, Jr. — Agriculture

Harvey Everheart — Water Districts

Bill Harbin — Electrical Generation

Don James — Agriculture

Bob Josserand — Municipalities (Medium)

Richard Leonard — Agriculture

Terry Lopas — River Authorities

Don McElroy — Small Business

Jared Miller—Municipalities (Small)

Sukant Misra, PhD — Agriculture

E.W. (Gene) Montgomery — Oil & Gas

Ken Rainwater, PhD — Public

Doug Hutcheson — Water Utilities

Kent Satterwhite — Water Districts

Jim Steiert — Environment

Non-voting Members — Agency

Joan Glass — Texas Parks and Wildlife Department

Steve Jones — Texas Department of Agriculture

Malcolm Laing — Texas Commission on Environmental Quality

Temple McKinnon — Texas Water Development Board

The LERWPG adopted the following Mission Statement:

> "Develop, promote, and implement water conservation, augmentation, and management strategies to provide adequate water supplies for the Llano Estacado Regional Water Planning Area of the High Plains of Texas and to stabilize or improve the economic and social viability and longevity of the region through these activities."

The Group designated the High Plains Underground Water Conservation District No. 1 as the political subdivision to act as principal contractor to apply for and administer a grant from the TWDB to develop the Water Plan. The prime planning and engineering consultant is HDR Engineering, Inc.

On January 3, 2001, the LERWPG adopted and submitted to the TWDB the "Llano Estacado Regional Water Planning Area Regional Water Plan." In response to directives of Senate Bill 2 (77^{th} Texas Legislature, 2001), the LERWPG prepared a Scope of Work and Budget to update and revise the January 3, 2001, Llano Estacado Regional Water Plan, and on April 1, 2002, the LERWPG applied to the TWDB for funding to accomplish the update and revision directed by Senate Bill 2. The updated and revised Llano Estacado Region Water Plan is presented below.

The planning horizon used by the LERWPG and all other water planning groups is the 60-year period from 2000 to 2060. This planning period allows for a long-term forecast of the prospective water situation, sufficiently in advance of needs, to allow for appropriate management measures to be implemented. As required in Senate Bill 1, the TWDB specified planning rules and guidelines (31 TAC §357.7 and §357.12) to focus the efforts and to provide for general consistency among the regions so that the regional plans can then be aggregated into an overall State Water Plan by January 2007. Besides specifying overall report and data formats, the TWDB rules also require the maximum use of existing state water planning information, except where better information is available. As authorized by Senate Bills 1 and 2, the TWDB has provided for coordination mechanisms among the regions where regions share common water issues.

The LERWPG has developed a regional water plan to serve the needs of the region during all types of weather, but specifically to meet the water needs during drought. Since there is little opportunity to increase the region's water supplies through conventional water development, emphasis has been placed upon water management strategies to increase efficiency of water use in irrigation, and to augment regional supplies through precipitation enhancement and brush management. All of these strategies are aimed directly at sustaining the region's existing groundwater reserves as far into the future as possible.

Description of the Region

The 21 county Llano Estacado Region has an area of 20,294 square miles (12,988,160 acres), or about 7.5 percent of the state's land area. Although the region is located in the upstream parts of four major river basins (Canadian, Red, Brazos, and Colorado), almost no surface water leaves the region as runoff into these rivers. Of the 20,294 total square miles covered by the area, 94 square miles are located in the Canadian Basin, 6,681 square miles are located in the Red Basin, 8,732 square miles are located in the Brazos Basin, and 4,787 square miles are located in the Colorado Basin. The regional population of 453,997 represents about 2.2 percent of the state total population of about 20.85 million people in 2000.[1]

Climate

The region is characterized as semi-arid, with a wide range in temperatures. In an average year, about 80 percent of the annual rainfall occurs during the period from May through October. The long-term average precipitation received in the region is 18.4 inches. The average ranges from a high of 22 inches per year in a small area in Crosby County, to a low of about 16 inches in Cochran County in the southwestern portion of the region. Mean annual temperature is about 60 degrees Fahrenheit, with mean temperatures in January of 24 degrees Fahrenheit, and mean high temperatures in July of 94 degrees Fahrenheit.

Land

Land elevations in the region generally range from about 1,900 feet-mean sea level in the southeast to 4,300 feet-mean sea level in the northwest. The plateau of the Southern High Plains contains many shallow depressions, or playa basins, a few of which hold water more or less permanently. There is broken terrain in the northwest corner of the planning region and on the eastern side of the planning region, which is a part of the Rolling Plains physiographic region, below the "caprock" escarpment. There are 15 general soil types in the region, 80 to 85 percent of which are suitable for irrigation. About 57 percent of the 20,294 square miles of land area in

[1] 2000 U. S. Census of Population and Housing, U. S. Department of Commerce, Washington, D.C., 2001.

the planning region is in cropland, approximately one-third of which is irrigated. The major irrigated crops are cotton, corn, grain sorghum, wheat, vegetables, peanuts, and soybeans.

Water

The Ogallala Formation of Pliocene Age houses the principal aquifer in the Llano Estacado Region.[2] The Ogallala Formation rests upon the eroded surface of the underlying Triassic and Cretaceous rocks and consists of beds and lenses of clay, silt, sand, and gravel. In general, the Ogallala Formation is thicker in the northern part of the area, with the thickness ranging from 400 to 500 feet in central Parmer, west-central Castro, and southwestern Floyd Counties, to a knife edge where the formation wedges out against outcrops of older rocks. Erosion has almost completely isolated the formation so that the segment in the Southern High Plains of Texas is cut off in all directions from any underground connection with other water-bearing beds, except through the underlying older rocks, which contain highly mineralized water, unlike the freshwater in the Ogallala.

Generally, the water in the Ogallala occurs under water-table conditions, and occupies the pore spaces and voids in the unconsolidated sediments that occur between the water-table and the underlying older rocks. The thickness of the zone of saturation varies throughout the region, chiefly because of the uneven nature of the bedrock surface. Within the region, the saturated thickness ranges from less than 1 foot to more than 300 feet.

The transmissivity of the Ogallala Formation ranges rather widely. Tests, both in the laboratory and in the field, indicate an average specific gravity yield of about 15 percent. The movement of water in the formation is generally from the northwest to the southeast, with the rate of movement of water in the formation being estimated at about 150 feet per year on a gradient of 10 feet per mile.

The long-term change in the water table throughout the region has generally been a decline; however, in recent years the rate of decline has leveled out and in a few counties in the southern part of the region has risen somewhat.

The principal source of recharge to the Ogallala Formation in the Llano Estacado Region is precipitation on the land surface. The amount of recharge depends on many factors, including the amount, distribution, and intensity of precipitation and the type of soil and vegetative cover.

[2] High Plains Underground Water Conservation District No. 1, Lubbock, Texas, December 1998.

The amount of recharge has been estimated at from less than 0.5 inch annually to about 3 inches annually. The water in the Ogallala Formation in the Llano Estacado Region is of good chemical quality, except that it is "hard" due to high levels of calcium and magnesium.

Precipitation is the only naturally reoccurring/renewable water supply for the Llano Estacado Region. The average annual precipitation received in the region is 18.4 inches, which is about 19,915,179 acft of water over the 12,988,160-acre region. Precipitation meets about 60 percent of urban landscape water and irrigated crop demands, and provides all the water for surface reservoirs, all the water for rangeland and dryland crop production, and water for wildlife and natural recharge to the region's aquifers.

There are an estimated 20,000 playa basins (2 percent of the total land surface) on the High Plains of Texas, of which approximately 14,000 are located within the Llano Estacado Region.[3] The majority of playa basins are ephemeral, holding water only during and for a short period of time after rains. Some of the dry playas are planted to crops, some are left fallow, and some are grazed. Approximately 70 percent of playas are modified with pits to recover rainfall runoff for irrigation or to create a water reserve for grazing livestock or wildlife when the bulk of the water collected in the basin from rainfall runoff has soaked into the soil or evaporated.

Vegetation

The original vegetation of the High Plains was classified as mixed prairie, shortgrass prairie, and, in some locations on deep, sandy soils, tallgrass prairie. Blue grama, buffalograss, and galleta were the principal natural vegetation on the clay and clay loam soils. Characteristic grasses that were on sandy loam soils are little bluestem, western wheatgrass, sideoats grama, and sand dropseed.

The High Plains area was characteristically free from brush, but sand sagebrush, along with pricklypear and yucca, have invaded the ranchland that has sandy and sandy loam soils. Honey mesquite has invaded the ranchland on most soils in the region. Several grass species of dropseeds are abundant on land containing coarse sandy soils. The playa depressions, which can contain several feet of water after heavy rains, support unique patterns of vegetation within their confines. Various aquatic species, such as curltop smartweed, are associated with the playa basins.

[3] Guthery, F.S., F.C. Bryant, B. Kramer, A. Stoecker, and M. Dvoracek, "Playa Assessment Study," U.S. Water and Power Resources Service, Southwest Region, Amarillo, Texas, 1981.

Wildlife

Virtually all wildlife habitats in the High Plains are on privately owned farms and ranchland. Quail, mourning dove, and feral hogs are abundant, and whitetail deer, mule deer, turkey, and exotic aoudad sheep provide hunting along the breaks and canyons of the caprock. Many playa basins and feedyard lagoons provide migratory waterfowl habitat, with as many as 2 million waterfowl and 350,000 to 400,000 sandhill cranes using playa lakes as wintering areas or as rest stops during annual migrations.[4] Pheasants are an economically important gamebird in irrigated areas, but their numbers tend to fluctuate widely with weather and habitat conditions.

In the region, approximately 25 wildlife species are listed by the Texas Parks and Wildlife Department as endangered, threatened, or just rare with no official listing.

Population

The area's population has grown from 11,418 in 1900 to 453,997 in 2000. In 2000, the age distribution across the region was fairly uniform from county to county.[5] The two age groups with the highest percentage of the population in 2000 were the group of 5 to 14 years of age (16.4 percent of the population) and age 60 and above (19.1 percent). The age group with the lowest percentage of the population in 2000 was the 55 to 59 years group (4.8 percent).

Economy

The region's economic base is agricultural crop and livestock production, with significant contributions from manufacturing, oil and gas, and trades and services, such as wholesale and retail trade, and finance, insurance, legal, advertising, medical, personnel, research, entertainment, repair services, and higher education. Agricultural processing, oilfield equipment, and electronics form the core of the region's manufacturing base. Beef cattle and cotton are the dominant agricultural enterprises, although peanuts, wheat, grain sorghum, vegetables, and oilseed crops are significant contributors to the region's economy. Cotton is the leading crop produced in the Llano Estacado Region, with an annual value of about $755 million, which is about 60 percent of the annual value of cotton grown in Texas annually.[6]

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[4] Ibid.
[5] 1990 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 1991.
[6] Calculated using the production value times the reported year 2000 price of $0.514/lb from "Crop Values, 2000 Summary," published by USDA in February 2001. Also assumes a bale equals 480 lbs.

The region produces 18 percent of the state's grain sorghum, or approximately 20 million bushels per year. In 2000, value of grain sorghum production in the area was approximately $36 million.[7]

Approximately 26 million bushes or 13 percent of the state's corn crop is grown in the Llano Estacado Region.[8] Corn contributes approximately $57 million annually to the region's economy, third only to cotton and peanuts.

In 2000, 633,428 bushels of soybeans with a value of $2.8 million were grown in the Llano Estacado Region.[9] Soybeans are frequently planted in the region as an alternative cash crop if hail destroys cotton; however, soybeans are not a dryland crop.

Peanut production is relatively new to the Llano Estacado Region, with peanut production having become a valuable crop for the region during the past 20 years. The Western Peanut Growers Association reports that the area now produces about 75 percent of the state's peanut crop. According to data provided by the Western Peanut Growers Association, value of production in 2000 was $115 million.[10]

The 2002 Census of Agriculture indicates that while irrigated lands comprise about 2.5 million acres (33 percent) of the cropland in the region, irrigation is responsible for $679 million in value of farm sales, or about 75 percent of the value of major crop production. All crops (irrigated plus dryland) grown in the Llano Estacado Region had a market value of over $905 million in 2002 (Figure ES-1). With a multiplier of 2.87, the total business effect of crop production in the Llano Estacado Region is estimated at $2.597 billion.

During the last 25 to 30 years, the South Plains of Texas observed the development of confined feeding of cattle to finish weights before slaughter. Fed cattle marketing in Texas in 1960 was 477,000 head and by 1998 had increased to 6.06 million head. Of the 142 cattle feedlots in the state, 69 (49 percent) are located in the Llano Estacado Region. In 1998, these 69 feedlots marketed over 3.39 million head, or about $2.2 billion (1999 prices) of fed cattle. With a multiplier of 2.49, this primary production has an economy-wide business effect of over

[7] Calculated using the production value times the reported year 2000 price of $1.80/bushel from "Crop Values, 2000 Summary," published by USDA in February 2001.

[8] Calculated using the production value times the reported year 2000 price of $2.15/bushel from "Crop Values, 2000 Summary," published by USDA in February 2001.

[9] Calculated using the production value times the reported year 2000 price of $4.35/bushel from "Crop Values, 2000 Summary," published by USDA in February 2001.

[10] Calculated using the production value times the reported year 2000 price of $0.227/lb from "Crop Values, 2000 Summary," published by USDA in February 2001.

$6.27 billion annually. Feedyards of the Llano Estacado Region employ about 2,000 people, with an economy-wide effect of an additional 3,600 jobs, or a total employment effect of 5,600.

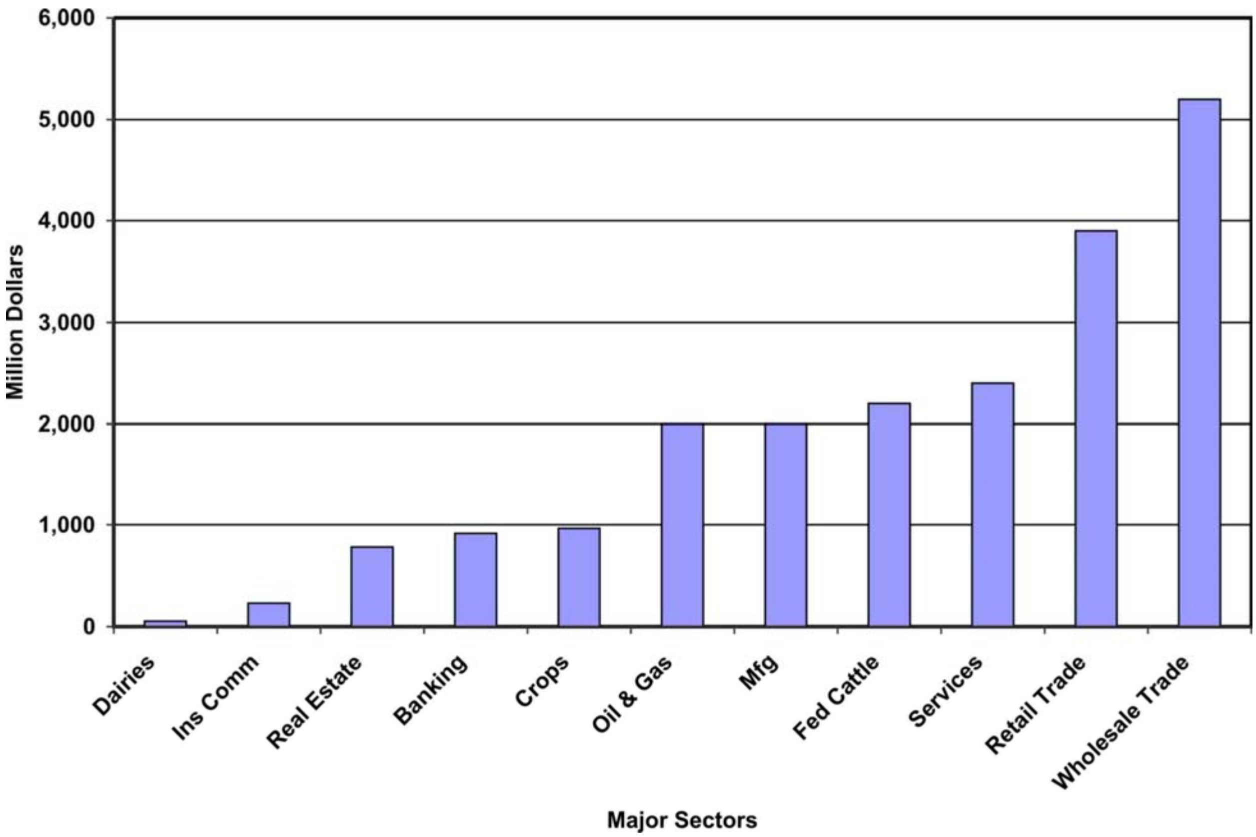

Figure ES-1. Llano Estacado Regional Economy Annual Value of Sales

In recent years, dairy production has increased in the Llano Estacado Region. In 2005, there were 43 dairies, with 27,149 head of dairy cattle. Value of production was reported at $54.9 million in 2002.

During the early 1920s, oil was discovered in the High Plains Region, and by 1926 the High Plains was a major oil- and gas-producing region. In the late 1990s, the production of oil and gas in the Llano Estacado Region contributed over $2 billion per year (1999 prices) to the economy.

In 1997, the region's 342 manufacturing establishments contributed over $2.0 billion to the region's economy in value of shipments and provided over 9,000 jobs with an annual payroll of over $249 million. The leading types of manufacturing in the region are food and kindred products, agricultural and industrial machinery and equipment, printing and publishing, and fabricated metal products.

The 7,700 wholesale trade, retail trade, services, finance, insurance, and real estate establishments located in the region have gross value of sales and billings of more than $11.5 billion annually, and employ about 82,000, with payrolls of more than $1.5 billion annually.

Water Agencies

There are two federal water agencies, three state water agencies, three water supply authorities and districts, and six underground water conservation districts in operation in the Llano Estacado Region at the present time. The federal and state agencies perform regulatory and development functions, while the underground water conservation districts were organized to conserve, preserve, protect, recharge, and prevent waste of the underground water.

Projections of Population and Water Demands

Population Projections

The TWDB provided population projections for the Llano Estacado Region for use in revising and updating the Regional Water Plan. Population of the Region was reported by the U.S. Census at 453,997 in 2000 and was projected to be 527,210 in 2060. Nearly 80 percent of the population of the region is projected to reside in the Brazos River Basin. The population projections for 53 individual cities, rural areas of each county, and parts of a county in each river basin area of the region were tabulated for use in developing the regional water plan.

Water Demand Projections

In addition to population projections, the TWDB prepared water demand projections for municipal, manufacturing, steam-electric power generation, irrigation, mining, and livestock uses. Municipal water demand includes residential and commercial water uses, and is projected to increase from 87,322 acft/yr in 2000 to 93,549 acft/yr on 2060. Per capita water use, in gallons per person per day, is projected to decline over the planning period, from 172 gallons per person per day to 158 gallons per person per day.

The Llano Estacado Region's major water using manufacturing sectors are food processing, industrial machinery and equipment, and fabricated metals. These industries used 10,064 acft of water in 2000 and are projected to have a demand of 15,999 acft/yr in 2060.

Only three counties (Lamb, Lubbock, and Yoakum) of the Region currently use or are projected to use water in steam-electric power production during the planning period. In 2000, 25,618 acft of water was used for steam-electric power generation; and by the year 2060, it is estimated that 49,910 acft of water will be needed for the production of steam-electric power.

In the Llano Estacado Region, the principal uses of water for mining are for recovery and processing of crude petroleum and for sand and gravel washing. In the region, mining water use was 21,436 acft in 2000, and is projected to decline to 258 acft in 2060. Overall, water use in this sector is expected to decline due to the fact that the present “water flood” technology will no longer be used, since many of the oil fields of the region will have reached their economic limit, suspended operations, and plugged wells. The continuation of the industry in the region will hinge on new technologies to recover the oil remaining in the reservoirs.

The TWDB irrigation water use data show annual use for irrigation in the Llano Estacado Region in 2000 of 4,347,877 acft. Projected irrigation water demands for the region in 2060 are 3,474,163 acft, or 20 percent less than in 2000. The projected decrease is based upon increased irrigation efficiency, declining well yields due to the thinning of the aquifer in some areas, economic factors, and reduced government programs affecting the profitability of irrigated agriculture.

Total livestock water demand projections for the Llano Estacado Region are the sum of water demand projections for beef cattle feedlots, swine feedlots, dairies, horses, range beef cows/bulls, range beef stocker cattle, sheep, and poultry. Total livestock water use in 2000 was estimated at 37,724 acft. Total livestock water demand for the region is projected to be 70,457 acft/yr in 2060.

Total water use in the Llano Estacado Region was 4,530,041 acft in 2000, with projected water demands in 2060 of 3,704,336 acft. The quantity of projected water demands in 2060 are 354 acft/yr for the Canadian River Basin, 816,626 acft/yr for the Red River Basin, 2,177,683 acft/yr for the Brazos River Basin, and 709,673 acft/yr for the Colorado River Basin.

Wholesale Water Providers

The Texas Water Code, Chapter 357.2(8) defines Wholesale Water Provider as follows:

> “Any person or entity, including river authorities, and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. The regional water planning groups shall include as wholesale water providers other persons

> and entities that enter or that the regional water planning group expects or recommends to enter contracts to sell more that 1,000 acre-feet of water wholesale during the period covered by the plan."

There are four Wholesale Water Providers in the Llano Estacado Region—Canadian River Municipal Water Authority, City of Lubbock, Mackenzie Municipal Water Authority, and White River Municipal Water District.

Projected Region O water demands for Canadian River Municipal Water Authority increase from 53,396 acft/yr of use in 2000 to 55,504 acft/yr in 2060. Water use from the City of Lubbock system was 41,910 acft/yr in 2000, and is projected to increase to 44,119 acft/yr in 2060.

Water use from the Mackenzie Municipal Water Authority in 2000 was 2,046 acft/yr in 2000, and is projected at 1,936 acft/yr in 2060. Water use from the White River Municipal Water District in 2000 was 4,789 acft/yr in 2000 and is projected at 1,497 acft/yr in 2060.

Water Supplies and Water Needs

Water Supplies Available During the Drought of Record

Two major and two minor aquifers supply water to the area. The two major aquifers are the Ogallala and Seymour aquifers. The two minor aquifers are the Edwards-Trinity (High Plains) and the Dockum. In addition, four reservoirs located within or near the region supply water for municipal and industrial uses within the region. These four reservoirs are Lake Meredith, located in the Canadian River Basin to the north of the Llano Estacado Region, Mackenzie Reservoir located in the Red River Basin in Swisher and Briscoe Counties, White River Reservoir located in the Brazos River Basin in the southeast corner of Crosby County, and Alan Henry Reservoir located on the Double Mountain Fork of the Brazos River in Garza County.

For purposes of this regional planning project, and in accordance with TWDB Rules, water supply projections and needs projections were calculated by river basin, county or part of county located within the river basin, and city and rural areas of each county or part of county. Estimates were made of the quantities of water available within each county at each decadal planning date. The supplies are the quantities available during the drought of record (firm yield for reservoirs and quantity that can be obtained from groundwater). These projected water supplies were then compared to projected water demands, and if demands exceeded supplies available, then the differences were shown as the measure of "water needs for that county, river basin and water user group."

The projected total water demands for the Llano Estacado Region decrease from 4.38 million acft/yr in 2010 to 4.09 million acft/yr in 2030, and 3.70 million acft/yr in 2060. Under drought of record water supply conditions, and with no water management strategies in place, water needs (shortages) are projected to be 1.26 million acft/yr in 2010, increasing to 2.08 million acft/yr in 2030 and to 2.33 million acft/yr by 2060. The water needs assessment identified 36 municipalities and one water supply district, and 20 of the 21 counties with needs (shortages) during the years 2000 through 2060 planning period (Table ES-1).

At the request of the LERWPG, the TWDB performed a socioeconomic economic impact analysis of the effects of not meeting projected water needs. The economic impact of projected water shortages (e.g., value of production [sales] losses) by irrigated agriculture, commercial establishments, the horticulture industry, and expenses to households are $263.49 million/year in 2010, $668.25 million/year in 2030, and $935.65 million/year in 2060. Due to this effect upon production, personal income losses in 2010 are estimated at $102.87 million/year, $248.11/year in 2030, and $336.35/year in 2060 (Table 4-24). Losses in tax payments to local, state, and federal governments are estimated at $9.84 million in 2010, $23.86 million in 2030, and $42.41 million in 2060. In 2010, irrigation accounts for about 73 percent of the totals, and increases to 78 percent in 2030 and to 80 percent in 2060.

The estimated effects of unmet water needs (projected shortages) upon the size of the population and school enrollment of the region are as follows. In 2010, lack of employment due to water shortages would affect 5,310 people (1.1%) of the projected year 2010 population of 486,997. This number of people would either not come to the region, of if they are here would be inclined to leave, or continue to reside within the region in an unemployed situation. The numbers for 2030 are 14,830 (2.8%) of the year 2030 projected population of 528,437, and for 2060 are 11,700 (2.2%) of the projected 527,210 population. School enrollment is projected to be 1,245 less in 2010, 3,590 less in 2030, and 2,530 less in 2060.

Table ES-1.
Water User Groups with Projected Needs (Shortages)
Llano Estacado Region

City (County)	Year Shortage Develops	Shortage in 2060 (acft/yr)
Municipal Shortages		
Briscoe County Other (Quitaque)	2010	86
Silverton (Briscoe)	2010	108
Dimmitt (Castro)	2030	1,130
Hart (Castro)	2050	256
Morton (Cochran)	2020	496
Crosbyton Crosby)	2010	336
Lorenzo (Crosby)	2030	108
Ralls (Crosby)	2030	0
Spur (Dickens)	2050	257
Lockney (Floyd)	2030	62
Seagraves (Gaines)	2010	499
Post (Garza)	2010	206
Lake Alan Henry WSD (Garza)	2010	22
Abernathy (Hale & Lubbock)	2020	700
Hale Center (Hale)	2030	498
Petersburg (Hale)	2050	306
Anton (Hockley)	2010	243
Ropesville (Hockley)	2030	81
Smyer (Hockley)	2060	62
Sundown (Hockley)	2020	316
Amherst (Lamb)	2020	181
Earth (Lamb)	2040	276
Littlefield (Lamb)	2010	211
Sudan (Lamb)	2020	243
Idalou (Lubbock)	2040	272
Lubbock (Lubbock)	2040	1,223
New Deal (Lubbock)	2020	20
Shallowater (Lubbock)	2010	184
Wolfforth (Lubbock)	2010	1,787
Wilson (Lynn)	2020	55
Farwell (Parmer)	2020	371
Friona (Parmer)	2030	791

County	Year Shortage Develops	Shortage in 2060 (acft/yr)
Municipal Shortages	**Continued**	
Kress (Swisher)	2010	96
Tulia (Swisher)	2020	417
Brownfield (Terry)	2020	457
Denver City (Yoakum)	2030	1,141
Plains (Yoakum)	2020	457
Total Municipal Shortages		**13,954**
Irrigation Shortages		
Bailey	2005	93,597
Briscoe	2005	14,581
Castro	2005	351,768
Cochran	2005	72,644
Crosby	2005	7,960
Dawson	2005	73,240
Deaf Smith	2005	240,650
Dickens	2005	2,737
Floyd	2005	100,072
Gaines	2005	140,268
Garza	2005	3,212
Hale	2005	223,093
Hockley	2005	80,584
Lamb	2005	253,586
Lubbock	2005	96,308
Lynn		0
Motley	2005	1,025
Parmer	2005	350,632
Swisher	2005	107,552
Terry	2005	90,149
Yoakum	2005	18,485
Total Irrigation Shortages		**2,322,143**

Llano Estacado Regional Water Plan

The LERWPG identified the following water management strategies as potential strategies to meet the projected needs of the region:

- Municipal and Irrigation Water Conservation;
- Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Water Supply;
- Water Supply from Lake Alan Henry, Groundwater Sources, and Reclaimed Water;
- Precipitation Enhancement;
- Brush Control;
- Desalt Brackish Groundwater;
- Post Reservoir – Raw Water at the Reservoir;
- Research and Development of Drought Tolerant Crops and New Technology;
- Reuse of Municipal Effluent;
- Stormwater Capture and Use; and
- Public Education.

Water management strategies selected to be included in the plan to meet the needs of specific water user groups include municipal water conservation, local groundwater development for municipalities, and best management irrigation practices by irrigators, while strategies that are not specific to a particular water user group, but instead are region-wide strategies include precipitation enhancement and brush control.

The proposed plan to meet the specific needs of cities located within the region is to develop additional groundwater supplies located as near as possible to each respective city. Each city with a projected need should gradually increase the number of existing wells and/or expand their well fields. Some cities will need to purchase land or groundwater rights for new well fields.

Also included in the proposed plan are non-specific strategies. These strategies would contribute to increasing the region's water supplies on a widespread scale for use by all water user groups, as opposed to being specifically applicable to an individual user group. These include precipitation enhancement and brush control.

Water Supply for Cities Having Projected Water Needs

Of the 51 cities in the Llano Estacado Region, 36 were projected to need additional water supplies during the planning period. In the plan, a selected strategy is presented for each city that is estimated to need additional water supplies. The individual plans show the approximate dates at which new wells will be needed by each city, the distance to potentially available supply, the capacity needed, and the estimated costs for land, wells and equipment, and pipelines. In addition, the costs are expressed as total capital costs, annual debt service, annual power costs, and cost per acre-foot and per 1,000 gallons of water. Total capital cost of the plan to meet municipal water needs of the 36 cities and one water supply district having projected shortages during the period from 2000 to 2060, in Second Quarter 2002 prices, is estimated at $38.73 million. In addition, estimates for projects for Lubbock are $393 million, projects by CRMWA for Region O are approximately $50 million, and projects for White River Municipal Water District are approximately $30 million. The cost estimates range from $52 per acft ($0.16 per 1,000 gallons) to $1,259 per acft ($3.86 per 1,000 gallons), with one strategy having an estimated cost of $2,252 per acft ($6.91 per 1,000 gallons).

Although water supplies are included as firm yields from surface sources and dependable quantities from groundwater sources, cities are expected to follow their respective Demand Management and Drought Contingency Plans, plus implement additional water conservation, if needed, during drought.

Water Supply for Irrigation Having Projected Water Needs

Of the total 8.3 million acres of cropland in production in the Llano Estacado Region, approximately 60 percent are farmed without irrigation and 40 percent are irrigated. The TWDB irrigation water demand projections for the Llano Estacado Region show a decline from the estimated level of use in year 2000 of about 4.35 million acft/yr to about 4.02 million acft/yr in 2020, and 3.47 million acft/yr in 2060. Projected irrigation water supplies available decline from about 2.94 million acft/yr in year 2010 to 1.84 million ft/yr in 2030, and 1.19 million acft/yr in 2060 resulting in a projected irrigation water shortage of 1.26 million acft/yr in 2010, and 2.34 million acft/yr in 2060.

The Region O Planning Group recognizes that the High Plains Ogalalla aquifer with any appreciable pumping, is not sustainable, however with the implementation of water conservation strategies, the longevity of the Ogallala can be appreciably extended. Ground water is an exceedingly valuable asset to all of the Region O landowners and water rights holders, whether agricultural, municipal or industrial, and justifies implementation of all currently available water conservation strategies and technologies, including refinements thereto, and all strategies which may be developed in the future. We believe water in the ground is like money in a bank and such should be spent wisely.

Irrigation farmers of Region O have implemented many of the irrigation water conservation application methods and farming practices considered to be the most efficient today. For example, irrigation farmers of the Region have adopted and are using the following irrigation water conservation Best Management Practices (BMPs):

1. Contour Farming;
2. Tailwater Recovery and Use;
3. Replacement of On-farm Irrigation Ditches with Pipelines;
4. Gated and Flexible Pipe for Field Water Distribution;
5. Low Pressure Center Pivot Sprinkler Irrigation Systems (LEPA and LESA);
6. Surge Flow Irrigation for Field Water Distribution Systems;
7. Furrow Dikes, Chiseling, and Deep Ripping;
8. Crop Residue Management and Conservation Tillage;
9. Linear Move Sprinkler Irrigation Systems;
10. Drip/Micro-Irrigation Systems; and
11. Volumetric Measuring.

The use of irrigation BMPs in the past has increased water use efficiency and thereby contributed to the current levels of irrigation production in the region. Such contributions are, in effect, operating to offset a part of the irrigation water shortages that have occurred in the past, and are projected to occur in the future as the Ogallala Aquifer water levels decline. The Llano Estacado Regional Water Plan includes the recommendation that Llano Estacado Region irrigation farmers continue to use irrigation water conservation BMPs, and further recommends that irrigation farmers of the Region consider installation of efficient irrigation application equipment, such as LEPA and/or LESA systems on approximately the 908.8 thousand irrigated acres that have not yet been equipped with such systems. When used in conjunction with furrow dikes, which hold both precipitation and sprinkler applied water within the furrows, this water management strategy has the potential to meet approximately 44 percent of the projected irrigation shortages in the region in 2010, 22 percent of projected shortages in 2030, and approximately 14 percent of projected shortages in 2060. The capital cost of this irrigation water management strategy is estimated at approximately $353 million in Second Quarter 2002 prices, with an annual cost of approximately $27.6 million. Capital cost per acre-foot of water is estimated at $50 in 2010, $62 in 2030, and $84 in 2060. Capital cost per acre-foot of water saved increases over time, since well yields are projected to decline as the aquifer levels decline, thus the irrigation equipment has less total quantity of water with which to work. However, with more efficient irrigation application methods, less water would be pumped per acre irrigated, thereby reducing farm production costs by at least the value of the energy that would have been needed to pump the water saved, and although data are not available with which to estimate its value, it is recognized that this is one of the major sources of income with which to make the payments to meet the capital costs of the irrigation water conservation strategy.

In addition to the following recommended irrigation water conservation strategies, the planning group recommends the adoption of newly developed irrigation water conservation methods and site specific water management methods that are currently available or may become available in the future, such as remote sensing for irrigation scheduling, and variable rate irrigation application. Particular attention should be given to using any successful management strategies that result from the Texas Alliance for Water Conservation Demonstration Project located in Floyd and Hale Counties. The Texas Alliance for Water Conservation Demonstration Project is an eight-year study to identify and quantify the best agricultural production practices and technologies to reduce groundwater pumpage from the Ogallala aquifer, while maintaining agricultural production and economic opportunities.

Region-Wide Water Management Strategies Included in the Llano Estacado Water Plan

Precipitation Enhancement

Precipitation enhancement has the potential to increase the quantity of water that would be available to many water user groups in the Llano Estacado Region, as well as reduce pumpage requirements from the Ogallala Aquifer. Although available data and cloud seeding experience are not adequate to give reliable estimates of long-term increases in precipitation, the present information indicates that precipitation can be increased by cloud seeding.

Additional precipitation during the growing season would directly and immediately benefit dryland and irrigated agriculture. Crop and grazing yields could be increased, irrigation water pumped from the Ogallala Aquifer could be reduced, and lawn irrigation could be reduced. The latter effect would contribute to meeting projected municipal water needs by reducing the quantities used per year from present supplies. Additional rainfall runoff would be collected in public water supply surface water reservoirs and in playa lakes, which could increase recharge to the aquifer, as well as provide water for wildlife.

Brush Control

Brush control could increase the water supply in the Llano Estacado Region by increasing quantities of water for recharge to the aquifers and increasing runoff into lakes and reservoirs. The areas of the region where significant concentrations of brush occur are in the east “caprock counties” and in the western counties.

Of the 21 counties in the region, 13 counties have 50,000 or more acres of mesquite and shinnery oak combined. The counties located on the eastern side of the planning area below the caprock have the highest acreages of mesquite, salt cedar, and shinnery oak and would primarily be the locations where brush control can be applied to increase water supplies. Salt cedar control is vitally important to the Llano Estacado Water Planning Region, since this plant can consume up to 200 gallons of water per plant per day. As has been demonstrated in Crosby County on the White River Reservoir watershed, brush control can contribute to increased inflows to a reservoir. The existing Alan Henry Reservoir and the proposed Post Reservoir are located in Garza County, which has over 185,000 acres of mesquite and shinnery oak. Brush control projects on the watersheds of these two reservoirs could result in increased firm yields and thereby contribute to the region’s water supply.

The capital outlay to implement brush control on 50 percent of the mesquite and shinnery oak infested acres in counties having more than 50,000 acres of these two species of brush is estimated at $40.78 million, with an annual cost of $2.74 million. For example, if brush control were to be implemented on the Alan Henry Reservoir contributing watershed, the annual cost would be approximately $323,750. If the yield of the reservoir were increased by 10 percent (or 2,250 acft/yr), the cost per acft of raw water yield at the reservoir would be $144—or $0.44 per 1,000 gallons.

Desalt Brackish Groundwater

The potential source of water for this option is the Santa Rosa Aquifer of the Dockum Formation, which underlies the entire area of the Llano Estacado Region. Data currently available indicate that the quality of water in the Santa Rosa in the majority of the planning region is unsuitable for most uses without treatment. Water treatment costs are estimated at $303 to $369 per acft, depending upon brine concentration of the feedwater. Individual cities that need water could consider this source.

Use of Reclaimed Water

Examples of the use of reclaimed water are the use of treated municipal effluent for irrigation of golf courses, parks, cemeteries, and other public lands, irrigation of agricultural land near to or adjacent to the town or city from which the effluent is obtained, and in some cases, for public supply. In the Llano Estacado Region, the primary use of reclaimed municipal and feedlot wastewater is to irrigate farmland. Approximately 95 percent of all the water obtained from the Ogallala Aquifer is used for irrigation purposes. By substituting water pumped from the Ogallala Aquifer with reclaimed water, the amount of groundwater withdrawal can be decreased.

Municipal Water Conservation

Municipal water is freshwater that meets drinking water standards. Such water is supplied by both public and private utilities. In areas not served by water utilities private wells supply individual households. The objective of the municipal water conservation option is to reduce per capita water use without adversely affecting the quality of life of the people involved. The municipal water conservation water management strategy is estimated to meet 2,858 acft/yr of municipal water needs in Region O in 2010, 3,412 acft/yr in 2020, 3,616 acft/yr in 2030, and 4,020 acft/yr in 2060 (Figure ES-2). In terms of projected municipal water demand, the municipal water conservation water management strategy could meet about 3.9 percent of the projected municipal water demand of 93,549 acft/yr in 2060. The proposed municipal water conservation water management strategy has the potential to reduce per capita water use in the region from an average of 168 gallons per person per day in 2010 to 151 gallons per person per day in 2060 (Figure ES-2). Municipal water conservation strategies are strongly recommended.

Agricultural Water Conservation Practices on Farms

Dryland and irrigation farmers in the Llano Estacado Region attempt to obtain maximum benefit from the use of the precipitation they receive on their farms. Irrigation application methods have been the subject of research and development since irrigation became possible in the Llano Estacado Region in the 1930s, and in recent decades there have been significant improvements in irrigation application and conservation methods. The following irrigation practices are currently being used in the planning region; (1) Subsurface Drip Irrigation—SDI, (2) Low Energy Precision Application—LEPA pivot, (3) Low Elevation Spray Applicator/Low Pressure in Canopy—LESA/LPIC, (4) Surge Valves, (5) Pipelines, (6) Lay Flat Tubing,

(7) Furrow Diking and Chiseling, and (8) Soil Moisture Monitoring. These methods and practices improve water use efficiencies and sustain present water supplies from the region's aquifers.

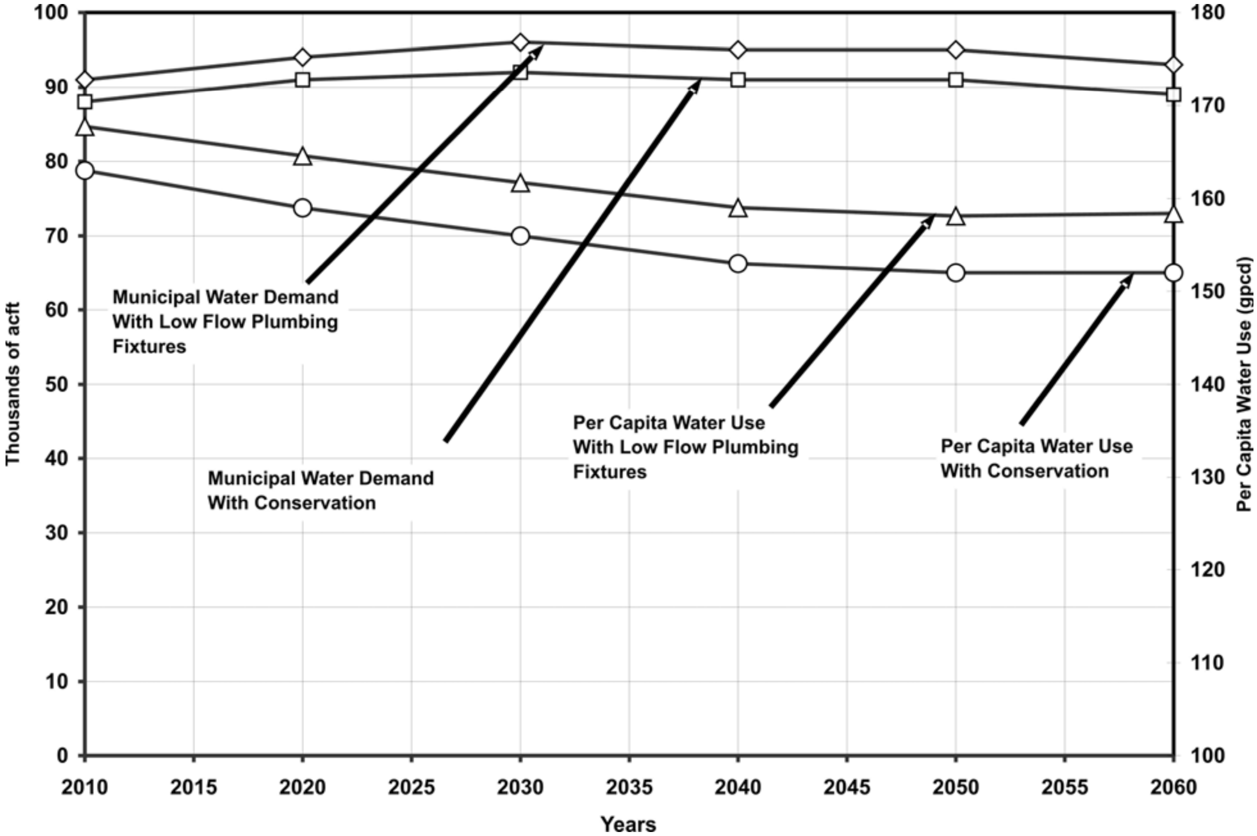

Figure ES-2. Municipal Water Demand Without and With Water Conservation

Post Reservoir

The proposed Post Reservoir Project is located on the North Fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas in Garza County. The Post Reservoir could serve as a future water supply source to cities and industries in the planning area. The firm yield of Post Reservoir is 9,500 acft/yr. The cost of raw water at the reservoir is computed at $231 per acft.

Research and Development of Drought Tolerant Crops and New Technology

Both public and private agricultural research organizations are presently engaged in research on plant crop breeding, plant nutritional needs, and cultural practices to improve the productivity, quality, and other characteristics of crops that can be produced in the Llano

Estacado and other regions of Texas, the United States, and other countries of the world. The LERWPG recommends that funding be continued in adequate levels for research and development of new and improved technology in the fields of drought tolerant strains of crops, new or alternative crops for arid and semiarid regions, plant nutritional needs, irrigation application methods, brush control, weather modification, aquifer recharge, and development of better information about the aquifers and other water resources of the region.

Reuse of Municipal Effluent

Of the total quantities of water used for municipal purposes, 45 percent to 65 percent is returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Region a large percentage of this treated effluent, or reclaimed water, is used for irrigation of open spaces, golf courses, and neighboring farmland. This water could become a significant source of municipal water in the future if treatment levels were increased to the extent that the use of this water does not pose a health risk. The LERWPG highly recommends that funding be made available to universities, water districts, and the cities to further study the quantity of water available from this option and to study treatment technologies to make this option feasible.

Stormwater Capture and Use

In some cities of the Llano Estacado Region, disposal of stormwater has become a serious problem. Lubbock is one of the cities having this problem. Therefore, in this water-short region, it has become desirable to evaluate the possibility to capture, treat, and use this water as a source of supply for non-potable as well as potable uses. The LERWPG strongly recommends that funding be made available to the cities and water districts to further study the quantity of water available from this option and to develop ways to successfully integrate flood protection, storage, and treatment of this storm water for useful purposes, including municipal supply.

Protecting and Enhancing Playas and Playa Watersheds

Protecting uplands surrounding playas can significantly slow their siltation. Maintaining the integrity of these basins ensures that they serve as catchments that provide valuable wildlife habitat and provide recharge to the Ogallala Aquifer. Measures to protect playa drainages include planting of native grass buffer strips and fencing to control grazing. The LERWPG recommends best management practices on playa watersheds that enhance their function as wildlife habitat and as a recharge source for the Ogallala Aquifer.

Public Education

Underground water conservation districts, cities, universities, the Texas Agricultural Extension Service, and other water agencies will continue existing education and information dissemination programs. In addition, Llano Estacado Region water suppliers and agencies will build a strong cooperative relationship with formal and informal educators including the region's Educational Service Centers and Independent School Districts.

Concluding Comments

Water Conservation: In 2003, the 78th Texas Legislature passed Senate Bill 1094 which established a task force to "review, evaluate, and recommend optimum levels of water-use efficiency and conservation for Texas and to concentrate on issues related to (1) best-management practices, (2) implementation of conservation strategies contained in regional water plans, (3) a statewide public-awareness program, (4) state funding of incentive programs, (5) goals and targets for per-capita water use considering climatic and demographic differences, and (6) evaluation of state oversight and support of conservation. In addition, Senate Bill 1094 directed the Task Force to develop a best-management practices guide (BMP Guide) for use by Planning Groups and political subdivisions responsible for water-delivery service."

The Water Conservation Implementation Task Force Report was published in November 2004 and made available to the Regional Planning Groups. The LERWPG has reviewed this document and has incorporated applicable water conservation strategies and best management practices into this water plan. Consistent with the strategies recommended in this plan, the Planning Group believes that:

1. A statewide public awareness initiative is critically needed,
2. Environmental practices should include protection and rehabilitation of playa basins and encouragement of landowners to maintain springs and seeps as they exist,
3. Municipal conservation must be implemented to achieve the goal of 172 GPCD, and
4. Application of new conservation technologies will need to be considered and applied in the future as appropriate.

Water Planning: The LERWPG has discussed at great length the planning process and the profound effect which the key parameters (population, water demand, and water supply) have on the accuracy and validity of the final plan and recommendations. All three key parameters for the most part have been provided to the Planning Group by the TWDB, with provisions for review and change to this fundamental data. The data, once accepted, then formed the foundation for the strategies and recommendations that are needed to close the gap between supply and demand.

Major topics of the discussion were the definitions of “water demand” and “water supply.” For example, should water demand be the quantity of water that would be needed to irrigate every farmable acre in the region, to grow the crops of choice, and to support the population growth associated with the increased agricultural and industrial activities? Or should demand projections be tempered to recognize the hydrologic limits, economic realities, and acres that can realistically be irrigated? The Planning Group recognizes that this region of the State is and will continue to be water supply limited and therefore the regional water plan should recommend conservation measures and infrastructure changes that will support the population necessary to maintain a realistic level of agriculture and industry.

Within the context of regional water planning, questions regarding water supply are paramount. Once it is recognized that the region is water supply limited, it becomes clear that the other two key parameters - “actual demand” and “actual population” – are directly dependent on “supply.” The Planning Group then must address two fundamental supply questions – how much do we have and how long can it be made to last? Again, the TWDB has provided data based on GAM runs that predict the supply of water available for use. The accuracy of these numbers has been called into question, as will be illustrated below. At the very least, the Planning Group believes that more study is needed to calibrate the results and to better understand the dynamics of the aquifer (local irrigation withdrawals, local recharge, local irrigation return flows, and lateral flow in the aquifer). More work is clearly needed to determine available water in storage. However, for the 2006 plan, the Planning Group has concluded that the TWDB data must be used as better data cannot be collected and reviewed within the scheduled timeline for this round of planning, but great strides can, and must be made in the next round.

Groundwater modeling and extensive measurements of water in storage strongly suggest that the Ogallala Aquifer has greater recharge capability than has been historically estimated. The recharge of the aquifer is obviously a very critical factor in the water planning process. The planning group believes that a more aggressive effort is needed to both understand the recharge mechanisms of the Ogallala and to find ways to enhance that recharge. Whatever can be done to increase supply in the aquifer will have a major impact on the region and will improve the economy of the area.

The Planning Group is relatively more comfortable with and confident in the municipal demand and supply estimates than those provided for agricultural irrigation. The municipalities have infrastructure, record-keeping, and reporting procedures that provided the municipal water use data to the TWDB that the TWDB used to make the municipal water demand projections. The municipal water demand projections were reviewed and confirmed in light of municipal water use information.

The dilemma that the Planning Group has tried to resolve, unsuccessfully, has been that the data which has been provided by the TWDB does not appear to realistically represent the irrigation conditions in Region O of West Texas. For example, the irrigation demands utilized in this plan were strongly impacted by a single high-demand drought year of 2000. In addition, the GAM runs that were provided in support of this planning effort suffer from inaccurate starting storage volumes, as compared to 1995 or 2000 observations, in many of the Region O counties, and provided what appear to many of the LERWPG members to be unrealistic estimates of quantity of water available annually (See Appendix E). For example, the GAM runs of water supply available annually from the aquifer in Bailey and Dawson Counties are cited here to illustrate the LERWPG's questions about the water demand and water supply data from which it was necessary to calculate the projected irrigation water needs (shortages). In the case of Bailey County, the GAM runs resulted in quantity of water supply available to meet only 15 percent of projected demands in 2020 (GAM supply in 2020 = 27,300; Demand in 2020 = 173,622), 12 percent in 2030, and 10 percent in 2060, while leaving over 80 percent of estimated quantity of water in storage in 2004 still in storage in 2060. In the case of Dawson County, the GAM runs provided estimates of supplies available to meet 65 percent of projected 2010 demands, 55 percent of 2030 projected demands, and 60 percent of 2060 projected demands, while adding 10 percent to estimates of quantity of water in storage over the 55 year projections period. Given these examples, the planning group made some revisions and adjustments to the water supply data provided by the GAMS, however, the planning group did not have a fast, inexpensive means to develop better data based on sound science with which to improve upon the TWDB estimates. Since better data were not available, the LERWPG had no option but to proceed using the only data available, those from the TWDB.

The Planning Group recognizes that the planning process, with periodic updates to the plan will serve to allow the introduction of newer and more advanced BMPs and better data in the longer term. Ongoing and new efforts by the groundwater conservation districts will provide better estimates of actual irrigation withdrawals and volumes of water in storage. The Planning Group recommends that current and future developed and refined irrigation water conservation methods be implemented to the extent possible, in order to extend the life of the irrigation water supply and meet as much of the projected irrigation water demand as possible.

The Planning Group recognizes and emphasizes that the water plan for this region is very heavily driven by agriculture. Therefore, the overall plan for the region will be irrigation water supply limited and our recommendations must focus on how to best utilize the available supply to the maximum benefit of the people of the region.

Moving on to the ultimate water management question – how long can the available supplies be made to last? It is well recognized that the freshwater supply in West Texas is a finite resource that is not sustainable – it is being depleted! Should attempts be made to slow the depletion and in so doing restrict the economic vitality of the region? Should the plan favor expanded economic development recognizing that the available water resource will be depleted more quickly? This is the crux of the water planning process in Region O. For this reason, the Planning Group has chosen to strongly recommend water conservation Best Management Practices (BMPs) for both municipal and irrigated agriculture so that the economy of the region be sustained as closely as possible to the current level. The projected water use seems to suggest a trend of 50 percent depletion of the current supply over a 50 year period. This 50/50 water use scenario appears to be a trend that is evolving naturally. Conservation efforts coupled with initiatives to supplement the supply such as improving recharge, brush control, and weather modification will all serve to reduce depletion which will translate into improved economic benefits and longevity of the region. The recommendations that evolve from this strategy of sustaining the economy of the region put a high focus on water conservation and supply enhancements. To the extent that unnecessary water use can be eliminated, those volumes can be applied to other uses beneficial to the economy and people of the region.

In summary, the water plan for the Llano Estacado Region of Texas does not recognize the "demand" projections to be the total volume of water that can be provided through water conservation water management strategies and recommendations. Instead, the Planning Group recognizes that the "supply" projections serve to reflect the total expected quantity of water available for use in the region. The irrigation water conservation strategies can reduce the projected irrigation shortages, however, the potentials from irrigation water conservation will not be adequate to meet the total projected irrigation water shortages. For agriculture, the “supply” and “actual demand” curves are synonymous and all implemented conservation measures translate into immediate additional opportunity for the regional economy and extending the longetivity of the Ogalalla aquifer. In the case of municipal water use, water conservation will indeed have an immediate impact on the demand for water. Toward that end, the conservation strategies and recommendations in the plan are aimed at improving the utilization of those projected volumes to the maximum extent practicable.

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Section 1
Planning Area Description
[31 TAC §357.7(a)(1)]

1.1 Introduction

In 1997, Senate Bill 1 was enacted by the 75th Texas Legislature to address experiences of drought and the needs of utilities and water management entities to meet the water supply needs of the State's growing population and economy. The new law emphasized the development of water plans at the regional level with greater local participation and input in order to gain acceptance and commitment to implementation. In addition to requiring the best information possible to guide future water resource decisions, Senate Bill 1 also provided that future regulatory and financing decisions of the Texas Commission on Environmental Quality and the Texas Water Development Board (TWDB) be consistent with approved regional plans. As stated in Senate Bill 1, the purpose of this regional planning effort is to:

> "Provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region."

The TWDB is the state agency designated to coordinate the overall statewide planning effort. After seeking public input, the TWDB divided the state into 16 planning regions. In the South Plains of Texas, a 21-county area was delineated by the TWDB as Planning Region O, which was subsequently named the Llano Estacado Regional Water Planning Region (herein referred to as the Llano Estacado Region). The counties of the region are:

1. Bailey
2. Briscoe
3. Castro
4. Cochran
5. Crosby
6. Dawson
7. Deaf Smith
8. Dickens
9. Floyd
10. Gaines
11. Garza
12. Hale
13. Hockley
14. Lamb
15. Lubbock
16. Lynn
17. Motley
18. Parmer
19. Swisher
20. Terry
21. Yoakum

The Llano Estacado Regional Water Planning Group (LERWPG) was appointed by the TWDB to represent a wide range of stakeholder interests and act as the steering and decision-making body of the regional planning effort. The LERWPG members are listed in Table 1-1. Non-voting members include representatives of state agencies and adjoining regions.

Table 1-1.
Current Members and Representation of the Llano Estacado Regional Water Planning Group

Voting Members — Water User Group
H. P. Brown, Jr., Chair, — Agriculture/Cattle
Ches Carthel, Vice Chair — Municipalities (Large)
Jim Conkwright, Secretary/Treasurer — Water Districts
Melanie Barnes, Ph.D. — Public
Delaine Baucum — Agriculture
Bruce Blalack — Municipalities (Large)
Dallas Brewer — County Government
Delmon Ellison, Jr. — Agriculture
Harvey Everheart — Water Districts
Bill Harbin — Electrical Generation
Don James — Agriculture
Bob Josserand — Municipalities (Medium)
Richard Leonard — Agriculture
Terry Lopas — River Authorities
Don McElroy — Small Business
Jared Miller – Municipalities (Small)
Sukant Misra, PhD — Agriculture
E.W. (Gene) Montgomery — Oil & Gas
Ken Rainwater, PhD — Public
Doug Hutcheson — Water Utilities
Kent Satterwhite — Water Districts
Jim Steiert — Environment
Non-voting Members — Agency
Joan Glass — Texas Parks and Wildlife Department
Steve Jones — Texas Department of Agriculture
Malcolm Laing — Texas Commission on Environmental Quality
Temple McKinnon — Texas Water Development Board

After considerable discussion, the LERWPG adopted a Mission Statement, dated April 16, 1998, which reads:

> "Develop, promote, and implement water conservation, augmentation, and management strategies to provide adequate water supplies for the Llano Estacado Regional Water Planning Area of the High Plains of Texas and to stabilize or improve the economic and social viability and longevity of the region through these activities."

This Mission Statement is meant to keep the LERWPG focused on the fact that the economy of the region is highly dependent upon agribusiness, which is totally dependent on a reliable water supply.

The LERWPG designated the High Plains Underground Water Conservation District No. 1 as the political subdivision to act on behalf of LERWPG as principal contractor to apply for and administer a grant from the TWDB to develop the Water Plan. The prime planning and engineering consultant is HDR Engineering, Inc.

On January 3, 2001, the LERWPG adopted and submitted to the TWDB the "Llano Estacado Regional Water Planning Area Regional Water Plan." In response to directives of Senate Bill 2 (77th Texas Legislature, 2001), the LERWPG prepared a Scope of Work and Budget to update and revise the January 3, 2001, Llano Estacado Regional Water Plan, and on April 1, 2002, the LERWPG applied to the TWDB for funding to accomplish the update and revision directed by Senate Bill 2. The updated and revised Llano Estacado Regional Water Plan is presented below.

The planning horizon used by the LERWPG and all other water planning groups is the 60-year period from 2000 to 2060. This planning period allows for a long-term forecast of the prospective water situation, sufficiently in advance of needs, to allow for appropriate management measures to be implemented. As required in Senate Bill 1, the TWDB specified planning rules and guidelines (31 TAC §357.7 and §357.12) to focus the efforts and to provide for general consistency among the regions so that the regional plans can then be aggregated into an overall State Water Plan by January 2007. Besides specifying overall report and data formats, the TWDB rules also require the maximum use of existing state water planning information, except where better information is available. As authorized by Senate Bills 1 and 2, the TWDB has provided for coordination mechanisms among the regions where regions share common water issues.

1.2 Physical Description of the Region, Including the Economy, Water Use, Water Supplies, Water Quality, and Major Entities with Water Resources Management Responsibilities

1.2.1 Description of the Region

The 21-county Llano Estacado Region has an area of 20,294 square miles (12,988,160 acres), about 7.5 percent of the state's land area (Figure 1-1). Although the region is located in the upstream parts of four major river basins (Canadian, Red, Brazos, and Colorado), almost no surface water exists within the region. Of the total area, 94 square miles are located in the Canadian Basin, 6,681 square miles are located in the Red Basin, 8,732 square miles are located in the Brazos Basin, and 4,787 square miles are located in the Colorado Basin. The region is bounded on the west by the Texas-New Mexico border, on the north by TWDB Planning Region A, on the south by TWDB Planning Region F, and on the east by the county lines of Deaf Smith, Briscoe, Motley, Dickens, Garza, and Dawson Counties. The region extends beyond the "caprock" escarpment and the eastern extent of the Ogallala into the Rolling Plains.

The regional population of 453,997 represents about 2.2 percent of the state total population of about 20.85 million persons in 2000.[1] Ten major cities with a population greater than 5,000 persons are located in the region, with these population centers relatively equally distributed within the 21 counties of the planning area. Lubbock County is the only county that contains more than one population center of 5,000 or more (Cities of Lubbock and Slaton). Twelve counties in the region (Bailey, Briscoe, Castro, Cochran, Crosby, Dickens, Floyd, Garza, Lynn, Motley, Parmer, and Yoakum) do not contain a city of greater than 5,000 persons.

1.2.2 Climate[2]

The climate of the Llano Estacado Region is classified as a dry, steppe type. The region is characterized as semi-arid, with a wide range in temperatures. In spite of occasional periods of very low temperatures, the winters in the region are generally mild. Although afternoon temperatures in the summer are hot, the season is usually a pleasant one, with cool nights. Spring offers the greatest variety in weather. It is also the windiest season of the year, and occasionally strong southeasterly to northwesterly winds carry blowing dust.

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[1] 2000 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 2001.
[2] Texas Water Development Board (TWDB), "Continuing Water Resources Planning and Development for Texas," May 1977.

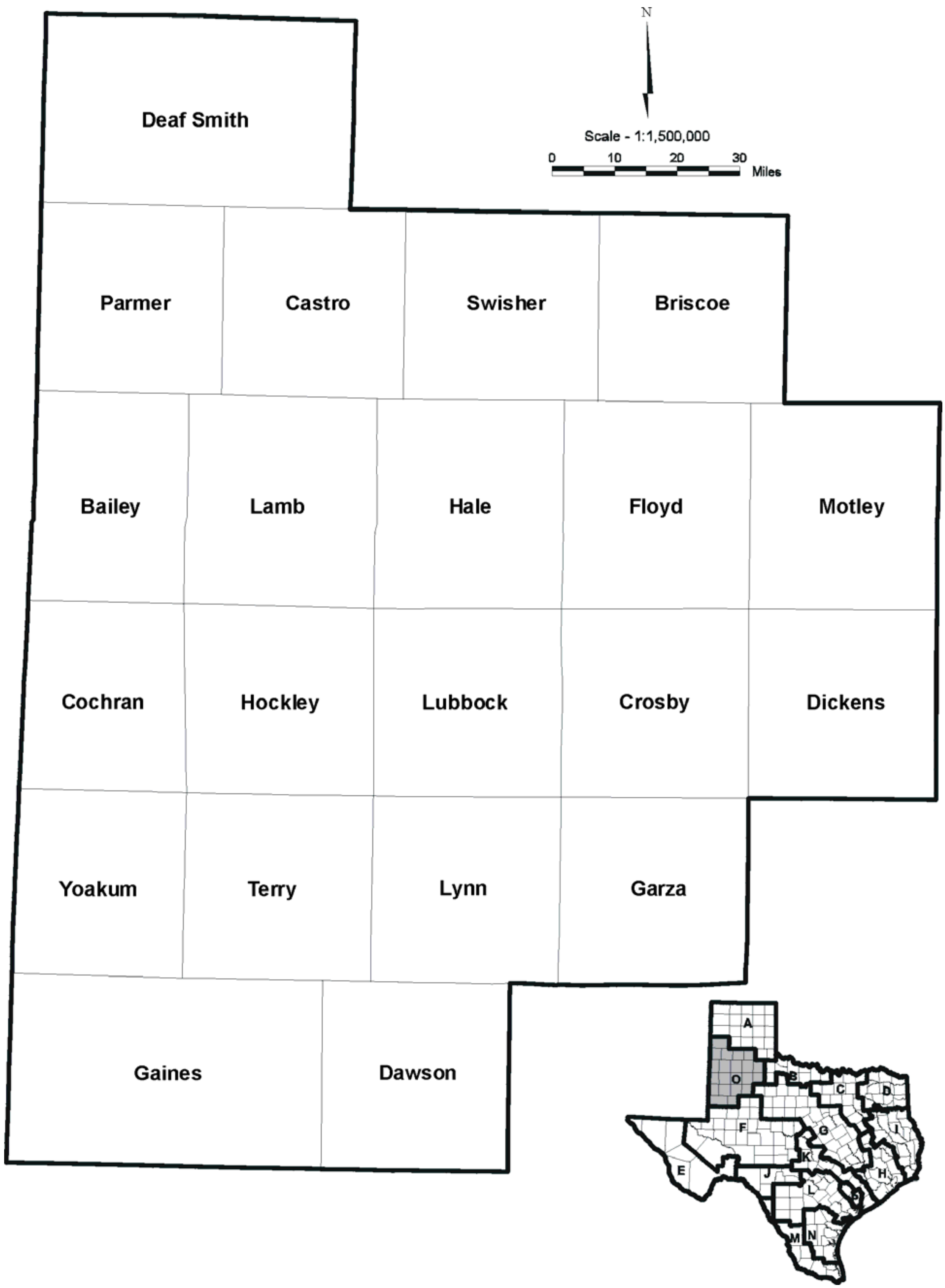

Figure 1-1. Map of Planning Region

In an average year, about 80 percent of the annual rainfall total occurs during the warm season (May through October). Monthly rainfall quantities ordinarily decline markedly in the colder months of the year, when frequent periods of cold, dry air from North American polar regions surge southward and cut off the supply of moisture from the Gulf of Mexico. Mean annual precipitation in the region ranges from a high of 22 inches per year in Crosby County to a low of 16 inches per year in the southern areas of the region. Values for annual net lake surface evaporation range from a high of 65 inches per year for the southern portion of the region to a low of 53 inches per year in the north. A summary of the climatological conditions for the region is shown in Table 1-2.

Table 1-2.
Climatological Data for Llano Estacado Region

	Precipitation			Temperature					Annual Net Lake Surface Evaporation (inches)
					Mean Daily Minimum		Mean Daily Maximum		
River Basin	Mean Annual (inches)	Wettest Month(s)	Driest Month(s)	Mean Annual (°F)	January (°F)	July (°F)	January (°F)	July (°F)	
Canadian	23	July	Jan.	60	21	67	53	93	53
Red	19	May, June	Jan., Feb.	58	22	65	51	93	53
Brazos	18	May, June	Dec.	58	25	67	53	92	54
Colorado	16	May, Sept.	Feb.	62	26	67	56	95	65

Source: Texas Water Development Board.

1.2.3 Physiography, Geology, Soils, and Vegetation[3]

The Southern High Plains area of Texas, spanning much of the Llano Estacado Region, is the most southerly extent of the Southern Great Plains of the United States. Land elevations in the region generally range from about 1,900 feet-mean sea level (ft-msl) in the southeast to 4,300 ft-msl in the northwest. The relatively level plateau of the Southern High Plains contains many shallow depressions, or playa basins, a few of which hold water more or less permanently (Section 1.6.4). There is broken terrain in the northwest corner of the planning region and on the eastern side of the planning region, which is a part of the Rolling Plains physiographic region, below the caprock escarpment.

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

Fluvial sands, clay, silts, and gravels of the Tertiary Miocene/Pliocene Ogallala Formation underlie the majority of the region. The uppermost portion of the formation is a resistant caprock caliche. The Ogallala Formation is overlain by the Quaternary aged Blackwater Draw Formation. Throughout the area recent aged fluvial deposits occur along major stream valleys.

The principal aquifer in the Llano Estacado region, the High Plains aquifer, is colloquially referred to as the Ogallala aquifer.[4] Although researchers prefer the terminology High Plains aquifer, in order to minimize confusion, this document will use the terminology Ogallala aquifer as a substitute for High Plains aquifer. The Ogallala aquifer (High Plains aquifer) consists of the saturated section of the Ogallala Formation as well as those underlying and overlying geologic units that are in hydraulic continuity. The Ogallala Formation consists chiefly of sediments deposited by streams with headwaters in the mountainous regions to the west and northwest. The Ogallala Formation was deposited on the eroded surfaces of underlying Triassic and Cretaceous aged sediments. In general, the Ogallala Formation is thicker in the northern part of the area, with the thickness ranging from 400 to 500 feet in central Parmer, west-central Castro, and southwestern Floyd counties to a knife edge where the formation pinches out against outcrops of older rocks.

The original blanket of sediments which formed the Ogallala Formation extended from the Rocky Mountains eastward through north central Texas. The Ogallala Formation has subsequently been eroded such that the segment in southeastern New Mexico and the Southern High Plains of Texas is isolated in all directions from underground connection with other water-bearing beds, except through underlying older sediments, which may contain highly mineralized water unlike the fresh water in the Ogallala aquifer. This emphasizes the fact that in Texas and New Mexico, the source of the recharge to the Ogallala aquifer is precipitation falling on the unconsolidated lacustrine, fluvial, and eolian deposits sediments which overlie the Ogallala Formation. Thus, these Quaternary aged materials serve as important conduits for recharge to the Ogallala aquifer. The amount of recharge depends on many factors, including the amount, distribution, and intensity of precipitation and the type of soil and vegetative cover. Annually the amount of recharge has been estimated to be from less than one-half inch to about 3 inches. One-

[4]McGuire, V.L., M.R. Johnson, R.L. Schieffer, J.S. Stanton, S.K. Sebree, and I.M. Verstraeten, 2003, Water in storage and approaches to ground-water management, High Plains Aquifer, 2000: U.S Geological Survey Circular 1243, U.S. Department of the Interior, Reston, Virginia, 51p.

half inch of recharge on the 12,988,160 acres of the region would equal 541,173 acre-feet (acft) of water, whereas 3 inches of recharge would equal about 3,247,040 acft of water.

Generally, the water in the Ogallala aquifer occurs under water-table conditions, although locally it may be under slight artesian pressure. The water in the Ogallala aquifer occupies the pore spaces or voids in the unconsolidated sediments. The thickness of the zone of saturation in the Ogallala aquifer varies throughout the Llano Estacado region ranging from less than 1 foot to more than 300 feet. The transmissivity of the Ogallala aquifer varies widely. Tests at Amarillo indicate a coefficient of 6,000 to 7,000 gallons per day (gpd) per foot and tests in the vicinity of Plainview indicate a transmissivity of about 34,000 gpd per foot. Numerous tests, both in the laboratory and in the field, indicate an average specific gravity yield of about 15 percent. In general the movement of water in the Ogallala aquifer is from the northwest to the southeast. The water-table slopes roughly parallel to the slopes of both the bedrock and land surface, the average slope of the water-table being about 8 to10 feet per mile. The rate of movement of water in the formation has been estimated to be about 150 feet per year, on a gradient of 10 feet per mile.

The long-term trend throughout the region has been a steady decline in the water table, due primarily to large quantities of water withdrawn for irrigation. The depth to water below land surface is affected by the topography of the land surface, the proximity to areas of recharge or natural discharge, the proximity of pumping wells, and the configuration of the bedrock surface. The depth to water in the aquifer within the region ranges from less than 50 feet to more than 300 feet.

The Ogallala aquifer is classified as a major drinking water aquifer in the State of Texas. The water in the Ogallala aquifer in the Llano Estacado Region can generally be said to be of good chemical quality, except that it is “hard”, due to high levels of calcium and magnesium. This causes the water to consume soap before it will lather. It may result in scale being formed in water heaters and pipes. It also contains a high silica content, which also can cause scale. Most of the water is suitable for irrigation and meets the U.S. Public Health Service recommendations for public supplies, although the water from some wells has excessive fluoride content.

Cretaceous-aged sediments directly underlie the Ogallala Formation in much of the central portion of the Southern High Plains, extending from New Mexico on the west to Garza County on the east and into the southern portions of Bailey and Lamb counties to the north and the northern portions of Gaines and Dawson counties to the south. Cretaceous-aged sediments are comprised of the Trinity, Fredericksburg, and Washita groups, consisting primarily of sandstone, shale, and limestone; the sandstone and limestone being the principal water-bearing units. In places where the Cretaceous rocks are in hydraulic continuity with the overlying Ogallala Formation, moderate quantities of water can be obtained, particularly from the limestone. Locally, the Cretaceous rocks may be important aquifers where other water is not available; however, the Cretaceous-aged sediments generally do not constitute a large source of water for irrigation or municipal use.

Upper Triassic-aged rocks underlie the Cretaceous or directly underlie the Ogallala Formation in the Llano Estacado Region. The Dockum sediments are comprised of the Cooper Canyon, Tecovas, Trujillo, and Santa Rosa formations. The Cooper Canyon, Trujillo and Tecovas formations consist chiefly of interbedded siltstone, mudstone, sandstone, and shale, while the Santa Rosa Formation consists mainly of medium to coarse conglomeratic sandstone. The formations of the Dockum Group are capable of yielding small to moderate quantities of water in many parts of the region, particularly in the coarser grained Santa Rosa Formation. However, in most places, the water quality can be saline to briny and probably unsuitable for most purposes. There are some areas, particularly in Deaf Smith County, were good supplies of fresh water are produced from the Dockum aquifer.

"Below the Triassic, rocks of Permian Age underlie the entire area and consist chiefly of red sandstone and shale containing numerous beds of gypsum and dolomite. The Permian rocks are not a significant source of water in the Llano Estacado Region. Water in these rocks contains gypsum and salts and is generally unsuitable for domestic use. However, it is used in the Rolling Plains area for livestock water."

The soils and the characteristics of the soils of the region are described in detail in a 1999 report, "Soils of the Llano Estacado Regional Water Planning Region" by Gerald Crenwelge, USDA, NRCS Soil Scientist. There are 15 general soil types in the region, 80 to 85 percent of which are suitable for irrigation.

The original vegetation of the High Plains was variously classified as mixed prairie, shortgrass prairie, and, in some locations on deep, sandy soils, as tallgrass prairie. Blue grama, buffalograss, and galleta were the principal natural vegetation on the clay and clay loam soils. Characteristic grasses that were on sandy loam soils are little bluestem, western wheatgrass, sideoats grama, and sand dropseed.

The High Plains area is characteristically free from brush, but sand sagebrush, along with pricklypear and yucca have invaded the ranchland that have sandy and sandy loam soils. Honey mesquite has invaded the ranchland on most soils in the region. Several grass species of dropseeds are abundant on land containing coarse sandy soils. The playa depressions, which can contain several feet of water after heavy rains, support unique patterns of vegetation within their confines. Various aquatic species, such as curltop smartweed, are associated with the playa basins.

1.2.4 Natural Resources

1.2.4.1 Water Resources

The Llano Estacado Region includes the upstream parts of four major river basins (Canadian, Red, Brazos, and Colorado) and overlies the southern part of the Ogallala aquifer, a small area of the Seymour aquifer, and two minor aquifers [Dockum and Edwards-Trinity (High Plains) aquifers], as shown in Figures 1-2 and 1-3. Details about the surface water and groundwater resources are presented in Section 1.6. Within the Llano Estacado Planning Area, none of the streams carry much water, except briefly after heavy precipitation events. Almost no water is carried from the region by the rivers.

Precipitation is the only reoccurring/renewable water supply for the Llano Estacado Region, with an average annual value of 18.4 inches (1945 through 2002), or 19,915,179 acft of water over the 12,988,160-acre region (Figure 1-4). Precipitation meets about 60 percent of urban landscape water and irrigated crop demands, provides all the water available for surface reservoirs, rangeland and dryland crop production, wildlife and natural recharge to the region's aquifers.

Less than 1 percent of the precipitation escapes from the area as runoff in streams or rivers, with the remainder of runoff being collected in playa basins, of which approximately 14,000 are located within the Llano Estacado Region.[5] Playas comprise approximately 2 percent of the total land surface. The majority of playa basins are ephemeral, holding water only during and for a short period of time after rains, unless augmented by irrigation tailwater. Some of the playas are planted to crops, some are left fallow, and some are grazed. Approximately 70 percent

[5] Guthery, F.S., F.C. Bryant, B. Kramer, A. Stoecker, and M. Dvoracek, "Playa Assessment Study," U.S. Water and Power Resources Service, Southwest Region, Amarillo, Texas, 1981.

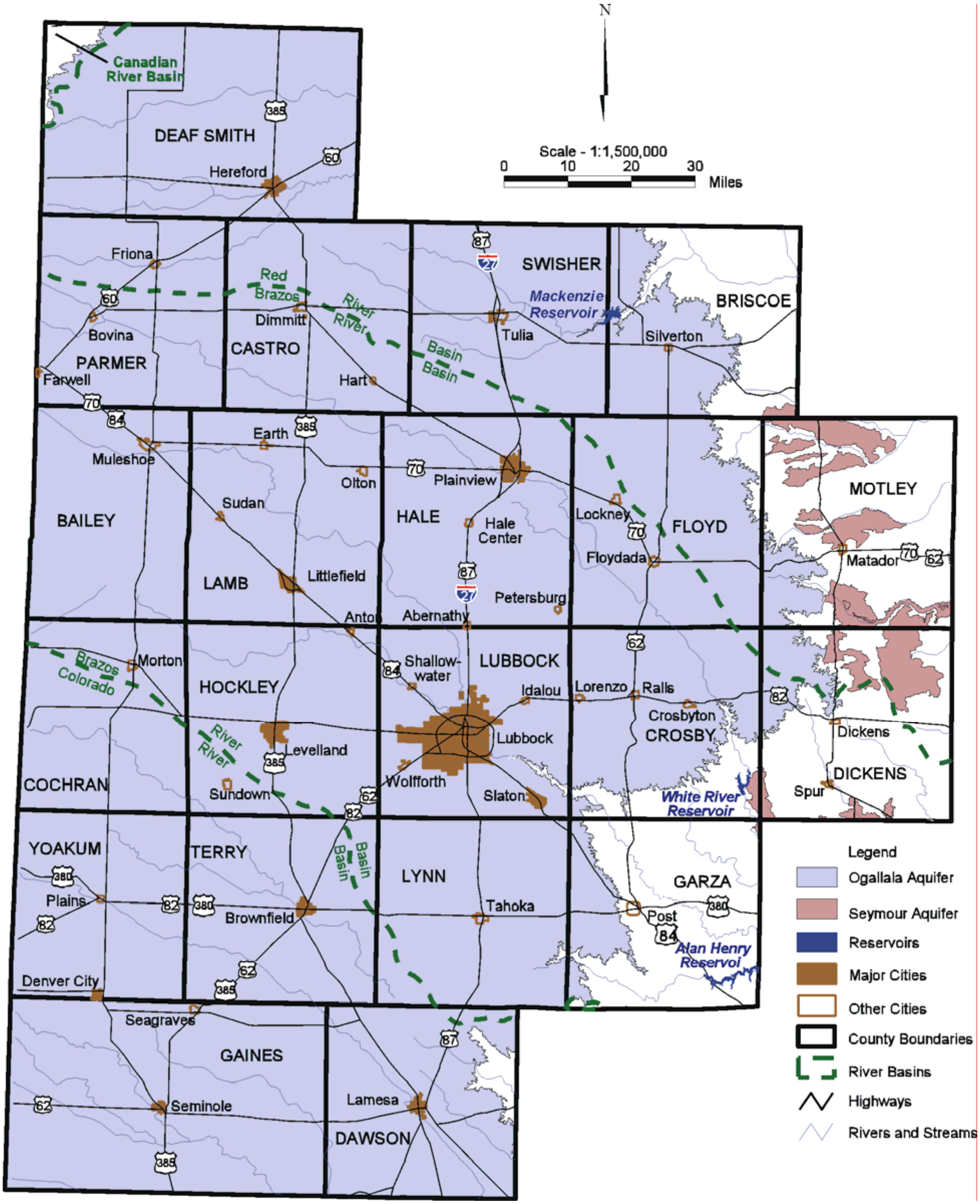

Figure 1-2. Map of Llano Estacado Region — Major Aquifers and River Basin Boundaries

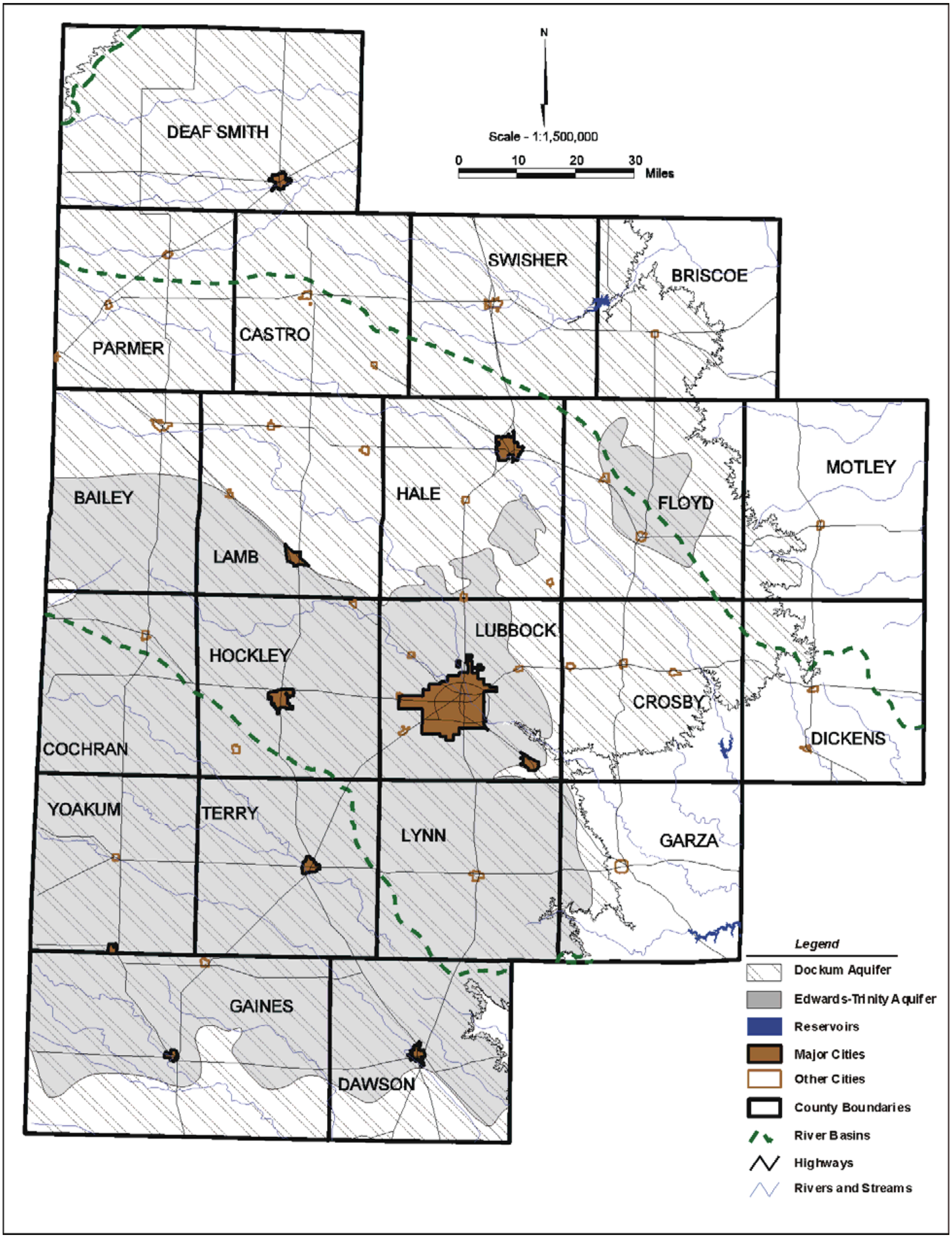

Figure 1-3. Map of Llano Estacado Region — Minor Aquifers and River Basin Boundaries

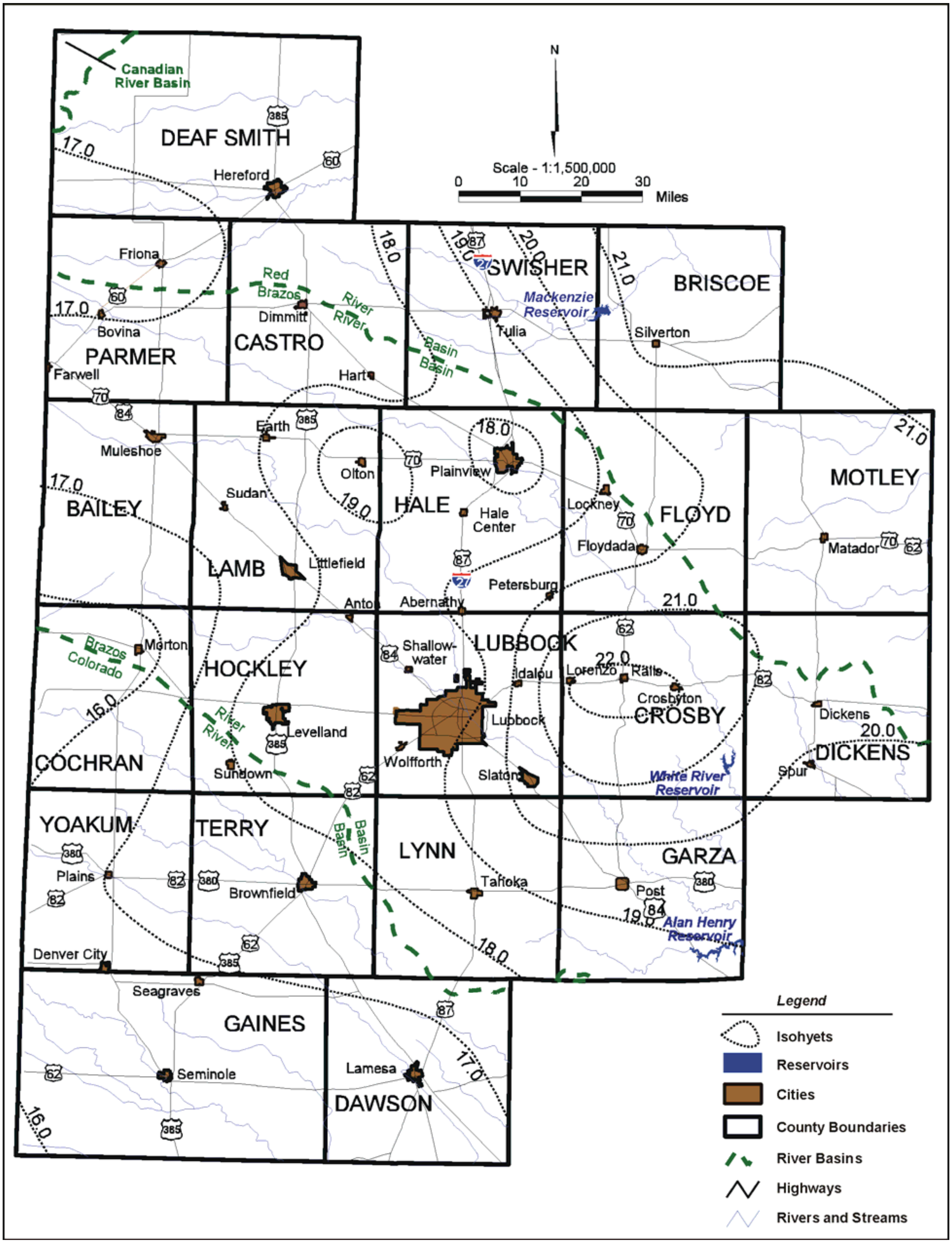

Figure 1-4. Average Annual Precipitation for the Llano Estacado Region (Inches per Year; 1945 to 1997)

of playas are modified with pits to recover rainfall runoff for irrigation or to create a water reserve for grazing livestock or wildlife when the bulk of the water collected in the basin from rainfall runoff has soaked into the soil or evaporated (Section 1.6.4)

1.2.4.2 Land Resources

About 57 percent of the 20,294 square miles of land area in the planning region is in cropland, one-third of which is irrigated. The major irrigated crops are cotton, corn, grain sorghum, wheat, vegetables, peanuts and soybeans. Winter cereals are used for stocker operations in preparation for feedlotting. Rangeland grazing, in the form of cow-calf and stocker operations, is carried out on about 38 percent of the area, with urban and other land uses constituting about 5 percent of the regional land area.

1.2.4.3 Wildlife Resources

Virtually all wildlife habitat in the High Plains is on privately-owned farm and ranchland. Quail and mourning dove are abundant, and whitetail deer, mule deer, turkey, and exotic aoudad sheep provide hunting along the breaks and canyons of the caprock. Pronghorn Antelope were once common, but now only remnant populations are present.[6] Many playa basins provide migratory waterfowl habitat, with as many as 2 million waterfowl and 350,000 to 400,000 sandhill cranes using playa lakes as wintering areas or as rest stops during annual migrations.[7] Pheasants are an economically important gamebird in irrigated areas, but their numbers tend to fluctuate widely with weather and habitat conditions.

In the region, approximately 25 wildlife species are listed by the Texas Parks and Wildlife Department as endangered, threatened, or just rare with no official listing (Appendix A).

1.3 Population and Demography

1.3.1 Historical and Recent Trends in Population

The area’s population has grown from 11,418 in 1900 to 453,997 in 2000 (Table 1-3 and Figure 1-5.)[8] From 1900 to 1920, the region experienced steady population growth as the large ranches that were predominant in the area, such as the XIT Ranch, and the railroads began to sell land to farmers. As ranchland was converted to row crops and small grains, the economy of the

[6] Information from High Plains Ogallala Area Regional Water Management Plan planning effort, 1996.
[7] Ibid.
[8] 2000 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 2001.

region broadened to an economy of broad based agribusiness, including the use of agricultural inputs from the non-farm manufacturing, trades and services sectors, including marketing and processing of agricultural commodities.

Table 1-3.
Population Growth (1900 to 2000)
Llano Estacado Region

Year	*Population*
1900	11,420
1910	47,020
1920	80,720
1930	206,020
1940	229,280
1950	309,330
1960	402,530
1970	408,580
1980	449,550
1990	438,490
2000	453,997

Source: U.S. Census Bureau.

As settlers moved to the area between 1920 and 1930, the population increased 154 percent. During the late 1920s, the number of farms peaked at 25,595; however, due to farm consolidation, the number has declined slightly almost every year since. In 2002, there were 11,691 farms in the region.[9,10]

Irrigation was introduced to the area about 1908. In the late 1940s, following World War II, an irrigated agricultural boom began, and during the period from 1940 to 1960, population growth was almost as high as the growth rate of the 1920s. It was during this period

[9] Inter-University Consortium for Political and Social Research Study 00003: Historical Demographic, Economic, and Social Data: U.S., 1790-1970.
[10] 2002 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 2002."

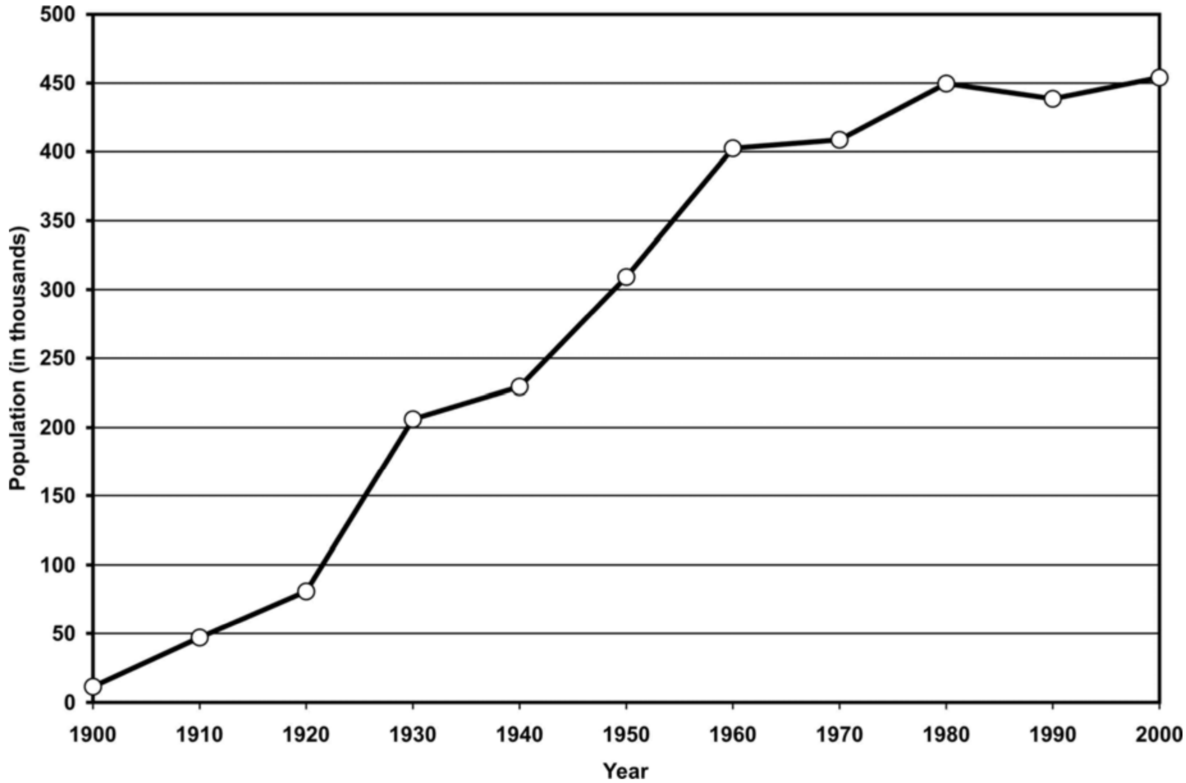

Figure 1-5. Population Growth (1900 to 2000)
Llano Estacado Region

that petroleum production was begun, particularly in the southern counties of the region. However, the region's population growth has leveled out since 1960 (Figure 1-5), with much of this slowdown in growth being attributed to the mechanization of agriculture, other improvements in farm technology, and a reduction in the petroleum and related work force.

Ten cities in the region have a population greater than 5,000 (Table 1-4). These larger urban areas constituted 64.3 percent of the region's 2000 population of 453,997. The majority of this urban population was in the City of Lubbock, which had a 2000 population of 199,564 persons.[11]

1.3.2 Demographic and Socioeconomic Characteristics

In terms of population density, Motley County was the least populated, with 1,426 residents, with 1.4 persons per square mile (Table 1-5). Lubbock County had the highest population density in the region, with 242,628 residents with 267.2 persons per square mile. The regional average population density is 22.3 persons per square mile (Table 1-5).

[11] Ibid.

Table 1-4.
Major Cities and Population (1990 and 2000)
Llano Estacado Region

City	County	1990 Population	1990 Percent of Region	2000 Population	2000 Percent of Region
Brownfield	Terry	9,560	2.2	9,488	2.1
Hereford	Deaf Smith	14,745	3.4	14,597	3.2
Lamesa	Dawson	10,809	2.5	9,952	2.2
Levelland	Hockley	13,986	3.2	12,866	2.8
Littlefield	Lamb	6,489	1.5	6,507	1.4
Lubbock	Lubbock	186,206	42.5	199,564	44.0
Plainview	Hale	21,700	5.0	22,336	4.9
Seminole	Gaines	6,342	1.4	5,910	1.3
Slaton	Lubbock	6,078	1.4	6,109	1.3
Tulia	Swisher	4,703	1.1	5,117	1.1
Total		**280,618**	**64.2**	**292,446**	**64.3**

Source: U.S. Census Bureau.

Table 1-5.
County Population and Area
Llano Estacado Region

County	Population[1] (2000)	Area[2] (sq. mi.)	Density[2] (sq. mi.)	County	Population[1] (2000)	Area[2] (sq. mi.)	Density[2] (sq. mi.)
Bailey	6,594	843	7.8	Hale	36,602	1,033	35.4
Briscoe	1,790	911	1.9	Hockley	22,716	914	24.8
Castro	8,285	911	9.1	Lamb	14,709	1,013	14.5
Cochran	3,730	776	4.8	Lubbock	242,628	908	267.2
Crosby	7,072	904	7.8	Lynn	6,550	893	7.3
Dawson	14,985	900	16.6	Motley	1,426	994	1.4
Deaf Smith	18,561	1,485	12.5	Parmer	10,016	854	11.7
Dickens	2,762	912	3.0	Swisher	8,378	915	9.2
Floyd	7,771	1,015	7.6	Terry	12,761	904	14.1
Gaines	14,467	1,507	9.6	Yoakum	7,322	798	9.2
Garza	4,872	904	5.4	**Total**	**453,997**	**20,294**	**22.3**

[1] U.S. Census Bureau.
[2] State of Texas General Land Office.

In 2000, the age distribution across the region was fairly uniform from county to county (Table 1-6.)[12] The two age groups that included the highest percentage of the population in 2000 were 5 to 14 years (16.4 percent), and age 60 and above (19.1 percent). The age group with the lowest percentage of the population in 2000 is the 55 to 59 years group (4.8 percent).

With respect to level of education, of those residents in the Llano Estacado Region who are 25 years of age or older, 65.6 percent have at least a high school diploma (State of Texas average is 75.7 percent), while only 12.7 percent have a college degree (State of Texas average is 23.2 percent) (Table 1-7).[13] The region's unemployment rate was 5.5 percent in 2003. Median income in 1999 was $28,993.[14]

1.4 Economy – Major Sectors and Industries

1.4.1 The Llano Estacado Region's Economy

The region's economic base is agriculture, with significant contributions from manufacturing, oil and gas, and trades and services, such as wholesale and retail trade, and finance, insurance, legal, business, advertising, medical, personal, research, entertainment, repair services, and higher education. Agricultural processing, oilfield equipment and electronics form the core of the region's manufacturing base. Beef cattle and cotton are the dominant agricultural enterprises, although vegetables and oilseed crops are significant contributors to the region's economy. Statistics for the major economic sectors are presented below.

The interests of small business in the region is the same as agricultural interests, since without agriculture, the area would never have been developed and would most likely not be very populated today.

1.4.2 Crop Production

According to the 2002 (most recent) Census of Agriculture, all crops grown in the Llano Estacado Region had a combined market value of over $905 million in 2002.[15] Due to the arid climate, limited water, and length of growing season, the region can only grow certain crops. The major crops grown are cotton, grain sorghum, wheat, corn, soybeans, and peanuts (Table 1-8).

[12] 2000 U.S. Census of Population and Housing, U.S. Department of Commerce, Washington, D.C., 2001.
[13] Ibid.
[14] Texas Workforce Commission.
[15] 2002 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 2002."

Table 1-6.
Age Distribution of the Population in 2000
Llano Estacado Region

County	Total Population (2000)	Age Distribution (values are percent of population)								
		0 - 4	5 - 14	15 - 19	20 - 24	25 - 34	35 - 44	45 - 54	55 - 59	60 +
Bailey	6,594	8.1	16.9	8.6	5.4	11.3	13.5	12.0	4.9	19.5
Briscoe	1,790	6.4	15.7	7.9	3.9	9.2	12.8	14.1	5.3	24.7
Castro	8,285	8.5	18.4	9.5	5.7	10.9	13.4	12.4	4.8	16.4
Cochran	3,730	6.5	17.9	10.6	4.6	10.4	14.5	10.9	4.8	20.0
Crosby	7,072	7.8	17.5	8.3	5.7	11.6	12.4	11.1	5.7	20.1
Dawson	14,985	6.3	14.2	7.7	6.3	14.6	16.2	12.6	4.2	17.9
Deaf Smith	18,561	9.0	18.8	8.7	6.5	12.5	13.0	11.4	4.1	16.0
Dickens	2,762	4.2	10.3	5.6	8.8	14.9	14.8	11.9	5.4	24.0
Floyd	7,771	8.2	17.5	8.3	4.8	11.5	12.9	11.5	4.9	20.4
Gaines	14,467	8.4	20.0	10.1	6.1	11.7	15.0	10.8	4.0	14.0
Garza	4,872	6.5	16.5	7.6	5.3	13.9	14.7	12.0	4.7	18.7
Hale	36,602	8.3	16.7	9.2	7.4	12.9	14.3	10.4	4.3	16.4
Hockley	22,716	7.2	16.1	10.4	7.2	11.1	14.8	12.0	4.7	16.7
Lamb	14,709	7.4	16.2	8.8	5.3	10.8	13.4	11.3	4.8	22.1
Lubbock	242,628	7.2	14.1	9.0	11.7	13.8	14.0	11.7	4.1	14.4
Lynn	6,550	7.3	17.9	9.1	4.8	10.7	15.3	11.2	5.0	18.8
Motley	1,426	5.9	12.9	7.2	4.1	8.0	13.1	12.8	6.9	29.1
Parmer	10,016	8.6	18.6	9.0	5.2	12.2	14.0	11.1	4.5	16.7
Swisher	8,378	7.4	15.4	8.3	7.1	12.5	13.0	11.0	4.8	20.4
Terry	12,761	7.3	15.6	8.5	6.4	12.2	14.8	11.7	4.9	18.7
Yoakum	7,322	7.5	17.8	10.2	4.9	10.7	16.1	12.7	4.7	15.4
Region Totals	**453,997**	**7.3**	**16.4**	**8.7**	**6.1**	**11.8**	**14.1**	**11.7**	**4.8**	**19.1**
State Totals	**20,851,820**	**7.8**	**15.7**	**7.8**	**7.4**	**15.2**	**15.9**	**12.5**	**4.3**	**13.3**

Source: 2000 U.S. Census, U.S. Department of Commerce, Washington, D.C., data released in 2001.

Table 1-7.
Summary of Selected Socioeconomic Indicators (2000 and 2003)
Llano Estacado Region

County	*High School Graduates (% of Population) (2000)*[1]	*College Graduates (% of Population) (2000)*[1]	*Civilian Labor Force (2003)*[2]	*Unemployment Rate (2003)*[2]	*Median Household Income (1999)*[1]
Bailey	61.5	9.3	3,813	5.5	$27,901
Briscoe	74.8	17.5	711	4.8	$29,917
Castro	65.4	14.7	3,319	5.2	$30,619
Cochran	62.7	10.2	1,426	10.4	$27,525
Crosby	61.8	10.5	2,928	6.9	$25,769
Dawson	65.2	10.5	5,805	6.5	$28,211
Deaf Smith	60.9	11.8	6,941	6.0	$29,601
Dickens	70.6	8.4	835	4.9	$25,898
Floyd	63.5	12.3	3,123	9.0	$26,851
Gaines	56.2	10.5	6,959	4.3	$30,432
Garza	70.1	10.0	2,459	4.7	$27,206
Hale	65.9	14.4	17,162	6.4	$31,280
Hockley	68.2	13.6	11,493	4.5	$31,085
Lamb	63.7	11.1	6,854	6.2	$27,898
Lubbock	78.4	24.4	130,645	3.6	$32,198
Lynn	61.9	13.4	2,777	5.3	$26,694
Motley	73.5	14.7	637	1.7	$28,348
Parmer	60.7	13.4	4,590	3.0	$30,813
Swisher	69.7	16.2	3,582	4.7	$29,846
Terry	62.5	9.5	5,402	6.9	$28,090
Yoakum	59.4	10.2	3,035	5.0	$32,672
Region Totals	**65.6**	**12.7**	**224,496**	**5.5**	**$28,993**
State Totals	**75.7**	**23.2**	**10,910,344**	**6.8**	**$39,927**

[1] 2000 U.S. Census, U.S. Department of Commerce, Washington, D.C.
[2] Texas Workforce Commission.

Table 1-8.
Summary of Crop Production Data (2002)
Llano Estacado Region

County	*Selected Crops Harvested* Corn (bushels)	Grain Sorghum (bushels)	Wheat (bushels)	Cotton (bales)	Soybeans (bushels)	Peanuts (lbs.)	Hay, alfalfa, other (tons)
Bailey	648,745	1,292,665	659,917	61,424	15,518	2,093,990	28,815
Briscoe	0	239,423	203,319	27,362	0	4,730,036	13,669
Castro	9,656,813	733,863	2,137,504	160,805	18,836	0	57,415
Cochran	0	903,940	130,280	125,453	0	28,832,540	8,729
Crosby	0	318,472	148,401	165,694	(D)	1,920,100	7,937
Dawson	0	1,292,894	91,072	177,518	0	39,196,036	16,309
Deaf Smith	2,670,395	2,134,541	1,963,899	60,534	151,270	0	40,358
Dickens	0	16,104	274,161	16,800	(D)	(D)	19,444
Floyd	616,318	2,482,434	825,836	144,294	168,558	(D)	17,492
Gaines	(D)	660,415	764,646	213,496	0	223,268,372	47,023
Garza	0	(D)	6,405	28,705	0	0	3,545
Hale	2,394,156	2,671,515	821,263	356,457	175,641	1,991,667	27,603
Hockley	0	1,173,237	128,299	192,393	(D)	34,908,075	20,182
Lamb	3,892,802	1,060,514	589,275	320,516	5,985	10,970,149	70,129
Lubbock	52,960	1,352,517	140,713	257,212	32,504	2,769,506	21,680
Lynn	(D)	177,635	135,230	202,861	0	3,122,030	8,658
Motley	0	3,875	49,465	10,099	0	4,489,906	13,774
Parmer	5,326,270	1,746,937	1,737,053	169,482	23,456	0	41,274
Swisher	988,558	826,777	818,606	111,729	41,660	0	16,772
Terry	37,843	463,302	143,063	168,701	(D)	89,891,674	17,410
Yoakum	(D)	496,197	344,281	88,389	0	58,029,818	19,784
Region Total[1]	**26,284,860**	**20,047,257**	**12,112,688**	**3,059,924**	**633,428**	**506,213,899**	**518,002**
State Total	**197,109,321**	**114,127,221**	**75,131,556**	**5,060,144**	**5,415,147**	**807,510,593**	**11,407,323**

[1] Total does not include data that was withheld for individual producers; see (D) below.
(D) – Withheld to avoid disclosing data for individual producers.

Source: 2002 Census of Agriculture, Volume 1 Geographic Area Series, “Table 1. County Summary Highlights: 2002,” except where noted.

Cotton, a somewhat drought tolerant plant, is the leading crop of the region. In 2000, the calculated value of cotton production was about $755 million.[16]

In the Llano Estacado Region there has been an increase in acres planted to grain sorghum, grain sorghum yields, and use of grain sorghum during the past 60 years. At present, the region produces 18 percent of the state's grain sorghum, or approximately 20 million bushels per year. In 2000, value of grain sorghum production in the area was calculated at approximately $36 million.[17]

Approximately 13 percent of the state's corn crop (26 million bushels) is grown in the Llano Estacado Region.[18] Corn contributes approximately $57 million annually to the region's economy, second only to cotton.

In 2000, 633,428 bushels of soybeans with a calculated value of $2.8 million were grown in the Llano Estacado Region.[19] Soybeans are frequently planted in the region as a "recovery" cash crop if hail destroys cotton; however, soybean production requires irrigation, since soybeans are not a dryland crop.

Peanut production is relatively new to the Llano Estacado Region, with peanut production having become a valuable crop for the region during the past 20 years. The Western Peanut Growers Association reports that the area now produces about 75 percent of the state's peanut crop. The value of peanut production is the Region was calculated at $115 million for 2000.[20]

1.4.2.1 Irrigated Crops

In the semi-arid Llano Estacado Region, irrigation from groundwater is used to supplement precipitation to increase crop yields, with the level of irrigation being determined by the quantities of precipitation received during the season. During wetter years, less irrigation water needs to be pumped from the aquifer than during drought years. During periods of severe

[16] Calculated using the production value from Table 1-8 times the reported year 2000 price of $0.514/lb from "Crop Values, 2000 Summary," published by USDA in February 2001. Also assumes a bale equals 480 lbs.
[17] Calculated using the production value from Table 1-8 times the reported year 2000 price of $1.80/bushel from "Crop Values, 2000 Summary," published by USDA in February 2001.
[18] Calculated using the production value from Table 1-8 times the reported year 2000 price of $2.15/bushel from "Crop Values, 2000 Summary," published by USDA in February 2001.
[19] Calculated using the production value from Table 1-8 times the reported year 2000 price of $4.35/bushel from "Crop Values, 2000 Summary," published by USDA in February 2001.
[20] Calculated using the production value from Table 1-8 times the reported year 2000 price of $0.227/lb from "Crop Values, 2000 Summary," published by USDA in February 2001.

drought, such as 1998, only irrigated crops produce “harvestable” yields. The 2002 Census of Agriculture indicates that while irrigated lands comprise about 2.5 million acres (33 percent) of the cropland in the region, irrigation is responsible for $679 million in value of farm sales, or about 75 percent of the value of major crop production.

When irrigation was begun in the 1940s, and for more than two decades, little thought was given to irrigation water use efficiency. However, at the present time, the Llano Estacado Region leads the world in adoption and use of highly efficient water use technology, and as new technology becomes available, it is adopted as rapidly as economics allow. In fact, the region has developed better and better water conservation methods and equipment, and in some cases, individual farmers have built prototypes of equipment that have been produced and sold by specialized manufacturers.

In the Llano Estacado Region, drought planning is a way of life as opposed to being a contingency plan. Farmers are always aware of how precious water is, and they work hard to use every drop of precipitation they receive, while saving the groundwater supply for use when precipitation is not adequate to grow crops.

1.4.2.2 Dryland Crops

Dryland farming produces crops without irrigation using only the precipitation provided by nature. Approximately 75 percent of the average annual precipitation, or about 13.8 inches, occurs during the summer crop growing season, which is from May through September. Maximum conservation of this precipitation is the key to producing acceptable crop yields. This is accomplished by holding the rainfall, which often falls in high intensity, short duration precipitation events, in place until it has time to soak into the soil. Methods that are effective at holding rainfall on the soil include bench leveling, parallel terraces, contour farming, furrow dikes, deep chiseling, and crop residue management. Minimum tillage using chemicals to control weeds instead of plowing also conserves moisture, since plowing provides an opportunity for moisture to evaporate when moist soil is turned to the surface.

Crops produced by the dryland farming method include cotton, wheat, rye, and grain sorghum. According to the 2002 Census of Agriculture, approximately 5.1 million acres (67 percent) of the Llano Estacado Region’s total cropland was dryland farmed. The value of production from dryland farming in the region was $226 million in 2002, or about 25 percent of the value of farm sales in the region.

1.4.3 Livestock Production

Total livestock water use in 2000 accounted for 0.83 percent of the water used in the Llano Estacado Region in 2000. Major types of livestock produced in the area include fed cattle, range cattle, milk cows, swine, and sheep. The largest classification of livestock in the area is cattle and calves, which includes feedlot livestock, followed by beef cows and sheep and lambs. The most recent information available about cattle feedlots in the Llano Estacado Region is from a Southwestern Public Service Company, Amarillo, Texas, survey in 1998, provided by the Texas Cattle Feeders Association. The survey indicates that the one-time feedlot capacity in 1997 was 1.69 million head (Table 1-9).

1.4.3.1 Beef Cows

Beef cows, which include any cow kept primarily for calf production, make up 5.4 percent of the total livestock in the Llano Estacado Region. In 2002, there were approximately 122,350 beef cows in the region, which is 2.2 percent of the state's total beef cow population. In 1997, the latest year for which estimates are available, these cows had a market value of $46 million—or 1.8 percent of the total market value for all livestock in the region.[21] The leading counties in beef cow production are Deaf Smith, Castro, and Dickens (Table 1-9).

1.4.3.2 Feedlot Livestock

During the last 25 to 30 years, the South Plains of Texas observed the development and growth of the confined feeding of cattle industry to finish weights before slaughter. In the early years of development, feedlots were built and operated by individual ranchers to add value to their own cattle. During the 1960s, feedlot operators expanded the size and numbers of feedlots, and began feeding cattle for others (custom feeding). This procedure opened a new market for ranchers across the region—they could now have their own cattle custom-fed in a custom cattle feedlot. Farmers saw immediate grain marketing benefits from the establishment of feedlots in the Llano Estacado Region.

Fed cattle marketings in Texas during the 1960s increased from 477,000 head in 1960 to 2.7 million in 1969, a 467 percent growth rate as new capital flowed into the industry and many

[21] 1997 Census of Agriculture, Volume 1 Geographic Area Series, "Table 14. Cattle and Calves - Inventory and Sales: 1997 and 1992."

Table 1-9.
Summary of Livestock Production Data (2002)[1]
Llano Estacado Region

County	Livestock and Poultry						
	Feedlot Capacity[2] (number)	Cattle & Calves[3] (number)	Beef Cows (number)	Milk Cows (number)	Swine (Hogs & Pigs) (number)	Sheep & Lambs (number)	Layers & Pullets (number)
Bailey	68,000	80,544	5,220	5,130	242	236	0
Briscoe	0	19,471	10,824	0	208	0	75
Castro	325,000	365,792	16,601	1,403	653	20,277	(D)
Cochran	36,000	7,659	4,354	0	(D)	(D)	30
Crosby	0	10,951	6,334	0	64	96	(D)
Dawson	0	5,204	3,004	0	85	89	60
Deaf Smith	467,000	527,338	16,632	8,000	65	505	283
Dickens	0	26,170	16,083	0	14	551	200
Floyd	35,000	79,644	8,807	0	90	727	(D)
Gaines	35,000	36,490	5,430	0	17	329	229
Garza	0	10,651	6,506	0	11	(D)	45
Hale	83,000	93,924	(D)	(D)	376	627	586
Hockley	16,000	33,209	(D)	(D)	293	374	534
Lamb	104,000	118,499	6,895	8,561	302	4,436	(D)
Lubbock	48,000	46,795	6,502	91	1,444	1,285	(D)
Lynn	0	3,742	(D)	(D)	309	133	442
Motley	0	21,810	(D)	(D)	60	0	0
Parmer	303,800	354,035	9,158	4,055	(D)	94	96
Swisher	170,000	219,539	(D)	(D)	76	564	261
Terry	0	7,823	(D)	(D)	315	(D)	823
Yoakum	0	16,473	(D)	(D)	122	(D)	0
Total [4]	**1,691,100**	**2,085,763**	**122,350**	**27,149**	**4,747**	**30,323**	**3,664**

1 Source: 2002 Census of Agriculture, Volume 1 Geographic Area Series, "Table 1. County Summary Highlights: 2002" except where noted.
2 Source: Bilbrey, D., B. Holland, & G. Boggs, "Cattle Feeding Capital of the World: 1998 fed Cattle Survey," Southwestern Public Service Company, Amarillo, Texas, 1998, most recent information provided by Texas Cattle Feeders Association.
3 "Cattle and calves" includes feedlot cattle.
4 Total does not include data that was withheld for individual producers; see (D) below.
(D) – Withheld to avoid disclosing data for individual producers.

new feedlots were built. During the 1970s, fed cattle marketings grew to 4.9 million head. The more modest 82 percent growth rate reflected the “market crash” of 1973 to 1974 that led to fewer new feedlots and slowed expansion of existing feedlots. During the 1980s, fed cattle marketings peaked at 5.3 million head in 1986, reflecting a 26 percent growth rate for the decade. Industry expansion resulted during the 1980s was predominantly from expansion of existing feedlots. During the decade of the 1990s, the Texas feedlot industry matured with a 12 percent growth rate and marketings of 6.06 million head in 1998—resulting primarily from expansion of the 142 feedlots. Of the 142 feedlots in the state of Texas in 1998, almost 50 percent of them were located in the Llano Estacado Region. In 1998, the cattle feedlots in the Llano Estacado Region marketed over 3.39 million head of fed cattle from 69 feedlots located across the 21 counties in the region.

1.4.3.3 Dairies

In 2002, there were approximately 27,149 head of milk cows in Bailey, Briscoe, Castro, Deaf Smith, Floyd, Hale, Lamb, Parmer, and Swisher Counties, with projections that dairies would expand into Cochran and Terry Counties in the near future (Table 1-9). (The estimated number of dairy cattle in the region in 2005 is about 175,000). In 2005, the Southwest Plains Dairy Directory and Reference Guide showed 43 dairies located within the Llano Estacado Region. The dairy industry is projected to grow to a total of about 91,300 head of milk cows in 2010, and to level off at about 166,350 head by 2020, remaining constant at 166,350 through 2060 (Table 2-11). Value of dairy production in the region in 2002 was reported at $54.9 million.

1.4.4 Oil and Gas

In the Llano Estacado Region, most of the oil and gas production activity is concentrated in the southern counties. Gaines County is the leading oil and gas-producing county in the region (Table 1-10).

Oil reservoirs are developed by drilling wells into the production zones of the oil-bearing formations; and as primary production approaches its economic limit, perhaps only a few percent and no more than about 25 percent of the crude oil will have been withdrawn from a given reservoir. In response to this, the oil industry has developed methods collectively known as enhanced recovery, which can increase the percentage of recoverable crude oil. In this way, the production of crude oil can be increased to over 50 percent of the original oil in the formation.

Table 1-10.
Summary of Oil and Gas Production (2003)
Llano Estacado Region

County	***Oil (bbl)***	***Condensate (bbl)***	***Casinghead Gas (mcf)***	***Gas Well Gas (mcf)***
Bailey	0	0	0	0
Briscoe	0	0	0	0
Castro	0	0	0	0
Cochran	4,044,555	1,904	3,370,119	283,471
Crosby	593,240	0	81,639	0
Dawson	5,262,123	0	6,053,124	0
Deaf Smith	0	0	0	0
Dickens	1,607,398	0	120,132	0
Floyd	1,646	0	0	0
Gaines	30,451,729	5,239	47,332,845	11,809,786
Garza	4,757,732	0	1,016,625	0
Hale	3,490,243	0	163,384	0
Hockley	21,685,595	2,410	43,802,333	145,989
Lamb	1,696,376	0	142,098	0
Lubbock	1,613,196	0	67,260	0
Lynn	178,963	0	54,193	0
Motley	60,860	0	86	0
Parmer	0	0	0	0
Swisher	0	0	0	0
Terry	4,699,377	0	1,796,709	402,732
Yoakum	24,830,689	0	110,297,716	1,188,995
Total	**104,973,722**	**9,553**	**214,298,263**	**13,830,973**

Source: The Railroad Commission of Texas.

Two methods of enhanced oil recovery are in use within the region at this time: water injection and carbon dioxide injection. Water injection, or water flooding, is a process of recycling water through the formation to force the oil out. In the region, some 90 percent of the injected water volumes are recycled water.

Natural gas almost always occurs in connection with oil deposits in the Llano Estacado Region and is brought to the surface with the oil when an oil well is produced. Such gas, called casinghead gas, contains valuable organic elements that are important raw materials of the natural gasoline and chemical industries. Before natural gas is used as fuel, heavy hydrocarbons such as butane and propane are extracted as liquids. The remaining gas constitutes so-called dry gas, which is piped to domestic and industrial consumers for use as fuels. Composed of the lighter hydrocarbons, methane and ethane, dry gas is also used in the manufacture of plastics, drugs, and dyes.

1.4.5 Manufacturing

In 1997, the region's 342 manufacturing establishments contributed over $2 billion to the region's economy in value of shipments and provided over 9,000 jobs with an annual payroll of over $249 million (Table 1-11).[22] The leading types of manufacturing plants in the region were food and kindred products, agricultural and industrial machinery and equipment, printing and publishing, and fabricated metal products.[23]

1.4.6 Wholesale Trade

The wholesale trade classification includes durable goods such as motor vehicles, furniture and home furnishings, lumber and construction materials, electrical goods and non-durable goods such as farm products, chemicals and allied products, and petroleum and petroleum products. The region's 927 wholesale trade establishments contributed over $5.2 billion to the region's economy in value of shipments and provided over 9,400 jobs with an annual payroll of over $249 million in 1997 (Table 1-12).[24] The leading area of wholesale trade within the Llano Estacado Region is non-durable goods.[25]

[22] Data for 1997 are the most recent data available.
[23] 1997 County Business Pattern, U.S. Department of Commerce, Washington, D.C., 1998.
[24] Data for 1997 are the most recent data available.
[25] 1997 County Business Patterns, U.S. Department of Commerce, Washington, D.C., 1998.

Table 1-11.
Summary of Manufacturing Activity (1997)
Llano Estacado Region

County	***Total Number of Establishments***	***Total Number of Employees***	***Annual Payroll (million dollars)***	***Value of Shipments (million dollars)***
Bailey	0	0	0	0
Briscoe	0	0	0	0
Castro	0	0	0	0
Cochran	0	0	0	0
Crosby	0	0	0	0
Dawson	0	0	0	0
Deaf Smith	32	1,128	28.9	376.7
Dickens	0	0	0	0
Floyd	0	0	0	0
Gaines	0	0	0	0
Garza	0	0	0	0
Hale	32	(D)	(D)	(D)
Hockley	0	0	0	0
Lamb	14	678	16.7	123.6
Lubbock	258	7,286	203.8	1,566.4
Lynn	0	0	0	0
Motley	0	0	0	0
Parmer	6	(D)	(D)	(D)
Swisher	0	0	0	0
Terry	0	0	0	0
Yoakum	0	0	0	0
Region Total	**342**	**9,092+(D)**	**249.4+(D)**	**2,066.7+(D)**
State Total	**21,808**	**959,665**	**32,760.8**	**297,657.0**

(D) – Withheld to avoid disclosing data for individual firms.

Source: 1997 Census of Manufacturers.

Table 1-12.
Wholesale Trade (1997)
Llano Estacado Region

County	*Total Number of Establishments*	*Total Number of Employees*	*Annual Payroll (million dollars)*	*Value of Shipments (million dollars)*
Bailey	20	203	4.3	112.1
Briscoe	6	(D)	(D)	(D)
Castro	20	(D)	(D)	(D)
Cochran	7	26	0.5	7.9
Crosby	12	171	4.8	65.4
Dawson	25	122	2.8	91.3
Deaf Smith	46	368	10.0	120.8
Dickens	1	(D)	(D)	(D)
Floyd	19	181	2.7	58.0
Gaines	22	182	5.2	135.6
Garza	8	32	0.8	18.7
Hale	74	540	13.3	294.4
Hockley	40	255	6.3	81.5
Lamb	25	146	3.1	72.6
Lubbock	505	6,628	181.2	3,867.8
Lynn	7	(D)	(D)	(D)
Motley	3	24	0.4	2.4
Parmer	28	186	4.1	122.0
Swisher	15	94	2.1	42.2
Terry	22	216	5.2	108.6
Yoakum	22	119	2.9	73.4
Region Total	**927**	**9,493+(D)**	**249.7+(D)**	**5,274.7+(D)**
State Total	**33,346**	**425,750**	**15,504.9**	**323,111.7**

(D) - Withheld to avoid disclosing data for individual firms.

Source: 1997 Economic Census, U.S. Department of Commerce, Washington, D.C., 1999.

1.4.7 Retail Trade

The retail trade classification includes building materials and garden supplies, general merchandise stores, food stores, automotive dealers and service stations, apparel and accessory stores, furniture and home furnishing stores, household appliance stores, restaurants, and retail stores. The region's 2,026 retail trade establishments contributed over $3.9 billion to the region's economy in value of shipments and provided over 21,000 jobs with an annual payroll of over $340 million in 1997 (Table 1-13).[26] The leading areas of retail trade within the Llano Estacado Region are restaurants, food stores, automotive dealers and service stations, and general merchandise stores.[27]

1.4.8 Services

The services group of businesses includes hotels and motels, personal services, photographic studios, beauty shops, barber shops, shoe repair, funeral services, business services, credit reporting, services to buildings, personnel supply services, computer services, auto repair, automobile parking, motion pictures, amusement services, commercial sports, health services, legal services, educational services, social services, membership organizations, engineering services, accounting services, research services, and management services. The region's 3,790 services establishments contributed over $2.4 billion to the region's economy in sales or receipts and provided over 44,000 jobs with an annual payroll of over $900 million in 1997 (Table 1-14).[28] The leading areas of services within the Llano Estacado Region are health services, business services, social services, and membership organizations.[29]

1.4.9 Finance, Insurance, and Real Estate

The finance, insurance and real estate classification includes banks, savings and loans, non-depository institutions, security and commodity brokers, insurance carriers, insurance agents, brokers and services, real estate, and holding and other investment offices. The region's 1,107 finance, insurance, and real estate establishments provided over 7,200 jobs with an annual payroll of over $180 million in 1997 (Table 1-15).[30]

[26] Data for 1997 are the most recent data available.
[27] 1997 County Business Patterns, U.S. Department of Commerce, Washington, D.C., 1998.
[28] Data for 1997 are the most recent data available.
[29] 1997 County Business Patterns, U.S. Department of Commerce, Washington, D.C., 1998.
[30] Data for finance, insurance, and real estate were not reported on a county level for the 1997 Economic Census, therefore, the data are from 1997 County Business Patterns conducted by the U.S. Bureau of the Census.

Table 1-13.
Retail Trade (1997)
Llano Estacado Region

County	***Total Number of Establishments***	***Total Number of Employees***	***Annual Payroll (million dollars)***	***Value of Shipments (million dollars)***
Bailey	36	271	3.1	33.9
Briscoe	9	29	0.3	4.3
Castro	41	208	3.2	47.7
Cochran	15	87	1.5	15.6
Crosby	33	226	3.2	41.8
Dawson	68	553	8.6	95.8
Deaf Smith	88	595	8.9	113.9
Dickens	12	54	0.5	7.4
Floyd	32	206	3.2	47.7
Gaines	62	470	7.4	88.9
Garza	29	123	1.5	18.3
Hale	164	1,566	23.6	264.7
Hockley	86	725	11.3	150.6
Lamb	63	450	5.9	75.4
Lubbock	1,084	14,538	238.0	2,673.0
Lynn	24	122	2.1	30.6
Motley	11	37	0.5	6.1
Parmer	42	279	3.8	48.3
Swisher	39	255	3.2	41.2
Terry	46	458	7.3	81.3
Yoakum	42	246	3.2	34.0
Region Total	**2,026**	**21,498**	**340.3**	**3,920.5**
State Total	**74,105**	**950,848**	**16,197.1**	**182,516.1**

Source: 1997 Economic Census, U.S. Department of Commerce, Washington, D.C., 1999.

Table 1-14.
Services (1997)
Llano Estacado Region

County	***Total Number of Establishments***	***Total Number of Employees***	***Annual Payroll (million dollars)***	***Value of Receipts (million dollars)***
Bailey	63	383	5.2	6.4
Briscoe	12	50	0.1	0.4
Castro	53	366	6.9	8.9
Cochran	19	174	2.9	0.8
Crosby	37	250	3.5	2.7
Dawson	103	684	11.0	27.0
Deaf Smith	128	1,210	17.0	23.3
Dickens	14	87	4.3	3.2
Floyd	48	350	5.5	11.3
Gaines	88	682	11.5	19.0
Garza	32	190	2.0	5.9
Hale	280	2,944	47.3	81.9
Hockley	131	1,836	23.6	44.6
Lamb	90	537	8.1	10.8
Lubbock	2,399	33,263	731.7	2,161.5
Lynn	33	234	2.7	3.3
Motley	12	33	0.4	0.4
Parmer	61	278	4.4	7.5
Swisher	52	333	4.7	6.3
Terry	84	672	11.4	27.3
Yoakum	51	257	4.8	5.6
Region Total	**3,790**	**44,813**	**909.0**	**2,458.1**
State Total	**171,136**	**2,555,781**	**67,426.9**	**2,621,441.0**

Source: 1997 Economic Census, U.S. Department of Commerce, Washington, D.C., 1998 and 1997 County Business Patterns.

Table 1-15.
Finance, Insurance, and Real Estate (1997)
Llano Estacado Region

County	*Total Number of Establishments*	*Total Number of Employees*	*Annual Payroll (million dollars)*
Bailey	11	73	1.8
Briscoe	6	33	0.9
Castro	22	118	2.8
Cochran	4	29	0.9
Crosby	20	129	3.1
Dawson	31	225	4.9
Deaf Smith	33	125	(D)
Dickens	9	27	0.7
Floyd	22	75	1.5
Gaines	22	131	3.1
Garza	12	53	0.8
Hale	85	435	9.8
Hockley	47	214	5.0
Lamb	33	162	3.4
Lubbock	664	4,979	132.1
Lynn	13	72	2.2
Motley	3	10	(D)
Parmer	14	128	2.6
Swisher	19	50	(D)
Terry	23	129	3.3
Yoakum	14	50	1.3
Region Total	**1,107**	**7,247**	**180.2**

(D) - Withheld to avoid disclosing data for individual firms.

Source: Bureau of the Census, U.S. Department of Commerce, Washington, D.C., 1998.

1.4.10 Recreation

Most of the area's revenue derived from recreation opportunities comes from spending on hunting and fishing. Based on 1985 data from the U.S. Fish and Wildlife Service, adjusted for inflation in a 1989 report by Comptroller Bob Bullock, hunters spent $48.2 million in the High Plains in 1989 on food, lodging, leases, equipment and other trip-related expenses. This equates to an average of $832 per hunter. Spending on fishing in the High Plains region was reported at $32.3 million in 1989, or an average of $736 per angler. Using a 3 percent rate of inflation (factor of 1.5579), spending on hunting in 2004 is projected to be $75.1 million, while spending on fishing would be $50.3 million, for a total projected recreation spending of $125.4 million.

While hunting and fishing will probably remain a substantial part of the outdoor recreation picture, the activity of ecotourism has been growing rapidly in the region since 1980. Ecotourism is defined as discretionary travel to natural areas that conserve the environmental, social and cultural values while generating an economic benefit to the local community. Ecotourists engage in activities including bird watching, wildlife viewing, hiking, rock climbing, backpacking, camping, and outdoor photography. This activity is expected to increase within the Llano Estacado Region in the future, especially where water is available to attract wildlife. Also, landowners can increase opportunities to attract hunters and ecotourists at fairly low cost and little effort.

1.5 Water Use

There are seven major types of water use in the Llano Estacado Region: (1) municipal; (2) manufacturing; (3) steam-electric power generation; (4) mining; (5) irrigation; (6) livestock (feedlots and range); and (7) environmental and recreation. Each of these types of water use is described below. Projections of demand for each type of use are shown in Section 2, Tables 2-4 through 2-19.

1.5.1 Municipal Water Use

Municipal water use, as defined by the TWDB, includes water used for residential and commercial purposes. Residential water use includes water for drinking, cooking, bathing, flushing toilets, general cleaning and sanitation, swimming pools, car washing, gardening, and lawn watering. A 1984 U.S. Department of Housing and Urban Development study found that toilet flushing (39 percent) and bathing (30 percent) are the largest components of inside household use. Outside household use ranges from near zero in humid areas to 60 percent of total domestic use in arid areas.

The TWDB municipal water use definition also includes water used by commercial facilities such as hotels, restaurants, laundries, car washes, office buildings, educational institutions, prisons, government and military facilities, retail establishments, public swimming pools, fire protection, and irrigation of public parks and open spaces. In the Llano Estacado Region, per capita municipal water use in 2000 was about 172 gallons (87,322 acft ÷ 453,997 people x 325,851 ÷ 365) (Tables 2-2 and 2-4).

Effective January 1, 1992, the Water-Efficient Plumbing Standards Act of the 73rd Texas Legislature required that certain plumbing fixtures (toilets, showerheads, and faucet aerators) sold after that date be water-efficient devices. In addition, the Federal Energy Policy Act of 1992 required that all new toilets produced for home use must operate on 1.6 gallons per flush or less. Older toilets used 3.5 to 5 gallons or more of water per flush. Other low-flow plumbing fixtures include low-flow showerheads that use 2.5 gallons per minute (gpm) instead of the standard 4.5 gpm and faucet aerators that can be installed in sinks to reduce water use. Water-conserving dishwashers and washing machines are also available, although they are still much more expensive to buy than other appliances. As these water conserving fixtures and appliances are adopted, it is reasonable to assume a decreased per capita water use within the Llano Estacado Region in future years.

Outside of the home, landscaping that includes directing the water which runs off the roof, sidewalks and driveways onto the lawn, garden, trees and shrubs when it rains can reduce irrigation water demand. Borders can be built around yards, flower beds and gardens to hold their rainfall runoff until it soaks into the soil. Additionally, if mulch is used on the soil surfaces in the garden, flowerbeds, and around shrubs and trees to reduce evaporation from the soil surface, the rainfall harvested plus this conservation effort can reduce outside of the home water use by 50 percent or more.

1.5.2 Manufacturing Water Use

Water is used in a variety of ways for manufacturing purposes, including process uses (water used in the manufacture of products), cooling of portions of the manufacturing process, wash-down water for cleaning, water for employee drinking purposes, sanitary uses in restrooms, and landscape irrigation. The amount of water used for each purpose is usually particular to the type of industry. In the Llano Estacado Region, the major manufacturing uses of water are for food processing, industrial machinery and equipment, and fabricated metal products.

In response to the high costs to treat and dispose of wastewater, rising energy costs, and environmental considerations, industries use water more efficiently now than they did in the past. Some specific areas where savings are taking place are process modification or substitution, cooling water recycling and reuse, and steam and hot water conservation. Methods used in manufacturing to conserve cooling water may include use of saline water or treated wastewater, air cooling, and using recirculating cooling systems. Methods used to conserve water used for steam and hot water manufacturing processes include energy conservation and waste heat recovery.

1.5.3 Steam-Electric Power Water Use

A steam-electric plant basically works by heating water in a boiler until it is turned into steam. The steam is used to turn the turbine-generator, which produces electricity, after which the steam is sent to the condenser to be cooled back into water. Most of the water used in steam-electric power generation is to cool the steam back into water. The condensed water is pumped back to the steam generator to become steam again, while the cooling water is discharged as wastewater or is recycled through cooling ponds or towers. Within a steam-electric plant, water is also used for make-up water to replace the water lost as steam, blowdown (purging) of boilers, washing of stacks, and plant and employee sanitation. In the Llano Estacado Region, steam-electric power generation is done in Lamb, Lubbock, and Yoakum Counties.

Steam-electric power generation closely resembles manufacturing uses of water where steam is required; therefore, conservation practices in the two industries closely resemble each other. Since water used for cooling purposes constitutes the majority of water use in a steam-electric plant, this is perhaps where the greatest water saving can be achieved. Methods used to conserve freshwater may include use of saline water or treated wastewater, air cooling, and using recirculating cooling systems.

1.5.4 Mining Water Use

Water is used in differing ways in the various types of mining or extractive industries. The primary water use in the mining industry in the Llano Estacado Region is for enhanced recovery of petroleum, such as with water injection. Water is also used in sand and gravel mining operations for washing mined deposits, although there is very little such activity in the Llano Estacado Region.

Several strategies have been used and continue to be used by the oil and gas industry to conserve water. For example, the use of freshwater has been reduced by the use of poorer quality water for injection. In some oil-producing geologic formations, this is not feasible because of the precipitation of a solid when water that contains a different combination of minerals is introduced into oil and gas formations. This water with a different chemical quality could be treated before use, although in the past, treating this water has proven to be cost-prohibitive. Another optional water supply for the oil and gas industry is treated wastewater. This has been used in the past, but the water must be treated thoroughly to eliminate oxygen and to prevent growth of bacteria, which can clog up the formation in the well. A final option for conserving freshwater in the oil and gas industry would be to develop and use some other method of petroleum recovery.

1.5.5 Irrigation Water Use

In the Llano Estacado Region, water is pumped from aquifers to supplement precipitation for crop production. This means that more water is pumped during periods of drought than during years when precipitation is higher. The five main methods used in the Llano Estacado Region to apply supplemental irrigation to crops are furrow, sprinkler, low-energy precision application, surge valves, and drip (trickle) irrigation. Each method is described below.

Furrow irrigation is used to apply water to row crops, such as cotton, corn, grain sorghum, and vegetables. Water is siphoned or released into furrows and allowed to flow down the furrow until the entire length is wetted.

Sprinkler irrigation uses drop lines that are spaced along an elevated pipe and extend to within 16 inches of the land surface. A sprinkler head is attached to each drop line to distribute the water evenly across the field. In the Llano Estacado Region, sprinkler systems are usually of the center-pivot type, most of which are sized to irrigate the center 123 acres of a one-quarter section (160 acres) of cropland. The center pad is located in the center of the tract to be irrigated and the system moves in a circular path around the center to irrigate the entire tract. Although more efficient than the furrow method, the center-pivot sprinklers lose a part of the water that is sprayed out to evaporation.

Low-Energy Precision Application (LEPA) is a technological improvement upon the partial drop center-pivot sprinkler irrigation system described above. LEPA systems use the center-pivot piping and transport systems; but instead of spraying water into the atmosphere, the water is delivered through lines hanging from the overhead transport frame and dragged on or near the land surface between crop rows. The advantages of LEPA systems are low pressure to operate, little evaporation from the application process, and control of rate of delivery of irrigation water. Also, they can be used with furrow dikes, which hold moisture in the furrows until it soaks into the ground. More uniform and timely applications of irrigation water results in higher yields (uniform production over the entire field). Less water is pumped, which reduces energy cost, and labor cost is lowered.

Surge valves are a variation of furrow irrigation in which gated pipes are used to release irrigation water into the furrows to be irrigated. The gates of the pipes are spaced to deliver a stream of water into a set of furrows. Surge irrigation consists of a time-controlled valve placed between two sets of gated pipe. The system alternately waters two sets of furrows in a series of timed "surges," with each cycle supplying only enough water to flow a part of the length of the field. During the off period of the cycle, the water in the furrow infiltrates into the soil and creates a surface sealing effect that reduces infiltration in that section of furrow when the valve recycles to the set. Through this method of alternating watering of the sets, water flows down the previously wetted section of the furrow more rapidly, reducing deep percolation at the top end of the field. The cycle continues until enough water has been discharged into each set to wet the soil uniformly throughout the field. Surge irrigation improves irrigation efficiency in comparison to the standard furrow method and is low cost in terms of capital investment.

Drip irrigation delivers small but frequent quantities of moisture to plants by means of buried small-diameter, plastic tubes with small orifices or holes spaced to allow the release of water near the plant roots. This method results in a minimum loss of water through evaporation or deep percolation into the ground. Yields have been increased from 500 to 1,500 pounds of lint cotton per acre on some drip irrigation tracts.

Adoption and use of equipment to improve irrigation application efficiencies was begun in the mid-1980s and has continued at a rapid pace to the present. As an example, in 1995, 12,931 center pivot systems were in place. This increased to 16,420 systems by 1998, an increase of about 9 percent per year since 1995. The TWDB inventory of irrigated acres in the Llano

Estacado Region shows an irrigated acreage of 3,280,576 acres in 2000.[31] In 2000, 2,276,472 acres were irrigated with center pivot systems, which is about 70 percent of the total irrigated acres.[32] These systems deliver water at an efficiency of 80 percent or higher (Table 1-16).

Table 1-16.
List of Irrigation Systems and Efficiency
Llano Estacado Region

Irrigation Systems	*Range of Application Efficiency (percent)*
Drip Irrigation	96 to 98%
LEPA Center Pivots	96 to 98%
Center Pivots w/ Low Heads (16")	86 to 90%
Furrow w/ Surge & Tailwater Pit (30 to 40%)	80 to 90%
Furrow w/ Surge (10 to 40%)	80 to 90%
Furrow w/ Tailwater Pit (15 to 20%)	70 to 85%
Over Crop Center Pivots	75 to 80%
Furrow w/ Pipeline (15 to 20%)	50 to 70%
Furrow w/ Ditch	40 to 60%

Source: High Plains Underground Water Conservation District

During the late 1940s and early 1950s, furrow irrigation was the primary method used to provide irrigation water to crops in the region. Water losses of 50 percent or more occurred through deep percolation and irrigation tailwater when open ditches were used to transport the water from the field to the crop. In the late 1950s and during the 1960s, underground pipelines were installed to replace open ditches, thereby eliminating losses from deep percolation and evaporation from the open unlined ditches. Additionally, during the 1960s and 1970s, irrigation tailwater return systems were installed on a high percentage of the farms in the tighter soils (clay) areas to reuse tailwater that would have been lost from previously used systems. During this same time period, high-pressure and side roll sprinkler systems were used to irrigate the sandy soil areas of the region. Although an improvement over furrow irrigation, these sprinkler

[31] TWDB, "Report 347: Surveys of Irrigation in Texas," August 2001.
[32] Ibid.

systems had water losses in the range of 50 percent due to evaporation from the small drops of water as it was sprayed high above the crops and from the irrigation water that wet the crop canopy.

Beginning in the early 1980s, high-pressure center pivot irrigation systems were modified or replaced with center pivot systems equipped with drop lines, which discharge water at lower pressure with a large water drop size at about 4 feet above land surface, reducing losses from 50 percent to about 20 percent, as compared to the previously used furrow irrigation method.

In 1983, time-controlled surge valves were added to the underground pipe systems used to provide water for furrow irrigation. These surge valves provided a method to alternate the flow of water down two sets of furrows on a timed sequence. Their addition greatly reduced deep percolation and irrigation tailwater. Water losses were reduced to about 20 percent.

In the late 1980s and early 1990s, many of the partial drop center pivot systems were further modified to deliver the water into the furrow through socks or drag hoses, further reducing water losses to as little as 2 or 3 percent during irrigation applications.

In 1998, about 75 percent of the total irrigated acreage (2,297,406 acres) in the Llano Estacado Region was irrigated with center pivot irrigation systems. Of these systems, about 25 percent utilized full drops, and about 50 percent had drops 4 feet above the ground. Of the remaining irrigated acreage, about 20 percent was furrow irrigated, utilizing underground pipe and surge valves, with the remaining 5 percent irrigated by some combination of side roll sprinkler systems, hand moved sprinkler line systems, drip irrigation systems, and conventional furrow irrigation systems without surge valves.

By the end of the 1990s, tailwater return systems had almost disappeared from use, since there was no tailwater from the irrigation systems being used. However, some have been left in place to provide holding ponds for water for wildlife, where there are small quantities of runoff.

1.5.6 Livestock Water Use

Cattle feeding operations constitute approximately 60 to 70 percent of water used for cattle purposes in the Llano Estacado Region. Reducing the amount of water used for dust control is an important component of reducing overall water use at a feedlot. Feedlots continue to experiment and quantify the smallest amount of water for effective dust control. Additionally, feedlot feedmills use a small amount of water to steam-flake grain and for office and sanitary purposes.

1.5.7 Environmental and Recreational Water Use

As mentioned in Section 1.2.4.3, as many as 2 million waterfowl and 350,000 to 400,000 sandhill cranes use playas as wintering areas or as rest stops during annual migrations.[33] In addition, small mammals, amphibians, and reptiles depend on playas for water and habitat. Those playas and other areas that have been historically important for waterfowl and sandhill cranes are listed in Table 1-17. In years of good rainfall, habitat is excellent for big game, upland game, and waterfowl, and runoff to the region's few streams, rivers, and area reservoirs benefits fish and water recreational opportunities. Wildlife resources indirectly benefit from the Ogallala and other aquifers, primarily due to irrigation and production of grain crops. In fact, the best pheasant and waterfowl populations are generally found in areas of intensive irrigated grain production.

Since the flows of the rivers or streams (or instream flows) are extremely limited, the productivity and diversity of aquatic species is quite limited. Nevertheless, these intermittent streams are a source of inflow to area lakes, helping to support the aquatic environment and fisheries of those water bodies.

The Llano Estacado Region has several water-oriented recreational facilities, which are summarized below. The location of these recreational facilities is shown in Figure 1-6.

White River Lake: White River Lake, located on the Salt Fork tributary of the Brazos River in Crosby County, covers 1,808 acres and supplies water for Crosbyton, Post, Spur, and Ralls. The lake features camping areas, lakeside cabins, boat rentals, picnic areas, and fishing supplies. Principal recreational activities are fishing and water skiing.

Lake Mackenzie: Lake Mackenzie, near Tulia in Briscoe County, covers 296 acres and offers facilities for fishing, picnicking, camping, RV hookups, boat ramps, and a swimming area.

Buffalo Springs Lake: Buffalo Springs Lake is a 200-acre lake on the Double Mountain Fork of the Brazos River in Lubbock County that serves as a fishing, boating, and picnicking facility.

Lake Meredith National Recreation Center: Lake Meredith, built by the U.S. Bureau of Reclamation and operated by the Canadian River Municipal Water Authority, is located on the Canadian River to the north of the Llano Estacado Region and covers 16,504 acres. Eight public parks are located around the lake with facilities for camping and picnicking

[33] Information from High Plains Ogallala Area Regional Water Management Plan planning effort, 1996.

Table 1-17.
Areas Identified as Historically Important for
Waterfowl and Sandhill Cranes
Llano Estacado Region

Area Historically Important to Waterfowl	Location
Armstrong Playa	Dimmitt
Beefco Cattle Feeders	near Easter
Bud Hill Feedlot	Dimmitt
Buffalo Springs, Ransom Canyon	Lubbock
Bull Lake	Littlefield
Cedar Lake	Seagraves
Dead Horse Lake (at Bartlett Feedyard No. 2)	north of Hereford
Cargill Beef, Friona	west of Friona
Solutions, Plainview	Plainview
Frost & Gooch Lakes	south of Lubbock
Fry Lake on Frio Draw	near Friona
Great Plains Feedlot	Flagg area in Castro County
GW Sugar Playa	Deaf Smith County
Hale County Feedlot	Hale Center
Happy Feedlot	Happy
Hill Feedlot & Hart Playa	Hart
Sugarland Feed Yard Playa	Hereford
Ivy Lake (east of Easter)	Castro County
Lake Mackenzie	Silverton
Muleshoe NWR	Needmore
Paco-Bovina Feedyards	western Parmer County
Veigel pasture lake	Summerfield
Rafter 3 Feedyard	west of Dimmitt
Rich & Mound Lakes	Brownfield
Simpson Lake (north of Dimmitt Feed Yard)	Dimmitt
Stud Horse Playa	Parmer County
Tahoka-Gordon Lakes	Tahoka
Upper Paul's Lake	Bailey County
Various City Park Lakes	Lubbock
White River Lake	Crosbyton

Source: Playa Lakes Joint Venture Management Board, "Final Implementation Plan," Albuquerque, NM, November 1994.

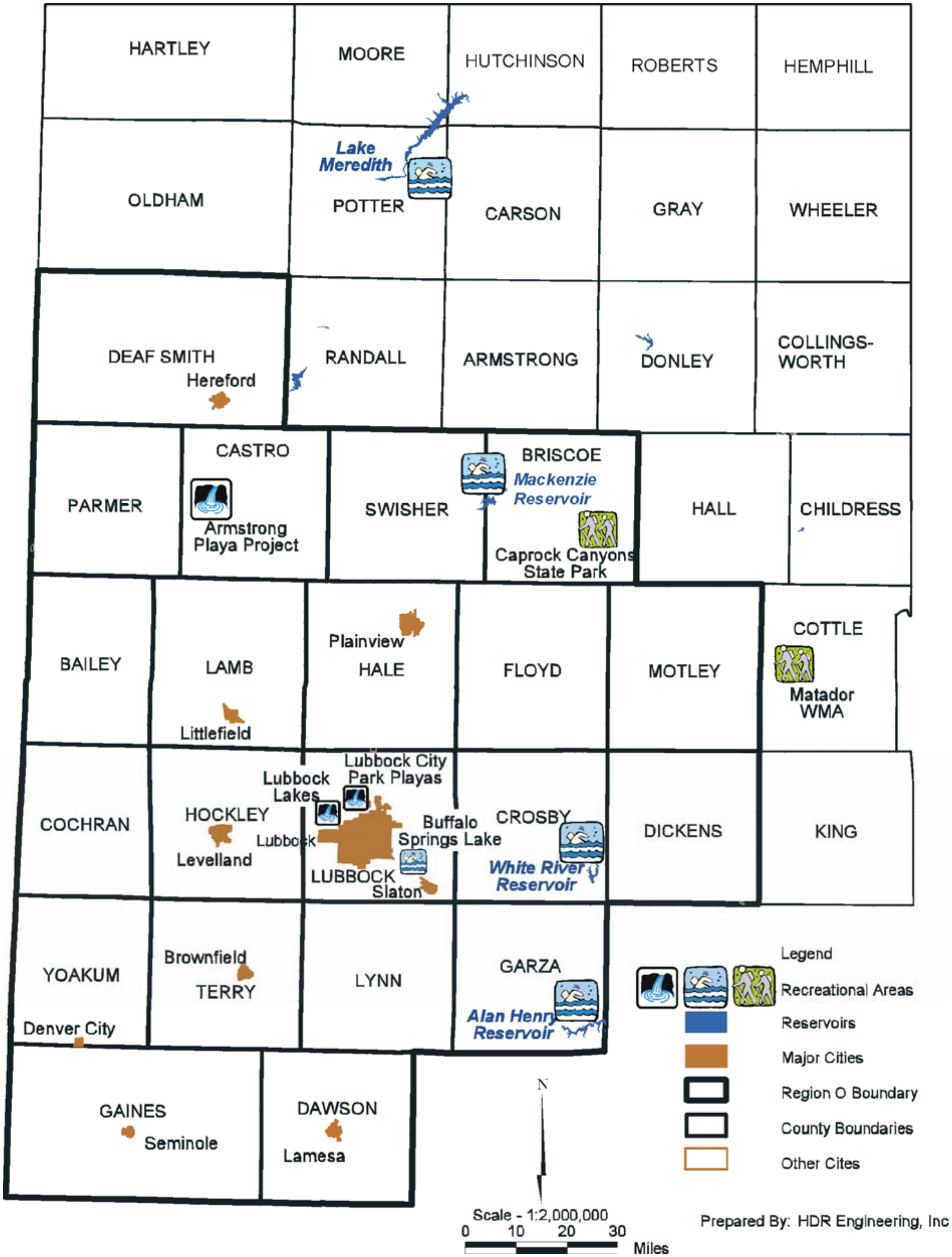

Figure 1-6. Location of Water-Oriented Recreational Facilities Llano Estacado Region

Lake Alan Henry: Lake Alan Henry, located near Post in Garza County, covers approximately 3,504 acres. The primary recreational activities associated with the lake are fishing, boating, and camping.

Caprock Canyons State Park: Caprock Canyons State Park covers 13,960 acres near Quitaque in Briscoe County. The park has facilities for hiking, picnicking, fishing, and swimming in the 100-acre lake.

Armstrong Playa Project: The Texas Parks and Wildlife Department owns a conservation easement on this property. It is located near Dimmitt in Castro County.

Lubbock City Park Playas: Many of the city parks in Lubbock are located around playa lakes. Many of these lakes are used for recreational purposes such as bird watching, fishing, and picnicking.

Lubbock Lake Landmark State Historical Park: This 336.6-acre, day-use only, historic site, is an archaeological and nature preserve located in Lubbock County. It is jointly operated by Texas Parks and Wildlife Department and Texas Tech University. The park lies along Yellowhouse Draw, a typically dry tributary of the Brazos River.

Hunting and fishing have become important economic enterprises in the Southern High Plains area, with an estimated annual expenditure of sportsmen of over $125 million in 2004.

1.5.8 Major Demand Centers

Although most of the counties of the Llano Estacado Region have small towns and communities, several major municipal demand centers exist within the region. The City of Lubbock is the largest demand center in the region for municipal and manufacturing water use. The major water demand centers for water used in oil and gas extraction are in counties located in the southern portion of the region, while large cattle feedlots, most of which are located in the northern half of the region, are the major demand centers for livestock water. Unlike water demand for municipal, manufacturing, electric power generation, and mining purposes, water demand for irrigation is spread throughout the region.

1.6 Water Supplies

1.6.1 Groundwater[34]

Two major and two minor aquifers supply water to the area. The two major aquifers are the Ogallala and Seymour Aquifers. The two minor aquifers are the Edwards-Trinity (High Plains) and the Dockum Aquifers.

1.6.1.1 Ogallala Aquifer

The Ogallala Aquifer is the major water-bearing formation of the 21 counties of the Llano Estacado Region. Vertical hydrologic communication occurs between the overlying Quaternary Blackwater Draw Formation, where present and the Cretaceous or Triassic formations which lie directly below the Ogallala Formation in a portion of the planning region. Although many communities use water from the Ogallala Aquifer as their primary source for drinking water, approximately 95 percent of the water obtained from the Ogallala is used for irrigation.

The Ogallala is composed primarily of sand, gravel, clay, and silt deposited during the Tertiary Period. Groundwater, under water-table conditions, moves slowly through the aquifer in a southeasterly direction toward the caprock edge or eastern escarpment of the High Plains. Saturated thickness of the aquifer is generally greater in the northern part of the region and thinner in the southern part where the formation overlaps Cretaceous rock units. The saturated thickness which is greatest where sediments have filled previously eroded drainage channels, ranges up to approximately 300 feet. Well yields range from as little as 10 gpm to as much as 1,000 gpm. The majority of wells yield between 200 to 600 gpm.

Recharge to the aquifer occurs primarily by infiltration of precipitation from the surface, and to a lesser extent, by upward leakage from underlying formations. Recharge rates vary from 0.3 inches to 3.0 inches per year, depending upon annual rainfall and geographic area. Playa basins appear to be areas of focused recharge.

Since the expansion of irrigated agriculture in the mid-1940s, greater amounts of water have been pumped from the aquifer than have been recharged. As a result, some areas have experienced water level declines in excess of 100 feet. However, conservation efforts have resulted in a reduction in the rate of water level declines.

[34] Information from the TWDB.

1.6.1.2 Seymour Aquifer

The Seymour Formation consists of isolated areas of alluvium found in parts of 23 north-central and Panhandle counties, including parts of Briscoe, Motley, Dickens, and Crosby Counties of the Llano Estacado Region. The Seymour aquifer supplies small quantities of water for municipal uses in these four counties.

1.6.1.3 Edwards-Trinity (High Plains) Aquifer

The Edwards-Trinity (High Plains) aquifer is a minor aquifer in the State of Texas that includes Cretaceous aged water-bearing formations of the Fredericksburg, Trinity, and Washita groups. These formations underlie the Ogallala Formation in 11 counties in the southwestern corner of the Llano Estacado Region and extend westward into New Mexico. The majority of the wells completed in the aquifer provide water for irrigation and yield 50 to 200 gpm.

Two distinct groundwater zones occur in the Edwards-Trinity (High Plains) aquifer. One occurs in the basal sand and sandstone deposits of the Antlers Formation (Trinity Group) and is usually under artesian pressure. The other water-bearing zone occurs primarily in the joints, solution cavities, and bedding planes in limestones of the Edwards Formation. In much of the area, this zone is hydrologically connected to the overlying Ogallala aquifer. Recharge to the aquifer occurs directly from the bounding Ogallala Formation along northern and western parts of the subcrop and by downward percolation from overlying units at other locations. Upward movement of groundwater from the Triassic Dockum aquifer into the Edwards-Trinity (High Plains) aquifer is also believed to occur in Lynn County. Some groundwater may also occur in the porous and permeable sections of the Duck Creek and Kiamichi formations.

Groundwater movement is generally to the southeast. In many places, the groundwater potentiometric surface in the Edwards-Trinity (High Plains) aquifer is higher than in the Ogallala aquifer, resulting in upward movement of water from the Edwards-Trinity (High Plains). In these areas, the Edwards-Trinity (High Plains) has a significant impact on the water levels and quality of the overlying Ogallala.

1.6.1.4 Dockum (Santa Rosa) Aquifer

Triassic Dockum Group rocks underlie the Ogallala Formation in portions of the High Plains area of Texas and New Mexico, the northern part of the Edwards Plateau, and the eastern part of the Cenozoic Pecos Alluvium. Where the Dockum Group is exposed east of the High

Plains caprock and in the Canadian River Basin, the land surface takes on a reddish color. In the subsurface, the Dockum is commonly referred to as the "red bed." The primary water-bearing zone in the formation, the Santa Rosa, consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale at the base of the Dockum section.

1.6.2 Surface Water

Although the Llano Estacado Region lies within four river basins, the region has very little surface water (Figure 1-2). Dams have been built to take advantage of what surface water exists. In other segments of rivers, surface water amounts to a trickle. Very little, if any, water leaves the region via streamflow. The surface water resources of the region are described below.

1.6.2.1 Canadian River Basin

Beginning in northeastern New Mexico, the Canadian River flows eastward across the Texas Panhandle into Oklahoma and merges with the Arkansas River in eastern Oklahoma. Total drainage area of the basin is 12,700 square miles, of which 94 square miles are located in the Llano Estacado Region (Figure 1-2).[35] Most of its course across the Panhandle is in a deep gorge. A tributary dips into Texas' northern Panhandle and then flows to a confluence with the main channel in Oklahoma. Lake Meredith, formed by the Sanford Dam on the Canadian, provides water for 11 Panhandle cities, including Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Plainview, Slaton, and Tahoka within the Llano Estacado Region.

1.6.2.2 Red River Basin

In the Llano Estacado Region, this basin is bounded on the north by the Canadian River Basin and on the south by the Brazos River Basin (Figure 1-2). The Red River Basin extends from the headwaters in eastern Curry County, New Mexico, across the Texas High Plains to the southwestern corner of Oklahoma, near Childress, Texas, where the river becomes the Texas-Oklahoma border. The Red River Basin encompasses 6,681 square miles in the region.[36] The uppermost tributary of the Red River in Texas is Tierra Blanca Creek, which rises in Curry County, New Mexico, and drains into the Prairie Dog Town Fork a few miles east of Canyon. However, these tributaries do not supply significant quantities of water to water users of the

[35] Information from the TWDB.
[36] Ibid.

Llano Estacado Region. Major population centers located in the basin include the Cities of Hereford (Deaf Smith County) and Tulia (Swisher County).

1.6.2.3 Brazos River Basin

In the Llano Estacado Region, the Brazos River Basin is bounded on the north by the Red River Basin and on the south by the Colorado River Basin and includes 8,732 square miles in the Llano Estacado Region (Figure 1-2).[37] In the region, the Brazos River rises in three upper forks, the Double Mountain, Salt, and Clear Forks of the Brazos. However, the Brazos River proper is considered to begin where the Double Mountain and Salt Forks flow together in Stonewall County, east of the Llano Estacado Region. Major population centers located in the basin include the Cities of Muleshoe (Bailey County), Littlefield (Lamb County), Plainview (Hale County), Levelland (Hockley County), Lubbock and Slaton (Lubbock County), and Post (Garza County). Alan Henry Reservoir on the Double Mountain Fork in southeastern Garza County was built to supply municipal water and industrial water to Lubbock in future years. At this time, the basin does not supply significant quantities of surface water for use in the Llano Estacado Region.

1.6.2.4 Colorado River Basin

In the Llano Estacado Region, this basin is bounded on the north by the Brazos River Basin and on the south by the Rio Grande Basin (Figure 1-2). The Colorado River Basin contains 4,787 square miles in the Llano Estacado Region.[38] The headwaters of the Colorado River occur in eastern New Mexico, and the river course is to the southeast across Texas approximately 600 miles, discharging into Matagorda Bay and the Gulf of Mexico. However, there is very little flow within the Llano Estacado Region. Major population centers of the planning region that are located in the basin include the Cities of Brownfield (Terry County), Denver City (Yoakum County), Lamesa (Dawson County), and Seminole (Gaines County). However, neither the Colorado River nor its tributaries supply water to any of these cities.

1.6.3 Developed Surface Water Resources

Development of surface water supply sources has been limited in the Llano Estacado Region simply because the area does not have flowing streams of any significance

[37] Ibid.
[38] Ibid.

(Section 1.6.2). However, four reservoirs are located nearby and supply water for municipal and industrial uses within the region (Figure 1-6). These four reservoirs are identified and described below. Those cities that do not receive water from these reservoirs rely on groundwater to supply their water needs for both municipal and industrial purposes.

1.6.3.1 Lake Meredith

Lake Meredith, located in Region A in the Canadian River Basin in Potter, Moore, and Hutchinson Counties, has a total storage capacity of 920,300 acft and can supply approximately 76,000 acft of water per year when at conservation pool elevation. Associated projects to use groundwater conjunctively and to reduce source water salt contamination have been implemented to firm up the reliability and improve the quality of currently contracted supplies. From Lake Meredith, a pipeline extends southward and delivers water for municipal and industrial purposes to Brownfield, Lamesa, Levelland, Lubbock, Plainview, O'Donnell, Slaton, and Tahoka within the Llano Estacado Region.

1.6.3.2 Mackenzie Reservoir

Mackenzie Reservoir is located in the Red River Basin in Swisher and Briscoe Counties, and supplies water to Silverton, Tulia, Floydada, and Lockney. The reservoir has a total storage capacity of 45,500 acft and can supply approximately 5,200 acft of water per year when at conservation pool elevation. During recent dry conditions, Lake Mackenzie was unable to meet its contracted demands.

1.6.3.3 White River Reservoir

White River Reservoir is located in the Brazos River Basin in the southeast corner of Crosby County. It is owned and operated by the White River Municipal Water District, which supplies water to Ralls, Spur, Post, and Crosbyton. The reservoir has a surface area of 1,808 acres at conservation pool elevation, a drainage area of 173 square miles, a total storage capacity of 44,897 acft, and a water right of 6,000 acft/yr. White River Municipal Water District has purchased groundwater rights and has drilled wells to supply its customers should the water levels in the reservoir drop below the level at which water can be removed.

1.6.3.4 Lake Alan Henry

Lake Alan Henry is located on the Double Mountain Fork of the Brazos River in Garza and Kent Counties and is owned by the City of Lubbock. The lake has a total storage capacity of 115,937 acft and a firm yield of approximately 22,500 acft of water per year. Lake Alan Henry was developed to serve as a future water supply for the City of Lubbock and at present is open for recreational purposes. In 2003, the Texas Legislature enacted legislation to create the Lake Alan Henry Water Supply District for the purpose of supplying water from the lake to developing areas adjacent to and near the lake. The District was confirmed in 2004 by voters of the service area.

1.6.4 Playa Basins

In addition to the rivers and streams in the planning area, there are as many as 20,000 playa basins located on the High Plains of Texas, of which about 14,000 are located in the Llano Estacado Region (Table 1-18).[39] Playas are naturally occurring depressions in the landscape of the Southern High Plains that provide the internal drainage for much of the region.

Table 1-18.
Number and Total Area of Playas in Planning Area
Llano Estacado Region

County	Number	Acres Covered	County	Number	Acres Covered
Bailey	598	4,772	Hale	1,383	23,263
Briscoe	787	12,266	Hockley	1,171	8,388
Castro	621	19,756	Lamb	1,280	13,405
Cochran	395	1,815	Lubbock	934	15,503
Crosby	925	18,278	Lynn	842	9,172
Dawson	702	7,074	Motley	0	0
Deaf Smith	451	14,069	Parmer	455	9,935
Dickens	0	0	Swisher	910	20,117
Floyd	1,783	40,605	Terry	532	3,022
Gaines	65	210	Yoakum	38	187
Garza	283	4,676	**Total**	**14,155**	**226,513**

Source: Guthery, F.S., F.C. Bryant, B. Kramer, A. Stoecker, and M. Dvoracek, "Playa Assessment Study," U.S. Water and Power Resources Service, Southwest Region, Amarillo, TX, 1981.

[39] Playa Lakes Joint Venture Management Board, "Final Implementation Plan," Albuquerque, NM, November 1994.

Playa watersheds are closed systems, with playa floors representing the deepest point of the watershed. In times of abundant rainfall, they collect water and form lakes. Playas have little elevational change as one proceeds across them in a horizontal gradient; playa floors are flat. Some playa floors are defined as wetlands by the presence of hydric, vertisol clay soil, usually Randall Clay, and despite being surrounded by intensive agricultural activities, the playas perform many functions beneficial to humans and biota of the region, as will be explained below.

The majority of playa basins are ephemeral, meaning that they only hold water during and for a period of time after rainfall events. In earlier days, irrigation tailwater kept many playa basins partially supplied for part or all of the year. However, as irrigation efficiency has improved, most playas have water in them only after a rainfall event, with the quantity of rainfall received during the spring months of March, April, and May being a critical factor in the life expectancy of a wet playa. Some playas have been modified by landowners to concentrate the stored water into deeper pools with smaller surfaces, which decreases evaporation. Some farmers recirculate this water for irrigation. However, the capacities of many playas to hold water have been reduced, since in the days of straight row furrow irrigation, soil was washed down the furrows into the playas. As they gradually silted in, the water-holding capacity has been lowered, and at the present rate of siltation, playas in heavily farmed areas may disappear in the next 20 years.

Given their sheer number and ability to retain water in arid and semi-arid periods, playas are especially important to numerous wildlife species. However, the abundance and diversity of wildlife species that use them depend on several factors, including the size of a basin and agricultural activity around the playa. Since larger basins are less likely to be tilled for crops or weed control, a large basin is more likely than a small basin to have natural vegetation to support wildlife year-round. With respect to activity around the playa, studies have found that playas surrounded by grain fields such as grain sorghum, small grains, corn, or some combination of these crops support a wider diversity of species than playas surrounded by cotton, potatoes, or sugar beets, but cropping activity without a grass buffer around the playas contributes a heavy load of silt to the basins.

Most, if not all, species of wildlife in the region use playas and many species are dependent on playas for their existence. Nearly 200 species of birds have been identified in playas. Nine species of amphibians, which consume a multitude of agricultural pest insects, would not exist in much of the region without playas. A minimum of 37 species of mammals have been associated with playas. Several species of reptiles use playas throughout the year. In fall and spring, migratory birds rest at playas during migration to and from wintering and summering grounds. Playas are of critical importance as habitat for wintering waterfowl. Some birds also use playas as breeding and nesting areas. A total of 346 plants are now reported in playa basins.

About 30 feedyards use playa basins and catchment ponds for feedlot runoff. Testing of pond water and soil below and around the pond shows no leaching of nutrients below 20 feet, and testing around the pond shows no sign of pollution. In fact, research by the Texas A&M Extension Service has shown that a natural Randall Clay bottom on a playa seals the bottom as effectively as any other liner.

1.6.5 Springs

According to “Major and Historical Springs of Texas,” published by the TWDB, there are four active springs located within the planning area (Hylsey, Roaring, Buffalo, and Couch Springs).[40] Hylsey Springs is located approximately 9 miles north of Vigo Park within Palo Duro Canyon in Briscoe County. Hylsey Springs produces water from the Santa Rosa Sandstone, which is the primary water-bearing unit of the Dockum Aquifer. Roaring Springs is located approximately 4 miles south of the Town of Roaring Springs in Motley County. Roaring Springs produces water from the Santa Rosa Sandstone (Dockum Aquifer) and the Ogallala Aquifer. Buffalo Springs is located approximately 9 miles southeast of the City of Lubbock. Buffalo Springs produces water from the Edwards-Trinity (High Plains) Aquifer. Couch Springs, located approximately 8 miles east of Crosbyton in Crosby County, produces water from the Ogallala Aquifer. Information obtained from area residents indicates that following unusually heavy rainfall in 2004 there has been renewed spring and seep flows in some locations (Appendix B).

[40] TWDB, “Major and Historical Springs of Texas (Report #189),” March 1975.

1.7 Water Quality

1.7.1 Groundwater Quality[41]

1.7.1.1 Ogallala Aquifer

The chemical quality of water in the Ogallala aquifer is generally fresh; however, both dissolved solids and chloride concentrations increase from north to south. In the Northern portion of the Llano Estacado Region, total dissolved solids are generally less than 400 milligrams per liter (mg/L). Total dissolved-solids concentrations typically exceed 400 mg/L in the Southern portion of the regional planning area, with some parts of the area having groundwater with concentrations exceeding 1,000 mg/L of total dissolved solids, especially in the vicinity of alkali lakes. Upward leakage and subsequent mixing of water from the underlying Cretaceous aquifers probably influences the chemical quality in the south. Fluoride content is commonly high, and selenium concentrations locally are in excess of drinking water standards.

1.7.1.2 Seymour Aquifer

Water quality in these alluvial remnants generally ranges from fresh to slightly saline. Total dissolved solids range from 500 to 3,000 mg/L in Motley County, while parts of the aquifer underlying Dickens County have a total dissolved solids concentration greater than 3,000 mg/L. High nitrate concentrations in excess of drinking water standards in Seymour groundwater may also occur in these two counties. However, as was noted in Section 1.6.1.2, very little water is used from this aquifer in the Llano Estacado Region.

1.7.1.3 Edwards-Trinity (High Plains) Aquifer

Water quality in the aquifer is typically fresh to slightly saline and is generally poorer in quality than water in the overlying Ogallala Aquifer. Water quality deteriorates in the vicinity of the saline lakes in Lynn, Dawson, Terry, and Gaines Counties.

1.7.1.4 Dockum Aquifer

Concentrations of dissolved solids in the groundwater range from less than 1,000 mg/L near the eastern outcrop to more than 35,000 mg/L in the deeper parts of the aquifer in Garza,

[41] Information from the TWDB.

Hockley, Lubbock, Lynn, and Terry Counties. Relatively high sodium concentrations make the water undesirable for irrigation use in some areas, although this aquifer is used for irrigation in other areas of the region. Irrigation and public supply use is limited to the areas of the Dockum Aquifer where water quality is acceptable. The Cities of Dickens, Happy, Hereford, and Tulia use or have used water from the aquifer. In addition, some livestock feedlots use water from the aquifer as their primary water supply. In areas where the water quality is not acceptable for irrigation, public supply, or livestock, the water may be suited for use in petroleum-related activities.

1.7.2 Surface Water Quality[42]

1.7.2.1 Canadian River Basin

The principal water quality problems in the Canadian River Basin are elevated total dissolved solids and chloride levels. The Canadian River at the New Mexico-Texas state line is moderately saline during low flow due to natural conditions. Additionally, a natural brine artesian aquifer with total dissolved solids greater than 30,000 mg/L seeps into the river near the Texas-New Mexico border. The high chloride levels affect water quality in Lake Meredith. The Canadian River Municipal Water Authority, owner of the lake, has implemented a chloride control project to alleviate this problem. The Cities of Brownfield, Lamesa, Levelland, Lubbock, Plainview, O'Donnell, Slaton, and Tahoka located in the Llano Estacado Region are provided water by the CRMWA from Lake Meredith.

1.7.2.2 Red River Basin

High concentrations of total dissolved solids, sulfate, and chloride are a general problem in most streams of the Red River Basin under low flow conditions. These high salt concentrations are caused, in large part, by natural conditions due to the presence of saltwater springs, seeps, and gypsum outcrops. Saltwater springs are located in the western portion of the basin in the upper reaches of the Wichita River, the North and South Forks of the Pease River and the Little Red, which is a tributary to the Prairie Dog Town Fork of the Red River. Gypsum outcrops are found in the area ranging westward from Wichita County to the High Plains Caprock Escarpment. The water in these areas usually contains extremely high levels of

[42] Information obtained from the Texas Natural Resources Conservation Commission.

dissolved solids. At times, the total dissolved solids are comparable to those found in seawater. However, since streams of the basin supply practically no water to the Llano Estacado Region, the water quality in the basin is of little, if any, importance to this planning effort.

1.7.2.3 Brazos River Basin

Water quality in most reaches of the upper Brazos River Basin is considered to be good, although in some areas of the upper basin high concentrations of natural salt contribute salt loads to area streams and rivers. Primary sources of salt include the watersheds of the Double Mountain and Salt Forks of the river. The Brazos River segment from the confluence with the Salt Fork of the Brazos River in Kent County to White River Dam in Crosby County contains above average concentrations of chloride, sulfate, and total dissolved solids. Since this is a source of water for some cities of the region, this quality condition is important to this planning effort.

1.7.2.4 Colorado River Basin

Due to a lack of perennially flowing streams in the upper Colorado River Basin, there are no regularly monitored water quality gauging stations along these streams (i.e., no water, no water quality concerns).

1.7.3 Water Quality Issues

1.7.3.1 Natural Chlorides

Chloride contamination of groundwater in the Ogallala Aquifer in several of the southern counties in the Llano Estacado Region appears to be from wind blowing dry soil material that contains chlorides and other minerals out of some of the older lake basins located in the region. Storm runoff water collects in the lake basins, as does water discharged from springs from the Ogallala. Even though the Ogallala water is considered to be fresh, it does contain minerals. When the water evaporates from the basins, the minerals are left behind. When these minerals dry, they are picked up by the wind and distributed across the countryside. They are then dissolved in rainwater, some of which may find its way into the aquifer (see Sections 1.7.2.1, 1.7.2.2, and 1.7.2.3 for references to natural chlorides in surface water).

1.7.3.2 Saltwater Disposal

Oilfields developed throughout the Llano Estacado Region contribute brine to area aquifers, lakes, streams, and rivers. Collective efforts of several state and local agencies have led the oil industry to eliminate the evaporation pit method of brine disposal. By 1983, most of the produced oilfield brine not utilized in secondary recovery operations was being properly disposed of by injection into deep formations. Both injection and disposal operations are performed under permits issued by the Railroad Commission of Texas. However, residual salts contained in and on soils near disposal sites that were in existence prior to 1983 continue to seep into groundwater aquifers in the general proximity of each active or inactive oilfield. Other contributing sources are identified as originating from failures of abandoned wells that were improperly plugged, commingling between saltwater injection zones and freshwater formations, and accidental spills.

1.7.3.3 Pesticides

Several water quality studies that tested for the presence of pesticides in the groundwater have been conducted in the planning region. In 1988, the High Plains Underground Water Conservation District No. 1 sampled approximately 90 wells located within the District's boundaries. The analyzed samples indicated no significant contamination from pesticides. The few wells from which water samples showed trace amounts of pesticides were revisited, and further investigation indicated that the pesticides may have been introduced into the wells through openings in the pumps. Follow-up samples indicated no traces of pesticides.

In addition, in August 1993, the TWDB released a report entitled "Water-Quality Evaluation of the Ogallala Aquifer, Texas," (Report Number 342) which covered all or parts of the 21 counties in the Llano Estacado Region. This study also concluded pesticides were not a significant contaminant in the groundwater underlying the region.

1.7.3.4 Urban Stormwater Runoff [43]

Stormwater runoff from city streets generated during a storm event is perceived as a source of possible contamination of surrounding playa basins. To determine if contamination is occurring, the City of Lubbock initiated the sampling of two local playas in 1993 as a part of the application process for the City's National Pollutant Discharge Elimination System Permit. The

[43] Information from Stormwater Management Water Quality Report, City of Lubbock, February 1998.

playas sampled in this study were located at Buster Long Park and Maxey Park. The results of the sampling showed that lead in both locations exceeded water quality standards on more than one occasion, but the level of pesticides was found to be low in both locations, with the exception of chlordane at the Buster Long Park location. Overall, the water quality remained high in both playas. Water in urban playas continues to be monitored to be sure quality remains high.

1.7.3.5 Nutrients Associated with Agricultural Production

As explained in Section 1.2, the semi-arid climate, uniform topography, low-permeability soils, large depth to groundwater, and gradually sloping terrain of the Llano Estacado Region restrict the movement of agricultural nutrients. The geographic features of the region, in combination with farm and livestock management practices, reduce the threat to surface water and groundwater quality.

Best Management Practices (BMPs) implemented by farmers include application of fertilizers at rates equal to the nutrient requirements for crops, wellhead buffers for land application of fertilizers, incorporation of fertilizers following application, and tillage practices to minimize runoff from fields.

Confined Animal Feeding Operations (CAFOs) are required to use BMPs, pursuant to Texas Commission on Environmental Quality (TCEQ) permits. Some of these BMPs include buffer zones around water wells, construction of berms to divert rainwater around the feedlot, protection of retention facilities from 100-year flood events, proper removal of pond sediments to maintain retention capacity, and proper removal of mortalities.

Fertilizers are required for proper plant growth to successfully accomplish production of cotton, corn, grain sorghum, peanuts, vegetables, and wheat throughout the Llano Estacado Region. In addition to commercially prepared fertilizers, manure from CAFOs is used in the production of cotton and grains, since it contains many crop nutrients and enhances soil quality by improving the organic matter content in the soil, which increases the water holding capacity of the soil and reduces the demand for irrigation.

1.7.3.6 Confined Animal Feeding Operations

There are approximately 69 cattle feedlots in the planning area, which utilize manmade retention ponds and playa lakes, as allowed by state and federal permits, to contain runoff from the feedlot surface.

Potential point sources of groundwater contamination in livestock feeding operations include open, unpaved feedlots, runoff-holding ponds, manure treatment and storage lagoons, silos, and manure stockpiles. Insecticide spray equipment, dipping vats, and disposal sites for waste pesticides, rinsates or containers also may contribute to localized groundwater contamination because of the possibility of direct entry runoff or infiltration around or through well casings or abandoned wells.

The primary constituents of livestock manure that can contaminate groundwater include pathogenic organisms, nitrates, and ammonia. Other constituents such as potassium, sodium, chloride, and sulfate also may leach through the soil and impair the quality of an aquifer. However, studies to evaluate playas as runoff holding ponds conducted by the USDA Agricultural Research Service in Bushland, Texas, at the time the feedlots were being established indicated this was an environmentally sound practice, because the playa clay bottoms were impermeable and the underlying water-table was generally more than 200 feet below the soil surface.[44]

Results from a recent study conducted by Texas A&M University, Texas Tech University, and the High Plains Underground Water Conservation District involving beef and dairy operations support earlier views that the playas having Randall Clay bottoms and other properly constructed retention ponds can be used for feedlot waste runoff/storage without posing a significant contamination threat to the underlying groundwater. However, caution needs to be observed around the coarser-textured playa rim, because this area is a more permeable zone, where deeper leaching of soluble nutrients may occur.[45] At the conclusion of the study, it was determined that most accumulations occurred in the top foot of the playa soil surface. Nitrate was the nutrient that leached most. Its maximum concentrations in the top 5 feet of soil were, on average, about 65 parts per million (ppm) reported as N. At no location was there evidence that

[44] Smith, B.A., et al., "Nitrate and Other Nutrients Associated with Playa Storage of Feedlot Wastes," Texas Agricultural Extension Service, November 1993.
[45] Sweeten, John M., "Groundwater Quality Protection for Livestock Operations," Texas Agricultural Extension Service, October 1993.

appreciable nitrate had penetrated the playa bottom proper below 10 feet, indicating no aquifer contamination associated with any feedlot.

Environmental protection has been an integral part of designing, building, operating and maintaining cattle feedlots in the Llano Estacado Region. The dry climate, low average annual rainfall, large depth to groundwater, and farmland application of manure as fertilizer, have provided a means by which feedlots can operate without threatening the natural resources of the region.[46]

For more than 30 years, cattle feedlots have been permitted to operate by the Texas water and air quality agencies, currently the TCEQ. TCEQ permits are among the most stringent in the nation, requiring certification of pond liner permeability and certification of retention pond capacity by a licensed professional engineer. In addition, feedlots must conduct periodic inspections of the site and document these inspections in a Pollution Prevention Plan maintained at each feedlot.[47]

Feedlot manure has provided nutrients for cotton, corn, grain sorghum, and wheat in parts of the region. Manure provides nutrients such as nitrogen, phosphorus and potassium, and micronutrients such as iron, magnesium, and sulfur. The addition of organic matter from manure also improves soil structure and water holding capacity of the soil, somewhat reducing the demand for irrigation.[48]

TCEQ permits also require implementation of BMPs, such as buffer zones around water wells, construction of berms to divert rainwater around feedlots, protection of retention facilities from 100-year flood events, proper removal of pond sediments to maintain retention capacity, and proper removal of mortalities.[49]

1.8 Threats to Agriculture and Natural Resources

Playa basins occupy a large percentage of the farmland and ranchland of the Llano Estacado Region. As discussed in Section 1.6.4, playa basins serve not only as crop and grazing land, but are the principal habitat for wildlife in this flat, arid region. Threats to playas are identified and described below.

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[46] Correspondence with Texas Cattle Feeders Association, Amarillo, Texas, July 13, 1999.
[47] Ibid.
[48] Ibid.
[49] Ibid.

1.8.1 Modification and Reduction of Playas and Corrective Measures

Playa basin habitats appear to be subject to the following threats:

(a) Management of Drainage Areas: If the drainage area above a playa basin is improperly managed, soil erosion from washing can occur and the basin can, over time, be filled with silt that robs it of water-holding capacity. In areas of intensive row-cropping, siltation of playas has resulted in diminished playa basin capacity over a large portion of the Llano Estacado Region, particularly where irrigation rows have run directly downhill into playa basins.[50] Some playas have lost 50 percent or more of their capacity to siltation, and may disappear within 20 years unless this trend is reversed. BMPs, such as farming parallel to the slope of the watershed and leaving buffer strips of native grasses around playa perimeters, protect playa basins from siltation, ensuring their ability to seasonally pool water and provide wildlife habitat.

(b) Production in Playa Basins: Plowing, planting and cultivating of playas that harbor native vegetation can spread noxious weeds onto farmland on surrounding upslopes, denude the basin of emergent vegetation, deprive wildlife species of habitat, and may even diminish the basin's ability to hold water. Playas produce valuable forages, and grazing is an historic and contemporary use of playa basins, employed in continuous or seasonal patterns. BMPs of prescribed, short duration, or limited grazing that does not remove all vegetation from the basin, can allow utilization of valuable forage, yet ensure protection of naturally-occurring plant and seed production activities of moist soil plants. These plants provide wildlife cover and feed during winter and spring months when they may represent the only pool of available habitat.

(c) Irrigation Water Application Methods: Large-scale conversion from furrow irrigation to more efficient sprinkler irrigation has become a practical water conserving necessity and a BMP to prolong the life of the Ogallala Aquifer in the Llano Estacado Region. Conversion to more efficient irrigation methods has eliminated the tailwater runoff that once supplemented many playa lakes, thus impacting wildlife habitat. With little or no irrigation tailwater flowing into playa basins in years of low rainfall, little open water may be available to ducks, geese, sandhill cranes, and shorebirds in the playas.

1.8.2 Playa Enhancements and Protective Measures

Playa habitats may be enhanced, as follows:

(a) Supplemental Sources of Water: (1) Overflow from watering troughs in cattle feedlots can collect in and sustain a water level in some playas used as drainage basins. During dry years and in periods of cold weather when shallow playas freeze, overflow from feedlot waterers into drainage playas can be especially important in providing open water areas to migrating and wintering waterfowl. Feedlot drainage playas and municipal and industrial effluent playas provide the only available surface water in dry times and the only open water during freezing weather. (2) Irrigation

[50] Luo, Hong-Ren, "Effects of Land Use on Sediment Deposition in Playas," submitted to the graduate faculty of Texas Tech University in partial fulfillment of the requirements of the degree of Master of Science, May 1994.

tailwater flowing through drainage ditches can supplement the water in playa lakes and create edge vegetation in playa basins that might otherwise be dry. Moist soil management techniques that manipulate water in playa basins may also enhance production of moist soil plants that benefit wildlife as food and habitat. It is noted, however, that these sources of water are being reduced through improved irrigation efficiency and water conservation measures on the playa watersheds.

(b) Soil Erosion Control on Playa Watersheds: A BMP of contour farming to minimize soil erosion that results in silt transport into playas is important to wildlife in the region and to contributing to recharge of the Ogallala Aquifer. Silted playas will not hold the volume of rainfall runoff that non-silted playas can contain.[51] A BMP of maintaining a native grass cover in areas surrounding playas protects the basins from volume-robbing siltation through natural filtration and can allow playas to more significantly contribute to aquifer recharge.

Best Land Management Practices and rainfall enhancement can benefit wildlife in the Llano Estacado Region without severely impacting groundwater supplies and can protect and enhance playa basins.

1.8.3 Drought

1.8.3.1 Drought Impact on Aquatic Ecosystems

Freshwater rivers and streams and reservoirs within the Llano Estacado Region are vulnerable to the effects of drought conditions and are manifested as reductions in streamflow and, primarily, in declines in the level of area reservoirs. Immediate drought impacts to freshwater ecosystems in the Llano Estacado Region can be losses in available habitat and a reduction in water available to municipal water supply systems from reservoirs.

Reservoir fisheries can be affected by drought. Reduced reservoir levels can have considerable impacts on reservoir fisheries as the amount of available habitat for spawning, feeding, nursery cover, and resting declines. As water levels decline, brush piles, rocks, and vegetated areas are exposed, affecting habitat complexity. The relative impact will be greatest to those species that utilize habitat close to shore or those fish that prey on such species. Negative impacts to the largemouth bass population in Lake Meredith (Section 1.6.3.1) due to reduced lake levels as a result of drought have been reported. Similar declines in available habitat for fish have also been noted at Lake Mackenzie and White River Lake within the Llano Estacado

[51] Ibid.

Region. Impacts include increased mortality of young fish, increased competition for space and food, impaired reproduction and growth rates, and reduced food sources.

Water quality problems may develop with reduced inflows to reservoirs. Lower dissolved oxygen levels, coupled with higher water temperatures, can limit fish distribution or contribute to diminished survival rates. Additional problems could develop or current problems worsen if surrounding land practices or municipal/industrial effluent contributes nutrients, organic matter, and/or toxic material.

1.8.3.2 Drought Impact on Terrestrial Ecosystems

Drought conditions during the crop-growing season dramatically increase pumpage for irrigation water from the Ogallala Aquifer. In addition, populations of terrestrial wildlife are put under stress when severe drought conditions develop. Habitat quantity and quality may gradually decline from lack of moisture and increasing competition for limited resources. Both wildlife and domesticated animals may suffer from lack of drinking water, a shortage of forage and cover, and heat stress, although this impact may be mitigated slightly in irrigated areas of the Llano Estacado Region.

Deer on poor range conditions can be severely impacted by drought, as can antelope. Pheasant and wild turkey populations in the Llano Estacado Region are severely reduced in the presence of drought, and quail suffer significant losses due to drought. However, data show that no significant or long-term impacts for waterfowl are typically detected for overwintering populations, although lack of playa water in the Llano Estacado Region can leave populations of up to 400,000 sandhill cranes and 2 million waterfowl short of wintering habitat that they must then find elsewhere. Drought has triggered severe outbreaks of botulism in past years that have affected waterfowl and shorebirds. Botulism may occur in the region when playas are drying and anaerobic conditions are created.

In the past, during droughts, migratory waterfowl have been crowded on roosting playas. Under these conditions they are more vulnerable to disease transmission outbreaks of avian cholera that have the potential to kill thousands of birds.

Periodic drying of playas can encourage moist-soil plant growth in their basins. If mudflat conditions that give rise to moist-soil plant populations are followed by fall rains, significant quantities of moist-soil plant seeds can be available as food to wintering birds.

Currently, terrestrial wildlife recreation and sportfishing account for an estimated $125 million impact to the Texas High Plains economy (Section 1.4.10). Drought has significant adverse effects upon aquatic and terrestrial ecosystems in the Llano Estacado Region and participation in and value of terrestrial wildlife recreation and sportfishing activities.

1.8.4 Water Quality

At the present time, the quality of Ogallala Aquifer water, the principle source of water for all water user groups of the region, is well suited for current uses. Obviously, if contamination of existing supplies occurs, the quantities contaminated could become unusable or only usable after treatment, and thereby the quantities of supply would be reduced to the extent that contamination occurs.

1.9 Major Entities with Water Resources Responsibilities

1.9.1 Federal and State

1.9.1.1 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USCOE) was charged by Congress in 1972 in the Federal Clean Water Act, Section 404, as one of the regulatory agencies to protect our nation's waters (including lakes, rivers, aquifers and coastal areas) from the discharge of dredge and fill material in defined U.S. waters. The Federal Clean Water Act's primary objective is to restore and maintain the integrity of the nation's waters. This objective translates into two fundamental national goals:

1. Eliminate the discharge of pollutants into the nation's waters; and
2. Achieve water quality levels that are fishable and support contact use.

Practically speaking, construction activities occurring in and around defined U.S. waters require the acquisition of a Section 404 permit and associated National Environmental Policy Act (NEPA) review. The USCOE also regulates the construction of dams in navigable waters through its Section 10 permit program.

1.9.1.2 U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (USEPA) administers several environmental programs authorized by Congress. The three principal acts and related programs are described below.

The Clean Water Act requires major industries to meet performance standards to ensure pollution control, charges states and tribes with setting specific water quality criteria appropriate for their waters and developing pollution control programs to meet them, provides funding to states and communities to help them meet their clean water infrastructure needs, and requires a permitting process to ensure that development and other activities are conducted in an environmentally sound manner. The Clean Water Act had its beginnings in the Water Pollution Control Act of 1948, which authorized the Surgeon General of the Public Health Service, in cooperation with other Federal, state, and local entities, to prepare comprehensive programs for eliminating or reducing the pollution of interstate water and tributaries and improving the sanitary condition of surface and underground waters. With the Clean Water Act Amendments in 1977, the Federal Water Pollution Control Act became known as the Clean Water Act.

Also included in the Clean Water Act is the National Pollutant Discharge Elimination System (NPDES) Permitting process. Facilities which discharge pollutants from point sources (such as discharge pipes) into waters of the United States are required to obtain a NPDES permit. The NPDES program falls under Section 402 of the Clean Water Act. Wastewater discharges regulated under the NPDES program include industrial wastewater, stormwater, and treated effluent from municipal sewage treatment plants.

The primary objective of the Safe Drinking Water Act of 1974, as amended in 1986 and 1996, is twofold: (1) to protect the Nation's sources of drinking water and (2) to protect public health to the maximum extent possible, using proper water treatment techniques. The Safe Drinking Water Act directs the USEPA and states to establish national primary and secondary drinking water standards and to establish techniques to meet those standards. States are responsible for enforcement and must submit regulatory programs to the USEPA for approval. Underground sources of drinking water are also protected through applying the same drinking water standards, identifying critical aquifer protection areas, and programs to protect wellhead areas from contaminants.

The Resource Conservation and Recovery Act (RCRA) of 1976 governs the disposal of solid waste. Subtitle D of the Act, as amended November 1984, establishes Federal standards and requirements for state and regional solid waste authorities. The objective of this subtitle is to assist in developing and encouraging methods for the disposal of solid waste which are environmentally sound and which maximize the utilization of valuable resources recovered from solid wastes. Subtitle C of this law establishes standards and procedures for the handling, storage, treatment, and disposal of hazardous wastes. Generators, transporters, and owners of treatment, storage, and disposal (TSD) facilities are subject to its regulatory scheme. RCRA also regulates the transportation and tracking of hazardous waste; establishes standards for the storage and treatment of hazardous wastes by generators; provides a procedure for identifying waste as hazardous; provides minimum technology standards for TSDs; provides for corrective actions for historic solid and hazardous waste management units; establishes land disposal prohibitions and restrictions; regulates the installation, testing, and removal and remediation of underground storage tanks; regulates the management of used oil; and provides an enforcement mechanism.

1.9.1.3 Texas Water Development Board

The TWDB was established in 1957 through a state constitutional amendment. The agency's original function was to provide loan assistance to political subdivisions for the development of surface water supply projects that could not be financed through commercial channels. During the 1960s, the Board's responsibilities grew to include the authority to obtain and develop water conservation storage facilities, prepare a state water plan, and assume operations of the Texas Water Commission not related to the question of water rights. The state water planning functions are described in more detail later in Section 1.10.1.

Currently, the TWDB has a number of broad responsibilities. One primary function is still providing loans and grants for local governments for:

- Water supply, water treatment, and distribution;
- Wastewater treatment and other pollution control;
- Municipal and solid waste management;
- Economically distressed areas;
- Flood protection;
- Agricultural water conservation; and
- Regional water, wastewater, and flood protection planning.

The agency is also responsible for collecting data and conducting studies regarding agricultural water conservation, freshwater needs of Texas estuaries and bays, and surface and groundwater resources. As the agency responsible for developing a state water plan, the TWDB uses a number of research programs to assess and project water availability, environmental impact, and water uses for both agricultural and municipal areas. The Board continually collects surface and underground water information through hydrologic monitoring. It provides technical evaluation of water resource problems and promotes programs on conservation education.

1.9.1.4 Texas Commission on Environmental Quality

The TCEQ was formed by the Texas Legislature in 1991 by joining the former Texas Water Commission, the Texas Air Control Board, portions of the Texas Department of Health and other smaller agencies into the state's environmental regulatory and enforcement agency.

The TCEQ operates a number of water-related regulatory and pollution prevention programs, including:

- Water rights permitting;
- NPDES wastewater and urban stormwater permitting;
- Clean Rivers (water quality) Program;
- Leaky underground storage tank removal and remediation program;
- Priority Groundwater Management Area program (in conjunction with TWDB);
- Injection and disposal well permitting (in conjunction with the Railroad Commission of Texas);
- Wellhead protection;
- Solid waste permitting;
- Weather modification permitting; and
- Others.

1.9.1.5 Railroad Commission of Texas

The Railroad Commission of Texas (RRC) is the state agency responsible for regulating the oil and gas industry's safety and compliance. The cornerstone of the Oil and Gas Division's environmental effort are two programs funded by the Oilfield Cleanup (OFC) Fund, which was enacted in Senate Bill 1103 in 1991. The OFC Fund provides money to administer the Commission's well plugging and site remediation programs. The Underground Injection Control (UIC) program requires a RRC permit for every injection and disposal well in both productive and non-productive formations. The UIC program coordination has been delegated to the RRC by the USEPA, as mandated by the Safe Drinking Water Act. The RRC rules have been approved by the USEPA and they set very specific standards for well construction and testing to protect fresh water zones.

The RRC also administers several other environmental services. The Rule 8 Permitting Section handles permitting for management of oil and gas wastes at the surface including the use of pits for storage or disposal of waste, disposal methods including discharge to surface water or landspreading and commercial hauling of oil and gas. The Hazardous Waste Program regulates management of hazardous oil and gas wastes under Rule 98. This section coordinates with the TCEQ while actively seeking RCRA authorization from the USEPA for the Commission's hazardous waste program. The Waste Minimization Program works with the oil and gas industry to reduce the volume of waste that must be treated or disposed. The RRC is also responsible for the permitting and monitoring of underground hydrocarbon storage in salt caverns and depleted reservoirs. The UIC program administers that portion of the federal UIC program relating to injection/disposal wells for disposal of oil and gas wastes and enhanced recovery of oil and gas under Rules 9 and 46. The RRC rules have been approved by the USEPA and they set very specific standards for well construction and testing to protect fresh water zones.

1.9.2 Regional

1.9.2.1 Underground Water Conservation Districts

The establishment of underground water conservation districts was authorized by the 51st Texas Legislature in 1949 to provide for the conservation, preservation, recharging, and prevention of waste of groundwater, and to control subsidence. Chapter 36 of the Texas Water Code lays out numerous powers and duties, both required and allowed, of underground water conservation districts. Underground water conservation can make and enforce rules providing for the conservation, preservation, protection, and control of those resources. In addition, these districts may participate in the Agricultural Water Conservation Loan Program administered by the TWDB. The Agricultural Water Conservation Loan Program was established in 1985 with authority to issue up to $200 million in agricultural water conservation bonds. The TWDB may make loans to Districts that in turn make loans to irrigation farmers to make improvements to their irrigation facilities, and for the purchase and installation of more water-use-efficient irrigation equipment. The funds may also be used to prepare irrigated lands to be converted to dryland conditions and to prepare drylands for more efficient use of natural precipitation.

Six districts are currently in operation in the Llano Estacado Region. They are the High Plains, Sandy Land, Mesa, South Plains, Garza County, and Llano Estacado. Figure 1-7 shows the area served by each of these districts. The districts have adopted and are enforcing well spacing rules. In addition, they have extensive water quality and water level monitoring networks, well spacing regulations, and public education programs that have been designed to meet the needs of their respective constituents, as is presented below.

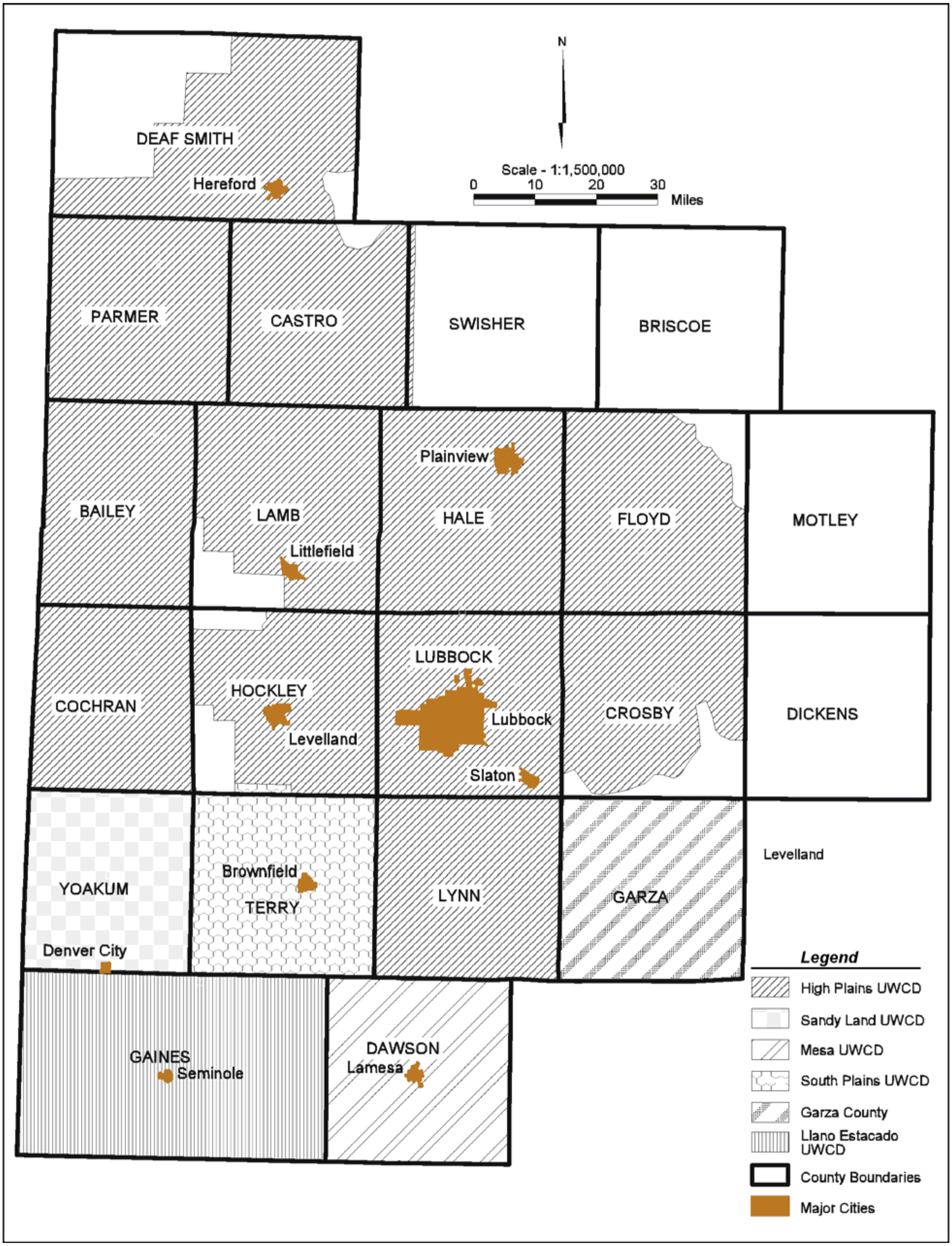

Figure 1-7. Underground Water Conservation District Boundaries (1999) Llano Estacado Region

High Plains Underground Water Conservation District No. 1

The Texas State Board of Water Engineers delineated the original boundaries of the High Plains Underground Water Conservation District No. 1 in March 1951. Then, on September 19, 1951, the people in all or parts of 13 Southern High Plains counties voted to create the District in accordance with the Underground Water Conservation Districts Act passed by the Texas Legislature in 1949. Additional territory has been annexed until the District now consists of six full counties (Bailey, Cochran, Hale, Lubbock, Lynn, and Parmer) and parts of nine more counties (Armstrong, Castro, Crosby, Deaf Smith, Floyd, Hockley, Lamb, Potter, and Randall).

The purpose of this District, as stated in the Texas Water Code, Chapter 36, is to provide for the conserving, preserving, protecting, and recharging of the underground water and prevention of waste of the underground water. During its history, the High Plains Underground Water Conservation District No. 1 has developed a management philosophy and associated management strategies. Between 1987 and 2002, the High Plains Underground Water Conservation District No. 1 participated in the Agricultural Water Conservation Loan Program. During its period of Agricultural Loan Program participation, the District loaned over $15.3 million to area farmers and ranchers who used the loans to install over 480 new center pivot irrigation systems.

The five-member Board makes and enforces rules with the advice and consent of 75 County Committee members to best accomplish the purposes of the District. A summary of the District's current activities and programs is shown in Table 1-19.

Sandy Land Underground Water Conservation District

The Sandy Land Underground Waster Conservation District was created in November 1989 by authority of Senate Bill 1777 of the 71st Legislature and has the same areal extent as Yoakum County. The District participates in the Agricultural Water Conservation Loan Program.

The District recognizes that the groundwater resources of the region are of vital importance to the continued vitality of the citizens, economy, and environment within the District. The District's Board feels that the preservation of the groundwater resources can be managed in the most prudent and cost effective manner through the regulation of production as effected by the District's well permitting and well spacing rules. Table 1-20 shows a summary of the District's activities and programs.

Table 1-19.
Summary of High Plains UWCD's Activities and Programs

Activities	***Comment***		
Well Permitting	The District requires permits for all new wells capable of producing in excess of 36,000 gpd.		
Well Construction Standards	Water Well Drillers and Pump Installers Rules.		
Well Spacing	Spacing is based upon the production capability of the new well, as follows:		
Well Production Factors		Minimum Distance From Nearest Well	Minimum Distance From Property Line
25 to 70 gpm		100 yards	25 yards
70 to 165 gpm		200 yards	50 yards
165 to 265 gpm		300 yards	75 yards
265 to 390 gpm		350 yards	87.5 yards
390 to 560 gpm		400 yards	100 yards
560 to 1,000 gpm		500 yards	125 yards
Greater than 1,000 gpm		540 yards	135 yards
Production Regulations	Production regulations are implemented through the spacing of wells.		
Water Level Monitoring	Annual measurement is taken in more than 1,200 wells within the District.		
Water Quality/Quantity Management Programs	Hydrologic atlases showing elevation of land surface, water-table, base of the formation, and saturated thickness are published every 5 years.		
Water Quality Testing and Monitoring	Selected wells are sampled from 3 counties each year on a rotational basis to allow a 5-year cycle to cover the District Service Area.		
Data Collection and Distribution	A database of water quality and approximate quantities of water in storage in the formation is maintained and published in Hydrologic Atlases and in the monthly newsletters.		
NPS and Point Source Regulations	Contamination of groundwater is addressed under the District's Waste Rule. It is a violation of High Plains Underground Water District rules to "pollute or harmfully alter the character of the underground water reservoir of the District by means of salt water or other deleterious material admitted from some other stratum or from the surface of the ground."		
Programs	***Comment***		
Public Education	Monthly newsletter, frequent Public Service Announcements on radio and TV, distribution of educational materials in public schools, presentations to civic and social groups, TV and radio interviews, and displays at area fairs.		
Special Activities	Programs of soil moisture monitoring, pump plant efficiency testing, tailwater abatement, open hole closing, leak detection for towns and cities, cost-in-water income tax depletion allowance, irrigation assessment, water well site validation, water well flow testing, and abandoned well closure.		

Table 1-20.
Summary of Sandy Land UWCD's Activities and Programs

Activities	***Comment***
Well Permitting	The District requires well permits for any wells capable of producing in excess of 25,000 gpd.
Well Construction Standards	The District requires proper completion of wells in accordance with Texas Water Well Drillers Board requirements.
Well Spacing	From property lines: 4-inch or smaller pump - 100 yards from the nearest property line; 5-inch pump - 125 yards from the nearest property line; 6-inch pump - 150 yards from nearest property line; 8-inch pump – 200 yards from nearest property line. Any pump larger than 8-inch – 300 yards from nearest property line.
Production Regulations	5 gpm per acre owned.
Water Level Monitoring	Measures approximately 100 wells within the District annually for water level. Data from measurements sent to the TWDB for their water level database. Data is used by the District to construct annual water level decline maps.
Water Quality/Quantity Management Programs	Water quality program consisting of approximately 100 wells, monitored yearly for various constituents. Coliform bacteria test upon request. Mineral analysis conducted on wells selected by the District upon request.
Water Quality Testing and Monitoring	Maintains an in-house lab where testing can be done at no cost to the well owner as well as no cost through certified labs, if deemed necessary. Works with the Railroad Commission in protecting the groundwater from certain oilfield activities such as saltwater storage and disposal. Conducts pesticide study in the southern and northern portions of Yoakum County.
Data Collection and Distribution	Gathers data through the District's annual water level monitoring program. Uses data to construct District's decline maps. Also, supplies data to the TWDB for their water level database. District also collects data from in-house lab.
NPS and Point Source Regulations	Conducts pesticide studies to evaluate point source possibilities.
Programs	***Comment***
Public Education	Educates the public through schools, libraries, speaking engagements and literature distribution.
Special Activities	Pumping efficiency test, flow tests, pumping level and pressure tests for sprinkler systems. Distributes the "Sandy Land News" quarterly. Awards two $1,000 scholarships and two $500 scholarships to area high school seniors based on essays relating to conservation and suggestions for future conservation. Free low flow shower heads available to the public. Grants to area farmers, IRS Depletion Program, Ag Water Conservation Equipment Loan Program, managing entity for Yoakum County Landfill. Participates in Precipitation Enhancement Program.

Mesa Underground Water Conservation District

The citizens of Dawson County, through a local election in January 1990, created the Mesa Underground Water Conservation District, which has boundaries the same as Dawson County. The District has five board members: one member representing each of the four county precincts and one at-large member elected by and representing all residents of the county.

The District believes its most valuable natural resource—water—can be managed at the local level in a prudent and cost-effective manner by regulating the spacing of wells and production of water from wells. A summary of the activities and programs of the District is shown in Table 1-21.

Table 1-21.
Summary of Mesa UWCD's Activities and Programs

Activities	***Comment***
Well Permitting	All new wells are registered prior to drilling.
Well Construction Standards	Consistent with Water Well Drillers and Pump Installers Rules.
Well Spacing	Permitted wells must be drilled no closer than 300 feet from the adjoining landowner's property line. Exceptions may be available with Board approval or with a signed waiver from the adjoining property owner. Exempt wells must meet Water Well Drillers State Rules.
Production Regulations	5 gpm per acre, not to exceed 4 acft per acre per year.
Water Level Monitoring	The District annually measures 188 wells for baseline comparison. This information is shared with the TWDB.
Water Quality/Quantity Management Programs	The District is involved with the City of Lamesa in a Wellhead Protection Plan. Plans are scheduled for the Cities of O'Donnell, Ackerly, Welch, and Gail.
Water Quality Testing and Monitoring	All wells registered with the District will be tested. The District annually monitors 47 wells for quality comparison.
Data Collection and Distribution	The District collects data and shares data with the TWDB. The District collects data from used oil collection and used oil filter collection and provides information to the TCEQ.
NPS and Point Source Regulations	The District provides drip oil containers for irrigation wells and is working on an oil drain container for irrigation engines. The District has implemented used oil collection, used oil filter collection, and crushing programs.
Programs	***Comment***
Public Education	The District distributes educational materials including conservation book covers to all schools in the District. The District also provides education booths at the County Fair, with presentations of "Willie the Water Dog" to younger students and demonstrations of their water model to older students.
Special Activities	The District provides news articles for the local newspaper and participates in Texas Recycles Day.

South Plains Underground Water Conservation District.

The South Plains Underground Water Conservation District (SPUWCD) was created by House Bill 281, (72nd Legislature) in 1991. Originally, the jurisdictional extent of the District was the same as Terry County. However, in 1994, landowners controlling 1,302 acres of land in Hockley County individually petitioned the District for annexation. Each petition was approved by unanimous vote of the Board.

To accomplish the District's mission of developing, promoting, and implementing management strategies to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater resources, the District has implemented several activities and programs. The SPUWCD participated in the Agricultural Water Conservation Loan Program from 1994 to 2000, during which time $4.7 million was loaned for irrigation system improvements. Table 1-22 shows a summary of the District's activities and programs, which comprise the management goals established by the District's Board.

Table 1-22.
Summary of South Plains UWCD's Activities and Programs

Activities	***Comment***
Well Permitting	The District requires drilling permits for wells whose expected production capability will be 25,000 gpd (17.36 gpm) or more.
Well Construction Standards	Same as those set by the state.
Well Spacing	From property lines and between wells. Based on the size of pump installed and corresponding gallon per minute pumping rate.
Production Regulations	5 gpm per acre, not to exceed 4 acft per acre per year.
Water Level Monitoring	Measures approximately 100 wells in the District annually. Data from measurements are sent to the TWDB for their water level database. Data are used by the District to construct annual water decline maps.
Water Quality/Quantity Management Programs	The District works with local and state agencies on water analysis and management programs.
Water Quality Testing and Monitoring	The District annually monitors water quality of approximately 100 water wells. Water quality testing services are extended to the District's residents at no charge and include coliform bacteria testing.
Data Collection and Distribution	The District collects and distributes water level measurement data to state agencies and to local government and individuals upon request. Quarterly newsletters and hydrologic maps are also posted on the District's website.
NPS and Point Source Regulations	The District has well construction standards and addresses pollution of groundwater in its rules.
Programs	***Comment***
Public Education	The District educates the public through schools, speaking engagements, literature distribution, and its website.
Special Activities	The District sponsors free flow testing and efficiency testing for local irrigated agricultural producers. The District sponsors educational curriculum for all fourth-graders in Terry County. The District sponsors awards for 4-H and assists in Natural Resources projects. The District participates in the Southern Ogallala Aquifer Rainfall Enhancement Program.

Llano Estacado Underground Water Conservation District

The Llano Estacado Underground Water Conservation District was created in 1991 by the 72nd Texas Legislature and encompasses all of Gaines County. District creation was confirmed by the voters in November 1998. The District adopted rules and a management plan in September 1999 and April 2000, respectively. Table 1-23 shows a summary of the District's activities and programs.

Table 1-23.
Summary Llano Estacado UWCD's Activities and Programs

Activities	Comment
Well Permitting	The District requires drilling permits for wells whose expected production capability will be 25,000 gpd (17.36 gpm) or more.
Well Construction Standards	Same as those set by the state.
Well Spacing	From property lines and between wells. Based on the size of pump installed and corresponding gallon per minute pumping rate.
Production Regulations	10 gpm per acre, per contiguous acre owned.
Water Level Monitoring	Measures approximately 175 wells in the District annually. Data from measurements are sent to the TWDB for their water-level database. Data are used by the District to construct annual water level change maps and periodic saturated thickness maps.
Water Quality/Quantity Management Programs	The District works with local and state agencies on water analysis and management programs.
Water Quality Testing and Monitoring	The District annually monitors water quality of approximately 100 water wells. Water quality testing services are extended to the District's residents at no charge and include coliform bacteria testing.
Data Collection and Distribution	The District collects and distributes water-level measurement data to state agencies and to local government and individuals upon request. Quarterly newsletters and hydrologic maps are also posted on the District's website.
NPS and Point Source Regulations	The District has well construction standards and addresses pollution of groundwater in its rules.
Programs	**Comment**
Public Education	The District educates the public through schools, speaking engagements and literature distribution.
Special Activities	The District sponsors free flow testing and efficiency testing for local irrigated agricultural producers. The District sponsors educational curriculum for all fourth-graders in Gaines County, sponsors awards for 4-H, and assists in Natural Resources projects. The District participates in the Southern Ogallala Aquifer Rainfall Enhancement Program.

Garza County Underground and Fresh Water Conservation District

The Garza County Underground and Fresh Water Conservation District was created and organized under the terms and provisions of Section 59, Article XVI, Texas Constitution and House Bill 846, including all amendments and additions, of the 74th Legislature in 1995. The District has all of the rights, powers, privileges, authority, functions, and duties provided by the general laws of this state, including Chapter 36 of the Texas Water Code, Vernon's Texas Codes Annotated, applicable to underground water conservation districts created under Section 59, Article XVI, Texas Constitution.

The District recognizes that the groundwater resources of the region are of vital importance to the residents of the District and that this resource must be managed and protected from contamination and waste. To accomplish these objectives, the District has instituted regulations governing well permitting and well spacing along with other regulations. Table 1-24 shows a summary of the District's activities and programs.

1.9.2.2 Surface Water Supply and Management Authorities and Districts

The Canadian River Municipal Water Authority (CRMWA), the White River Municipal Water District (WRMWD), the Mackenzie Municipal Water Authority (MMWA), the Red River Authority (RRA), and the Brazos River Authority (BRA) are present and have water supply and management functions in the Llano Estacado Region, as presented below.

Canadian River Municipal Water Authority

In November 1953 the Texas Legislature authorized the CRMWA to organize as a legal entity and independent political subdivision of Texas for the purpose of implementing the Canadian River Project, which had been authorized by Congress in 1950. Eleven cities formed the Authority: Amarillo, Borger, Pampa, Plainview, Lubbock, Slaton, Brownfield, Levelland, Lamesa, Tahoka, and O'Donnell. Under a tri-state compact, Texas was entitled to 100,000 acft of water a year for use by the member cities and 51,000 acft for use by industries.[52] A dam was

[52] **Canadian River Compact.** Entered into by New Mexico, Oklahoma, and Texas, the compact guarantees that Oklahoma shall have free and unrestricted use of all waters of the Canadian River in Oklahoma and that Texas shall have free and unrestricted use of all water of the Canadian River in Texas subject to limitations upon storage of water (500,000 acft of storage until such time as Oklahoma has acquired 300,000 acft of conservation storage, at which time Texas's limitation shall be 200,000 acft plus the amount stored in Oklahoma reservoirs). New Mexico shall have free and unrestricted use of all waters originating in the drainage basin of the Canadian River above Conchas Dam and free and unrestricted use of all waters originating in the drainage basin of the Canadian River below Conchas Dam, provided that the amount of conservation storage in New Mexico available for impounding water originating below Conchas Dam be limited to 200,000 acft.

Table 1-24.
Summary of Garza County Underground and Freshwater Conservation District's Activities and Programs

Activities	Comment
Well Permitting	The District requires well permits for any well capable of producing in excess of 25,000 gallons of water per day.
Well Construction Standards	The District requires proper completion of wells in accordance with Texas Water Well Driller's Board requirements.
Well Spacing	Based on size of pump installed and corresponding gpm pumping rate.
Production Regulations	Production allowable is based on distance from other wells, starting at 50 yards for a 1.5-inch pump or well producing 40 to 70 gpm.
Water Level Monitoring	Pending.
Water Quality/Quantity Management Programs	The District works with local and state agencies on water analysis and management programs.
Water Quality Testing and Monitoring	Pending.
Data Collection and Distribution	Pending.
NPS and Point Source Regulations	The District rules state that all wells drilled will be at least 150 feet from any contamination (e.g., livestock or poultry yards, septic absorption fields or privies) and not located in an area generally subject to flooding. In case of a flood area, a sanitary water tight seal must be installed at least 24 inches above the known flood level.
Programs	***Comment***
Public Education	Yes.
Special Activities	Yes.

constructed on the Canadian river 9 miles west of Borger, Texas, and an aqueduct was constructed to deliver water from the reservoir to the member cities. The dam crossing the Canadian River 9 miles west of Borger is 226 feet high and 6,380 feet long. The aqueduct system, with 322 miles of pipeline, ten pumping plants, and three regulating reservoirs, furnishes municipal and industrial water to the cities of the Authority. In recent years, CRMWA has acquired groundwater rights from property located in Region A to improve the quality and increase the quantity of water delivered via its aqueduct to its member cities. A summary of CRMWA's programs and activities is shown in Table 1-25.

Table 1-25.
Summary of Canadian River Municipal Water Authority's Programs and Activities

Programs & Activities	***Comment***
Chloride Control	The Authority has implemented a plan to reduce the natural salt flow into Lake Meredith. The plan includes pump saltwater from wells drilled into a natural brine artesian aquifer currently discharging into the Canadian River. The saltwater disposed is by deep-well injection into a formation below those that affect local aquifers and streams.
Water Quality Improvements	A Conjunctive Use Groundwater Supply Project has been developed in Roberts and Hutchinson Counties which is supplying groundwater that is being mixed with surface water before being delivered to member cities.
Water Quality Monitoring	The Authority regularly monitors the water quality of Lake Meredith.
Water Supply Programs	The Authority supplies water from Lake Meredith and a well field to its 11 member cities.

White River Municipal Water District

The WRMWD owns and operates White River Reservoir, from which the District's water right authorizes the diversion of up to 6,000 acft of water per year for municipal and mining purposes. The District delivers water to Crosbyton, Ralls, Spur, and Post. In addition, the WRMWD holds a permit for the construction of the Post Reservoir located on the North Fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas, in Garza County. The Post Reservoir conservation pool would have a surface area of 2,280 acres, and provide approximately 56,000 acft of storage before sedimentation and 37,000 acft of storage after 50 years of sedimentation. A 1968 reservoir analysis indicated that the Post Reservoir would have a firm yield of approximately 9,500 acft/yr in 2020 considering runoff declines and sedimentation.[53] The 1968 construction cost estimate was $2.2 million. Table 1-26 shows a summary of WRMWD's activities and programs.

WRMWD has obtained groundwater rights and drilled and equipped several wells so that groundwater will be available to supplement the surface water in times of drought.

[53] Freese, Nichols, and Endress, "Feasibility Report on Post Reservoir Site," prepared for White River Municipal Water District, September 1968.

Table 1-26.
Summary of White River Municipal Water District's Programs and Activities

Programs & Activities	Comment
Water Quality Monitoring	The District maintains a water quality monitoring program at its treatment plant.
Water Supply Programs	The District supplies water to communities located in five counties.
Public Participation & Education	**Comment**
Educational Programs	The District hosts field trips by area schools to view its facilities.

Mackenzie Municipal Water Authority

The MMWA owns and operates Lake Mackenzie located in Swisher and Briscoe Counties. The Authority delivers water to the Cities of Silverton, Tulia, Floydada, and Lockney. Table 1-27 shows a summary of MMWA's activities and programs.

Table 1-27.
Summary of Mackenzie Municipal Water Authority's Programs and Activities

Programs & Activities	Comment
Water Quality Monitoring	The Authority maintains a water quality monitoring program.
Water Supply Programs	The Authority supplies water to four cities.
Public Participation & Education	**Comment**
Educational Programs	The Authority hosts field trips by area school children to view its facilities.

Brazos River Authority

The BRA was established in 1929 by the Texas Legislature as a public agency of the state of Texas. It has statutory responsibility for developing and conserving the surface water resources of the Brazos River Basin in Texas and for putting these resources to use in the best interest of the people of Texas. The Brazos River Basin covers some 42,000 square miles in Texas, about one-sixth of the area of the state; the boundaries of the river authority include all or part of 65 Texas counties. About 8,732 square miles (43 percent) of the Llano Estacado Region lie in the Brazos Basin or BRA management area. Table 1-28 shows a summary of BRA's programs and activities.

Table 1-28.
Summary of Brazos River Authority's Programs and Activities

Programs & Activities	Comment
Texas Clean Rivers Program	The Authority contracts with the TCEQ to conduct the Clean Rivers Program for the Brazos River Basin.
Watershed Protection	The Authority established the Watershed Protection Program in 1994 to focus attention on watersheds where water quality problems have been identified and to establish instream water quality targets.
Water Quality Monitoring	The Authority evaluates water quality conditions of the reservoirs and stream segments that comprise the Authority's basin-wide water supply system. The Authority also maintains a water quality testing lab.
Water Supply Programs	The Authority supplies water to numerous entities in the Brazos River Basin.
Public Participation & Education	**Comment**
Newsletter	The Brazos Basin Update is a quarterly newsletter about Authority programs and activities.
Educational Programs	The Authority participates in the Major Rivers Water Education Program, which targets fourth-grade students throughout the Brazos River Basin.

Red River Authority

The RRA of Texas, an official agency of the state, was created by an act of the 56th Legislature in 1959. It has jurisdiction over the entire Red River watershed in Texas, including all or part of 43 counties, an area encompassing 40,266 square miles. About 6,681 square miles (32.9 percent) of the Llano Estacado Region is in the Red River Basin and is within the RRA management area. The RRA has broad powers over the conservation, storage, control, preservation, quality, and utilization of water along the Red River and its Texas tributaries. Headquarters for the authority is located in Wichita Falls. The Authority assists communities, towns, municipalities, and other entities in an effort to identify and encourage development of potential water supply sources, to conserve and protect existing water supplies, and to develop and improve water and wastewater facilities. In compliance with the Clean Rivers Act, the RRA has prepared a 5-year work plan for water quality assessment of the Red River Basin. Table 1-29 shows a summary of the RRA's activities and programs.

Table 1-29.
Summary of Red River Authority's Programs and Activities

Programs & Activities	***Comment***
Texas Clean Rivers Program	The RRA contracts to perform Clean River Act duties on behalf of both the Canadian River Basin and the Red River Basin.
Chloride Control	The RRA is playing a role in the Red River Basin Chloride Control Project, a federal endeavor to reduce the naturally occurring levels of chlorides in the Red River and its tributaries.
Water Quality Monitoring	The Authority collects water quality samples to determine quantitative cause and effect relationships of water quality, obtain sufficient data for updating water quality management plans, set effluent limits, identify non-point sources of pollution and classify stream segments.
Water Supply Programs	The Authority supplies water to several entities within the Red River Basin.
Public Participation & Education	***Comment***
Texas Rivers Project	The Texas Rivers Project is a grassroots initiative developed as a result of a joint partnership between the RRA and River Bend Nature Works, Inc. of Wichita Falls. The program consists of a multi-disciplinary curriculum with focus on math, science, technology and social studies relating to water ecology and includes volunteer environmental monitoring.
Educational Programs	The Authority participates in the Major Rivers Water Education Program, which is intended to help fourth-grade children throughout Texas learn about how we get and use water and how important it is for us to conserve water.

1.9.3 Local

1.9.3.1 City of Lubbock

The City of Lubbock is supplied water by CRMWA and obtains water from its own well fields in Bailey and Lamb Counties. In addition, Lubbock uses water from wells within the City for irrigation of parks and open spaces. In the foreseeable future, Lubbock will continue to rely on surface water from CRMWA, groundwater from CRMWA's new Roberts County well field and from the City's own well fields to meet its needs. The City also has water rights in Lake Alan Henry, and is planning to develop a pipeline and water treatment plant to use this source of supply.

1.10 Existing Water-Related Plans

1.10.1 State Water Plan [54]

In Section 16.051 of the Texas Water Code, the Executive Administrator of the TWDB is charged with producing a State Water Plan that addresses the broad public interest of the state. As currently specified in Section 16.055 and 16.056, the Plan is to be periodically reviewed and updated and serves as a flexible guide to state policy for the development of its water resources.

The Plan provides a statewide perspective that places local and regional needs in a broader context. New legislation, passed by the 75th Legislature in 1997, specifies a 5-year update period for the Plan, which is to be based on regional planning studies, and provides that related financial assistance applications must be consistent with the regional and state plans for regulatory approval by state agencies. The ultimate goal of the State Water Plan is to identify those policies and actions that may be needed to meet Texas' near- and long-term water needs, based on a reasonable projected use of water, affordable water supply availability, and a goal of conservation of the state's natural resources.

The following sections provide a summary of recommendations for this region contained in the 2002 Water for Texas Update to the State Water Plan.

1.10.1.1 Canadian River Basin

Due to the scarcity of locally-developable surface water supplies, any additional water needed for the basin will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development of minor aquifers present in the basin. A recent example of additional well field development is the planned CRMWA's well fields in Roberts County, which are expected to supplement and improve the quality of Lake Meredith's surface water. The Authority is permitted to use a maximum of 40,000 acft of groundwater per year from these wells and up to 50,000 acft under unusual or emergency conditions. This approach cannot necessarily be used throughout the area; however, there are certain other areas of the Ogallala that could be developed.

[54] TWDB, "Water for Texas, A Consensus-Based Update to the State Water Plan," August 1997.

1.10.1.2 Red River Basin

Due to the scarcity of locally-developable surface water supplies in the High Plains portion in the upper basin, any additional supplies needed to this area will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development of minor aquifers present in the basin.

1.10.1.3 Brazos River Basin

Due to the scarcity of locally-developable surface water supplies, any additional supplies needed for the Southern High Plains portion of the upper basin will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development of minor aquifers present in the basin. The recently completed Lake Alan Henry will be required to provide additional water supplies to Lubbock. The Post Reservoir project is permitted for development in the Brazos Basin.

The WRMWD has a state permit to construct the Post Reservoir project on the North Fork Double Mountain Fork of the Brazos River in Garza County, but has yet to apply for the necessary federal permits. The state permit authorizes the owner to impound 57,420 acft of water at elevation 2,430 ft-msl. This project is permitted to supply 10,600 acft of water per year for municipal, industrial and mining use. The estimated cost for the Post project is $30.5 million (2002 prices).

1.10.1.4 Colorado River Basin

Due to scarcity of locally-developable surface water supplies, any additional supplies needed for the Southern High Plains portion of the upper basin will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development of minor aquifers present in the basin.

1.10.2 Regional Drought Contingency and Groundwater Management Plans

1.10.2.1 Brazos River Authority [55]

The BRA's drought contingency plan defines triggering conditions, based on reservoir levels, for water shortage conditions and actions designed to lower water use during these

[55] Brazos River Authority, "Drought Contingency Policy," July 1999, and "Water Conservation Policy," July 1999.

conditions. Upon the declaration of drought conditions for a particular reservoir, the Authority will develop a specific drought contingency plan for the system or local use reservoir. In addition to the drought contingency plan, the Authority has also developed a water conservation plan which outlines several goals to encourage water conservation within the Brazos River Basin, including developing and implementing a water conservation education and information program and encouraging and assisting contract users in developing and implementing water conservation programs.

1.10.2.2 Canadian River Municipal Water Authority [56]

The CRMWA supplies raw water to 11 Member Cities via a 322-mile aqueduct system. The CRMWA's primary source of water is Lake Meredith located in the Canadian River Basin. The CRMWA's water conservation plan provides conservation goals, as well as setting standards for leak control and repair, measurement of diverted water, and records management. The CRMWA has also adopted a drought contingency plan which defines trigger conditions for water shortage conditions and goals of water use reduction while the water shortage condition persists. To achieve the water use reduction goals, during times of water shortages CRMWA's Member Cities will implement their individual drought contingency plans.

1.10.2.3 Garza County Underground and Freshwater Conservation District [57]

This management plan becomes effective upon Certification by the TWDB after adoption by the District Board of Directors and remains in effect until September 1, 2008, or for a period of 10 years, whichever is later. The plan may be revised at any time or after 5 years, when the plan will be reviewed to insure that it is consistent with the applicable Regional Water Plan and the State Water Plan. The overall objective of the District is the conservation, preservation, protection, recharge, and enhancement of the groundwater supplies within the boundaries of the District and to make wise and beneficial use of the resources for the benefit of the citizens and economy of the District. To accomplish these goals, the District plans to implement a program to monitor both the quantity and quality of these water supplies and also to promote a brush control program for the District.

[56] Canadian River Municipal Water Authority, "Drought Contingency Plan," July 14, 1999, and "Water Conservation Plan," July 14, 1999.
[57] Garza County Underground and Freshwater Conservation District, "Water Management Plan," 1998.

In developing a drought contingency plan, the District will consider the economic effects of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage and weather conditions, and the appropriate conditions under which to implement the contingency plan.

1.10.2.4 High Plains Underground Water Conservation District No. 1[58]

This current management plan is a revision of the management plan adopted by the Board in June 1998. This plan became effective August 11, 1998, upon adoption by the Board of Directors of the District and will remain in effect until a revised plan is approved or until August 31, 2008, whichever is earlier. From the District's inception, the Board of Directors has upheld the philosophy that ownership of the groundwater is a private property right. The Directors continue to support this right for the landowners. The philosophy of groundwater management in the District was established early and formally adopted by the Board; the District is dedicated to the principle that conservation is best accomplished through public education.

The District enforces its rules to conserve, preserve, protect, and prevent the waste of groundwater resources in its jurisdiction. Besides public education, the District management plan outlines its well registration, well spacing, water level monitoring, pre-plant soil moisture, potential evapotranspiration irrigation scheduling, and agricultural water conservation loan equipment programs. The District also publishes an annual report outlining its performance in achieving its goals.

All of the District's programs and activities are directed at promoting maximum conservation of the area's water resources. The adoption and utilization of the best available technology and equipment by area water users, on a continuous basis, is the best drought contingency plan possible. Installing and utilizing equipment that result in minimum loss or waste of water prior to a drought reduces the impact of a drought when one occurs.

1.10.2.5 Mackenzie Municipal Water Authority[59]

The MMWA owns and operates Lake Mackenzie from which the Authority supplies water to the Cities of Floydada, Lockney, Silverton, and Tulia, located within the planning area. The triggering criteria for water allocation in this plan are based entirely on the water level in

[58] High Plains Underground Water Conservation District No. 1, "Management Plan," August 11, 1998.
[59] Mackenzie Municipal Water Authority, "Drought Contingency Plan for Mackenzie Municipal Water Authority," August 1, 1999.

Lake Mackenzie. This plan also identifies water conservation goals that will be placed into effect during water shortage conditions. Under this plan, during a mild water shortage condition, the Authority will try to achieve a voluntary 10 to 20 percent reduction in total water use, while during a severe water shortage condition, the Authority's goal is to achieve a 50 to 60 percent reduction in total water use.

1.10.2.6 Mesa Underground Water Conservation District [60]

The District's August 31, 1998 management plan, has been readopted, following adoption by the local Board of Directors and certification as administratively complete by the TWDB. As a result of SB 2, a new management plan had to be prepared. The new District management plan became effective January 2, 2004 and will remain in effect for a period of 10 years (minimum planning period), until a revised or amended plan is certified or January 2, 2014, whichever comes first. The guiding principles in developing the management plan is to better understand groundwater conditions, to encourage the most effective use of groundwater, to preserve and protect groundwater quality, to increase public awareness and education, and to monitor legislative activities along with rules and orders of state agencies which may effect the private ownership of groundwater including the authority to manage at the local level.

A contingency plan to cope with the effects of water supply shortages due to climatic or other conditions will be developed by the District and will be adopted by the Board after notice and hearing. In developing the contingency plan, the District will consider the economic effect of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage conditions, the unique hydrologic conditions of the aquifer, and the appropriate conditions under which to implement the contingency plan.

1.10.2.7 Sandy Land Underground Water Conservation District [61]

This management plan became effective on September 1, 1998 upon adoption by the Sandy Land Underground Water Conservation District Board of Directors and certification as administratively complete by the TWDB. The plan will remain in effect through September 2008 or until a revised plan is adopted and certified. The Sandy Land Underground Water Conservation District recognizes that the groundwater resources of the region are of vital importance to the continued vitality of the citizens, economy and environment within the

[60] Mesa Underground Water Conservation District, "Management Plan," January 2, 2004.
[61] Sandy Land Underground Water Conservation District, "Groundwater Management Plan," July 10, 1998.

District. The District feels that the preservation of the groundwater resources can be managed in the most prudent and cost effective manner through the regulation of production as effected by the District's well permitting and well spacing rules. This management plan is intended as a tool to focus the thoughts and actions of those individuals charged with the responsibility for the execution of District activities.

A contingency plan to cope with the effects of water supply deficits due to climatic or other conditions will be developed by the District and will be adopted by the Board after notice and hearing. In developing the contingency plan, the District will consider the economic effect of conservation measures upon all water resource user groups, the local implications of the degree and effect of changes in water storage conditions, the unique hydrogeologic conditions of the aquifers within the District, and the appropriate conditions under which to implement the contingency plan.

1.10.2.8 South Plains Underground Water Conservation District [62]

This management plan became effective September 1, 1998, upon adoption by the Board of Directors of the District and will remain in effect until a revised plan is approved or until August 31, 2008, whichever is earlier. The District was formed, and has been operated from its inception, with the guiding belief that the ownership and pumpage of groundwater is a private property right. The Board has adopted the principle of "education first" and regulation as a last resort in their effort to encourage conservation of the resource. As a result, the rules of the District were designed to give all landowners a fair and equal opportunity to use the groundwater resource underlying their property for beneficial purposes. Effective July 1, 1999, the District adopted new rules that regulate the spacing between wells.

In the District, groundwater conservation is stressed at all times. The Board recognizes that irrigated agriculture provides the economic stability to the communities within the District. Therefore, through the notice and hearing provisions required in the development and adoption of this management plan, the Board has adopted the official position that, in times of precipitation shortage, irrigated agricultural producers will not be limited to any less pumpage of groundwater than is provided for by District rules. In order to treat all other groundwater user groups fairly and equally, the District will encourage more stringent measures, where practical, but will not limit groundwater use in any way not already provided for by District rules.

[62] South Plains Underground Water Conservation District, "Management Plan," September 1, 1998.

1.10.2.9 White River Municipal Water District [63]

The White River Municipal Water District's primary water supply is obtained from surface water diverted from White River Lake; however, the District has purchased groundwater rights and drilled wells to supplement its surface water supply during times of prolonged drought. The District's Water Conservation Plan applies to each of the District's customers which the District bills directly. However, the plan does not apply to the District's member cities (Crosbyton, Post, Ralls, and Spur).

It is the goal of the District to maintain unaccounted-for water at 15 percent or less and to achieve a 1 percent reduction in average day municipal per capita water use by the year 2050. In order to achieve these goals the District will promote water conservation by informing the public of ways to conserve water, adopting a new plumbing code, and instituting a plumbing retrofit program. In addition to these measures, the District will also test or replace meters that appear to have abnormally high or low water usage and will establish a leak detection and repair program.

1.10.3 Local Drought Contingency Plans

1.10.3.1 City of Brownfield [64]

The City of Brownfield's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of drought response stages as well as the water use restrictions in effect during times of water shortages. It is the goal of this plan to reduce total water use by 50 percent during "critical water shortage conditions" and 75 percent during "emergency water shortage conditions." To achieve these goals, the plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use. Water uses regulated or prohibited under this plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender to penalties such as fines or citations.

[63] White River Municipal Water District, "Water Conservation Plan," July 2, 1999.
[64] City of Brownfield, "Drought Contingency Plan for the City of Brownfield," August 19, 1999.

1.10.3.2 City of Denver City [65]

The City of Denver City owns and operates the water system and provides potable water to its residents. The city's current water supply is well water from the Ogallala Aquifer system and the Trinity Group. Six wells are located 1 mile west of the city; and other wells are located 7 miles west of the city. The total pumping capacity of these wells is 6.5 million gallons per day (MGD). The city leases the water rights of the wells 1 mile west of the city from Exxon, Inc. Additional water rights are owned on two sections 7.5 miles northwest of the city. The city is planning to extend water lines east of the city and expects to provide water to approximately 40 customers who currently have domestic water wells. Some of these privately-owned wells are threatened with contamination.

Denver City's average daily usage was 126 gallons per capita per day (gpcd) in 1987 and 149 gpcd in 1988. It is the goal of the water conservation plan to reduce water usage to 140 gpcd.

The city's drought contingency program includes measures to significantly reduce water use on a temporary basis. These measures involve voluntary reductions, restrictions and/or elimination of certain types of water use, and water rationing. It is the goal of the drought contingency plan to reduce water use during an emergency or prolonged drought by 35 percent.

1.10.3.3 City of Lamesa [66]

The City of Lamesa's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of drought response stages, as well as the water use restrictions in effect during times of water shortages. It is the goal of this plan to reduce total water use by 50 percent during "critical water shortage conditions" and 75 percent during "emergency water shortage conditions." To achieve these goals, the plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use.

[65] City of Denver City, "Water Conservation and Drought Contingency Plan," December 4, 1989.
[66] City of Lamesa, "Drought Contingency Plan," August 16, 1999.

1.10.3.4 City of Levelland [67]

The City of Levelland's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of five water shortage conditions, as well as the water use restrictions in effect during these stages. The goals of this plan are to achieve a voluntary 3 percent reduction in daily water demand during mild water shortage conditions and to achieve an 18 percent reduction in daily water demand when under a "critical water shortage condition." To achieve these goals, the plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use. Water uses regulated or prohibited under this plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender to penalties such as fines or citations.

1.10.3.5 City of Littlefield [68]

The City of Littlefield owns, operates, and manages the waterworks system. The city's waterworks system serves approximately 2,921 connections. The majority of these connections are within the city limits of Littlefield; however, a few of the customers live outside the corporate limits of the city. The waterworks system covers approximately 3.5 square miles. Over the past several years the city has experienced moderate growth. The city's waterworks system has not been exceeded in its available capacity to supply the customers' demand. Littlefield is considering obtaining additional water rights to assure future water for its customers. From the Utility Evaluation, the City of Littlefield has set a goal of per capita water use reduction of 15 percent.

The City of Littlefield's Emergency Water Demand Management Plan contains trigger conditions to stipulate when water use should be curtailed. The plan includes restrictions on lawn watering, car washing, and certain public water uses that are not essential for public health or safety.

[67] City of Levelland, "Drought Contingency Plan," July 29, 1999.
[68] Oller Engineering, Inc. for the City of Littlefield, "Water Conservation Plan and Drought Contingency Plan," March 1997.

1.10.3.6 City of Lubbock [69]

The purpose of the City of Lubbock's Water Conservation Plan is to promote the responsible use of water by (1) supporting public education programs, (2) maintaining policies that support wise use of water, and (3) providing for enforcement of water conservation policies and practices. It is the goal of the Plan to reduce water usage by 20 gpcd by the year 2014. To achieve this goal, the City of Lubbock will continue its programs for universal metering and controlling unaccounted-for uses of water, as well as continue the city's program of continuing education regarding water conservation.

The City of Lubbock's Drought Contingency Plan outlines the city's drought and emergency contingency procedures and identifies the triggering criteria for initiation and termination of the four water shortage conditions, as well as the water use restrictions in effect during times of water shortages. The plan contains restrictions on water use to be in effect during water shortages that include irrigation of landscaped areas, use of water to wash any motor vehicle, operation of any ornamental fountain or pond, and other restrictions on outdoor water use. Water uses regulated or prohibited under this plan are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender to penalties such as fines or discontinuance by the city of water services to water utility customers or other users.

1.10.3.7 City of Plainview [70]

The City of Plainview's Conservation and Drought Contingency Plan outlines ordinances the city has put into effect to reduce per capita use and to curtail water use during times of drought. In order to lower the city's per capita water use, the city has adopted a plumbing code that limits residential meters to 1-inch or smaller, has initiated a water meter retrofit program, provides educational materials on water conserving landscaping, and maintains a leak detection and repair program.

The city's drought contingency plan outlines the city's drought response procedures. The plan contains restrictions on water use to be in effect during water shortages that include

[69] City of Lubbock, "Water Conservation Plan," August 26, 1999, and "Drought Contingency Plan," August 26, 1999.

[70] Freese & Nichols for the City of Plainview, "Drought Contingency Plan," July 26, 1994.

irrigation of landscaped areas, use of water to wash any motor vehicle, and other restrictions on outdoor water use.

1.10.3.8 City of Seminole [71]

The City of Seminole operates a water system for approximately 2,400 utility customers. It has the capability of producing 5.5 MGD of potable water from 18 wells in the Ogallala Aquifer system. Seven of these wells are located inside the city limits with the other eleven scattered over five sections of land. All wells are included in a computerized water automation system in which radio signals sent to a computer control the levels of water in the groundwater storage and elevated storage tanks along with the operation of the wells. This system also allows the city to sequence the wells desired so that different wells turn on at different times and under different conditions.

In an additional effort to conserve water, a policy of voluntary conservation is in effect. There are two additional stages of conservation that may be implemented by the Mayor upon the recommendation of the City Administrator and Public Works Director. The first is to move the voluntary conservation policy into a water warning in which outdoor watering is curtailed. The second is to declare a water emergency, prohibit all outdoor watering and limit all other water use to essential domestic purposes.

1.10.3.9 City of Tulia [72]

The City of Tulia waterworks system serves approximately 2,033 connections. The majority of these connections are within the city limits of Tulia, although a few customers live outside the corporate limits of the city. The waterworks system covers approximately 3.72 square miles. Over the past several years, the city has experienced moderate growth. The city’s waterworks system has not been exceeded in its available capacity to supply the customers’ demand. Tulia is a member of the MMWA, but since drought conditions in the area have reduced the reservoir’s available supply to all member cities Tulia has obtained its own groundwater supplies to assure future water supplies for its customers.

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[71] Information transmitted in a letter received from the City of Seminole dated October 26, 1999.
[72] Oller Engineering, Inc. for the City of Tulia, “Water Conservation Plan and Drought Contingency Plan,” March 1997.

The City of Tulia's Emergency Water Demand Management plan contains trigger conditions to stipulate when water use should be curtailed. The plan includes restrictions on lawn watering, car washing, and certain public water uses that are not essential for public health or safety.

1.10.4 Water Availability Requirements Promulgated by County Commissioners Courts

In Region O, there are no known actions by county commissioners courts to establish water availability requirements.

1.10.5 Summary of Current Preparations for Drought

During periods of drought, water usage quite often exceeds the capacity of the distribution systems of many of the small towns in the region. Citizens are notified by the local news media that they need to curtail usage to prevent emptying the water tower storage. The reason given is that water may be needed to fight a fire. Most citizens readily comply without ordinances. Most water supply entities have indicated they will adopt mandatory water conservation during times of prolonged drought, which may include limitations on outdoor and recreational water use. Because of recent droughts in the region, many local planning authorities are now looking more towards future drought planning.

1.10.6 Other Relevant Natural Resource Plans

1.10.6.1 Playa Lakes Joint Venture [73]

The Playa Lakes Joint Venture (PLJV) was organized to implement the North American Waterfowl Management Plan in the Playa Lakes Region (PLR). The PLR includes portions of southeastern Colorado, southwestern Kansas, eastern New Mexico, western Oklahoma, and northwestern Texas. The goal of the PLJV is successful accommodation of objective numbers of waterfowl, migratory birds, and other wildlife, wintering in, migrating through, and breeding in the PLR. The five general objectives of the PLJV are:

- No loss or further degradation of playa wetlands, saline lakes, reservoirs, tanks, riparian areas, or other wetlands in the PLR;
- To have sufficient high-quality wetland habitat to permit wide-spread dispersion of waterfowl within the PLR;

[73] Playa Lakes Joint Venture Management Board, "Final Implementation Plan," Albuquerque, NM, November 1994.

- To have sufficient seasonal food resources for waterfowl and other wetland-dependent wildlife populations in the PLR;
- To have healthy and secure wetland and upland habitats to ensure optimum survival and diversity of waterfowl and other wildlife in the PLR; and
- To maintain successful reproduction of waterfowl and other wildlife breeding in the PLR.

There are six specific habitat objectives:

- Protection of valuable historical migratory bird use areas;
- Protection and enhancement of wetland areas that are adequately distributed throughout the PLR;
- Direct conservation of 10 percent of playas and associated uplands;
- Indirect conservation of 10 percent of playas and associated uplands;
- Protection and enhancement of important riparian areas; and
- Conservation of at least 10,000 acres of other wetlands (e.g., seepage areas, saline lakes) and their associated habitats.

1.10.6.2 Wholesale Water Providers

The Texas Water Code, Chapter 357.2(8) defines Wholesale Water Provider as follows:

"Any person or entity, including river authorities, and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. The regional water planning groups shall include as wholesale water providers other persons and entities that enter or that the regional water planning group expects or recommends to enter contracts to sell more that 1,000 acre-feet of water wholesale during the period covered by the plan."

There are four Wholesale Water Providers in the Llano Estacado Region, as follows:

Canadian River Municipal Water Authority

(1) City of Brownfield
(2) City of Lamesa
(3) City of Levelland
(4) City of Lubbock
(5) City of O'Donnell
(6) City of Plainview
(7) City of Slaton
(8) City of Tahoka

City of Lubbock

(1) Buffalo Springs Lake Water Supply Corporation
(2) Lake Ransom Canyon
(3) City of Shallowater
(4) Lubbock-Reese Redevelopment Authority
(5) City of Littlefield (emergency supply, only)
(6) Lake Alan Henry Water Supply District (contract in negotiation).

White River Municipal Water District

(1) City of Crosbyton
(2) City of Post
(3) City of Ralls
(4) City of Spur

Mackenzie Municipal Water Authority

(1) City of Floydada
(2) City of Lockney
(3) City of Silverton
(4) City of Tulia

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Section 2
Population and Water Demand Projections
[31 TAC §357.7(a)(2)]

In order to develop water plans to meet future water needs, it is necessary to make projections of future population and water demands for the region. The TWDB has made both population and water demand projections for cities, rural areas, and water use purposes for each of the 21 counties in the region. These counties are located in four major river basins—Canadian, Red, Brazos, and Colorado (Table 2-1). In accordance with TWDB Rules, Section 357.5(d), these projections are presented below.

2.1 Population Projections

The 2000 Census of Population and Housing by the U.S. Bureau of the Census indicates that Texas is the state with the second highest number of people among the states in the nation, with a population of 20.85 million. The population of the Llano Estacado Region was reported at 453,997 in 2000 and is projected to be 527,210 in 2060 (Table 2-2 and Figure 2-1), with nearly 80 percent of the population of the region projected to reside in the Brazos River Basin. The population projections for 53 individual cities and 35 rural areas of each county and part of county of each river basin area of the region are shown in Table 2-3.

Table 2-1.
Llano Estacado Region—List of Counties
Location by River Basin

County Number	County	River Basin[1]			
		Canadian Basin	Red Basin	Brazos Basin	Colorado Basin
1	Bailey			X	
2	Briscoe		X		
3	Castro		X	X	
4	Cochran			X	X
5	Crosby		X	X	
6	Dawson			X	X
7	Deaf Smith	X	X		
8	Dickens		X	X	
9	Floyd		X	X	
10	Gaines				X
11	Garza			X	X
12	Hale		X	X	
13	Hockley			X	X
14	Lamb			X	
15	Lubbock			X	
16	Lynn			X	X
17	Motley		X		
18	Parmer		X	X	
19	Swisher		X	X	
20	Terry			X	X
21	Yoakum				X

[1] An X in the column indicates that all or part of the county is located in the River Basin named in the column heading

Table 2-2. Population Projections[1] Llano Estacado Region Individual Counties with River Basin Summaries

County Number	County	Total in 1990	Total in 2000	Projections					
				2010	2020	2030	2040	2050	2060
Counties									
1	Bailey	7,064	6,594	7,060	7,558	7,875	8,207	8,238	8,086
2	Briscoe	1,971	1,790	1,862	1,899	1,865	1,779	1,747	1,700
3	Castro	9,070	8,285	9,070	9,762	10,224	10,587	10,567	10,381
4	Cochran	4,377	3,730	4,086	4,338	4,449	4,375	4,193	3,989
5	Crosby	7,304	7,072	7,678	8,174	8,514	8,856	8,873	8,731
6	Dawson	14,349	14,985	15,523	16,010	16,421	16,665	16,268	15,652
7	Deaf Smith	19,153	18,561	20,533	22,685	24,568	26,152	26,716	26,911
8	Dickens	2,571	2,762	2,712	2,661	2,547	2,375	2,304	2,221
9	Floyd	8,497	7,771	8,173	8,580	8,723	8,793	8,491	8,053
10	Gaines	14,123	14,467	16,130	17,663	18,774	19,560	19,434	19,169
11	Garza	5,143	4,872	5,072	5,265	5,158	4,961	4,733	4,416
12	Hale	34,671	36,602	39,456	42,103	44,034	45,204	44,940	44,069
13	Hockley	24,199	22,716	24,432	25,495	26,114	26,141	25,129	23,896
14	Lamb	15,072	14,709	15,515	16,500	17,355	17,995	17,900	17,668
15	Lubbock	222,636	242,628	259,231	270,924	277,223	278,255	282,782	279,309
16	Lynn	6,758	6,550	6,969	7,280	7,243	7,216	6,891	6,413
17	Motley	1,532	1,426	1,409	1,359	1,262	1,143	1,060	1,008
18	Parmer	9,863	10,016	10,641	11,302	11,585	11,666	11,301	10,674
19	Swisher	8,133	8,378	8,772	9,103	9,329	9,423	9,250	8,849
20	Terry	13,218	12,761	13,804	14,778	15,704	16,608	16,700	16,607
21	Yoakum	8,786	7,322	8,183	8,966	9,470	10,006	9,738	9,408
	Total	438,490	453,997	486,311	512,405	528,437	535,967	537,255	527,210
River Basin Summary[2]									
	Canadian	27	3	4	5	6	7	7	7
	Red	37,848	36,821	39,679	42,590	44,763	46,309	46,383	45,720
	Brazos	346,335	365,628	390,807	410,106	420,961	424,494	426,509	418,548
	Colorado	54,280	51,545	55,821	59,704	62,707	65,157	64,356	62,935
	Total	438,490	453,997	486,311	512,405	528,437	535,967	537,255	527,210

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basins tabulations of counties, cities, and rural areas.

Source: TWDB, Consensus Projections adopted by the TWDB, September 17, 2003.

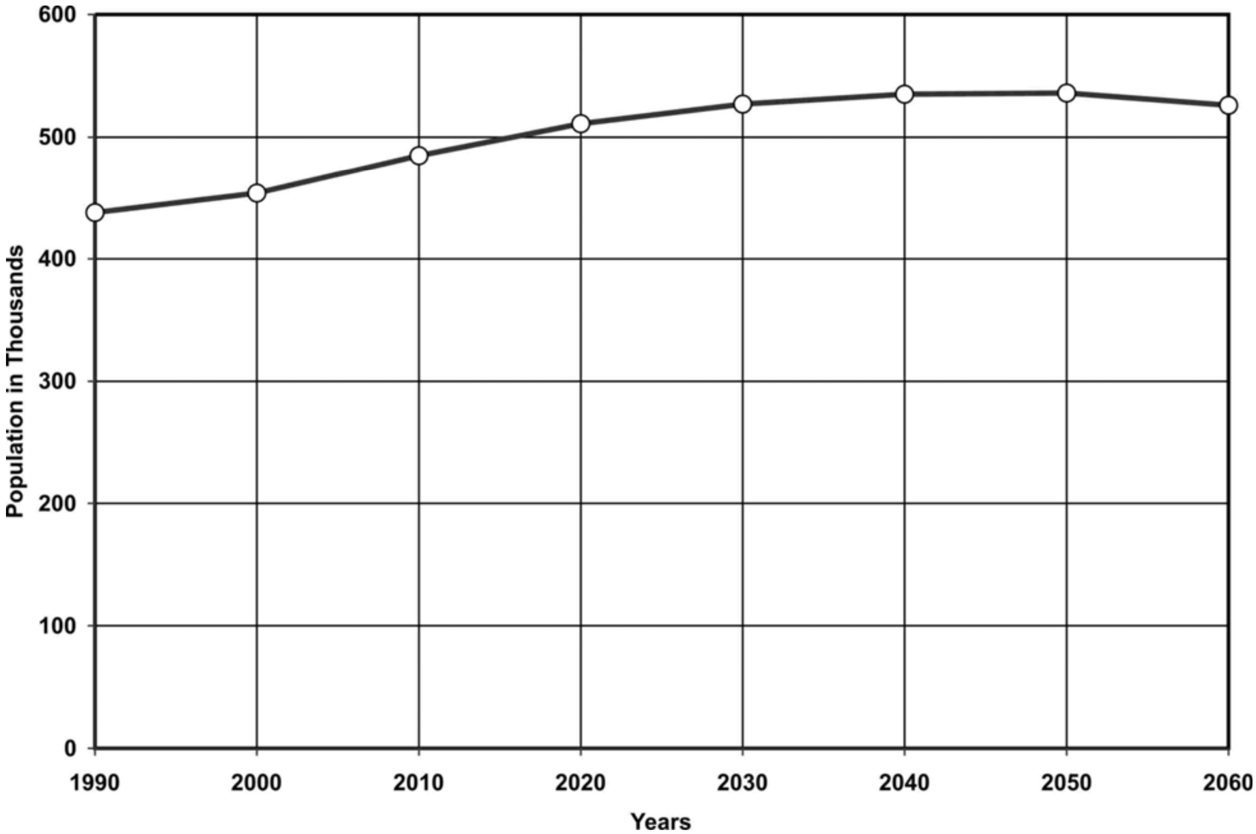

Figure 2-1. Summary of Llano Estacado Region's Projected Population

Table 2-3.
Population Projections
Llano Estacado Region
River Basins, Counties, and Cities[1]

Basin-County-City	*Census*		*Projections*					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Canadian Basin (part)								
Deaf Smith (part)								
Rural	27	3	4	5	6	7	7	7
Total	27	3	4	5	6	7	7	7
Canadian Basin Total	**27**	**3**	**4**	**5**	**6**	**7**	**7**	**7**
Red Basin (part)								
Briscoe (all)								
Silverton	779	771	802	818	803	766	752	732
Rural	1,192	1,019	1,060	1,081	1,062	1,013	995	968
Total	1,971	1,790	1,862	1,899	1,865	1,779	1,747	1,700
Castro (part)								
Rural	1,509	1,472	1,611	1,734	1,817	1,880	1,877	1,844
Total	1,509	1,472	1,611	1,734	1,817	1,880	1,877	1,844
Crosby (part)								
Rural	44	6	6	7	7	7	8	7
Total	44	6	6	7	7	7	8	7
Deaf Smith (part)								
Hereford	14,745	14,597	15,090	15,628	16,099	16,495	16,636	16,685
Rural	4,381	3,961	5,439	7,052	8,463	9,650	10,073	10,219
Total	19,126	18,558	20,529	22,680	24,562	26,145	26,709	26,904
Dickens (part)								
Rural	295	272	264	256	237	209	197	184
Total	295	272	264	256	237	209	197	184
Floyd (part)								
Rural	898	748	787	826	840	847	817	775
Total	898	748	787	826	840	847	817	775
Hale (part)								
Rural	46	0	0	0	0	0	0	0
Total	46	0	0	0	0	0	0	0
Motley (all)								
Matador	790	740	732	708	662	606	567	542
Rural	742	686	677	651	600	537	493	466
Total	1,532	1,426	1,409	1,359	1,262	1,143	1,060	1,008

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Table 2-3 Continued

Basin-County-City	Census		Projections					
	1990	2000	2010	2020	2030	2040	2050	2060
Parmer (part)								
Friona	3,688	3,854	4,094	4,349	4,458	4,489	4,348	4,107
Rural	1,012	790	840	891	913	919	892	842
Total	4,700	4,644	4,934	5,240	5,371	5,408	5,240	4,949
Swisher (part)								
Happy		612	641	665	681	688	676	646
Kress	739	652	683	708	726	733	720	689
Tulia	4,699	5,117	5,358	5,560	5,698	5,755	5,650	5,405
Rural	2,289	1,524	1,595	1,656	1,697	1,715	1,682	1,609
Total	7,727	7,905	8,277	8,589	8,802	8,891	8,728	8,349
Red Basin Total	**37,848**	**36,821**	**39,679**	**42,590**	**44,763**	**46,309**	**46,383**	**45,720**
Brazos Basin (part)								
Bailey (all)								
Muleshoe	4,571	4,530	4,850	5,192	5,410	5,638	5,659	5,555
Rural	2,493	2,064	2,210	2,366	2,465	2,569	2,579	2,531
Total	7,064	6,594	7,060	7,558	7,875	8,207	8,238	8,086
Castro (part)								
Dimmitt	4,408	4,375	4,790	5,155	5,399	5,591	5,580	5,482
Hart	1,221	1,198	1,312	1,412	1,478	1,531	1,528	1,501
Rural	1,932	1,240	1,357	1,461	1,530	1,585	1,582	1,554
Total	7,561	6,813	7,459	8,028	8,407	8,707	8,690	8,537
Cochran (part)								
Morton	2,597	2,249	2,464	2,616	2,683	2,638	2,528	2,405
Rural	1001	963	1,055	1,120	1,148	1,129	1,083	1,030
Total	3,598	3,212	3,519	3,736	3,831	3,767	3,611	3,435
Crosby (part)								
Crosbyton	2,026	1,874	2,035	2,166	2,256	2,347	2,351	2,314
Lorenzo	1,208	1,372	1,490	1,586	1,652	1,718	1,721	1,694
Ralls	2,172	2,252	2,445	2,603	2,711	2,820	2,826	2,780
Rural	1,854	1,568	1,702	1,812	1,888	1,964	1,967	1,936
Total	7,260	7,066	7,672	8,167	8,507	8,849	8,865	8,724
Dawson (part)								
O'Donnell		111	115	119	122	123	121	116
Rural	116	145	150	154	158	161	157	151
Total	116	256	265	273	280	284	278	267

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Table 2-3 Continued

Basin-County-City	***Census***		***Projections***					
	1990	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Dickens (part)								
Spur	1,300	1,088	1,088	1,088	1,088	1,088	1,088	1,088
Rural	976	1,402	1,360	1,317	1,222	1,078	1,019	949
Total	2,276	2,490	2,448	2,405	2,310	2,166	2,107	2,037
Floyd (part)								
Floydada	3,896	3,676	3,866	4,059	4,126	4,159	4,017	3,809
Lockney	2,207	2,056	2,162	2,270	2,308	2,326	2,246	2,131
Rural	1,496	1,291	1,358	1,425	1,449	1,461	1,411	1,338
Total	7,599	7,023	7,386	7,754	7,883	7,946	7,674	7,278
Garza (part)								
Post	3,768	3,708	3,860	4,007	3,926	3,776	3,602	3,361
Rural	1,370	1,164	1,212	1,258	1,232	1,185	1,131	1,055
Total	5,138	4,872	5,072	5,265	5,158	4,961	4,733	4,416
Hale (part)								
Abernathy (part)	2,132	2,131	2,297	2,451	2,564	2,632	2,616	2,566
Hale Center	2,067	2,263	2,439	2,603	2,722	2,795	2,779	2,725
Petersburg	1,292	1,262	1,360	1,452	1,518	1,559	1,549	1,519
Plainview	21,700	22,336	24,078	25,693	26,871	27,585	27,424	26,893
Rural	7,434	8,610	9,282	9,904	10,359	10,633	10,572	10,366
Total	34,625	36,602	39,456	42,103	44,034	45,204	44,940	44,069
Hockley (part)								
Anton	1,212	1,200	1,291	1,347	1,380	1,381	1,327	1,262
Levelland	13,986	12,866	13,838	14,440	14,791	14,806	14,233	13,534
Ropesville		517	556	580	594	595	572	544
Smyer		480	516	539	552	553	532	506
Rural	6,806	5,860	6,302	6,577	6,736	6,743	6,481	6,164
Total	22,004	20,923	22,503	23,483	24,053	24,078	23,145	22,010
Lamb (all)								
Amherst	742	791	834	887	933	968	963	950
Earth	1,228	1,109	1,170	1,244	1,308	1,357	1,350	1,332
Littlefield	6,489	6,507	6,864	7,299	7,678	7,961	7,919	7,816
Olton	2,116	2,288	2,413	2,567	2,700	2,799	2,784	2,748
Sudan	983	1,039	1,096	1,166	1,226	1,271	1,264	1,248
Rural	3,514	2,975	3,138	3,337	3,510	3,639	3,620	3,574
Total	15,072	14,709	15,515	16,500	17,355	17,995	17,900	17,668

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Table 2-3 Continued

Basin-County-City	Census		Projections					
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Lubbock (all)								
Abernathy (part)	588	708	808	878	916	922	949	928
Idalou	2,074	2,157	2,226	2,275	2,301	2,305	2,324	2,310
Lubbock	186,206	199,564	210,658	218,471	222,680	223,370	226,395	224,074
New Deal	521	708	863	972	1,031	1,041	1,083	1,051
Ransom Canyon	763	1,011	1,461	1,911	2,361	2,811	3,261	3,433
Shallowater	1,708	2,086	2,400	2,621	2,740	2,760	2,846	2,780
Slaton	6,078	6,109	6,135	6,153	6,163	6,165	6,172	6,167
Wolfforth	1,941	2,554	9,360	11,457	12,047	12,645	13,270	13,566
Rural	22,757	27,731	25,320	26,186	26,984	26,236	26,482	25,000
Total	222,636	242,628	259,231	270,924	277,223	278,255	282,782	279,309
Lynn (part)								
O'Donnell		900	958	1,000	995	992	947	881
Tahoka	2,868	2,910	3,096	3,234	3,218	3,206	3,061	2,849
Wilson	568	532	566	591	588	586	560	521
Rural	2,213	2,160	2,298	2,402	2,389	2,379	2,273	2,115
Total	5,649	6,502	6,918	7,227	7,190	7,163	6,841	6,366
Parmer (part)								
Bovina	1,549	1,874	1,991	2,115	2,168	2,183	2,114	1,997
Farwell	1,373	1,364	1,449	1,539	1,578	1,589	1,539	1,454
Rural	2,241	2,134	2,267	2,408	2,468	2,486	2,408	2,274
Total	5,163	5,372	5,707	6,062	6,214	6,258	6,061	5,725
Swisher (part)								
Kress		174	182	189	194	196	192	184
Rural	406	299	313	325	333	336	330	316
Total	406	473	495	514	527	532	522	500
Terry (part)								
Rural	168	93	101	107	114	122	122	121
Total	168	93	101	107	114	122	122	121
Brazos Basin Total	**346,335**	**365,628**	**390,807**	**410,106**	**420,961**	**424,494**	**426,509**	**418,548**
Colorado Basin (part)								
Cochran (part)								
Rural	779	518	567	602	618	608	582	554
Total	779	518	567	602	618	608	582	554
Dawson (part)								
Lamesa	10,809	9,952	10,309	10,633	10,906	11,068	10,804	10,395
Rural	3,424	4,777	4,949	5,104	5,235	5,313	5,186	4,990
Total	14,233	14,729	15,258	15,737	16,141	16,381	15,990	15,385

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Table 2-3 Concluded

Basin-County-City	Census		Projections					
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Gaines (all)								
Seagraves	2,398	2,334	2,602	2,850	3,029	3,156	3,135	3,093
Seminole	6,342	5,910	6,589	7,216	7,669	7,991	7,939	7,831
Rural	5,383	6,223	6,939	7,597	8,076	8,413	8,360	8,245
Total	14,123	14,467	16,130	17,663	18,774	19,560	19,434	19,169
Garza (part)								
Rural	5	0	0	0	0	0	0	0
Total	5	0	0	0	0	0	0	0
Hockley (part)								
Sundown	1,759	1,505	1,619	1,689	1,730	1,732	1,665	1,583
Rural	436	288	310	323	331	331	319	303
Total	2,195	1,793	1,929	2,012	2,061	2,063	1,984	1,886
Lynn (part)								
O'Donnell (part)	968							
Rural	141	48	51	53	53	53	50	47
Total	1,109	48	51	53	53	53	50	47
Terry (part)								
Brownfield	9,560	9,488	10,263	10,988	11,676	12,348	12,417	12,348
Meadow	547	658	712	762	810	856	861	856
Rural	2,943	2,522	2,728	2,921	3,104	3,282	3,300	3,282
Total	13,050	12,668	13,703	14,671	15,590	16,486	16,578	16,486
Yoakum (all)								
Denver City	5,145	3,985	4,454	4,880	5,154	5,446	5,300	5,120
Plains	1,422	1,450	1,621	1,776	1,875	1,982	1,928	1,863
Rural	2,219	1,887	2,108	2,310	2,441	2,578	2,510	2,425
Total	8,786	7,322	8,183	8,966	9,470	10,006	9,738	9,408
Colorado Basin Total	**54,280**	**51,545**	**55,821**	**59,704**	**62,707**	**65,157**	**64,356**	**62,935**
Llano Estacado Region	**438,490**	**453,997**	**486,311**	**512,405**	**528,437**	**535,967**	**537,255**	**527,210**
River Basin Summary								
Canadian	27	3	4	5	6	7	7	7
Red	37,848	36,821	39,679	42,590	44,763	46,309	46,383	45,720
Brazos	346,335	365,628	390,807	410,106	420,961	424,494	426,509	418,548
Colorado	54,280	51,545	55,821	59,704	62,707	65,157	64,356	62,935
Llano Estacado Region	**438,490**	**453,997**	**486,311**	**512,405**	**528,437**	**535,967**	**537,255**	**527,210**

[1] Parts of Canadian, Red, Brazos, and Colorado River Basins.

Source: TWDB; Consensus Projections adopted by the TWDB, September 17, 2003.

2.2 Municipal Water Demand Projections

Municipal water is water for drinking, bathing, food preparation, dishwashing, laundry, toilet flushing, lawn watering and landscape irrigation, sanitation, restaurants, office buildings and institutions, fire protection, and cleaning and sanitation. The projected quantity of water needed for municipal purposes depends upon the number of people who reside in an area, population growth of the area, climatic conditions, and water conservation measures. For planning purposes, municipal water demand includes residential and commercial water uses. Commercial water use includes business establishments and public offices and institutions. Residential and commercial uses are categorized together because they are similar types of uses (i.e., they both use water primarily for drinking, cleaning, sanitation, air conditioning, and landscape watering), and are served from the same water distribution systems.

In the Llano Estacado Region, per capita water use, the basic municipal water use planning statistic, is projected to decline over the planning period from 172 gpcd in 2000 to 158 gpcd in 2060 (Figure 2-2). Total municipal water demand is projected to increase by 7.1 percent per year between 2000 and 2060, from 87,322 acft/yr in 2000 to 93,549 acft/yr in 2060 (Table 2-4 and Figure 2-2.). The projected municipal water demand for individual counties of the region is shown in Table 2-4. Since Lubbock County has the largest population, it also has the largest projected water demand, with 53.1 percent of the regional total in 2000 and 52.9 percent in 2060 (Table 2-4).

Table 2-4.
Municipal Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County Number	County	Total in 1990 (acft)	Total in 2000 (acft)	Projections					
				2010	2020	2030	2040	2050	2060
Counties									
1	Bailey	1,425	1,310	1,369	1,440	1,473	1,508	1,505	1,477
2	Briscoe	323	306	311	311	299	280	270	263
3	Castro	1,567	1,653	1,764	1,866	1,920	1,952	1,937	1,904
4	Cochran	931	763	816	853	860	831	792	753
5	Crosby	1,195	1,104	1,159	1,207	1,233	1,252	1,245	1,226
6	Dawson	2,285	3,126	3,185	3,220	3,254	3,245	3,151	3,031
7	Deaf Smith	4,409	4,136	4,378	4,627	4,852	5,032	5,088	5,119
8	Dickens	508	554	538	520	495	462	445	432
9	Floyd	1,185	1,181	1,211	1,232	1,222	1,203	1,153	1,093
10	Gaines	2,920	3,139	3,417	3,683	3,850	3,957	3,909	3,856
11	Garza	959	777	787	798	766	720	681	635
12	Hale	6,375	6,370	6,677	6,982	7,160	7,198	7,105	6,967
13	Hockley	3,755	3,800	3,953	4,040	4,050	3,966	3,784	3,599
14	Lamb	2,652	3,349	3,467	3,624	3,756	3,833	3,793	3,745
15	Lubbock	42,342	46,408	48,539	49,849	50,114	49,504	50,028	49,507
16	Lynn	942	973	1,009	1,026	995	967	916	852
17	Motley	302	387	377	360	330	295	272	259
18	Parmer	2,248	1,875	1,951	2,029	2,040	2,016	1,940	1,832
19	Swisher	1,523	1,476	1,515	1,532	1,540	1,525	1,488	1,423
20	Terry	1,947	3,038	3,210	3,387	3,547	3,696	3,697	3,676
21	Yoakum	1,815	1,597	1,745	1,879	1,954	2,031	1,966	1,900
	Total	81,608	87,322	91,378	94,465	95,710	95,473	95,165	93,549
River Basin Summary[2]									
	Canadian	3	0	1	1	1	1	1	1
	Red	7,927	7,548	7,875	8,177	8,378	8,474	8,417	8,301
	Brazos	64,091	68,459	71,507	73,666	74,273	73,627	73,602	72,383
	Colorado	9,587	11,315	11,995	12,621	13,058	13,371	13,145	12,864
	Total	81,608	87,322	91,378	94,465	95,710	95,473	95,165	93,549

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: TWDB; Consensus Projections adopted by the TWDB, September 17, 2003.

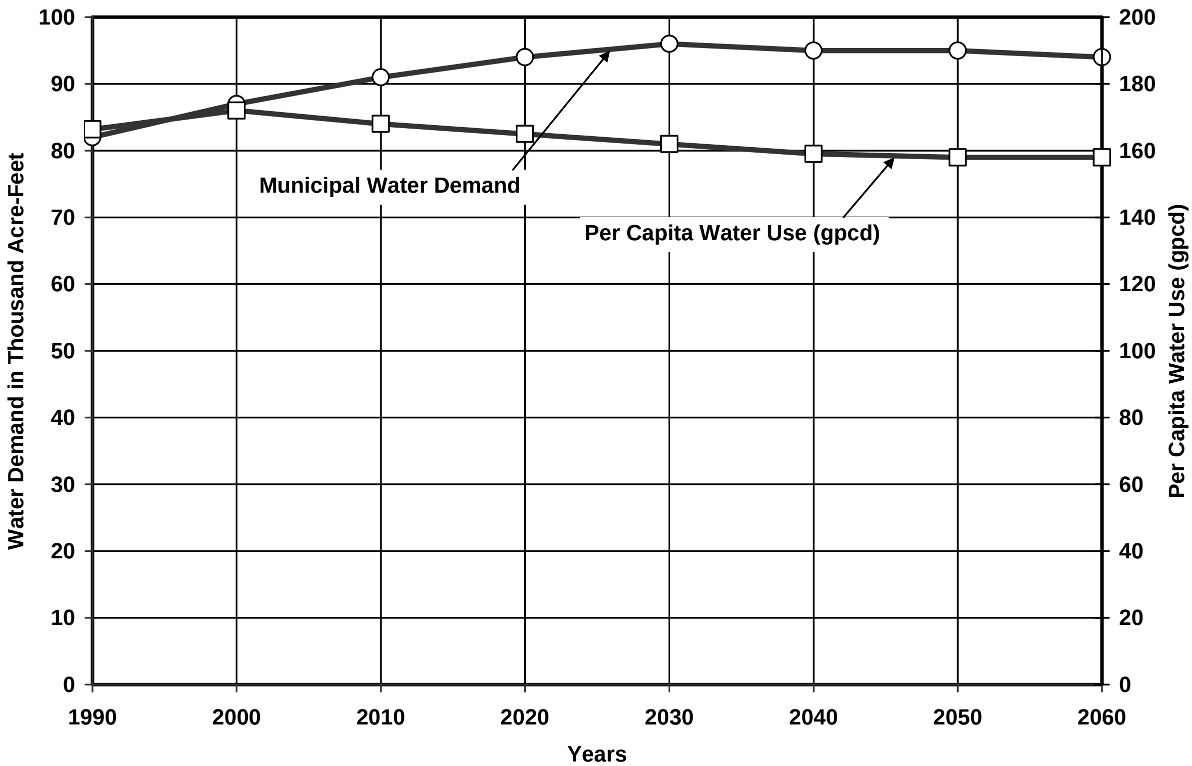

Figure 2-2. Projected Per Capita Water Use and Municipal Water Demand: Llano Estacado Region – 1990 to 2060

2.3 Manufacturing Water Demand Projections

Manufactured products in Texas range from food and clothing to refined chemical and petroleum products, computers, and automobiles. Some processes incorporate water as part of the products being manufactured, while others use large volumes of water for cooling or cleaning purposes. Five manufacturing industries (chemical products, petroleum refining pulp and paper, food and kindred products, and primary metals) account for approximately 90 percent of water used by all manufacturing industries in Texas. The chemical and petroleum refining industries account for nearly 60 percent of the state's annual manufacturing water use.

The Llano Estacado Region's major water using manufacturing sectors are food processing, industrial machinery and equipment, and fabricated metals. These industries used 10,064 acft of water in 2000 and are projected to have a demand of 15,999 acft/yr in 2060 (Table 2-5 and Figure 2-3). As can be seen in Figure 2-3, manufacturing water demand is projected to increase at a steady rate throughout the planning period.

Table 2-5.
Manufacturing Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County Number	County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Counties									
1	Bailey	147	264	303	316	326	335	343	365
2	Briscoe	0	0	0	0	0	0	0	0
3	Castro	2,177	1,732	2,035	2,203	2,341	2,473	2,587	2,769
4	Cochran	0	0	0	0	0	0	0	0
5	Crosby	7	5	6	6	6	6	6	6
6	Dawson	44	101	119	129	137	144	150	162
7	Deaf Smith	498	1,234	1,454	1,594	1,710	1,821	1,917	2,055
8	Dickens	0	0	0	0	0	0	0	0
9	Floyd	1	0	0	0	0	0	0	0
10	Gaines	303	0	0	0	0	0	0	0
11	Garza	2	2	2	2	2	2	2	2
12	Hale	1,521	2,605	2,993	3,188	3,339	3,482	3,604	3,840
13	Hockley	67	53	61	65	68	71	73	78
14	Lamb	753	426	490	519	541	562	580	618
15	Lubbock	1,469	1,566	1,881	2,103	2,291	2,472	2,625	2,836
16	Lynn	0	0	0	0	0	0	0	0
17	Motley	0	5	6	6	6	6	6	6
18	Parmer	1,502	2,070	2,427	2,617	2,772	2,921	3,051	3,261
19	Swisher	3	0	0	0	0	0	0	0
20	Terry	0	1	1	1	1	1	1	1
21	Yoakum	0	0	0	0	0	0	0	0
	Total	8,494	10,064	11,778	12,749	13,540	14,296	14,945	15,999
River Basin Summary[2]									
	Canadian	0	0	0	0	0	0	0	0
	Red	2,395	3,404	3,999	4,338	4,616	4,884	5,116	5,474
	Brazos	5,752	6,558	7,659	8,281	8,786	9,267	9,678	10,362
	Colorado	347	102	120	130	138	145	151	163
	Total	8,494	10,064	11,778	12,749	13,540	14,296	14,945	15,999

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

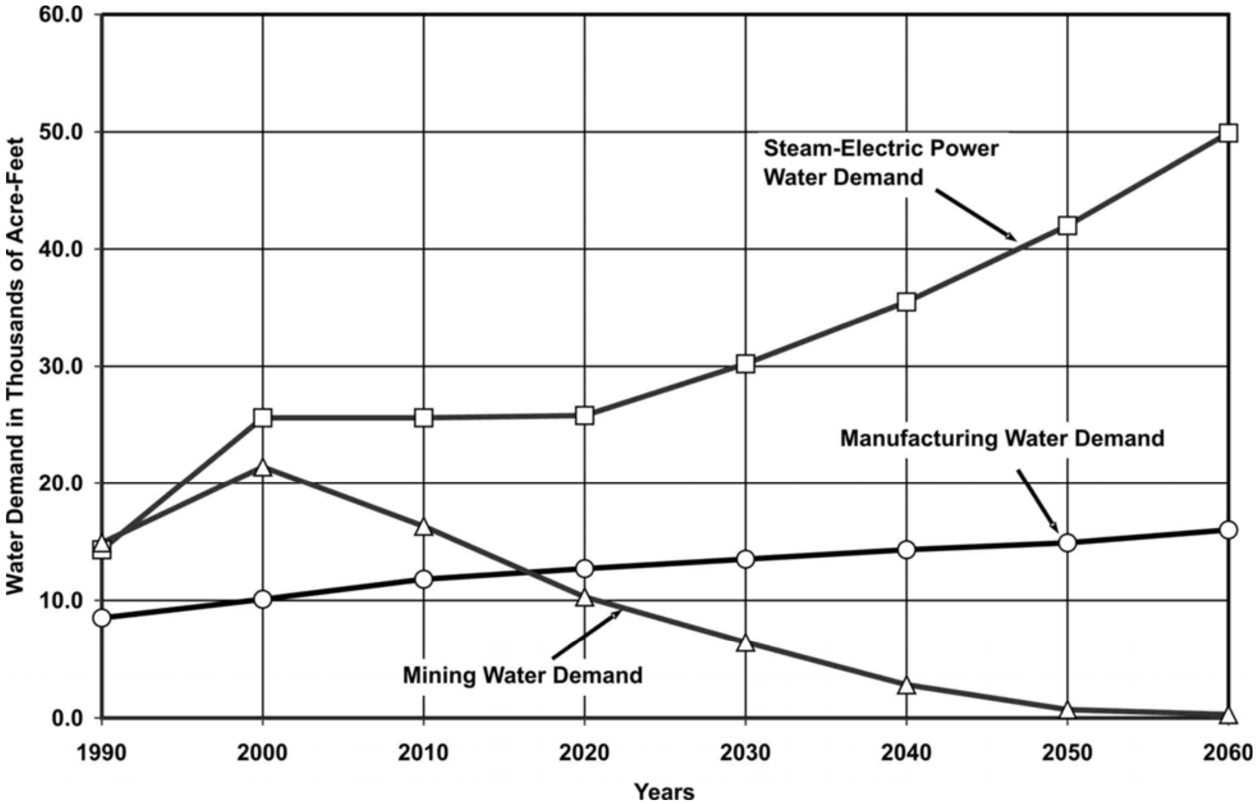

Figure 2-3. Projections of Manufacturing, Steam-Electric, and Mining Water Demands: Llano Estacado Region – 1990 to 2060

2.4 Steam-Electric Power Water Demand Projections

Although Texas has the second highest population of states in the United States, it is the largest generator and consumer of electricity. Power production in Texas is concentrated in ten privately owned utilities, which account for 85 percent of production. Nine percent is both publicly and privately held, while only 6 percent are publicly owned. The industry has faced and will continue to face significant changes in the structure of power generation. These changes range from new generation technology to government regulations on the marketing of electricity. These changes will not only have an impact on how and where power will be generated, but also on how water will be used in the process.

Only three counties (Lamb, Lubbock, and Yoakum) of the Llano Estacado Region currently use water in steam-electric power production or are projected to use water in steam-electric power production. In 2000, 25,618 acft of water was used for steam-electric power generation; by the year 2060, it is estimated that 49,910 acft of water will be needed for the production of steam-electric power (Table 2-6 and Figure 2-3).

Table 2-6.
Steam-Electric Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County Number	County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Counties									
1	Bailey	0	0	0	0	0	0	0	0
2	Briscoe	0	0	0	0	0	0	0	0
3	Castro	0	0	0	0	0	0	0	0
4	Cochran	0	0	0	0	0	0	0	0
5	Crosby	0	0	0	0	0	0	0	0
6	Dawson	0	0	0	0	0	0	0	0
7	Deaf Smith	0	0	0	0	0	0	0	0
8	Dickens	0	0	0	0	0	0	0	0
9	Floyd	0	0	0	0	0	0	0	0
10	Gaines	0	0	0	0	0	0	0	0
11	Garza	0	0	0	0	0	0	0	0
12	Hale	0	0	0	0	0	0	0	0
13	Hockley	0	0	0	0	0	0	0	0
14	Lamb	12,587	17,990	17,827	17,663	20,651	24,292	28,731	34,142
15	Lubbock	1,715	5,776	5,221	4,440	5,191	6,106	7,222	8,582
16	Lynn	0	0	0	0	0	0	0	0
17	Motley	0	0	0	0	0	0	0	0
18	Parmer	0	0	0	0	0	0	0	0
19	Swisher	0	0	0	0	0	0	0	0
20	Terry	0	0	0	0	0	0	0	0
21	Yoakum	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
	Total	14,302	25,618	25,645	25,821	30,188	35,511	42,000	49,910
River Basin Summary[2]									
	Canadian	0	0	0	0	0	0	0	0
	Red	0	0	0	0	0	0	0	0
	Brazos	14,302	23,766	23,048	22,103	25,842	30,398	35,953	42,724
	Colorado	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
	Total	14,302	25,618	25,645	25,821	30,188	35,511	42,000	49,910

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

2.5 Mining Water Demand Projections

Although the Texas mineral industry is foremost in the production of crude petroleum and natural gas in the United States, it also produces a wide variety of important non-fuel minerals. Texas is the only state to produce native asphalt and is the leading producer nationally of Frasch-mined sulfur. It is also one of the leading states in the production of clay, gypsum, lime, salt, stone, and aggregate. In the Llano Estacado Region, the principal uses of water for mining are for recovery of crude petroleum and for sand and gravel washing.

In the region, mining water use was 21,436 acft in 2000, and is projected to decline to 258 acft in 2060 (Table 2-7 and Figure 2-3). Mining water demand projections are based upon major water conservation activity by the mining water user group, as opposed to considering mining water conservation as a separate water management strategy, since water conservation measures are integral to regular operations. Overall, water use in this sector is expected to decline by 98 percent by 2060, due to water conservation by operators, including recycling and reuse of water produced from operating fields, and the fact that the presently used “water flood” technology will no longer be used, as many of the oil fields of the region will have reached their economic limit, suspended operations, and plugged the wells. The continuation of the industry in the region will hinge on yet to be developed technologies to recover the oil remaining in the reservoirs.

2.6 Irrigation Water Demand Projections

Irrigated agriculture accounts for almost 65 percent of the total water used in the state. Currently, approximately 10 million acft of water is used to grow a variety of crops ranging from food and feed grains to fruits, vegetables, and cotton. Of this 10 million acft, groundwater resources provide approximately 70 percent of the water used for irrigation purposes, with surface water supplies accounting for the remaining 30 percent. The TWDB irrigation water use data show annual use for irrigation in the Llano Estacado Region in 2000 of 4,347,877 acft/yr, or 37 percent of the total irrigation water use in Texas in 2000 (Table 2-8 and Figure 2-4). For dry-weather precipitation conditions, the TWDB’s projected irrigation water demands for the region in 2060 are 3,474,163 acft/yr, or 20 percent less than in 2000 (Table 2-8 and Figure 2-4). The projected declining trend in irrigation water demand in future years is based upon increased irrigation efficiency, economic factors, and government programs affecting the profitability of irrigated agriculture.

Table 2-7.
Mining Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County Number	County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Counties									
1	Bailey	20	0	0	0	0	0	0	0
2	Briscoe	0	0	0	0	0	0	0	0
3	Castro	0	0	0	0	0	0	0	0
4	Cochran	924	1,720	1,462	1,032	860	645	430	258
5	Crosby	843	189	112	54	31	13	0	0
6	Dawson	654	2,728	1,624	779	455	195	0	0
7	Deaf Smith	0	0	0	0	0	0	0	0
8	Dickens	13	165	98	47	27	12	0	0
9	Floyd	63	0	0	0	0	0	0	0
10	Gaines	3,340	6,071	5,746	4,011	2,493	1,084	217	0
11	Garza	575	1,264	752	361	211	90	0	0
12	Hale	166	258	88	34	19	0	0	0
13	Hockley	3,552	4,416	3,154	2,019	1,312	505	25	0
14	Lamb	76	88	52	25	15	6	0	0
15	Lubbock	191	352	209	101	59	25	0	0
16	Lynn	116	81	48	23	13	6	0	0
17	Motley	23	15	9	4	3	1	0	0
18	Parmer	0	0	0	0	0	0	0	0
19	Swisher	0	0	0	0	0	0	0	0
20	Terry	822	930	554	266	155	66	0	0
21	Yoakum	3,473	3,159	2,416	1,524	706	204	56	0
	Total	14,851	21,436	16,324	10,280	6,359	2,852	728	258
River Basin Summary[2]									
	Canadian	0	0	0	0	0	0	0	0
	Red	344	85	50	24	14	6	0	0
	Brazos	4,207	5,630	3,681	2,141	1,351	530	23	2
	Colorado	10,300	15,721	12,593	8,115	4,994	2,316	705	256
	Total	14,851	21,436	16,324	10,280	6,359	2,852	728	258

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

Table 2-8.
Irrigation Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County Number	County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Counties									
1	Bailey	220,775	182,865	178,478	174,197	170,018	165,939	161,958	158,071
2	Briscoe	39,592	26,329	25,373	24,453	23,566	22,710	21,886	21,091
3	Castro	351,189	503,792	484,475	465,902	448,039	430,861	414,342	398,457
4	Cochran	32,679	119,985	115,352	110,903	106,623	102,506	98,549	94,744
5	Crosby	105,634	112,135	107,617	103,281	99,120	95,126	91,295	87,618
6	Dawson	39,097	146,039	137,803	130,036	122,705	115,786	109,260	103,102
7	Deaf Smith	285,459	372,827	361,015	349,580	338,504	327,780	317,396	307,341
8	Dickens	4,779	9,486	9,203	8,928	8,663	8,405	8,153	7,908
9	Floyd	131,706	237,020	227,579	218,516	209,812	201,454	193,431	185,727
10	Gaines	392,950	414,772	393,170	372,693	353,283	334,884	317,442	300,908
11	Garza	4,383	12,165	11,451	10,783	10,148	9,556	8,997	8,471
12	Hale	461,931	367,700	355,516	343,737	332,349	321,337	310,690	300,396
13	Hockley	92,968	174,996	168,151	161,578	155,261	149,188	143,354	137,749
14	Lamb	351,050	377,893	363,313	349,294	335,816	322,858	310,401	298,425
15	Lubbock	230,717	242,978	229,267	216,397	204,248	192,782	181,961	171,747
16	Lynn	39,988	120,372	113,895	107,766	101,972	96,482	91,295	86,387
17	Motley	3,883	9,168	8,894	8,628	8,372	8,121	7,877	7,641
18	Parmer	475,000	415,449	411,037	406,673	402,356	398,084	393,858	389,676
19	Swisher	139,650	171,706	170,725	163,566	168,780	167,816	166,857	165,903
20	Terry	131,901	203,141	192,725	182,844	173,471	164,577	156,139	148,133
21	Yoakum	122,409	127,059	120,979	115,187	109,674	104,426	99,427	94,668
	Total	3,657,740	4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163
River Basin Summary[2]									
	Canadian	0	0	0	0	0	0	0	0
	Red	730,231	909,585	883,748	855,251	834,628	811,278	788,702	766,868
	Brazos	2,226,798	2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
	Colorado	700,711	941,172	893,030	847,371	804,060	762,975	724,003	687,033
	Total	3,657,740	4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: TWDB: Consensus Projections adopted by the TWDB, September 17, 2003.

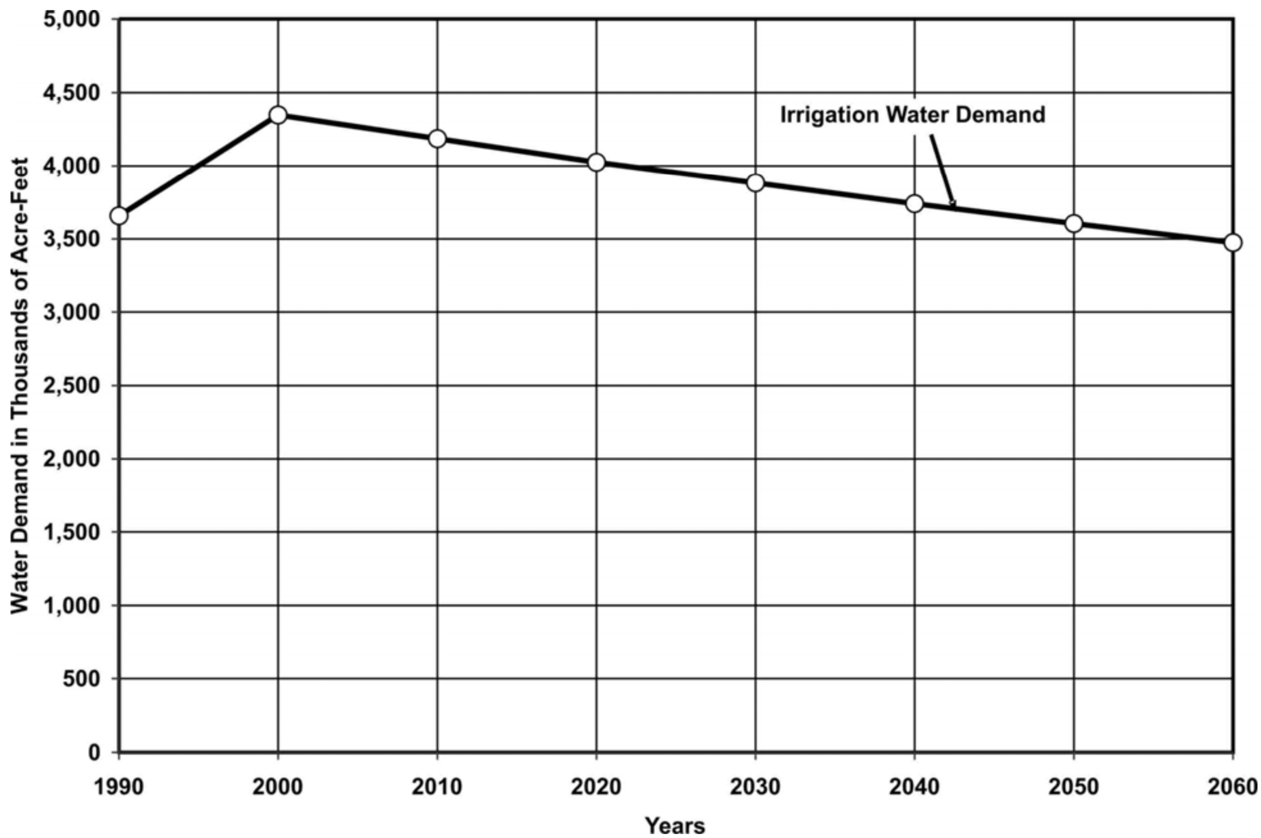

Figure 2-4. Projections of Irrigation Water Demands: Llano Estacado Region – 1990 to 2060

2.7 Livestock Water Demand Projections

For the Llano Estacado Region, livestock water demand projections are presented separately for beef cattle feedlots, swine feedlots, dairies, horses, range beef cows/bulls, range beef stocker cattle, sheep, and poultry.[1] The projections for all types of livestock were based upon data obtained from the Texas Cattle Feeders Association and the Texas A&M University and Research Center. In 2000, water use in the Llano Estacado Region for beef cattle feedlot purposes was estimated at 26,215 acft/yr, with projections of beef cattle feedlot water demands in 2060 of 45,512 acft/yr (Table 2-9 and Figure 2-5).

Swine feedlot water use in the region in 2000 was estimated at 58.8 acft/yr with projected demands at this level throughout the planning period (Table 2-10).

[1] The TWDB presented livestock water demand for all types of livestock grouped together. For purposes of this report, beef cattle feedlot, swine feedlot, dairy, horse, range beef cows/bulls, range beef stocker cattle, sheep, goats, and poultry livestock water demands are shown separately (Tables 2-9 through 2-16).

Table 2-9.
Beef Cattle Feedlots Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	938	971	1,184	1,327	1,409	1,496	1,588	1,686
Briscoe	0	0	0	0	0	0	0	0
Castro	4,591	5,370	6,546	7,339	7,791	8,272	8,782	9,323
Cochran	496	514	627	703	746	792	841	893
Crosby	0	0	0	0	0	0	0	0
Dawson	0	0	0	0	0	0	0	0
Deaf Smith	6,534	7,041	8,583	9,623	10,216	10,846	11,514	12,224
Dickens	0	0	0	0	0	0	0	0
Floyd	854	885	1,079	1,210	1,285	1,364	1,448	1,537
Gaines	482	500	609	683	725	770	817	868
Garza	0	0	0	0	0	0	0	0
Hale	1,173	1,185	1,445	1,620	1,720	1,826	1,939	2,058
Hockley	331	343	418	468	497	528	561	595
Lamb	1,502	1,328	1,619	1,815	1,927	2,046	2,172	2,306
Lubbock	689	714	870	976	1,036	1,100	1,168	1,240
Lynn	0	0	0	0	0	0	0	0
Motley	0	0	0	0	0	0	0	0
Parmer	4,694	4,863	5,928	6,646	7,056	7,491	7,953	8,443
Swisher	2,412	2,499	3,047	3,416	3,626	3,850	4,087	4,339
Terry	0	0	0	0	0	0	0	0
Yoakum	0	0	0	0	0	0	0	0
Total	24,696	26,215	31,955	35,826	38,035	40,380	42,869	45,512
River Basin Summary[2]								
Canadian	0	0	0	0	0	0	0	0
Red	13,610	14,811	18,054	20,242	21,491	22,815	24,222	25,715
Brazos	10,604	10,861	13,239	14,843	15,756	16,729	17,760	18,855
Colorado	482	543	662	741	787	836	887	942
Total	24,696	26,215	31,955	35,826	38,035	40,380	42,869	45,512

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Beef Cattle (No. Head)	Water Demand[1] (acft)
1990	1,470,000	24,696
2000	1,560,175	26,215
2010	1,901,845	31,955
2020	2,132,229	35,826
2030	2,263,673	38,035
2040	2,403,220	40,380
2050	2,551,369	42,869
2060	2,708,652	45,512

[1] Calculated at 15 gallons per head per day.

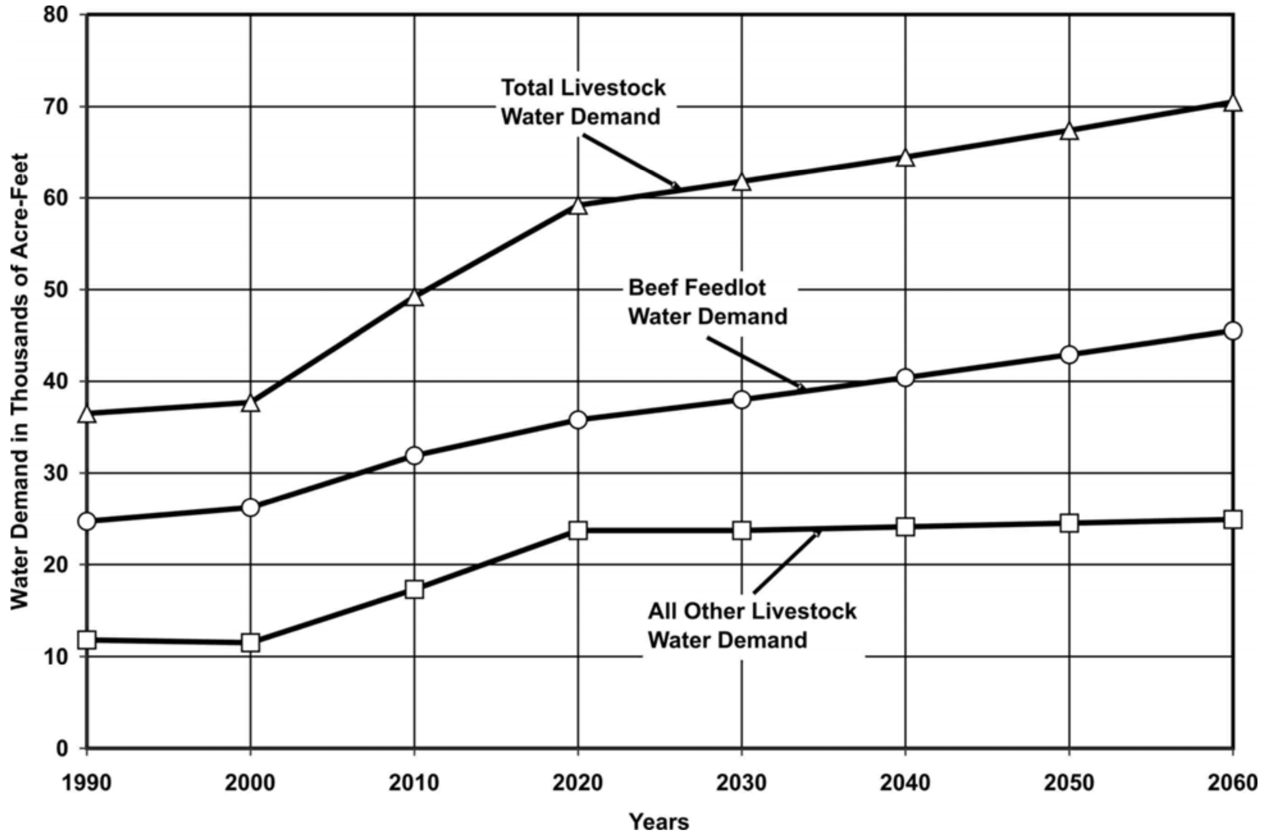

Figure 2-5. Projections of Beef Feedlot and All Other Livestock Water Demands: Llano Estacado Region – 1990 to 2060

Table 2-10.
Swine Feedlots Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	0	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Briscoe	1	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Castro	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Cochran	1	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Crosby	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Dawson	0	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Deaf Smith	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Dickens	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Floyd	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Gaines	4	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Garza	0	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Hale	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Hockley	4	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Lamb	6	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Lubbock	80	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Lynn	1	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Motley	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Parmer	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Swisher	11	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Terry	2	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Yoakum	1	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Total	129	58.8	58.8	58.8	58.8	58.8	58.8	58.8
River Basin Summary[2]								
Canadian	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Red	20.0	33.2	33.2	33.2	33.2	33.2	33.2	33.2
Brazos	100.0	24.4	24.4	24.4	24.4	24.4	24.4	24.4
Colorado	9.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Total	129.0	58.8	58.8	58.8	58.8	58.8	58.8	58.8

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Swine (No. Head)	Water Demand[1] (acft)
1990	12,000	129
2000	10,500	58.8
2010	10,500	58.8
2020	10,500	58.8
2030	10,500	58.8
2040	10,500	58.8
2050	10,500	58.8

[1] Calculated at 5 gallons per head per day.

In 2000, water use in the Llano Estacado Region for dairies was estimated at 1,183.2 acft/yr, with projections of dairy water demands increasing to 12,111.8 acft/yr in 2020, and holding steady at this level to 2060, a tenfold increase (Table 2-11). Only six counties (Bailey, Castro, Deaf Smith, Lamb, Parmer, and Swisher) in the Llano Estacado Region have one or more dairies located within them (Table 2-11).

Horse water use in the region in 2000 was estimated at 227.9 acft/yr with projected demands of 414 acft/yr in 2060, an increase of 81 percent of the estimated 2000 use (Table 2-12).

In 2000, water use in the Llano Estacado Region for range beef cows and bulls was estimated at 4,032.6 acft/yr (Table 2-13). The water use for this type of livestock is projected to remain constant at 4,032.6 acft/yr throughout the planning period (Table 2-13).

Range beef stocker cattle water use in the region in 2000 was estimated at 5,937 acft/yr with projected demands of 8,008.2 acft/yr in 2060; a 34 percent increase over the estimated 2000 use (Table 2-14).

In 2000, sheep and goat water use in the Llano Estacado Region was estimated at 69.5 acft/yr (Table 2-15). Water use for this type of livestock is projected to remain at this level to 2060 (Table 2-15).

Poultry water use in the region in 2000 was estimated at 0 acft/yr, but is projected to be 252 acft/yr in 2020, and remain constant at 252 acft/yr throughout the planning period (Table 2-16). All commercial poultry water demand occurs in Castro, Cochran, Garza, Hockley, and Yoakum Counties.

Total livestock water demand projections for the Llano Estacado Region are the sum of water demand projections for beef cattle feedlots, swine feedlots, dairies, horses, range beef cows/bulls, range beef stocker cattle, sheep, and poultry (Tables 2-9 through 2-16) and are shown in Table 2-17. Total livestock water use in 2000 was estimated to be 37,723 acft/yr (Table 2-17). Projected total livestock water demand for the region is 70,457 acft/yr in 2060 (Table 2-17).

Projections of total livestock water demand for all livestock other than beef feedlot livestock are shown in Table 2-18 and Figure 2-5. Livestock water demand for all livestock other than beef feedlot livestock was estimated at 11,510 acft/yr in 2000 (Table 2-18 and Figure 2-5). Projected water demand for all types of livestock other than beef cattle feedlot for the region is 24,946 acft/yr in 2060 (Table 2-18 and Figure 2-5).

Table 2-11.
Dairy Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	252	233.0	1,099.1	1,965.2	1,965.2	1,965.2	1,965.2	1,965.2
Briscoe	0	32.8	32.8	32.8	32.8	32.8	32.8	32.8
Castro	104	145.6	1,115.9	2,086.1	2,086.1	2,086.1	2,086.1	2,086.1
Cochran	0	0.0	67.0	134.0	134.0	134.0	134.0	134.0
Crosby	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dawson	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deaf Smith	157	36.4	1,130.7	2,224.9	2,224.9	2,224.9	2,224.9	2,224.9
Dickens	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Floyd	0	32.8	103.9	175.1	175.1	175.1	175.1	175.1
Gaines	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garza	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hale	0	29.1	391.3	753.4	753.4	753.4	753.4	753.4
Hockley	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lamb	102	611.6	1,551.5	2,491.4	2,491.4	2,491.4	2,491.4	2,491.4
Lubbock	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lynn	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Motley	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parmer	88	29.1	967.8	1,906.4	1,906.4	1,906.4	1,906.4	1,906.4
Swisher	0	32.8	108.1	183.5	183.5	183.5	183.5	183.5
Terry	0	0.0	79.5	159.1	159.1	159.1	159.1	159.1
Yoakum	38	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	741	1,183.2	6,647.5	12,111.8	12,111.8	12,111.8	12,111.8	12,111.8
River Basin Summary[2]								
Canadian	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Red	157.0	254.3	1,435.7	2,614.8	2,605.4	2,601.0	2,600.7	2,600.7
Brazos	546.0	865.7	4,852.9	8,843.3	8,849.1	8,863.4	8,853.0	8,853.0
Colorado	38.0	63.2	358.9	653.7	657.2	647.5	658.1	658.1
Total	741.0	1,183.2	6,647.5	12,111.8	12,111.8	12,111.8	12,111.8	12,111.8

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Dairy Cattle (No. Head)	Water Demand[1] (acft)
1990	8,820	741
2000	16,250	1,183.2
2010	91,299	6,647.5
2020	166,348	12,111.8
2030	166,348	12,111.8
2040	166,348	12,111.8
2050	166,348	12,111.8
2060	166,348	12,111.8

[1] Calculated at 65 gallons per head per day.

Table 2-12.
Horse Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	3	8.0	8.8	9.7	10.7	11.9	13.1	14.5
Briscoe	5	12.6	13.9	15.4	17.0	18.8	20.7	22.9
Castro	3	7.3	8.0	8.9	9.8	10.8	12.0	13.2
Cochran	1	3.6	4.0	4.4	4.9	5.4	5.9	6.5
Crosby	2	4.9	5.4	5.9	6.6	7.2	8.0	8.8
Dawson	2	4.9	5.4	6.0	6.6	7.3	8.1	9.0
Deaf Smith	8	20.0	22.1	24.4	27.0	29.8	32.9	36.3
Dickens	8	21.0	23.2	25.6	28.3	31.2	34.5	38.1
Floyd	2	4.4	4.8	5.3	5.9	6.5	7.2	7.9
Gaines	3	8.6	9.5	10.5	11.6	12.8	14.2	15.7
Garza	6	15.3	16.9	18.7	20.7	22.8	25.2	27.9
Hale	5	11.8	13.0	14.4	15.9	17.6	19.4	21.4
Hockley	4	10.1	11.1	12.3	13.6	15.0	16.6	18.3
Lamb	3	7.0	7.7	8.5	9.4	10.4	11.5	12.7
Lubbock	14	33.7	37.2	41.1	45.4	50.1	55.4	61.1
Lynn	3	6.2	6.8	7.6	8.4	9.2	10.2	11.3
Motley	3	8.0	8.9	9.8	10.8	12.0	13.2	14.6
Parmer	8	19.3	21.3	23.5	26.0	28.7	31.7	35.0
Swisher	5	13.5	15.0	16.5	18.2	20.2	22.3	24.6
Terry	1	3.3	3.7	4.1	4.5	5.0	5.5	6.1
Yoakum	3	4.4	4.9	5.4	6.0	6.6	7.3	8.1
Total	92	227.9	251.7	278.1	307.1	339.3	374.8	414.0
River Basin Summary								
Canadian	1.0	1.7	1.8	1.7	1.7	1.7	1.8	1.9
Red	27.0	46.9	50.0	60.3	66.2	77.5	85.8	94.8
Brazos	53.0	90.5	96.4	110.6	125.6	137.8	154.1	170.2
Colorado	11.0	88.8	103.5	105.5	113.7	122.3	133.1	147.0
Total	92.0	227.9	251.7	278.1	307.1	339.3	374.8	414.0

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Horses (No. Head)	Water Demand[1] (acft)
1990	6,836	92
2000	16,953	227.9
2010	18,727	251.7
2020	20,686	278.1
2030	22,850	307.1
2040	25,241	339.3
2050	27,882	374.8
2060	30,799	414.0

[1] Calculated at 12 gallons per head per day.

Table 2-13.
Range Beef Cows/Bulls Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	157	89.6	89.6	89.6	89.6	89.6	89.6	89.6
Briscoe	134	134.4	134.4	134.4	134.4	134.4	134.4	134.4
Castro	269	201.6	201.6	201.6	201.6	201.6	201.6	201.6
Cochran	46	89.6	89.6	89.6	89.6	89.6	89.6	89.6
Crosby	179	179.2	179.2	179.2	179.2	179.2	179.2	179.2
Dawson	90	89.6	89.6	89.6	89.6	89.6	89.6	89.6
Deaf Smith	493	492.9	492.9	492.9	492.9	492.9	492.9	492.9
Dickens	224	380.9	380.9	380.9	380.9	380.9	380.9	380.9
Floyd	179	224.0	224.0	224.0	224.0	224.0	224.0	224.0
Gaines	157	156.8	156.8	156.8	156.8	156.8	156.8	156.8
Garza	314	201.6	201.6	201.6	201.6	201.6	201.6	201.6
Hale	90	179.2	179.2	179.2	179.2	179.2	179.2	179.2
Hockley	157	156.8	156.8	156.8	156.8	156.8	156.8	156.8
Lamb	112	112.0	112.0	112.0	112.0	112.0	112.0	112.0
Lubbock	246	156.8	156.8	156.8	156.8	156.8	156.8	156.8
Lynn	134	67.2	67.2	67.2	67.2	67.2	67.2	67.2
Motley	246	425.7	425.7	425.7	425.7	425.7	425.7	425.7
Parmer	134	156.8	156.8	156.8	156.8	156.8	156.8	156.8
Swisher	179	336.0	336.0	336.0	336.0	336.0	336.0	336.0
Terry	90	67.2	67.2	67.2	67.2	67.2	67.2	67.2
Yoakum	134	134.4	134.4	134.4	134.4	134.4	134.4	134.4
Total	3,764	4,032.6	4,032.6	4,032.6	4,032.6	4,032.6	4,032.6	4,032.6
River Basin Summary[2]								
Canadian	32.0	34.3	34.3	34.3	34.3	34.3	34.3	34.3
Red	1,210.0	1,296.3	1,296.3	1,296.3	1,296.3	1,296.3	1,296.3	1,296.3
Brazos	1,988.0	2,129.8	2,129.8	2,129.8	2,129.8	2,129.8	2,129.8	2,129.8
Colorado	534.0	572.1	572.1	572.1	572.1	572.1	572.1	572.1
Total	3,764.0	4,032.6	4,032.6	4,032.6	4,032.6	4,032.6	4,032.6	4,032.6

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Range Beef Cows/Bulls (No. Head)	Water Demand[1] (acft)
1990	168,000	3,764
2000	180,000	4,032.6
2010	180,000	4,032.6
2020	180,000	4,032.6
2030	180,000	4,032.6
2040	180,000	4,032.6
2050	180,000	4,032.6
2060	180,000	4,032.6

[1] Calculated at 20 gallons per head per day.

Table 2-14.
Range Beef Stocker Cattle Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	656	405.0	425.8	447.5	470.4	494.5	519.8	546.3
Briscoe	227	134.4	141.3	148.5	156.1	164.1	172.5	181.3
Castro	1,520	80.7	84.8	89.1	93.7	98.5	103.5	108.8
Cochran	143	35.8	37.7	39.6	41.6	43.8	46.0	48.3
Crosby	168	107.5	113.0	118.8	124.9	131.3	138.0	145.0
Dawson	105	53.8	56.5	59.4	62.4	65.6	69.0	72.5
Deaf Smith	674	2,562.5	2,693.5	2,831.3	2,976.0	3,128.2	3,288.2	3,456.4
Dickens	340	215.1	226.1	237.6	249.8	262.6	276.0	290.1
Floyd	285	217.8	228.9	240.6	252.9	265.8	279.4	293.7
Gaines	154	127.7	134.2	141.1	148.3	155.9	163.9	172.2
Garza	207	134.4	141.3	148.5	156.1	164.1	172.5	181.3
Hale	111	129.5	136.1	143.1	150.4	158.1	166.2	174.7
Hockley	68	95.0	99.8	105.0	110.3	116.0	121.9	128.1
Lamb	153	349.0	366.9	385.7	405.4	426.1	447.9	470.8
Lubbock	104	62.7	65.9	69.3	72.9	76.6	80.5	84.6
Lynn	117	62.7	65.9	69.3	72.9	76.6	80.5	84.6
Motley	357	188.2	197.8	207.9	218.6	229.7	241.5	253.8
Parmer	707	623.5	655.4	688.9	724.1	761.1	800.1	841.0
Swisher	652	235.2	247.3	259.9	273.2	287.2	301.9	317.3
Terry	79	44.8	47.1	49.5	52.0	54.7	57.5	60.4
Yoakum	117	71.7	75.4	79.2	83.3	87.5	92.0	96.7
Total	6,944	5,937.0	6,240.7	6,559.8	6,895.3	7,247.9	7,618.6	8,008.2
River Basin Summary[2]								
Canadian	43.0	37.7	38.8	41.1	43.1	45.4	47.4	49.8
Red	3,064.0	2,636.9	2,777.0	2,913.2	3,063.2	3,221.9	3,385.4	3,558.5
Brazos	3,272.0	2,811.6	2,951.9	3,105.4	3,262.7	3,426.2	3,601.4	3,785.5
Colorado	565.0	450.9	473.0	500.0	526.2	554.3	584.4	614.3
Total	6,944.0	5,937.0	6,240.7	6,559.8	6,895.3	7,247.9	7,618.6	8,008.2

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Range Beef Stocker Cattle (No. Head)	Water Demand[1] (acft)
1990	309,960	6,944.0
2000	662,525	5,937.0
2010	696,407	6,240.7
2020	732,021	6,559.8
2030	769,457	6,895.3
2040	808,807	7,247.9
2050	850,169	7,618.6
2060	893,647	8,008.2

[1] Calculated at 8 gallons per head per day.

Table 2-15.
Sheep and Goats Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	1	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Briscoe	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Castro	1	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Cochran	1	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Crosby	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dawson	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Deaf Smith	4	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Dickens	1	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Floyd	1	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Gaines	4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Garza	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Hale	6	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Hockley	6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Lamb	24	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Lubbock	8	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Lynn	1	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Motley	1	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Parmer	5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Swisher	4	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Terry	1	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Yoakum	1	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Total	75	69.5	69.5	69.5	69.5	69.5	69.5	69.5
River Basin Summary[2]								
Canadian	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Red	13.0	11.9	12.9	12.4	12.4	11.8	11.9	11.9
Brazos	52.0	47.4	46.9	47.9	48.3	48.6	49.0	49.0
Colorado	10.0	10.2	9.7	9.3	8.8	9.0	8.6	8.6
Total	75.0	69.5	69.5	69.5	69.5	69.5	69.5	69.5

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Sheep and Goats (No. Head)	Water Demand[1] (acft)
1990	309,960	75.0
2000	49,050	69.5
2010	49,050	69.5
2020	49,050	69.5
2030	49,050	69.5
2040	49,050	69.5
2050	49,050	69.5
2060	49,050	69.5

[1] Calculated at 1.33 gallons per head per day.

Table 2-16.
Poultry Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Briscoe	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Castro	0	0.0	0.0	50.4	50.4	50.4	50.4	50.4
Cochran	0	0.0	0.0	50.4	50.4	50.4	50.4	50.4
Crosby	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dawson	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Deaf Smith	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dickens	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Floyd	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gaines	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garza	0	0.0	0.0	50.4	50.4	50.4	50.4	50.4
Hale	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hockley	0	0.0	0.0	50.4	50.4	50.4	50.4	50.4
Lamb	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lubbock	51	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lynn	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Motley	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Parmer	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Swisher	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Terry	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yoakum	0	0.0	0.0	50.4	50.4	50.4	50.4	50.4
Total	51	0.0	0.0	252.0	252.0	252.0	252.0	252.0
River Basin Summary[2]								
Canadian	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Red	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brazos	51.0	0.0	0.0	252.0	252.0	252.0	252.0	252.0
Colorado	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	51.0	0.0	0.0	252.0	252.0	252.0	252.0	252.0

1 As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
2 See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Poultry (No. Head)	Water Demand[1] (acft)
1990	504,433	51
2000	0	0
2010	0	0
2020	2,500,000	252.0
2030	2,500,000	252.0
2040	2,500,000	252.0
2050	2,500,000	252.0
2060	2,500,000	252.0

1 Calculated at 0.09 gallons per head per day.

Table 2-17.
Total Livestock Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	2,007	1,723	2,824	3,856	3,962	4,074	4,192	4,318
Briscoe	368	317	325	334	343	353	363	374
Castro	6,490	5,846	7,997	9,816	10,273	10,760	11,276	11,824
Cochran	688	647	828	1,024	1,070	1,119	1,170	1,225
Crosby	353	295	301	307	314	321	329	336
Dawson	199	152	155	158	162	166	170	174
Deaf Smith	7,873	10,156	12,926	15,200	15,940	16,725	17,557	18,438
Dickens	575	620	634	648	662	678	695	712
Floyd	1,323	1,371	1,647	1,861	1,949	2,042	2,140	2,244
Gaines	804	796	913	995	1,045	1,099	1,156	1,216
Garza	528	355	363	423	432	442	453	465
Hale	1,387	1,540	2,169	2,715	2,823	2,939	3,061	3,191
Hockley	570	608	689	796	832	870	910	952
Lamb	1,902	2,412	3,661	4,817	4,949	5,090	5,239	5,397
Lubbock	1,192	972	1,136	1,248	1,316	1,389	1,466	1,548
Lynn	256	140	143	147	152	156	161	166
Motley	609	625	636	647	659	671	684	698
Parmer	5,638	5,695	7,733	9,425	9,872	10,347	10,851	11,385
Swisher	3,263	3,121	3,757	4,216	4,442	4,681	4,935	5,205
Terry	173	119	201	283	286	289	293	296
Yoakum	294	214	218	273	278	282	288	293
Total	36,492	37,724	49,257	59,189	61,761	64,493	67,389	70,457
River Basin Summary[2]								
Canadian	76	73	88	99	100	102	103	108
Red	18,101	19,243	25,283	30,554	31,976	33,480	35,062	36,660
Brazos	16,666	16,759	21,800	26,112	27,199	28,353	29,585	30,930
Colorado	1,649	1,649	2,087	2,423	2,486	2,558	2,638	2,758
Total	36,492	37,724	49,257	59,189	61,761	64,493	67,389	70,457

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Livestock (No. Head)	Water Demand[1] (acft)
1990	See Table 2-8 through Table 2-15 for numbers of each type of Livestock	36,492
2000		37,724
2010		49,257
2020		59,189
2030		61,761
2040		64,493
2050		67,389
2060		70,457

[1] Sum of Tables 2-8 through 2-15.

Table 2-18.
All Livestock Other than Beef Feedlot Livestock Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	1,069	752	1,640	2,529	2,553	2,578	2,604	2,632
Briscoe	368	317	325	334	343	353	363	374
Castro	1,899	476	1,451	2,477	2,482	2,488	2,494	2,501
Cochran	192	133	202	321	324	327	329	332
Crosby	353	295	301	307	314	321	329	336
Dawson	199	152	155	158	162	166	170	174
Deaf Smith	1,339	3,115	4,343	5,577	5,724	5,880	6,043	6,214
Dickens	575	620	634	648	662	678	695	712
Floyd	469	485	568	651	664	678	692	707
Gaines	322	296	304	312	320	329	338	348
Garza	528	355	363	423	432	442	453	465
Hale	214	354	724	1,095	1,103	1,113	1,123	1,133
Hockley	239	265	271	328	335	342	349	357
Lamb	400	1,084	2,042	3,001	3,022	3,044	3,067	3,091
Lubbock	503	258	265	272	280	289	298	308
Lynn	256	140	143	147	152	156	161	166
Motley	609	625	636	647	659	671	684	698
Parmer	944	832	1,805	2,779	2,817	2,856	2,898	2,943
Swisher	851	622	711	800	815	831	848	866
Terry	173	119	201	283	286	289	293	296
Yoakum	294	214	218	273	278	282	288	293
Total	11,796	11,510	17,302	23,363	23,727	24,113	24,520	24,946
River Basin Summary[2]								
Canadian	76	73	88	99	100	102	103	108
Red	4,491	4,432	7,228	10,313	10,484	10,665	10,841	10,946
Brazos	6,062	5,898	8,561	11,269	11,444	11,624	11,825	12,076
Colorado	1,167	1,107	1,425	1,682	1,699	1,722	1,751	1,816
Total	11,796	11,510	17,302	23,363	23,727	24,113	24,520	24,946

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: Weinheimer, Ben, and Sweeten, John M.; Texas Cattle Feeders Assn., and Texas A&M University Research and Extension Center, Amarillo, Texas, July 2003.

Year	Livestock (No. Head)	Water Demand[1] (acft)
1990	See Table 2-9 through Table 2-15 for numbers of each type of Livestock	11,796
2000		11,510
2010		17,302
2020		23,363
2030		23,727
2040		24,113
2050		24,520
2060		24,946

[1] Sum of Tables 2-9 through 2-15.

2.8 Total Water Demand Projections

Total water demand projections for the Llano Estacado Region are the sum of water demand projections for municipal, industrial, steam-electric power generation, mining, irrigation, and total livestock water demand projections (Tables 2-4 through 2-8, and 2-17), and are shown in Table 2-19 and Figure 2-6. Total water use in 2000 was estimated at 4,530,041 acft/yr (Table 2-19). Projected total water demand for the region is 4,090,338 acft/yr in 2030 and 3,704,336 acft/yr in 2060 (Table 2-19 and Figure 2-6). Projections of future water demands for municipal, industrial, steam-electric power, and livestock increase, while projections for irrigation and mining purposes decrease. The reasons for the decline in the projections of demand in future years for irrigation are predictions of increased efficiency in irrigation, economic factors adversely affecting the profitability of irrigation in future years, and expectation of decreased government programs supporting agricultural incomes. Projections for mining water demand decrease due to the expectation that secondary recovery of crude petroleum using water flooding will decrease in future years as this method is phased out or is no longer a viable technology for the industry in the Llano Estacado Region.

Projections of future water demands for the Llano Estacado Region show irrigation demand at 95.98 percent of total demand in 2000 and 93.79 percent in 2060 (Table 2-20). Municipal demand, as a percent of total demand, increases from 1.93 percent in 2000 to 2.53 percent in 2060 (Table 2-20), with beef cattle feedlot livestock demand as a percent of total demand increasing from 0.58 percent in 2000 to 1.23 percent in 2060 (Table 2-20).

Table 2-19.
Total Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections					
			2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	224,374	186,163	182,975	179,809	175,778	171,857	168,000	164,230
Briscoe	40,283	26,952	26,009	25,098	24,208	23,343	22,519	21,728
Castro	361,423	513,023	496,271	479,787	462,573	446,046	430,142	414,954
Cochran	35,222	123,115	118,458	113,812	109,413	105,101	100,941	96,980
Crosby	108,032	113,728	109,195	104,855	100,704	96,718	92,875	89,186
Dawson	42,279	152,146	142,886	134,322	126,713	119,536	112,731	106,469
Deaf Smith	298,239	388,353	379,773	371,001	361,006	351,358	341,958	332,953
Dickens	5,875	10,825	10,473	10,143	9,847	9,557	9,293	9,052
Floyd	134,278	239,572	230,437	221,609	212,983	204,699	196,724	189,064
Gaines	400,317	424,778	403,246	381,382	360,671	341,024	322,724	305,980
Garza	6,447	14,563	13,355	12,367	11,559	10,810	10,133	9,573
Hale	471,380	378,473	367,443	356,656	345,690	334,956	324,460	314,394
Hockley	100,912	183,873	176,008	168,498	161,523	154,600	148,146	142,378
Lamb	369,020	402,158	388,810	375,942	365,728	356,641	348,744	342,327
Lubbock	277,626	298,052	286,253	274,138	263,219	252,278	243,302	234,220
Lynn	41,302	121,566	115,095	108,962	103,132	97,611	92,372	87,405
Motley	4,817	10,200	9,922	9,645	9,370	9,094	8,839	8,604
Parmer	484,388	425,089	423,148	420,744	417,040	413,368	409,700	406,154
Swisher	144,439	176,303	175,997	169,314	174,762	174,022	173,280	172,531
Terry	134,843	207,229	196,691	186,781	177,460	168,629	160,130	152,106
Yoakum	127,991	133,881	127,955	122,581	116,958	112,056	107,784	104,047
Total	3,813,487	4,530,041	4,380,400	4,227,446	4,090,338	3,953,303	3,824,795	3,704,336
River Basin Summary[2]								
Canadian	79	73	89	100	101	103	104	109
Red	758,998	939,865	920,955	898,344	879,612	858,122	837,297	817,303
Brazos	2,331,816	2,618,292	2,536,935	2,454,623	2,381,543	2,308,600	2,240,704	2,176,663
Colorado	722,594	971,811	922,422	874,378	829,082	786,478	746,689	710,260
Total	3,813,487	4,530,041	4,380,400	4,227,446	4,090,338	3,953,303	3,824,795	3,704,336

1 As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
2 See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

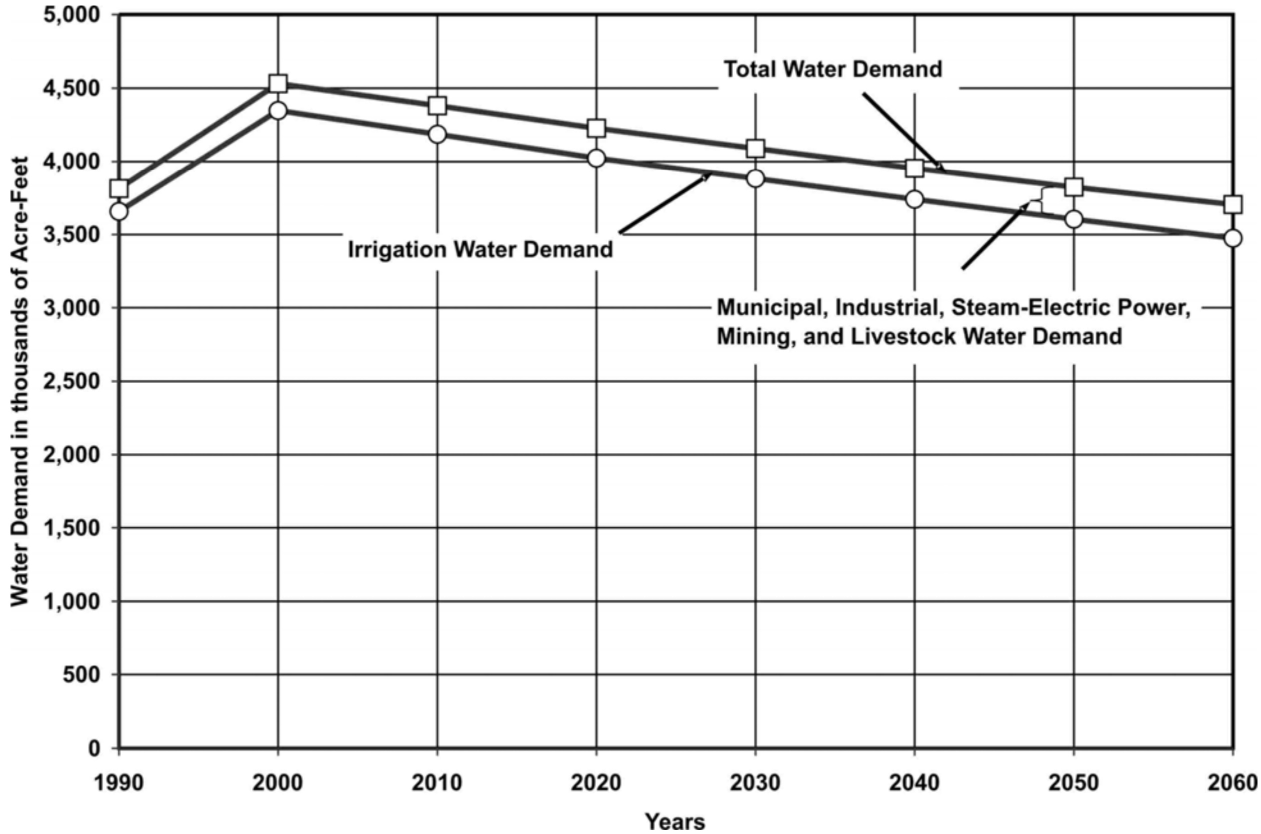

Figure 2-6. Total Water Demand Projections: Llano Estacado Region – 1990 to 2060

Table 2-20. Composition of Projected Total Water Demand Llano Estacado Region 2000, 2030, and 2060

Purpose of Use	2000		2030		2060	
	acft	% of total	(acft)	% of total	(acft)	% of total
Municipal	87,322	1.93%	95,710	2.34%	93,549	2.53%
Industrial	10,064	0.22%	13,540	0.33%	15,999	0.43%
Steam-Electric Power	25,618	0.57%	30,188	0.74%	49,910	1.35%
Mining	21,436	0.47%	6,359	0.16%	258	0.01%
Irrigation	4,347,877	95.98%	3,882,780	94.93%	3,474,163	93.79%
Beef Feedlot Livestock	26,215	0.58%	38,035	0.93%	45,512	1.23%
Range & All Other Livestock	11,510	0.25%	23,727	0.58%	24,946	0.67%
Total	4,530,041	100.00%	4,090,338	100.00%	3,704,336	100.00%

2.9 Water Demand Projections for Counties and Parts of Counties of River Basins of the Llano Estacado Region

For purposes of this regional planning project, and in accordance with TWDB Rules, Section 357.7(a)(2), water demand projections are tabulated by river basin, county or part of county located within a river basin, as well as city and rural areas of each county or part of county for the Llano Estacado Region (Table 2-21).[2] For example, a part of the rural area of Deaf Smith County is located in the Canadian River Basin. The projected 1 acft/yr of water demand for the people who live in this rural area is shown as municipal water demand (Table 2-21). There is no manufacturing, steam-electric power, irrigation, mining, or beef feedlot livestock demand projected for the part of Deaf Smith County located in the Canadian River Basin. However, there is a range and all other livestock demand of 73 acft/yr in 2000 with a projection of 108 acft/yr in 2060 (Table 2-21).

All of Briscoe County is located in the Red River Basin. Most of the county is rural, but it contains the City of Silverton. The municipal water use by Silverton in 2000 was 126 acft/yr, with projected 2060 municipal water demands of 108 acft/yr (Table 2-21). Rural areas of Briscoe County located in the Red River Basin used 180 acft/yr for household purposes (municipal type of water use) in 2000, with projections for 2060 of 155 acft/yr (Table 2-21).

There are no industrial, steam-electric power, mining, or feedlot livestock water demands in Briscoe County in the Red River Basin. However, an estimated 26,329 acft/yr of water was used for irrigation in 2000, with projected irrigation water demand in 2060 of 21,091 acft/yr (Table 2-21). Range and all other livestock water demand in Briscoe County was estimated at 317 acft/yr in 2000 and is projected to increase to 374 acft/yr in 2060 (Table 2-21).

Total water use in Briscoe County in 2000 was 26,952 acft/yr, with projected total water demand of 21,728 acft/yr in 2060 (Table 2-21).

Projections for each county or part of county of each respective river basin of the region are shown in Table 2-21. Total projections for counties and parts of counties of each river basin area located in the Llano Estacado Planning Region are shown at the end of the listing of individual counties and parts of counties of each river basin. In addition, the basin totals are listed at the end of Table 2-21. For example, total water use in 2000 in the Red River Basin part of the Llano Estacado Planning Region was 940,787 acft/yr, of which 7,548 acft/yr was for

[2] 31 Texas Administrative Code, Chapter 357, Regional Water Planning Guidelines Rules, TWDB, Austin, Texas, March 11, 1998.

municipal purposes, 3,404 acft/yr was for manufacturing purposes, 909,585 acft/yr was for irrigation, 85 acft/yr was for mining, 14,731 acft/yr was for beef feedlot livestock, and 5,433 acft/yr was for range and all other livestock. Projected water demand for the Red River Basin part of the planning region in 2060 is 816,905 acft/yr, with 8,301 acft/yr being municipal demand, 5,474 acft/yr being for manufacturing, zero acft/yr being for steam-electric power, 766,868 acft/yr being for irrigation, zero acft/yr being for mining 25,576 acft/yr being for beef feedlot livestock, and 10,685 acft/yr being for range and all other livestock. The reader can readily see the projections, by type of demand, for the Canadian, Red, Brazos, and Colorado River Basin areas of the Llano Estacado Planning Region in Table 2-21.

Total water use in the Llano Estacado Region was 4,530,041 acft/yr in 2000, with projected 2060 water demands of 3,704,336 acft/yr. The quantity of projected water demands in 2060 are 109 acft/yr for the Canadian River Basin areas of the Region, 816,905 acft/yr for the Red River Basin areas of the Region, 2,177,563 acft/yr for the Brazos River Basin areas of the Region, and 709,759 acft/yr for the Colorado River Basin areas of the Region.

Table 2-21.
Water Demand Projections
Llano Estacado Region
River Basins, Counties, and Cities[1]

Basin/County/City/Rural	***Total in 1990 (acft)***	***Total in 2000 (acft)***	***Projections (acft)***					
			2010	***2020***	***2030***	***2040***	***2050***	***2060***
Canadian Basin (part)								
Deaf Smith (part)								
Rural (Municipal)	3	0	1	1	1	1	1	1
Total Municipal Demand	3	0	1	1	1	1	1	1
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	0	0	0	0	0	0	0	0
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	76	73	88	99	100	102	103	108
Total Demand	79	73	89	100	101	103	104	109
Canadian Basin Total	**79**	**73**	**89**	**100**	**101**	**103**	**104**	**109**
Red Basin (part)								
Briscoe County (all)								
(Left Blank Intentionally)								
Silverton (Municipal)	135	126	128	128	123	115	111	108
Rural (Municipal)	188	180	183	183	176	165	159	155
Total Municipal Demand	323	306	311	311	299	280	270	263
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	39,592	26,329	25,373	24,453	23,566	22,710	21,886	21,091
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	368	317	325	334	343	353	363	374
Total Demand	40,283	26,952	26,009	25,098	24,208	23,343	22,519	21,728
Castro County (part)								
Rural (Municipal)	221	247	263	278	285	288	286	281
Total Municipal Demand	221	247	263	278	285	288	286	281
Manufacturing Demand	392	95	112	121	128	136	142	152
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	115,892	166,251	159,877	153,748	147,853	142,184	136,733	131,491
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	2,689	3,145	3,834	4,299	4,563	4,845	5,143	5,461
Range & All Other Livestock Demand	855	215	653	1,116	1,118	1,123	1,129	1,133
Total Demand	120,049	169,952	164,739	159,562	153,948	148,576	143,433	138,518
Crosby County (part)								
Rural (Municipal)	5	1	1	1	1	1	1	1
Total Municipal Demand	5	1	1	1	1	1	1	1
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	2,113	2,243	2,152	2,066	1,982	1,903	1,826	1,752
Mining Demand	291	70	41	20	11	5	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	4	3	3	3	4	4	4	4
Total Demand	2,413	2,317	2,197	2,090	1,998	1,913	1,831	1,757

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Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Deaf Smith (part)								
Hereford (Municipal)	3,869	3,564	3,634	3,694	3,751	3,788	3,801	3,813
Rural (Municipal)	537	572	743	932	1,100	1,243	1,286	1,305
Total Municipal Demand	4,406	4,136	4,377	4,626	4,851	5,031	5,087	5,118
Manufacturing Demand	498	1,234	1,454	1,594	1,710	1,821	1,917	2,055
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	285,459	372,827	361,015	349,580	338,504	327,780	317,396	307,341
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	6,534	7,041	8,583	9,623	10,216	10,846	11,514	12,224
Range & All Other Livestock Demand	1,263	3,043	4,257	5,478	5,623	5,779	5,941	6,105
Total Demand	298,160	388,281	379,686	370,901	360,904	351,257	341,855	332,843
Dickens County (part)								
Rural (Municipal)	34	45	43	41	38	33	30	28
Total Municipal Demand	34	45	43	41	38	33	30	28
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	2,055	4,079	3,957	3,839	3,725	3,614	3,506	3,400
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	213	230	233	239	246	251	258	264
Total Demand	2,302	4,354	4,233	4,119	4,009	3,898	3,794	3,692
Floyd County (part)								
Rural (Municipal)	107	103	106	107	106	104	100	95
Total Municipal Demand	107	103	106	107	106	104	100	95
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	59,268	106,659	102,411	98,332	94,415	90,654	87,044	83,577
Mining Demand	30	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	259	272	317	364	368	376	386	393
Total Demand	59,664	107,034	102,834	98,803	94,889	91,134	87,530	84,065
Hale County (part)								
Rural (Municipal)	6	0	0	0	0	0	0	0
Total Municipal Demand	6	0	0	0	0	0	0	0
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	4,619	3,677	3,555	3,437	3,323	3,213	3,107	3,004
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	0	2	3	4	4	4	4	3
Total Demand	4,625	3,679	3,558	3,441	3,327	3,217	3,111	3,007
Motley County (all)								
Matador (Municipal)	221	239	234	224	207	187	174	166
Rural (Municipal)	81	148	143	136	123	108	98	93
Total Municipal Demand	302	387	377	360	330	295	272	259
Manufacturing Demand	0	5	6	6	6	6	6	6
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	3,883	9,168	8,894	8,628	8,372	8,121	7,877	7,641
Mining Demand	23	15	9	4	3	1	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	609	625	636	647	659	671	684	698
Total Demand	4,817	10,200	9,922	9,645	9,370	9,094	8,839	8,604

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Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Parmer County (part)								
Friona (Municipal)	912	803	835	872	879	870	838	791
Rural (Municipal)	138	106	110	113	112	110	106	100
Total Municipal Demand	1,050	909	945	985	991	980	944	891
Manufacturing Demand	1,502	2,070	2,427	2,617	2,772	2,921	3,051	3,261
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	137,750	120,480	119,201	117,935	116,683	115,444	114,219	113,006
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	1,975	2,046	2,494	2,797	2,968	3,153	3,347	3,553
Range & All Other Livestock Demand	322	283	616	948	957	974	995	1,012
Total Demand	142,599	125,788	125,683	125,281	124,371	123,471	122,555	121,723
Swisher County (part)								
Happy		107	109	110	111	110	108	103
Kress (Municipal)	101	80	82	82	83	81	79	76
Tulia (Municipal)	1,062	1,020	1,050	1,065	1,072	1,064	1,038	993
Rural (Municipal)	310	207	211	211	211	207	202	193
Total Municipal Demand	1,473	1,414	1,452	1,468	1,477	1,462	1,427	1,365
Manufacturing Demand	3	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	79,600	97,872	97,313	93,233	96,205	95,655	95,108	94,565
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	2,412	2,499	3,047	3,416	3,626	3,850	4,087	4,339
Range & All Other Livestock Demand	598	444	513	617	636	657	678	699
Total Demand	84,086	102,230	102,325	98,733	101,944	101,624	101,300	100,968
Red Basin Total								
Total Municipal Demand	7,927	7,548	7,875	8,177	8,378	8,474	8,417	8,301
Manufacturing Demand	2,395	3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	730,231	909,585	883,748	855,251	834,628	811,278	788,702	766,868
Mining Demand	344	85	50	24	14	6	0	0
Beef Feedlot Livestock Demand	13,610	14,731	17,958	20,134	21,374	22,693	24,091	25,576
Range & All Other Livestock Demand	4,491	5,433	7,556	9,751	9,958	10,192	10,440	10,685
Total Demand	758,998	940,787	921,186	897,674	878,968	857,527	836,767	816,905
Brazos Basin (part)								
Bailey County (all)								
Muleshoe (Municipal)	1,073	979	1,027	1,082	1,109	1,137	1,135	1,114
Rural (Municipal)	352	331	342	358	364	371	370	363
Total Municipal Demand	1,425	1,310	1,369	1,440	1,473	1,508	1,505	1,477
Manufacturing Demand	147	264	303	316	326	335	343	365
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	220,775	182,865	178,478	174,197	170,018	165,939	161,958	158,071
Mining Demand	20	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	938	971	1,184	1,327	1,409	1,496	1,588	1,686
Range & All Other Livestock Demand	1,069	752	1,640	2,529	2,552	2,578	2,604	2,632
Total Demand	224,374	186,162	182,974	179,809	175,779	171,856	167,998	164,231

Continued on next page

Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft)					
			2010	2020	2030	2040	2050	2060
Castro County (part)								
Dimmitt (Municipal)	894	975	1,041	1,103	1,137	1,159	1,150	1,130
Hart (Municipal)	187	223	238	251	258	262	260	256
Rural (Municipal)	265	208	222	234	240	243	241	237
Total Municipal Demand	1,346	1,406	1,501	1,588	1,635	1,664	1,651	1,623
Manufacturing Demand	1,785	1,637	1,923	2,082	2,213	2,337	2,445	2,617
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	235,297	337,541	324,598	312,154	300,186	288,677	277,609	266,966
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	1,902	2,225	2,712	3,040	3,228	3,427	3,638	3,862
Range & All Other Livestock Demand	1,044	261	798	1,360	1,364	1,364	1,365	1,367
Total Demand	241,374	343,070	331,532	320,224	308,626	297,469	286,709	276,436
Cochran County (part)								
Morton (Municipal)	631	499	535	560	565	547	521	496
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Rural (Municipal)	176	172	183	191	192	185	176	167
Total Municipal Demand	807	671	718	751	757	732	697	663
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	20,915	76,790	73,825	70,978	68,239	65,604	63,071	60,636
Mining Demand	0	16	14	10	8	6	4	2
Beef Feedlot Livestock Demand	496	514	627	703	746	792	841	893
Range & All Other Livestock Demand	67	45	69	110	114	116	118	118
Total Demand	22,285	78,037	75,253	72,552	69,864	67,250	64,731	62,312
Crosby County (part)								
Crosbyton (Municipal)	409	351	369	386	394	402	400	394
Lorenzo (Municipal)	227	260	275	288	296	302	301	296
Ralls (Municipal)	313	290	304	315	322	325	323	318
Rural (Municipal)	241	202	210	217	220	222	220	217
Total Municipal Demand	1,190	1,103	1,158	1,206	1,232	1,251	1,244	1,225
Manufacturing Demand	7	5	6	6	6	6	6	6
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	103,521	109,892	105,465	101,215	97,138	93,223	89,469	85,866
Mining Demand	552	119	71	34	20	8	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	349	292	298	303	310	318	325	332
Total Demand	105,619	111,411	106,998	102,764	98,706	94,806	91,044	87,429
Dawson (part)								
O'Donnell		17	17	17	17	17	17	16
Rural (Municipal)	14	18	18	18	19	18	18	17
Total Municipal Demand	14	35	35	35	36	35	35	33
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	391	1,460	1,378	1,300	1,227	1,158	1,093	1,031
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	2	1	1	2	1	2	2	2
Total Demand	407	1,496	1,414	1,337	1,264	1,195	1,130	1,066

Continued on next page

Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft)					
			2010	2020	2030	2040	2050	2060
Dickens County (part)								
Dickens (Municipal)	99							
Spur (Municipal)	251	275	271	267	263	260	257	257
Rural (Municipal)	124	234	224	212	194	169	158	147
Total Municipal Demand	474	509	495	479	457	429	415	404
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	2,724	5,407	5,246	5,089	4,938	4,791	4,647	4,508
Mining Demand	13	165	98	47	27	12	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	362	391	401	408	417	427	437	449
Total Demand	3,573	6,472	6,240	6,023	5,839	5,659	5,499	5,361
Floyd County (part)								
Floydada (Municipal)	570	663	680	696	693	685	657	623
Lockney (Municipal)	321	237	242	244	240	234	224	212
Rural (Municipal)	187	178	183	185	183	180	172	163
Total Municipal Demand	1,078	1,078	1,105	1,125	1,116	1,099	1,053	998
Manufacturing Demand	1	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	72,438	130,361	125,168	120,184	115,397	110,800	106,387	102,150
Mining Demand	33	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	854	885	1,079	1,210	1,285	1,364	1,448	1,537
Range & All Other Livestock Demand	210	213	251	287	296	301	306	314
Total Demand	74,614	132,538	127,604	122,807	118,094	113,564	109,194	104,999
Garza County (part)								
Post (Municipal)	770	623	631	642	616	579	549	512
Rural (Municipal)	188	154	156	156	150	141	132	123
Total Municipal Demand	958	777	787	798	766	720	681	635
Manufacturing Demand	2	2	2	2	2	2	2	2
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	4,383	12,165	11,451	10,783	10,148	9,556	8,997	8,471
Mining Demand	575	1,264	752	361	211	90	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	528	355	363	423	432	442	453	465
Total Demand	6,446	14,563	13,355	12,367	11,559	10,810	10,133	9,573
Hale County (part)								
Abernathy (part) (Municipal)	395	461	486	508	526	531	525	514
Hale Center (Municipal)	410	446	470	493	509	513	507	498
Petersburg (Municipal)	222	276	289	304	313	316	312	306
Plainview (Municipal)	4,421	4,078	4,288	4,490	4,605	4,635	4,577	4,488
Rural (Municipal)	921	1,109	1,144	1,187	1,207	1,203	1,184	1,161
Total Municipal Demand	6,369	6,370	6,677	6,982	7,160	7,198	7,105	6,967
Manufacturing Demand	1,521	2,605	2,993	3,188	3,339	3,482	3,604	3,840
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	457,312	364,023	351,961	340,300	329,026	318,124	307,583	297,392
Mining Demand	166	258	88	34	19	0	0	0
Beef Feedlot Livestock Demand	1,173	1,185	1,445	1,620	1,720	1,826	1,939	2,058
Range & All Other Livestock Demand	214	353	721	1,090	1,099	1,109	1,119	1,130
Total Demand	466,755	374,794	363,885	353,214	342,363	331,739	321,350	311,387

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Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft)					
			2010	2020	2030	2040	2050	2060
Hockley County (part)								
Anton (Municipal)	200	250	263	270	272	268	256	243
Levelland (Municipal)	2,377	2,219	2,310	2,362	2,369	2,322	2,216	2,107
Ropesville		85	89	91	91	89	85	81
Smyer		67	69	70	70	68	65	62
Rural (Municipal)	771	814	840	855	853	831	791	753
Total Municipal Demand	3,348	3,435	3,571	3,648	3,655	3,578	3,413	3,246
Manufacturing Demand	67	53	61	65	68	71	73	78
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	83,764	157,496	151,336	145,420	139,735	134,269	129,019	123,974
Mining Demand	2,465	3,302	2,358	1,510	981	378	19	0
Beef Feedlot Livestock Demand	331	343	418	468	497	528	561	595
Range & All Other Livestock Demand	199	221	226	273	280	286	292	299
Total Demand	90,174	164,850	157,970	151,385	145,216	139,110	133,377	128,192
Lamb County (all)								
Amherst (Municipal)	147	163	168	176	182	185	183	181
Earth (Municipal)	312	248	257	268	277	283	280	276
Littlefield (Municipal)	1,010	1,480	1,530	1,602	1,660	1,694	1,676	1,655
Olton (Municipal)	457	474	492	512	532	542	536	529
Sudan (Municipal)	283	218	226	236	244	249	246	243
Rural (Municipal)	443	766	794	830	861	880	872	861
Total Municipal Demand	2,652	3,349	3,467	3,624	3,756	3,833	3,793	3,745
Manufacturing Demand	753	426	490	519	541	562	580	618
Steam-Electric Power Demand	12,587	17,990	17,827	17,663	20,651	24,292	28,731	34,142
Irrigation Demand	351,050	377,893	363,313	349,294	335,816	322,858	310,401	298,425
Mining Demand	76	88	52	25	15	6	0	0
Beef Feedlot Livestock Demand	1,502	1,328	1,619	1,815	1,927	2,046	2,172	2,306
Range & All Other Livestock Demand	400	1,084	2,042	3,001	3,022	3,044	3,067	3,091
Total Demand	369,020	402,158	388,810	375,941	365,728	356,641	348,744	342,327
Lubbock County (all)								
Abernathy (part) (Municipal)	109	153	171	182	188	186	190	186
Idalou (Municipal)	356	288	289	288	281	274	273	272
Lubbock (Municipal)	36,656	40,460	41,765	42,580	42,652	42,033	42,349	41,915
New Deal (Municipal)	96	126	149	165	173	173	178	173
Ransom Canyon (Municipal)	162	310	440	569	698	825	953	1,004
Reese Redevelopment (Municipal)	657							
Shallowater (Municipal)	325	311	344	367	377	371	379	371
Slaton (Municipal)	865	931	907	889	870	849	837	836
Wolfforth (Municipal)	337	412	1,468	1,758	1,822	1,884	1,962	2,006
Rural (Municipal)	2,779	3,417	3,006	3,051	3,053	2,909	2,907	2,744
Total Municipal Demand	42,342	46,408	48,539	49,849	50,114	49,504	50,028	49,507
Manufacturing Demand	1,469	1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric Power Demand	1,715	5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation Demand	230,717	242,978	229,267	216,397	204,248	192,782	181,961	171,747
Mining Demand	191	352	209	101	59	25	0	0
Beef Feedlot Livestock Demand	689	714	870	976	1,036	1,100	1,168	1,240
Range & All Other Livestock Demand	503	258	265	272	280	289	298	308
Total Demand	277,626	298,052	286,252	274,138	263,219	252,278	243,302	234,220

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Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Lynn County (part)								
O'Donnell		139	144	146	142	138	130	121
Tahoka (Municipal)	488	473	492	504	490	478	453	421
Wilson (Municipal)	53	65	67	68	65	63	60	55
Rural (Municipal)	278	290	299	301	292	282	267	249
Total Municipal Demand	819	967	1,002	1,019	989	961	910	846
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	39,616	119,289	112,870	106,796	101,054	95,614	90,473	85,610
Mining Demand	116	66	39	19	11	5	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	235	128	132	136	139	144	149	153
Total Demand	40,786	120,450	114,043	107,970	102,193	96,724	91,532	86,609
Parmer County (part)								
Bovina (Municipal)	316	309	321	334	335	330	317	300
Farwell (Municipal)	410	370	388	405	410	408	393	371
Rural (Municipal)	472	287	297	305	304	298	286	270
Total Municipal Demand	1,198	966	1,006	1,044	1,049	1,036	996	941
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	337,250	294,969	291,836	288,738	285,673	282,640	279,639	276,670
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	2,719	2,817	3,434	3,849	4,087	4,338	4,606	4,890
Range & All Other Livestock Demand	622	549	1,189	1,832	1,860	1,883	1,903	1,931
Total Demand	341,789	299,301	297,464	295,463	292,669	289,897	287,144	284,432
Swisher County (part)								
Kress		21	22	22	22	22	21	20
Rural (Municipal)	50	41	41	42	41	41	40	38
Total Municipal Demand	50	62	63	64	63	63	61	58
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	60,050	73,834	73,412	70,333	72,575	72,161	71,749	71,338
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	253	178	197	183	179	174	170	167
Total Demand	60,353	74,074	73,672	70,580	72,817	72,398	71,980	71,563
Terry County (part)								
Rural (Municipal)	21	13	14	14	15	16	15	15
Total Municipal Demand	21	13	14	14	15	16	15	15
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	6,595	10,157	9,636	9,142	8,674	8,229	7,807	7,407
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	5	4	7	10	8	12	10	7
Total Demand	6,621	10,174	9,657	9,166	8,697	8,257	7,832	7,429

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Table 2-21 Continued

Basin/County/City/Rural	***Total in 1990 (acft)***	***Total in 1996 (acft)***	***Projections (acft)***					
			2000	***2010***	***2020***	***2030***	***2040***	***2050***
Brazos Basin Total								
Total Municipal Demand	64,091	68,459	71,507	73,666	74,273	73,627	73,602	72,383
Manufacturing Demand	5,752	6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric Power Demand	14,302	23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation Demand	2,226,798	2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
Mining Demand	4,207	5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock Demand	10,604	10,983	13,388	15,009	15,935	16,917	17,960	19,068
Range & All Other Livestock Demand	6,062	5,085	8,600	12,220	12,354	12,488	12,618	12,763
Total Demand	2,331,816	2,617,601	2,537,122	2,455,740	2,382,633	2,309,652	2,241,698	2,177,563
Colorado Basin (part)								
Cochran County (part)								
Rural (Municipal)	124	92	98	102	103	99	95	90
Total Municipal Demand	124	92	98	102	103	99	95	90
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	11,764	43,195	41,527	39,925	38,384	36,902	35,478	34,108
Mining Demand	924	1,704	1,448	1,022	852	639	426	256
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	125	87	132	212	210	210	211	214
Total Demand	12,937	45,078	43,205	41,261	39,549	37,850	36,210	34,668
Dawson County (part)								
Lamesa (Municipal)	1,827	2,486	2,540	2,573	2,602	2,603	2,529	2,433
Rural (Municipal)	444	605	610	612	616	607	587	565
Total Municipal Demand	2,271	3,091	3,150	3,185	3,218	3,210	3,116	2,998
Manufacturing Demand	44	101	119	129	137	144	150	162
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	38,706	144,579	136,425	128,736	121,478	114,628	108,167	102,071
Mining Demand	654	2,728	1,624	779	455	195	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	197	150	154	156	161	164	168	172
Total Demand	41,872	150,649	141,472	132,985	125,449	118,341	111,601	105,403
Gaines County (all)								
Seagraves (Municipal)	555	416	449	482	502	513	506	499
Seminole (Municipal)	1,676	2,019	2,214	2,401	2,525	2,605	2,579	2,544
Rural (Municipal)	689	704	754	800	823	839	824	813
Total Municipal Demand	2,920	3,139	3,417	3,683	3,850	3,957	3,909	3,856
Manufacturing Demand	303	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	392,950	414,772	393,170	372,693	353,283	334,884	317,442	300,908
Mining Demand	3,340	6,071	5,746	4,011	2,493	1,084	217	0
Beef Feedlot Livestock Demand	482	500	609	683	725	770	817	868
Range & All Other Livestock Demand	322	296	304	312	320	329	338	348
Total Demand	400,317	424,778	403,246	381,382	360,671	341,024	322,724	305,980

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Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 1996 (acft)	Projections (acft) 2000	2010	2020	2030	2040	2050
Garza County (part)								
Rural (Municipal)	1	0	0	0	0	0	0	0
Total Municipal Demand	1	0	0	0	0	0	0	0
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	0	0	0	0	0	0	0	0
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	0	0	0	0	0	0	0	0
Total Demand	1	0	0	0	0	0	0	0
Hockley (part)								
Sundown (Municipal)	353	325	341	350	353	347	332	316
Rural (Municipal)	54	40	41	42	42	41	39	37
Total Municipal Demand	407	365	382	392	395	388	371	353
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	9,204	17,500	16,815	16,158	15,526	14,919	14,335	13,775
Mining Demand	1,087	1,114	796	509	331	127	6	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	40	44	45	55	55	56	57	59
Total Demand	10,738	19,023	18,038	17,114	16,307	15,490	14,769	14,187
Lynn County (part)								
Left Blank Intentionally								
Rural (Municipal)	123	6	7	7	6	6	6	6
Total Municipal Demand	123	6	7	7	6	6	6	6
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	372	1,083	1,025	970	918	868	822	777
Mining Demand	0	15	9	4	2	1	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	21	11	11	11	12	12	13	14
Total Demand	516	1,115	1,052	992	938	887	841	797
Terry County (part)								
Brownfield (Municipal)	1,481	2,593	2,747	2,905	3,047	3,181	3,185	3,167
Meadow (Municipal)	87	70	73	75	78	80	79	79
Rural (Municipal)	358	362	376	393	407	419	418	415
Total Municipal Demand	1,926	3,025	3,196	3,373	3,532	3,680	3,682	3,661
Manufacturing Demand	0	1	1	1	1	1	1	1
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	125,306	192,984	183,089	173,702	164,797	156,348	148,332	140,726
Mining Demand	822	930	554	266	155	66	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	168	115	194	274	278	277	283	289
Total Demand	128,222	197,055	187,034	177,616	168,763	160,372	152,298	144,677

Continued on next page

Table 2-21 Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 1996 (acft)	Projections (acft) 2000	2010	2020	2030	2040	2050
Yoakum County (all)								
Denver City (Municipal)	1,079	955	1,043	1,126	1,172	1,220	1,181	1,141
Plains (Municipal)	438	378	416	448	468	488	473	457
Rural (Municipal)	298	264	286	305	314	323	312	302
Total Municipal Demand	1,815	1,597	1,745	1,879	1,954	2,031	1,966	1,900
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation Demand	122,409	127,059	120,979	115,187	109,674	104,426	99,427	94,668
Mining Demand	3,473	3,159	2,416	1,524	706	204	56	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	294	214	218	273	278	282	288	293
Total Demand	127,991	133,881	127,955	122,581	116,958	112,056	107,784	104,047
Colorado Basin Total								
Total Municipal Demand	9,587	11,315	11,995	12,621	13,058	13,371	13,145	12,864
Manufacturing Demand	347	102	120	130	138	145	151	163
Steam-Electric Power Demand	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation Demand	700,711	941,172	893,030	847,371	804,060	762,975	724,003	687,033
Mining Demand	10,300	15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock Demand	482	500	609	683	725	770	817	868
Range & All Other Livestock Demand	1,167	918	1,059	1,292	1,314	1,331	1,358	1,389
Total Demand	722,594	971,580	922,003	873,931	828,635	786,021	746,227	709,759
Llano Estacado Region River Basin Totals								
Canadian River Basin (part)								
Total Municipal Demand	3	0	1	1	1	1	1	1
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	0	0	0	0	0	0	0	0
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	76	73	88	99	100	102	103	108
Total Demand	79	73	89	100	101	103	104	109
Red River Basin (part)								
Total Municipal Demand	7,927	7,548	7,875	8,177	8,378	8,474	8,417	8,301
Manufacturing Demand	2,395	3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	730,231	909,585	883,748	855,251	834,628	811,278	788,702	766,868
Mining Demand	344	85	50	24	14	6	0	0
Beef Feedlot Livestock Demand	13,610	14,731	17,958	20,134	21,374	22,693	24,091	25,576
Range & All Other Livestock Demand	4,491	5,433	7,556	9,751	9,958	10,192	10,440	10,685
Total Demand	758,998	940,787	921,186	897,674	878,968	857,527	836,767	816,905
Brazos River Basin (part)								
Total Municipal Demand	64,091	68,459	71,507	73,666	74,273	73,627	73,602	72,383
Manufacturing Demand	5,752	6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric Power Demand	14,302	23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation Demand	2,226,798	2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
Mining Demand	4,207	5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock Demand	10,604	10,983	13,388	15,009	15,935	16,917	17,960	19,068
Range & All Other Livestock Demand	6,062	5,085	8,600	12,220	12,354	12,488	12,618	12,763
Total Demand	2,331,816	2,617,601	2,537,122	2,455,740	2,382,633	2,309,652	2,241,698	2,177,563

Continued on next page

Table 2-21 Concluded

Basin/County/City/Rural	***Total in 1990 (acft)***	***Total in 1996 (acft)***	***Projections (acft)***					
			2000	***2010***	***2020***	***2030***	***2040***	***2050***
Colorado River Basin (part)								
Total Municipal Demand	9,587	11,315	11,995	12,621	13,058	13,371	13,145	12,864
Manufacturing Demand	347	102	120	130	138	145	151	163
Steam-Electric Power Demand	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation Demand	700,711	941,172	893,030	847,371	804,060	762,975	724,003	687,033
Mining Demand	10,300	15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock Demand	482	500	609	683	725	770	817	868
Range & All Other Livestock Demand	1,167	918	1,059	1,292	1,314	1,331	1,358	1,389
Total Demand	722,594	971,580	922,003	873,931	828,635	786,021	746,227	709,759
Llano Estacado Region Total								
Total Municipal Demand	81,608	87,322	91,378	94,465	95,710	95,473	95,165	93,549
Manufacturing Demand	8,494	10,064	11,778	12,749	13,540	14,296	14,945	15,999
Steam-Electric Power Demand	14,302	25,618	25,645	25,821	30,188	35,511	42,000	49,910
Irrigation Demand	3,657,740	4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163
Mining Demand	14,851	21,436	16,324	10,280	6,359	2,852	728	258
Beef Feedlot Livestock Demand	24,696	26,214	31,955	35,826	38,035	40,380	42,869	45,512
Range & All Other Livestock Demand	11,796	11,510	17,303	23,362	23,726	24,114	24,520	24,945
Total Demand	3,813,487	4,530,041	4,380,400	4,227,445	4,090,338	3,953,303	3,824,795	3,704,336
River Basin Summary								
Canadian	79	73	89	100	101	103	104	109
Red	758,998	940,787	921,186	897,674	878,968	857,527	836,767	816,905
Brazos	2,331,816	2,617,601	2,537,122	2,455,740	2,382,633	2,309,652	2,241,698	2,177,563
Colorado	722,594	971,580	922,003	873,931	828,635	786,021	746,227	709,759
Llano Estacado Region Total	3,813,487	4,530,041	4,380,400	4,227,445	4,090,338	3,953,303	3,824,795	3,704,336

[1] Parts of the Canadian, Red, Brazos, and Colorado River Basins.

Source: TWDB, Consensus Projections adopted by the TWDB, September 17, 2003.

2.10 Water Demand Projections for Wholesale Water Providers in the Llano Estacado Region

The Texas Water Code, Chapter 357.2(8) defines Wholesale Water Provider (WWP) as follows:

> "Any person or entity, including river authorities, and irrigation districts, that has contracts to sell more than 1,000 acre-feet of water wholesale in any one year during the five years immediately preceding the adoption of the last regional water plan. The regional water planning groups shall include as wholesale water providers other persons and entities that enter or that the regional water planning group expects or recommends to enter contracts to sell more that 1,000 acre-feet of water wholesale during the period covered by the plan."

There are four WWPs in the Llano Estacado Region. The four WWPs and the water user groups to which they provide water are described below.

2.10.1 Canadian River Municipal Water Authority [3]

The CRMWA supplies water to eight cities (Brownfield, Lamesa, Levelland, Lubbock, O'Donnell, Plainview, Slaton, and Tahoka) located within the Llano Estacado Planning Area as well as several entities located in Planning Region A.[4] Historically, CRMWA has been the sole provider of water to the City of O'Donnell; the remaining seven cities have historically obtained a portion of their water supply from self-supplied groundwater. The total quantity of water used by these CRMWA customers in 2000 was 53,396 acft. Projected demand of these CRMWA customers in 2030 is 56,794 acft/yr and in 2060 is 55,504 acft/yr (Table 2-22).

CRMWA is not projected to supply water to industrial customers located within the region, however some cities to which CRMWA supplies water may supply water to industrial customers during the planning period. In the projections shown in Table 2-22, these amounts are included in the municipal total for CRMWA's customers.

[3] The values in Table 2-22 for CRMWA during planning years 2000 through 2060 reflect the lesser of the City's combined entire municipal demand and the maximum delivery rate from CRMWA.
[4] The City of Lubbock is also a Wholesale Water Provider, whose customer list is presented in Section 2.10.2, and Slaton supplies a part of its CRMWA water to the City of Post.

Table 2-22.
Water Demand Projections for Wholesale Water Providers
Llano Estacado Region

Wholesale Water Providers with Lists of Customers	Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Canadian River Municipal Water Authority (CRMWA)								
City of Brownfield	1,481	2,593	2,747	2,905	3,047	3,181	3,185	3,167
City of Lamesa	1,827	2,486	2,540	2,573	2,602	2,603	2,529	2,433
City of Levelland	2,377	2,219	2,310	2,362	2,369	2,322	2,216	2,107
City of Lubbock	36,656	40,460	41,765	42,580	42,652	42,033	42,349	41,915
City of O'Donnell	121	156	161	163	159	155	147	137
City of Plainview	4,421	4,078	4,288	4,490	4,605	4,635	4,577	4,488
City of Slaton	865	931	907	889	870	849	837	836
City of Tahoka	488	473	492	504	490	478	453	421
Llano Estacado Region (Region O) Total	48,236	53,396	55,210	56,466	56,794	56,256	56,293	55,504
Panhandle Region (Region A) Total								
CRMWA Total								
City of Lubbock								
City of Lubbock Municipal	36,656	40,460	41,765	42,580	42,652	42,033	42,349	41,915
Buffalo Springs Lake Water Supply Corp. Mun.[2]	807	807	807	807	807	807	807	807
Ransom Canyon	162	310	440	569	698	825	953	1,004
Shallowater	0	311	344	367	377	371	379	371
Lake Alan Henry Water District[2]	22	22	22	22	22	22	22	22
Lubbock-Reese Redevelopment Authority[2]	7	7	7	7	7	7	7	7
Lubbock Total	37,654	41,917	43,385	44,352	44,563	44,065	44,517	44,126
Mackenzie Municipal Water Authority (MMWA)								
City of Floydada	570	663	680	696	693	685	657	623
City of Lockney	321	237	242	244	240	234	224	212
City of Silverton	135	126	128	128	123	115	111	108
City of Tulia	1,062	1,020	1,050	1,065	1,072	1,064	1,038	993
MMWA Total	2,088	2,046	2,100	2,133	2,128	2,098	2,030	1,936

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Table 2-22 Concluded

Wholesale Water Providers with Lists of Customers	*Total in 1990 (acft)*	*Total in 2000 (acft)*	*Projections*					
			2010 (acft)	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
White River Municipal Water District (WRMWD)								
City of Crosbyton								
Municipal	409	351	369	386	394	402	400	394
Industrial	0	0	0	0	0	0	0	0
City of Post								
Municipal	770	623	631	642	616	579	549	512
Industrial	2	2	2	2	2	2	2	2
City of Ralls								
Municipal	313	290	304	315	322	325	323	318
Industrial	6	5	6	6	6	6	6	6
City of Spur								
Municipal	251	275	271	267	263	260	257	257
Industrial	0	0	0	0	0	0	0	0
Mining								
Crosby County		189	112	54	31	13	0	0
Dickens county		165	98	47	27	12	0	0
Garza County		1,264	752	361	211	90	0	0
WRMWD								
Municipal	1,743	1,539	1,575	1,610	1,595	1,566	1,529	1,481
Industrial	8	7	8	8	8	8	8	8
Mining	0	1,618	962	462	269	115	0	0
WRMWD Total	1,751	3,164	2,545	2,080	1,872	1,689	1,537	1,489

2.10.2 City of Lubbock

The City of Lubbock has wholesale water supply contracts with Buffalo Springs Lake Water Supply Corporation, Lake Ransom Canyon, Shallowater, Lubbock-Reese Redevelopment Authority, and is in the process of negotiating a wholesale water supply contract with the Lake Alan Henry Water Supply District. In addition, Lubbock has a contract to supply water to the City of Littlefield in cases of emergency. Total water use by Lubbock and its customers was 49,917 acft in 2000 (Table 2-22). Projected water demand by Lubbock and its customers in 2030 is 44,563 acft/yr and in 2060 is 44,126 acft/yr (Table 2-22)

2.10.3 Mackenzie Municipal Water Authority

The MMWA supplies water to Floydada, Lockney, Silverton, and Tulia. Floydada, Lockney, and Tulia also meet a part of their needs from groundwater (i.e., their own wells). The total amount of water supplied by the Authority in 2000 was 2,046 acft (Table 2-22). The projected total quantity of water needed by the Authority's customers in 2030 and 2060 is 2,128 acft/yr and 1,936 acft/yr, respectively (Table 2-22).

2.10.4 White River Municipal Water District

The WRMWD supplies water to Crosbyton, Post, Ralls, and Spur. Historically, the District has been the sole water provider for these cities. The total amount of water used by the District's customers in 2000 was 1,546 acft, of which 1,539 acft was for municipal purposes, and 7 acft was for industrial purposes (Table 2-22). The projected total quantity of water needed to meet WRMWD's customers' projected demands in 2030 is 1,603 acft/yr, with 1,595 acft/yr being for municipal purposes and 8 acft/yr being for industrial purposes. Projected demand in 2060 is 1,489 acft/yr, of which 1,481 acft/yr is for municipal purposes and 8 acft/yr is for industry (Table 2-22). WRMWD purchased groundwater rights in Crosby County in 1998, and drilled several wells in 1999. The groundwater will be used during periods of drought when the water level in the reservoir is low. In addition, the City of Post has constructed a pipeline to Slaton, and has a contract with Slaton for a part of Slaton's CRMWA supply for a minimum of 153.44 acft/yr and a maximum of 306.88 acft/yr, provided Slaton's CRMWA supply is not reduced.

The Cities of Post and Ralls are projected to utilize water obtained from the District for industrial purposes during the planning period (Table 2-22).

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Section 3
Water Supply Analysis
[31 TAC §357.7(a)(3)

The Llano Estacado Region is located in a semiarid climatic area of west Texas. Precipitation ranges from an average annual level of about 18 inches on the eastern border to only about 14 inches on the west at the New Mexico state line. Therefore, surface water supplies are very low. However, the region is underlain with aquifers in which large quantities of water have been captured and stored over very long periods of time. The ground and surface water resources of the region are identified and described below.

3.1 Groundwater

The major sources of water in the Llano Estacado Region are the Ogallala, Seymour, Edwards-Trinity (High Plains), and Dockum Aquifers. Each of these aquifers is identified and characterized briefly below. A more complete description of these aquifers is presented in Section 1, and is not repeated here.

3.1.1 Ogallala Aquifer

The Ogallala Aquifer is the major water-bearing formation in most of the 21 counties of the Llano Estacado Region. Most of the communities within the region obtain water from the Ogallala Aquifer as their primary source of drinking water; however, approximately 95 percent of the water obtained from the Ogallala is used for irrigation.

3.1.2 Seymour Aquifer

The Seymour Formation consists of isolated areas of alluvium found in parts of 23 north-central and High Plains counties, including parts of Briscoe, Motley, Dickens, and Crosby Counties of the Llano Estacado Region. The Seymour Aquifer supplies small quantities of water for municipal and irrigation use in these four counties.

3.1.3 Edwards-Trinity (High Plains) Aquifer

The Edwards-Trinity (High Plains) Aquifer includes Cretaceous Age water-bearing formations of the Fredericksburg and Trinity Groups. These formations underlie the Ogallala Formation in 11 counties in the southwestern corner of the Llano Estacado Region and extend westward into New Mexico. The Edwards-Trinity (High Plains) Aquifer supplies water for municipal and irrigation use in Lynn County.

3.1.4 Dockum (Santa Rosa) Aquifer

The Dockum Group of Triassic Age underlies the Ogallala Formation of the High Plains area of Texas and New Mexico, the northern part of the Edwards Plateau, and the eastern part of the Cenozoic Pecos Alluvium. The Dockum Aquifer supplies small quantities of water for municipal and irrigation use in Briscoe, Deaf Smith, Garza, and Swisher Counties.

3.2 Surface Water

Although the Llano Estacado Region lies within the headwaters areas of the Canadian, Red, Brazos, and Colorado River Basins, the region has very little surface water; rainfall is less than 18 inches per year, and is not adequate to result in runoff to streams. Even though streamflow in the region is relatively low, four dams and reservoirs (Lake Meredith, Mackenzie, White River, and Alan Henry) have been built within and near the region to capture and store most of the surface water that is available from the streams on which they are located. The four reservoirs supply water for municipal and industrial uses to 15 of the 46 cities located in the region. These four reservoirs are described below. In segments of rivers where dams have not been built, surface water amounts to a trickle, with very little water leaving the region. Those entities that do not obtain water from the reservoirs mentioned above must rely upon groundwater to supply their water needs due to the lack of a reliable surface water source.

There are a limited number of surface water rights within the region; however, none of these rights are reliable during a drought according the WAM model. A total of 94 water rights, included rights for reservoirs, exist in the Llano Estacado Region, with a total authorized diversion of approximately 116,500 acft/yr. It is important to note that a small percentage of the water rights make up a large percentage of the authorized diversion volume. In the region, five water rights (5.3 percent) make up 100,910 acft/yr (86.6 percent) of the authorized diversion volume. The remaining 89 water rights primarily consists of small irrigation and municipal rights distributed throughout the region. Appendix F contains a list of all surface water rights in the region and their authorized diversion volumes.

3.2.1 Lake Meredith

Lake Meredith, operated by the CRMWA, is located in the Canadian River Basin to the north of the Llano Estacado Region, in Potter, Moore, and Hutchinson Counties. From Lake Meredith, a pipeline extends southward and delivers water for municipal and industrial purposes to Brownfield, Lamesa, Levelland, Lubbock, Plainview, O'Donnell, Slaton, and Tahoka of the Llano Estacado Region. The lake has a total storage capacity of 920,300 acft, a firm yield of approximately 69,750 acft of water per year, and a safe yield of 63,750 acft per year. Groundwater projects that obtain water from the Ogallala Aquifer in Roberts County have been added to increase the supply to present entities obtaining water from Lake Meredith. In addition, this water from the Ogallala Aquifer is firming up the reliability and improving the quality of current supplies from Lake Meredith.

3.2.2 Mackenzie Reservoir

Mackenzie Reservoir is located in the Red River Basin in Swisher and Briscoe Counties. Mackenzie Reservoir has a total storage capacity of 45,500 acft and can supply approximately 5,200 acft of water per year when the reservoir is at conservation pool elevation. Mackenzie Reservoir supplies water to Silverton, Tulia, Floydada, and Lockney. However, during recent dry years, Mackenzie Reservoir was unable to meet its contracted demands.

3.2.3 White River Reservoir

White River Reservoir is located in the Brazos River Basin in the southeast corner of Crosby County. It is owned and operated by the WRMWD, which supplies water to Ralls, Spur, Post, and Crosbyton. The reservoir has a surface area of 1,808 acres at conservation pool elevation, a drainage area of 173 square miles, total storage capacity of 31,846 acft, and can supply approximately 4,000 acft/yr when at conservation pool elevation. WRMWD has purchased groundwater rights and has drilled wells to supply its customers should the water levels in the reservoir drop below the level at which water can be removed.

3.2.4 Lake Alan Henry

Lake Alan Henry, owned by the City of Lubbock, Texas, is located on the Double Mountain Fork of the Brazos River in Garza and Kent Counties. TCEQ Permit 4146, with Priority Date of October 5, 1981, authorizes impoundment of 115,937 acft and the diversion of up to 35,000 acft/yr of water for municipal purposes. Based upon the hydrologic record for the period 1940 through 2002, the firm yield of Lake Alan Henry was calculated at 22,500 acft/yr.[1] Lake Alan Henry was developed to serve as a future water supply for the City of Lubbock and at present is open for recreational purposes. In addition, the Lake Alan Henry Water Supply District, created in 2001, plans to contract with Lubbock to obtain water from Lake Alan Henry to supply municipal water to developing areas in southeastern Garza County of the Llano Estacado Region and western Kent County of the neighboring Brazos G Water Planning Region.

3.2.5 Surface Water Rights

Lake Alan Henry, owned by the City of Lubbock, Texas, is located on the Double Mountain Fork of the Brazos River in Garza and Kent Counties. TCEQ Permit 4146, with Priority Date of October 5, 1981, authorizes impoundment of 115,937 acft and the diversion of up to 35,000 acft/yr of water for municipal purposes. Based upon the hydrologic record for the period 1940 through 2002, the firm yield of Lake Alan Henry was calculated at 22,500 acft/yr.[2] Lake Alan Henry was developed to serve as a future water supply for the City of Lubbock and at present is open for recreational purposes. In addition, the Lake Alan Henry Water Supply District, created in 2001, plans to contract with Lubbock to obtain water from Lake Alan Henry to supply municipal water to developing areas in southeastern Garza County of the Llano Estacado Region and western Kent County of the neighboring Brazos G Water Planning Region.

3.3 Methodology to Calculate the Water Supplies Available to the Llano Estacado Region and Methodology for Calculating Water Supplies Available for Water User Groups

The water supplies available to the Llano Estacado Region during the **"drought of record"** were calculated from the following data sources:

A. The LERWPG requested that TWDB run the Southern Ogallala Groundwater Availability Model (GAM) using the water demand projections for water user groups (WUGs) of LERWPG, as approved by the TWDB on September 17, 2003, for the planning period of 2010 through 2060. The TWDB performed the runs, as requested, and provided information showing the volume of groundwater present in each county-basin area of the Llano Estacado Region (Region O) for each of the projection dates 2004,

[1] "Draft Memorandum to File," Gooch, Thomas C., P.E., and Andres A. Salazar, Ph.D., Freese and Nichols, March 19, 2003.
[2] "Draft Memorandum to File," Gooch, Thomas C., P.E., and Andres A. Salazar, Ph.D., Freese and Nichols, March 19, 2003.

2010, 2020, 2030, 2040, 2050 and 2060. The quantity of water that could be pumped from each of the county-basin areas at each of the projection dates was calculated based upon the recharge and aquifer parameters of the Southern Ogallala GAM, and the water wells in place at the present time (the quantity of water available annually from the aquifer in the immediate future could be increased by adding more wells). However, well spacing is regulated by the Underground Water Conservation Districts of the area, and the addition of wells requires permits from the Districts. In a second request by the LERWPG, the TWDB made volumetric calculations for the counties in the region using a mass balance approach with 1995 as the base starting point and continuing through 2060 with only average recharge from the model as the primary input and projected water demands, as approved by the TWDB on September 17, 2003, as the primary output. The results of the GAM and the mass balance calculations were used to obtain estimates of the quantities of water available from the Ogallala Aquifer for use in meeting projected water demand of the region (see Appendix E).

B. Groundwater availability by aquifer for the Dockum, Edwards-Trinity (High Plains), and Seymour Aquifers was obtained from the TWDB. The groundwater availability by county was further subdivided into river basin parts of each county according to the TWDB estimates.

C. Surface water availability for cities obtaining all or part of their water supply from surface water sources was estimated from water use data supplied by surface water suppliers and cities within the planning region that use surface water.

D. Water availability from reclaimed water was obtained from TCEQ discharge permits.

E. Range livestock water supply was allocated to local sources (stock tanks and windmills) and set at projected quantities of range livestock water demands.

The estimated quantity of water available from each source (Aquifer and Surface Source) to meet projected water demands in each county-basin area of the planning region is presented in Table 3-1 and Tables 4-1 through 4-21.

3.4 Projected Water Supplies Available to the Llano Estacado Region

Water demand projections for water user groups of each county and river basin area of the Llano Estacado Region were presented in Section 2, Table 2-21. The projected quantity of water available from each aquifer and other water source for use in each county and river basin area of each county of the Llano Estacado Region is presented below. The water supply information is explained briefly below for Bailey and Castro Counties and for the region. The explanations for Bailey and Castro Counties are illustrative as to how to read Table 3-1.

The total quantity of water used in Bailey County, which is located entirely in the Brazos River Basin, in 2000 was 179,414 acft (Table 3-1). The quantity estimated to be available for use in 2010 is 103,289 acft, of which 101,923 acft are from the Ogallala Aquifer, 541 acft are from stock tanks and windmills, and 825 acft are reclaimed wastewater (Table 3-1). The projected quantity available in 2060 in Bailey County is 76,234 acft, which is only 42 percent as much as was available in 2000 (Table 3-1). The reason for the decline in quantity available between 2000 and 2060 is the decline in the quantity available from the Ogallala Aquifer (i.e., more water is being withdrawn from the aquifer than is being recharged to it).

The total quantity of water used in Castro County, which is located partially in the Red River Basin and partially in the Brazos River Basin, in 2000 was 517,384 acft (Table 3-1). The quantity estimated to be available for use in 2010 is 350,128 acft, of which 110,256 acft are from the Ogallala Aquifer in the Red River Basin and 235,507 acft are from the Ogallala Aquifer in the Brazos River Basin, 151 acft are from stock tanks and windmills in the Red River Basin and 184 acft are from stock tanks and windmills in the Brazos River Basin. In addition, in 2010 Castro County has available a projected quantity of 4,031 acft of reclaimed wastewater in the Brazos River Basin (Table 3-1). The projected quantity available in 2060 in Castro County is 63,402 acft, which is only 12 percent as much as was available in 2000, with the reason for the decline in quantity available between 2000 and 2060 the same as for Bailey County (i.e., more water is being withdrawn from the Ogallala Aquifer than is being recharged to it) (Table 3-1).

The total quantity of water used in the Llano Estacado Region in 2000 was 4,695,049 acft, of which 96.5 percent was from the Ogallala Aquifer, 0.81 percent was from Lake Meredith of the CRMWA System, and 1.08 percent was from reclaimed wastewater (Table 3-1). The estimated total quantity of water available for use in the Region in 2060 is 1,493,971 acft, or only 32 percent as much as was available in 2000. As was explained above for Bailey and Castro Counties, more water is being withdrawn from the Ogallala Aquifer than is being recharged to it (Table 3-1 and Figure 3-1).

The Ogallala Aquifer supplied 96 percent of the water used in the Llano Estacado Region in 2000, and even though the quantity available annually from the Ogallala Aquifer is projected to decline from 4.530 million acft/yr in 2000 to 1.325 million acft/yr in 2060, it is still projected to provide about 88 percent of the region's total water supply in 2060 (Table 3-1 and Figure 3-1).

Table 3-1
Water Supply Projections
Individual Counties with River Basin Summaries
Llano Estacado Region

County	River Basin	Source	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Counties									
Bailey	Brazos	Ogallala Aquifer	178,070	101,923	91,945	87,132	81,924	77,780	74,742
Bailey	Brazos	Stock Tanks and Windmills	519	541	563	587	612	639	667
Bailey	Brazos	Reclaimed	825	825	825	825	825	825	825
Bailey		Total	179,414	103,289	93,333	88,544	83,362	79,244	76,234
Briscoe	Red	Ogallala Aquifer	26,952	22,800	15,867	9,872	7,460	5,388	4,888
Briscoe	Red	Dockum Aquifer	100	100	100	100	100	100	100
Briscoe	Red	Seymour Aquifer	4,063	4,063	4,063	1,821	1,821	1,821	1,821
Briscoe	Red	Other Aquifers	115	109	96	94	95	91	91
Briscoe	Red	Stock Tanks and Windmills	284	292	301	310	320	330	341
Briscoe	Red	Lake Mackenzie	85	0	0	0	0	0	0
Briscoe		Total	31,599	27,364	20,427	12,197	9,797	7,731	7,241
Castro	Red	Ogallala Aquifer	163,591	110,256	72,609	45,405	25,992	23,784	20,890
Castro	Red	Stock Tanks and Windmills	149	151	176	178	181	185	188
Castro	Brazos	Ogallala Aquifer	349,432	235,507	211,116	147,124	59,674	44,832	38,066
Castro	Brazos	Stock Tanks and Windmills	181	184	214	218	220	223	227
Castro	Brazos	Reclaimed	4,031	4,031	4,031	4,031	4,031	4,031	4,031
Castro		Total	517,384	350,128	288,146	196,957	90,099	73,055	63,402
Cochran	Brazos	Ogallala Aquifer	77,961	44,285	43,420	36,681	33,797	12,126	12,157
Cochran	Brazos	Stock Tanks and Windmills	45	46	64	67	69	70	70
Cochran	Brazos	Reclaimed	267	267	267	267	267	267	267
Cochran	Colorado	Ogallala Aquifer	45,154	33,836	31,610	35,447	35,458	11,783	11,752
Cochran	Colorado	Stock Tanks and Windmills	87	88	123	123	124	125	128
Cochran	Colorado	Reclaimed	27	27	27	27	27	27	27
Cochran		Total	123,542	78,550	75,511	72,612	69,742	24,398	24,401
Crosby	Red	Ogallala Aquifer	1,391	1,307	1,256	1,204	1,158	1,101	1,078
Crosby	Red	Stock Tanks and Windmills	3	3	3	4	4	4	4
Crosby	Brazos	Ogallala Aquifer	112,337	96,710	92,844	89,147	85,593	83,138	79,835
Crosby	Brazos	Seymour Aquifer	483	483	483	474	474	474	474
Crosby	Brazos	Stock Tanks and Windmills	292	298	303	310	318	325	332
Crosby	Brazos	White River Reservoir	707	707	707	707	707	389	8
Crosby	Brazos	Reclaimed	583	583	583	583	583	583	583
Crosby		Total	115,796	100,091	96,179	92,430	88,836	86,014	82,314
Dawson	Brazos	Ogallala Aquifer	19	19	19	19	18	18	17
Dawson	Brazos	Stock Tanks and Windmills	1	1	2	1	2	2	2
Dawson	Colorado	Ogallala Aquifer	152,146	45,194	37,508	34,547	31,266	31,239	31,195
Dawson	Colorado	Ogallala (Roberts Co.)	892	892	892	892	892	692	692
Dawson	Colorado	Stock Tanks and Windmills	150	154	156	161	164	168	172
Dawson	Colorado	Lake Meredith (CRMWA)	1,694	1,694	1,694	1,694	1,694	1,694	1,694
Dawson		Total	154,903	47,954	40,271	37,314	34,036	33,813	33,772
Deaf Smith	Canadian	Ogallala Aquifer	171	112	74	1	1	1	1
Deaf Smith	Canadian	Stock Tanks and Windmills	220	281	317	326	336	344	353
Deaf Smith	Red	Ogallala Aquifer	388,182	204,702	170,696	128,078	88,180	86,199	81,704
Deaf Smith	Red	Dockum Aquifer	930	720	578	7,502	7,576	7,602	7,602
Deaf Smith	Red	Stock Tanks and Windmills	2,859	2,931	3,035	3,174	3,319	3,474	3,636
Deaf Smith	Red	Reclaimed	2,810	2,810	2,810	2,810	2,810	2,810	2,810
Deaf Smith		Total	395,172	211,556	177,511	141,891	102,222	100,430	96,106
Dickens	Red	Ogallala Aquifer	4,626	2,662	2,575	2,503	2,217	2,159	2,108
Dickens	Red	Seymour Aquifer	7,937	7,937	7,937	5,217	5,217	5,217	5,217
Dickens	Red	Other Aquifer	86	86	86	86	86	86	86

Continued on next page

Table 3-1 Continued

County	River Basin	Source	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Dickens	Red	Stock Tanks and Windmills	230	233	239	246	251	258	264
Dickens	Brazos	Ogallala Aquifer	6,199	3,585	3,468	3,366	3,481	3,390	3,312
Dickens	Brazos	Seymour Aquifer	4,348	4,348	4,348	2,858	2,858	2,858	2,858
Dickens	Brazos	Stock Tanks and Windmills	391	401	408	417	427	437	449
Dickens	Brazos	White River Reservoir	275	271	267	263	260	106	0
Dickens		Total	24,091	19,523	19,329	14,955	14,797	14,511	14,293
Floyd	Red	Ogallala Aquifer	101,292	52,505	32,434	25,205	21,096	20,270	19,510
Floyd	Red	Stock Tanks and Windmills	253	259	266	271	279	288	296
Floyd	Brazos	Ogallala Aquifer	138,280	86,288	81,860	78,044	73,821	70,449	68,588
Floyd	Brazos	Stock Tanks and Windmills	199	205	210	218	223	229	236
Floyd	Brazos	Lake Mackenzie	362	0	0	0	0	0	0
Floyd	Brazos	Reclaimed	449	449	449	449	449	449	449
Floyd		Total	240,835	139,706	115,219	104,187	95,868	91,685	89,079
Gaines	Colorado	Ogallala Aquifer	424,778	335,917	275,995	241,173	213,273	188,235	165,735
Gaines	Colorado	Stock Tanks and Windmills	296	304	312	320	329	338	348
Gaines		Total	425,074	336,221	276,307	241,493	213,602	188,573	166,083
Garza	Brazos	Ogallala Aquifer	14,563	7,527	6,879	6,394	5,946	5,554	5,262
Garza	Brazos	Dockum Aquifer	136	136	136	136	136	136	136
Garza	Brazos	Stock Tanks and Windmills	355	363	423	432	442	453	465
Garza	Brazos	White River Reservoir	1,021	1,021	973	493	12	0	0
Garza	Brazos	Lake Alan Henry (WSD)	0	22	22	22	22	22	22
Garza	Brazos	Slaton CRMWA Supply	0	306	306	306	306	306	306
Garza	Colorado	Ogallala Aquifer	0	0	0	0	0	0	0
Garza	Colorado	Stock Tanks and Windmills	0	0	0	0	0	0	0
Garza		Total	16,075	9,375	8,739	7,783	6,864	6,471	6,191
Hale	Red	Ogallala Aquifer	3,499	829	0	0	0	0	0
Hale	Red	Stock Tanks and Windmills	1	1	1	1	1	1	1
Hale	Brazos	Ogallala Aquifer	374,974	348,301	302,704	206,807	127,551	98,721	89,136
Hale	Brazos	Ogallala (Roberts Co.)	1,476	1,476	1,476	1,476	1,476	1,076	1,076
Hale	Brazos	Stock Tanks and Windmills	324	331	340	349	358	368	379
Hale	Brazos	Lake Meredith (CRMWA)	2,805	2,805	2,805	2,805	2,805	2,805	2,805
Hale	Brazos	Reclaimed	5,477	5,477	5,477	5,477	5,477	5,477	5,477
Hale		Total	388,556	359,221	312,803	216,915	137,668	108,448	98,874
Hockley	Brazos	Ogallala Aquifer	163,639	96,889	79,415	67,208	55,876	53,945	50,540
Hockley	Brazos	Ogallala (Roberts Co.)	1,116	1,116	1,116	1,116	1,116	688	688
Hockley	Brazos	Stock Tanks and Windmills	221	226	273	280	286	292	299
Hockley	Brazos	Lake Meredith (CRMWA)	2,120	2,120	2,120	2,120	2,120	2,120	2,120
Hockley	Brazos	Reclaimed	1,359	1,359	1,359	1,359	1,359	1,359	1,359
Hockley	Colorado	Ogallala Aquifer	20,274	12,761	10,678	8,807	8,186	7,686	7,689
Hockley	Colorado	Stock Tanks and Windmills	44	45	55	55	56	57	59
Hockley	Colorado	Reclaimed	162	162	162	162	162	162	162
Hockley		Total	188,935	114,679	95,178	81,107	69,160	66,309	62,915
Lamb	Brazos	Ogallala Aquifer	402,158	267,764	210,668	156,745	109,741	91,026	81,651
Lamb	Brazos	Stock Tanks and Windmills	472	491	510	531	552	575	599
Lamb	Brazos	Reclaimed	7,199	7,199	7,199	7,199	7,199	7,199	7,199
Lamb		Total	409,829	275,454	218,377	164,475	117,492	98,801	89,449
Lubbock	Brazos	Ogallala Aquifer	298,052	163,283	131,367	110,204	88,545	85,490	80,557
Lubbock	Brazos	Ogallala Aquifer (Bailey Co)	8,092	8,353	8,516	8,530	8,407	8,470	8,383
Lubbock	Brazos	Ogallala (Roberts Co.)	15,453	16,648	16,647	14,262	11,878	10,215	10,215
Lubbock	Brazos	Stock Tanks and Windmills	258	265	272	280	289	298	308
Lubbock	Brazos	Lake Meredith (CRMWA)	28,948	24,174	24,174	24,174	24,174	24,174	24,174
Lubbock	Brazos	Lake Alan Henry	0	22,478	22,478	22,478	22,478	22,478	22,478
Lubbock	Brazos	Reclaimed Lubbock-El Pr.	5,776	5,221	4,440	5,191	6,106	7,222	8,582
Lubbock	Brazos	Reclaimed Lubbock-Irrig.	7,958	9,166	10,354	9,639	8,415	7,457	5,880
Lubbock	Brazos	Reclaimed Other Mun & Ind	4,209	4,209	4,209	4,209	4,209	4,209	4,209
Lubbock		Total	368,746	253,797	222,457	198,967	174,499	170,012	164,785

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Table 3-1 Continued

County	River Basin	Source	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Lynn	Brazos	Ogallala Aquifer	120,425	120,425	120,425	120,425	120,425	120,425	120,425
Lynn	Brazos	Edwards-Trinity (H-P Aqu)	4,944	4,160	3,580	2,802	2,335	2,065	2,065
Lynn	Brazos	Ogallala (Roberts Co.)	184	184	184	184	184	110	110
Lynn	Brazos	Stock Tanks and Windmills	128	132	136	139	144	149	153
Lynn	Brazos	Lake Meredith (CRMWA)	350	350	350	350	350	350	350
Lynn	Brazos	Reclaimed (Lubbock-Irrig)	6,496	6,496	6,496	6,496	6,496	6,496	6,496
Lynn	Brazos	Reclaimed Other Mun & Ind	346	346	346	346	346	346	346
Lynn	Colorado	Ogallala Aquifer	1,141	491	473	462	467	422	381
Lynn	Colorado	Ogallala (Roberts Co.)	91	91	91	91	91	61	61
Lynn	Colorado	Stock Tanks and Windmills	11	11	11	12	12	13	14
Lynn	Colorado	Lake Meredith (CRMWA)	173	173	173	173	173	173	173
Lynn		Total	134,290	132,860	132,265	131,480	131,023	130,609	130,573
Motley	Red	Ogallala Aquifer	10,200	5,717	5,565	5,411	5,254	5,115	4,991
Motley	Red	Seymour Aquifer	18,817	18,817	18,817	13,507	13,507	13,507	13,507
Motley	Red	Other Aquifers	239	234	224	207	187	174	166
Motley	Red	Stock Tanks and Windmills	625	636	647	659	671	684	698
Motley		Total	29,881	25,404	25,253	19,784	19,619	19,480	19,362
Parmer	Red	Ogallala Aquifer	135,705	76,545	26,066	19,901	36,235	37,658	35,109
Parmer	Red	Stock Tanks and Windmills	273	286	298	309	324	341	356
Parmer	Red	Reclaimed	2,486	2,486	2,486	2,486	2,486	2,486	2,486
Parmer	Brazos	Ogallala Aquifer	289,384	182,317	60,373	31,879	15,545	14,122	16,671
Parmer	Brazos	Stock Tanks and Windmills	530	551	575	601	626	651	680
Parmer	Brazos	Reclaimed	401	401	401	401	401	401	401
Parmer		Total	428,779	262,586	90,199	55,577	55,617	55,659	55,703
Swisher	Red	Ogallala Aquifer	109,814	93,170	84,809	75,784	66,827	64,355	63,614
Swisher	Red	Dockum Aquifer	846	846	846	846	846	846	846
Swisher	Red	Stock Tanks and Windmills	421	435	475	493	512	531	551
Swisher	Red	Lake Mackenzie	417	0	0	0	0	0	0
Swisher	Brazos	Ogallala Aquifer	66,489	59,724	23,582	2,488	1,098	533	531
Swisher	Brazos	Stock Tanks and Windmills	168	167	141	139	136	133	132
Swisher	Brazos	Total	178,155	154,342	109,854	79,749	69,418	66,398	65,673
Terry	Brazos	Ogallala Aquifer	10,250	6,069	5,756	5,461	4,704	4,713	4,719
Terry	Brazos	Stock Tanks and Windmills	4	7	10	8	12	10	7
Terry	Colorado	Ogallala Aquifer	196,979	113,165	86,251	67,983	54,595	54,570	54,553
Terry	Colorado	Ogallala (Roberts Co.)	879	879	879	879	879	879	879
Terry	Colorado	Stock Tanks and Windmills	115	115	114	119	118	124	130
Terry	Colorado	Lake Meredith (CRMWA)	1,670	1,670	1,670	1,670	1,670	1,670	1,670
Terry		Total	209,897	121,904	94,681	76,121	61,979	61,966	61,958
Yoakum	Colorado	Ogallala Aquifer	133,881	103,958	99,734	95,204	91,342	88,062	85,269
Yoakum	Colorado	Stock Tanks and Windmills	214	218	273	278	282	288	293
Yoakum		Total	134,095	104,176	100,007	95,482	91,624	88,350	85,562
River Basins									
	Canadian	Ogallala Aquifer	171	112	74	1	1	1	1
	Canadian	Ogallala (Roberts Co.)	0	0	0	0	0	0	0
	Canadian	Dockum Aquifer	0	0	0	0	0	0	0
	Canadian	Seymour Aquifer	0	0	0	0	0	0	0
	Canadian	Other Aquifers	0	0	0	0	0	0	0
	Canadian	Stock Tanks and Windmills	220	281	317	326	336	344	353
	Canadian	Lake Mackenzie	0	0	0	0	0	0	0
	Canadian	White River Reservoir	0	0	0	0	0	0	0
	Canadian	Lake Meredith (CRMWA)	0	0	0	0	0	0	0
	Canadian	Reclaimed Lubbock-El Pr.	0	0	0	0	0	0	0
	Canadian	Reclaimed Lubbock-Irrig.	0	0	0	0	0	0	0
	Canadian	Reclaimed Other Mun & Ind	0	0	0	0	0	0	0
	Canadian	Total	390	393	391	327	337	345	354

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Table 3-1 Continued

County	River Basin	Source	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
River Basins (Concluded)									
	Red	Ogallala Aquifer	945,251	570,492	411,878	313,364	254,419	246,029	233,892
	Red	Ogallala (Roberts Co.)	0	0	0	0	0	0	0
	Red	Dockum Aquifer	1,876	1,666	1,524	8,448	8,522	8,548	8,548
	Red	Seymour Aquifer	30,817	30,817	30,817	20,545	20,545	20,545	20,545
	Red	Other Aquifers	440	429	406	387	368	351	343
	Red	Stock Tanks and Windmills	5,100	5,227	5,442	5,645	5,863	6,095	6,335
	Red	Lake Mackenzie	502	0	0	0	0	0	0
	Red	White River Reservoir	0	0	0	0	0	0	0
	Red	Lake Meredith (CRMWA)	0	0	0	0	0	0	0
	Red	Reclaimed Lubbock-El Pr.	0	0	0	0	0	0	0
	Red	Reclaimed Lubbock-Irrig.	0	0	0	0	0	0	0
	Red	Reclaimed Other Mun & Ind	5,296	5,296	5,296	5,296	5,296	5,296	5,296
	Red	Total	989,282	613,927	455,363	353,685	295,013	286,865	274,959
	Brazos	Ogallala Aquifer	2,610,326	1,828,971	1,474,356	1,157,654	876,144	774,733	734,591
	Brazos	Ogallala (Roberts Co.)	18,229	19,424	19,423	17,038	14,654	12,089	12,089
	Brazos	Dockum Aquifer	136	136	136	136	136	136	136
	Brazos	Seymour Aquifer	4,831	4,831	4,831	3,332	3,332	3,332	3,332
	Brazos	Edwards-Trinity (H-P Aqu)	4,944	4,160	3,580	2,802	2,335	2,065	2,065
	Brazos	Stock Tanks and Windmills	4,088	4,210	4,446	4,577	4,716	4,854	5,003
	Brazos	Lake Mackenzie	362	0	0	0	0	0	0
	Brazos	White River Reservoir	2,003	1,999	1,947	1,463	979	495	8
	Brazos	Lake Meredith (CRMWA)	34,223	29,755	29,755	29,755	29,755	29,755	29,755
	Brazos	Lake Alan Henry	0	22,500	22,500	22,500	22,500	22,500	22,500
	Brazos	Reclaimed Lubbock-El Pr.	5,776	5,221	4,440	5,191	6,106	7,222	8,582
	Brazos	Reclaimed Lubbock-Irrig.	14,454	15,662	16,850	16,135	14,911	13,953	12,376
	Brazos	Reclaimed Other Mun & Ind	25,146	25,146	25,146	25,146	25,146	25,146	25,146
	Brazos	Total	2,724,518	1,962,014	1,607,410	1,285,729	1,000,714	896,279	855,583
	Colorado	Ogallala Aquifer	974,352	645,323	542,249	483,623	434,588	381,997	356,573
	Colorado	Ogallala (Roberts Co.)	1,862	1,862	1,862	1,862	1,862	1,632	1,632
	Colorado	Dockum Aquifer	0	0	0	0	0	0	0
	Colorado	Seymour Aquifer	0	0	0	0	0	0	0
	Colorado	Other Aquifers	0	0	0	0	0	0	0
	Colorado	Stock Tanks and Windmills	918	936	1,045	1,068	1,086	1,113	1,144
	Colorado	Lake Mackenzie	0	0	0	0	0	0	0
	Colorado	White River Reservoir	0	0	0	0	0	0	0
	Colorado	Lake Meredith (CRMWA)	3,537	3,537	3,537	3,537	3,537	3,537	3,537
	Colorado	Reclaimed Lubbock-El Pr.	0	0	0	0	0	0	0
	Colorado	Reclaimed Lubbock-Irrig.	0	0	0	0	0	0	0
	Colorado	Reclaimed Other Mun & Ind	189	189	189	189	189	189	189
		Total	980,859	651,846	548,882	490,279	441,262	388,468	363,075
Llano Estacado Region — Totals									
Region		Ogallala Aquifer	4,530,100	3,044,897	2,428,556	1,954,642	1,565,152	1,402,760	1,325,057
Region		Ogallala (Roberts Co.)	20,091	21,286	21,285	18,900	16,516	13,721	13,721
Region		Dockum Aquifer	2,012	1,802	1,660	8,584	8,658	8,684	8,684
Region		Seymour Aquifer	35,648	35,648	35,648	23,877	23,877	23,877	23,877
Region		Other Aquifers	5,384	4,589	3,986	3,189	2,703	2,416	2,408
Region		Stock Tanks and Windmills	10,326	10,653	11,250	11,616	12,000	12,406	12,835
Region		Lake Mackenzie	864	0	0	0	0	0	0
Region		White River Reservoir	2,003	1,999	1,947	1,463	979	495	8
Region		Lake Meredith (CRMWA)	37,760	33,292	33,292	33,292	33,292	33,292	33,292
Region		Lake Alan Henry	0	22,500	22,500	22,500	22,500	22,500	22,500
Region		Reclaimed Lubbock-El Pr.	5,776	5,221	4,440	5,191	6,106	7,222	8,582
Region		Reclaimed Lubbock-Irrig.	14,454	15,662	16,850	16,135	14,911	13,953	12,376
Region		Reclaimed Other Mun & Ind	30,631	30,631	30,631	30,631	30,631	30,631	30,631
Region		Total	4,695,049	3,228,180	2,612,046	2,130,019	1,737,325	1,571,957	1,493,971

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Table 3-1 Concluded

County	River Basin	Source	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Llano Estacado Region — Percent of Total									
Region		Ogallala Aquifer	96.49%	94.32%	92.98%	91.77%	90.09%	89.24%	88.69%
Region		Ogallala (Roberts Co.)	0.43%	0.66%	0.81%	0.89%	0.95%	0.87%	0.92%
Region		Dockum Aquifer	0.04%	0.06%	0.06%	0.40%	0.50%	0.55%	0.58%
Region		Seymour Aquifer	0.76%	1.10%	1.36%	1.12%	1.37%	1.52%	1.60%
Region		Other Aquifers	0.11%	0.14%	0.15%	0.15%	0.16%	0.15%	0.16%
Region		Stock Tanks and Windmills	0.22%	0.33%	0.43%	0.55%	0.69%	0.79%	0.86%
Region		Lake Mackenzie	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Region		White River Reservoir	0.04%	0.06%	0.07%	0.07%	0.06%	0.03%	0.00%
Region		Lake Meredith (CRMWA)	0.80%	1.03%	1.27%	1.56%	1.92%	2.12%	2.23%
Region		Lake Alan Henry	0.00%	0.70%	0.86%	1.06%	1.30%	1.43%	1.51%
Region		Reclaimed Lubbock-El Pr.	0.12%	0.16%	0.17%	0.24%	0.35%	0.46%	0.57%
Region		Reclaimed Lubbock-Irrig.	0.31%	0.49%	0.65%	0.76%	0.86%	0.89%	0.83%
Region		Reclaimed Other Mun & Ind	0.65%	0.95%	1.17%	1.44%	1.76%	1.95%	2.05%
Region		Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

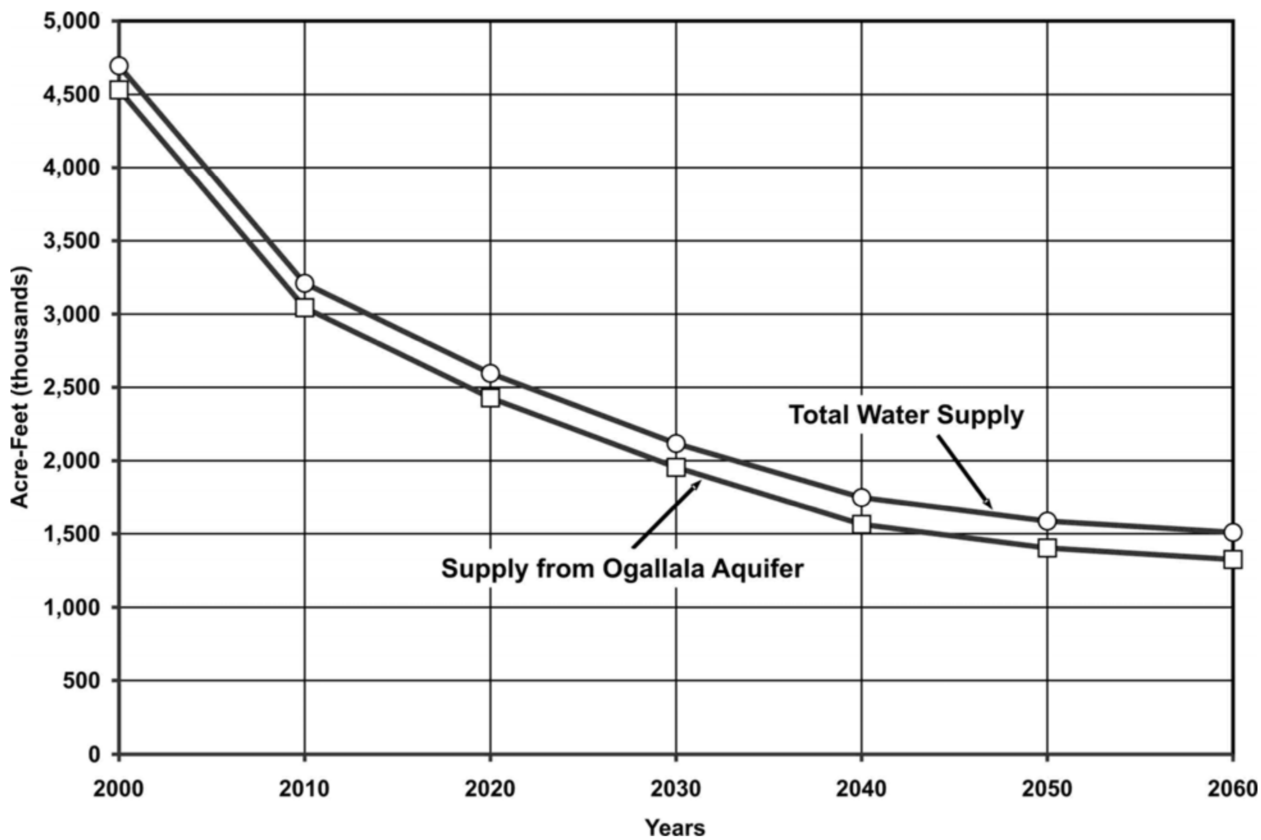

Figure 3-1. Projected Water Supply for the Llano Estacado Water Planning Region

The estimated quantity of water in storage in the Ogallala Aquifer in 2000 was 124,653,395 acft and is projected to decline to 62,418,860 acft in 2060(i.e., in 2060 it is projected that the quantity of water remaining in storage will be about 50.1 percent of the quantity estimated to have been in storage in 2000) (Table 3-2 and Figure 3-2).

It is reiterated that the quantity of water available from the Ogallala and the quantity remaining in storage at each of the projection dates was calculated using the TWDB GAM, and is based upon the capability of the aquifer to yield water to the wells presently in place. If the number of water wells is increased in future years, the Model Runs could result in larger quantities of water available per year in the early years of the projections, but due to the fact that pumpage is much greater than recharge, would be lower in later years. The calculated quantity that could be pumped for use by water user groups for each county-basin area for each projected year is less than the projected water demands for the same area (i.e., water supplies available annually are projected to be less than projected water demands) (Table 3-1).

Table 3-2
Projected Quantity of Water in Storage
Individual Counties with River Basin Summaries
Llano Estacado Region

County	*2000 acft*	*2010 acft*	*2020 acft*	*2030 acft*	*2040 acft*	*2050 acft*	*2060 acft*
Bailey	4,272,200	3,380,925	2,546,788	1,769,102	1,229,855	1,216,106	1,212,373
Briscoe	2,164,466	2,036,351	1,870,525	1,756,762	1,680,434	1,650,541	1,632,676
Castro	8,801,770	6,895,847	4,238,764	2,254,998	1,223,544	1,054,373	897,274
Cochran	2,578,704	1,834,111	1,308,992	813,743	347,354	81,708	37,705
Crosby	10,949,015	10,612,852	10,085,108	9,980,291	9,152,440	9,038,236	8,946,553
Dawson	7,266,792	7,202,322	7,202,322	7,202,322	7,202,322	7,202,322	7,202,322
Deaf Smith	7,851,767	6,647,546	5,230,982	4,163,213	3,383,867	3,152,925	3,000,017
Dickens	1,119,192	1,037,297	1,032,409	1,027,698	862,252	817,846	813,589
Floyd	13,012,008	11,832,107	11,397,458	10,489,267	9,764,296	9,587,136	9,409,491
Gaines	12,495,883	10,232,860	7,998,429	6,120,700	4,493,051	3,708,105	3,651,389
Garza	662,851	643,700	643,700	643,700	643,700	643,700	643,700
Hale	9,867,018	8,192,891	5,591,955	3,651,208	2,463,726	2,164,064	1,886,697
Hockley	5,480,511	4,993,208	4,432,736	3,965,426	3,615,247	3,591,108	3,533,107
Lamb	8,246,693	6,944,619	5,155,582	3,861,385	2,953,511	2,743,521	2,533,373
Lubbock	7,439,809	6,632,577	5,611,743	4,952,167	4,159,806	4,141,607	4,114,001
Lynn	3,786,579	3,645,979	3,655,103	3,655,103	3,655,103	3,655,103	3,655,103
Motley	355,295	282,644	231,003	180,893	132,340	85,257	39,482
Parmer	1,775,591	1,228,925	732,604	512,575	436,291	416,838	401,421
Swisher	7,568,857	6,816,315	5,837,065	5,156,220	4,622,929	4,392,133	4,184,417
Terry	4,576,781	4,161,424	3,801,304	3,563,138	3,428,883	3,520,915	3,619,055
Yoakum	4,381,613	3,620,371	3,017,014	2,457,580	1,939,772	1,457,384	1,005,116
Region	124,653,395	108,874,870	91,621,586	78,177,491	67,390,724	64,320,927	62,418,860
Basin Totals							
Canadian	2,599	1,798	894	684	684	684	684
Red	26,802,969	23,822,702	20,386,139	17,699,494	15,718,619	15,035,381	14,476,096
Brazos	66,322,545	57,639,248	47,478,393	39,860,073	33,829,805	32,839,469	31,939,798
Colorado	31,525,282	27,411,121	23,756,159	20,617,240	17,841,616	16,445,393	16,002,283
Total	124,653,395	108,874,870	91,621,586	78,177,491	67,390,724	64,320,927	62,418,860
Percent of Total in each Basin							
Canadian	0.0021%	0.0017%	0.0010%	0.0009%	0.0010%	0.0011%	0.0011%
Red	21.5020%	21.8808%	22.2504%	22.6401%	23.3246%	23.3756%	23.1919%
Brazos	53.2056%	52.9408%	51.8201%	50.9866%	50.1995%	51.0557%	51.1701%
Colorado	25.2904%	25.1767%	25.9286%	26.3723%	26.4749%	25.5677%	25.6369%
Total	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%	100.0000%

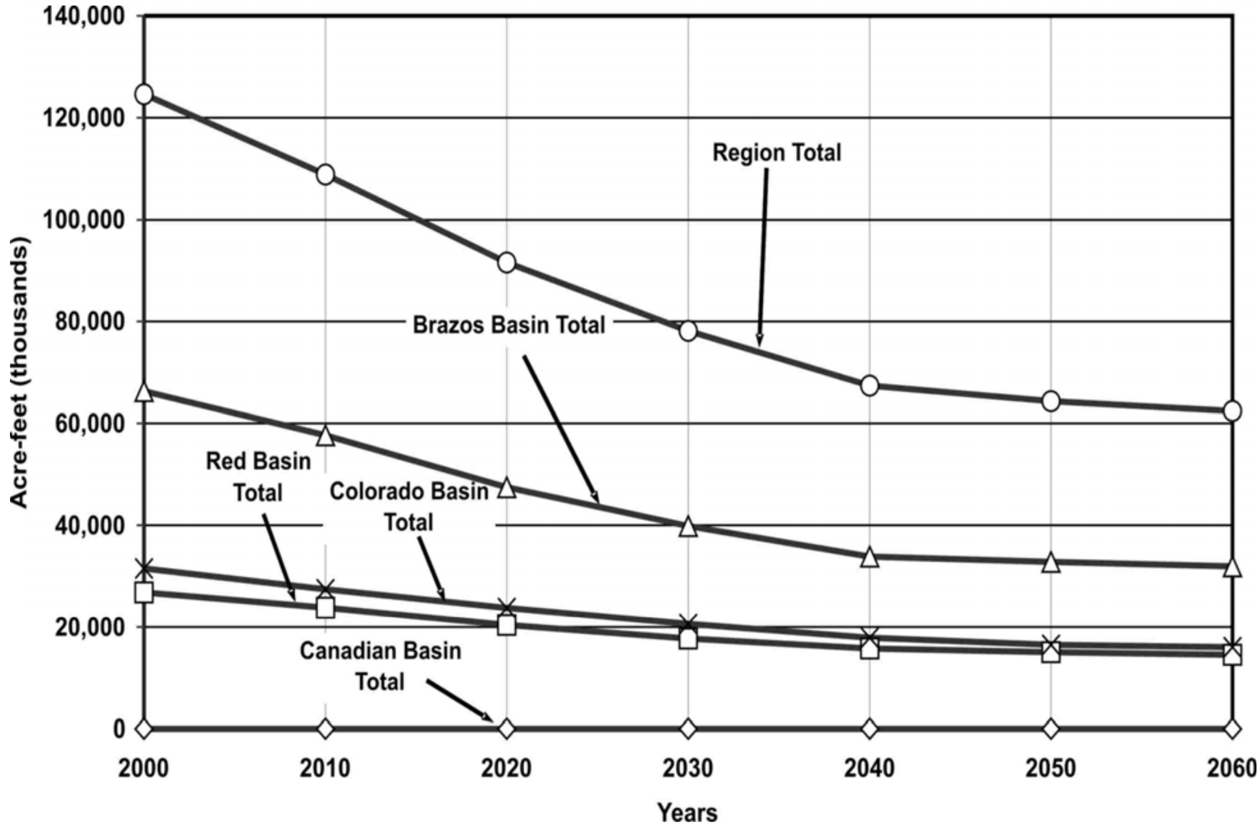

Figure 3-2. Projected Quantity of Water in Storage—Ogallala Aquifer Llano Estacado Water Planning Region

Section 4
Identification, Evaluation, and Selection of Water Management Strategies Based on Needs [31 TAC §357.7(a)(5-7)]

4.1 Water Needs Projections by Water User Group

For purposes of this regional planning project, and in accordance with TWDB Rules, water supply projections and needs projections are tabulated by river basin, county or part of county located within each river basin, and city and rural areas of each county or part of county for the Llano Estacado Region (Tables 4-1 through 4-22). The water demands by river basin and water user group were brought forward from Section 2, Population and Water Demand Projections, Tables 2-4 through 2-12. The water supplies were brought forward from Section 3, Water Supply Projections for the Planning Region, Table 3-1.

An illustration of how to read Tables 4-1 through 4-22 is given below. For example, as shown in Table 4-3, a portion of Castro County is located in the Red River Basin, and a portion is located in the Brazos River Basin. The total projected water supplies available to Castro County in 2000 were 517,384 acft, of which 163,740 acft were located in the Red Basin and 353,644 acft were located in the Brazos Basin. The county's projected water supplies are shown by river basin for each decade of the planning period (Table 4-3). Of the total projected water supply of 350,128 acft in 2010 for Castro County, 345,762 acft is projected to be available from the Ogallala Aquifer (Table 4-3). Castro County is not projected to obtain water from any other aquifers during the planning period. However, in addition to the projected groundwater supplies, Castro County is projected to obtain 4,030 acft of reclaimed water and 335 acft of water from local supplies for range and all other livestock use in 2010 (Table 4-3).

That part of Castro County located in the Brazos River Basin contains the cities of Dimmitt and Hart, and rural areas. The projected municipal water demand for Dimmitt is 1,041 acft in 2010 and 1,130 acft in 2060, while the projected municipal water supply for Dimmitt is 1,041 acft in 2010 and zero acft in 2030, 2040, 2050, and 2060 (Table 4-3). Comparing the projected demands with the projected supplies for Dimmitt in Castro County results in a surplus/shortage of zero acft in 2010 and 2020, a shortage of 1,137 acft in 2030, a shortage of 1,159 acft in 2040, a shortage of 1,150 acft in 2050, and a shortage of 1,130 in 2060 (Table 4-3). This type of analysis is shown for each water user group for each county located within the Llano Estacado Region, and is the source of information as to time additional water supply is needed, and the quantity needed by each water user group. In Section 5, water plans to meet the projected needs (shortages) are presented.

Total projections for counties and parts of counties of each river basin area located in the Llano Estacado Region are shown at the end of each county's supplies and needs analysis table. In addition, the basin totals are listed in Table 4-22. For example, total water supply in the Red River Basin is projected to be 612,044 acft in 2010, of which 7,501 acft is for municipal purposes, 3,999 acft is for industrial purposes, 549,954 acft is for irrigation purposes, 50 acft is for mining purposes, 17,958 is for beef feedlot livestock purposes, 2,116 acft is for dairies, and 5,227 is for range and all other livestock purposes (Table 4-22). In 2010 the Red River Basin part of the Llano Estacado Region is projected to have an irrigation water shortage of 333,794 acft and in 2060 is projected to have an irrigation shortage of 563,526 acft (Table 4-22).

The reader can readily see the projections for water demand, water supply, and surplus/shortage, by type of demand, for the Canadian, Red, Brazos, and Colorado River Basin areas of the Llano Estacado Region (Table 4-22).

Total estimated water supply in the Llano Estacado Region in 2000 was 4,655,113 acft and in 2060 is 1,442,745 acft (Table 4-22). The projected water supply in 2060 is 90,443 acft for municipal use, 15,999 acft for industrial use, 49,410 acft for steam-electric use, 1,194,864 acft for irrigation use, 258 acft for mining use, 45,512 acft for beef feedlot livestock use, 12,112 acft for dairies, and 12,833 acft for range and other livestock use. In 2010, the Llano Estacado Region is projected to have a municipal water surplus of 17,013 acft and an irrigation water shortage of 1,242,250 acft; in 2060 the region is projected to have a municipal water shortage of 3,106 acft and an irrigation water shortage of 2,279,299 acft (Table 4-22).

Of the 168 water user groups of the region (75 municipalities and rural domestic users, 11 industry groups, 3 steam-electric users, 21 counties with irrigation use, 14 counties with mining water use, 12 counties with beef feed-lot uses, 11 counties with dairy uses, and 21 counties with range and other livestock uses), it has been calculated that 58 user groups will have a shortage sometime during the 50-year projection period. Of the estimated 58 user groups showing shortages, 36 are municipalities and 21 are counties in which projected irrigation water demands exceed projected irrigation water supplies.

Table 4-1. Projected Water Demands, Supplies, and Needs Bailey County Llano Estacado Region

Basin		Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	4,272,200	3,380,925	2,546,788	1,769,102	1,229,855	1,216,106	1,212,373
	Quantity Pumped[2]	Ogallala	186,162	110,276	100,461	95,662	90,331	86,250	83,125
	Supply	(Ogallala)[3]	186,162	110,276	100,461	95,662	90,331	86,250	83,125
	Local Surface	Stock Tanks and Windmills	519	541	563	587	612	639	667
	Reclaimed Water[4]		825	825	825	825	825	825	825
	Total Supply		187,506	111,641	101,849	97,074	91,768	87,714	84,617
	Supply from Ogallala (Bailey County)		178,070	96,323	86,344	81,531	76,324	72,180	69,142
Data LERWPG	Supply from Ogallala (To Lubbock County)[5]		8,092	8,353	8,516	8,530	8,407	8,470	8,383
Oct. 28, 04	Total Supply from Ogallala		186,162	104,676	94,860	90,062	84,731	80,650	77,525
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Muleshoe			979	1,027	1,082	1,109	1,137	1,135	1,114
Rural			331	342	358	364	371	370	363
	Subtotal		1,310	1,369	1,440	1,473	1,508	1,505	1,477
Total Municipal Demand			1,310	1,369	1,440	1,473	1,508	1,505	1,477
Municipal Existing Supply									
Brazos Basin									
Muleshoe		Ogallala	979	1,027	1,082	1,109	1,137	1,135	1,114
Rural		Ogallala	331	342	358	364	371	370	363
	Subtotal		1,310	1,369	1,440	1,473	1,508	1,505	1,477
Total Municipal Existing Supply			1,310	1,369	1,440	1,473	1,508	1,505	1,477
Municipal Surplus/Shortage									
Brazos Basin									
Muleshoe			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Surplus/Shortage			0	0	0	0	0	0	0
Municipal New Supply Need									
Brazos Basin									
Muleshoe			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	0	0	0	0	0	0
Industrial Demand									
Brazos Basin			264	303	316	326	335	343	365
Total Industrial Demand			264	303	316	326	335	343	365
Industrial Existing Supply									
Brazos Basin		Ogallala	264	303	316	326	335	343	365
Total Industrial Existing Supply			264	303	316	326	335	343	365
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0

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Table 4-1 Continued

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Steam-Electric Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need								
Brazos Basin		0	0	0	0	0	0	0
Total Steam-Electric New Supply Need		0	0	0	0	0	0	0
Irrigation Demand								
Brazos Basin		182,865	178,478	174,197	170,018	165,939	161,958	158,071
Total Irrigation Demand		182,865	178,478	174,197	170,018	165,939	161,958	158,071
Irrigation Supply								
Brazos Basin	Ogallala	175,292	92,368	81,296	76,358	71,020	66,779	63,649
	Reclaimed Water	825	825	825	825	825	825	825
Total Irrigation Supply		176,117	93,193	82,121	77,183	71,845	67,604	64,474
Irrigation Surplus/Shortage								
Brazos Basin		-6,748	-85,285	-92,076	-92,835	-94,094	-94,354	-93,597
Total Irrigation Surplus/Shortage		-6,748	-85,285	-92,076	-92,835	-94,094	-94,354	-93,597
Mining Demand								
Brazos Basin		0	0	0	0	0	0	0
Total Mining Demand		0	0	0	0	0	0	0
Mining Supply								
Brazos Basin	Ogallala	0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		971	1,184	1,327	1,409	1,496	1,588	1,686
Total Beef Feedlot Livestock Demand		971	1,184	1,327	1,409	1,496	1,588	1,686
Beef Feedlot Livestock Supply								
Brazos Basin	Ogallala	971	1,184	1,327	1,409	1,496	1,588	1,686
Total Beef Feedlot Livestock Supply		971	1,184	1,327	1,409	1,496	1,588	1,686
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		233	1,099	1,965	1,965	1,965	1,965	1,965
Total Dairies Demand		233	1,099	1,965	1,965	1,965	1,965	1,965
Dairies Supply								
Brazos Basin	Ogallala	233	1,099	1,965	1,965	1,965	1,965	1,965
Total Dairies Supply		233	1,099	1,965	1,965	1,965	1,965	1,965
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		519	541	563	587	612	639	667
Total Range & All Other Livestock Demand		519	541	563	587	612	639	667
Range & All Other Livestock Supply								
Brazos Basin	Local	519	541	563	587	612	639	667
Total Range & All Other Livestock Supply		519	541	563	587	612	639	667
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		1,310	1,369	1,440	1,473	1,508	1,505	1,477
Industrial		264	303	316	326	335	343	365
Steam-Electric		0	0	0	0	0	0	0
Irrigation		182,865	178,478	174,197	170,018	165,939	161,958	158,071
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		971	1,184	1,327	1,409	1,496	1,588	1,686

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Table 4-1 Concluded

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Dairies		233	1,099	1,965	1,965	1,965	1,965	1,965
Range & All Other Livestock		519	541	563	587	612	639	667
Total County Demand		186,162	182,974	179,809	175,779	171,856	167,998	164,231
Total Supply								
Municipal		1,310	1,369	1,440	1,473	1,508	1,505	1,477
Industrial		264	303	316	326	335	343	365
Steam-Electric		0	0	0	0	0	0	0
Irrigation		176,117	93,193	82,121	77,183	71,845	67,604	64,474
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		971	1,184	1,327	1,409	1,496	1,588	1,686
Dairies		233	1,099	1,965	1,965	1,965	1,965	1,965
Range & All Other Livestock		519	541	563	587	612	639	667
Total County Supply		179,414	97,689	87,733	82,944	77,762	73,644	70,634
Total Surplus/Shortage								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-6,748	-85,285	-92,076	-92,835	-94,094	-94,354	-93,597
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	
Total County Surplus/Shortage		-6,748	-85,285	-92,076	-92,835	-94,094	-94,354	-93,597
Total Basin Demand								
Brazos								
Municipal		1,310	1,369	1,440	1,473	1,508	1,505	1,477
Industrial		264	303	316	326	335	343	365
Steam-Electric		0	0	0	0	0	0	0
Irrigation		182,865	178,478	174,197	170,018	165,939	161,958	158,071
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		971	1,184	1,327	1,409	1,496	1,588	1,686
Dairies		233	1,099	1,965	1,965	1,965	1,965	1,965
Range & All Other Livestock		519	541	563	587	612	639	667
Total Brazos Basin Demand		186,162	182,974	179,809	175,779	171,856	167,998	164,231
Total Basin Supply								
Brazos								
Municipal		1,310	1,369	1,440	1,473	1,508	1,505	1,477
Industrial		264	303	316	326	335	343	365
Steam-Electric		0	0	0	0	0	0	0
Irrigation		176,117	93,193	82,121	77,183	71,845	67,604	64,474
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		971	1,184	1,327	1,409	1,496	1,588	1,686
Dairies		233	1,099	1,965	1,965	1,965	1,965	1,965
Range & All Other Livestock		519	541	563	587	612	639	667
Total Brazos Basin Supply		179,414	97,689	87,733	82,944	77,762	73,644	70,634
Total Basin Surplus/Shortage								
Brazos								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-6,748	-85,285	-92,076	-92,835	-94,094	-94,354	-93,597
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		-6,748	-85,285	-92,076	-92,835	-94,094	-94,354	-93,597

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Muleshoe and Minsa Southwest. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entites, the quantity was calculated as 75 percent of the maximum waste discharge permit.

[5] Twenty percent of the City of Lubbock's projected municipal demand.

Table 4-2.
Projected Water Demands, Supplies, and Needs
Briscoe County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	2,164,466	2,036,351	1,870,525	1,756,762	1,680,434	1,650,541	1,632,676
	Quantity Pumped[2]	Ogallala	26,952	22,800	15,867	9,872	7,460	5,388	4,888
	Supply	(Ogallala)[3]	26,952	22,800	15,867	9,872	7,460	5,388	4,888
	Dockum Aquifer		100	100	100	100	100	100	100
	Seymour Aquifer		4,063	4,063	4,063	1,821	1,821	1,821	1,821
	Other Aquifers		115	109	96	94	95	91	91
	Local Surface	Stock Tanks and Windmills	284	292	301	310	320	330	341
	Other Surface	Lake Mackenzie	85	0	0	0	0	0	0
	Total Supply		31,599	27,364	20,427	12,197	9,797	7,731	7,241
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Silverton			126	128	128	123	115	111	108
Rural	Includes Quitaque demands		180	183	183	176	165	159	155
	Subtotal		306	311	311	299	280	270	263
Total Municipal Demand			306	311	311	299	280	270	263
Municipal Existing Supply									
Red Basin									
Silverton		Ogallala	41	0	0	0	0	0	0
		Lake Mackenzie	85	0	0	0	0	0	0
Silverton Subtotal			126	0	0	0	0	0	0
Rural	Includes Quitaque supply	Ogallala + other	295	76	89	84	72	70	69
	Subtotal		421	76	89	84	72	70	69
Total Municipal Existing Supply			421	76	89	84	72	70	69
Municipal Surplus/Shortage									
Red Basin									
Silverton			0	-128	-128	-123	-115	-111	-108
Rural			115	-107	-94	-92	-93	-89	-86
	Subtotal		115	-235	-222	-215	-208	-200	-194
Total Municipal Surplus/Shortage			115	-235	-222	-215	-208	-200	-194
Municipal New Supply Need									
Red Basin									
Silverton			0	128	128	123	115	111	108
Rural			0	107	94	92	93	89	86
	Subtotal		0	235	222	215	208	200	194
Total Municipal New Supply Need			0	235	222	215	208	200	194
Industrial Demand									
Red Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Red Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0

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Table 4-2 Continued

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Steam-Electric Demand								
Red Basin		0	0	0	0	0	0	0
Total Steam-Electric Demand		0	0	0	0	0	0	0
Steam-Electric Existing Supply								
Red Basin		0	0	0	0	0	0	0
Total Steam-Electric Existing Supply		0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need								
Red Basin		0	0	0	0	0	0	0
Total Steam-Electric New Supply Need		0	0	0	0	0	0	0
Irrigation Demand								
Red Basin		26,329	25,373	24,453	23,566	22,710	21,886	21,091
Total Irrigation Demand		26,329	25,373	24,453	23,566	22,710	21,886	21,091
Irrigation Supply								
Red Basin	Ogallala	26,583	22,359	15,468	9,509	7,131	5,079	4,589
	Dockum	100	100	100	100	100	100	100
	Seymour	4,063	4,063	4,063	1,821	1,821	1,821	1,821
Total Irrigation Supply		30,746	26,522	19,631	11,430	9,052	7,000	6,510
Irrigation Surplus/Shortage								
Red Basin		4,417	1,149	-4,822	-12,136	-13,658	-14,886	-14,581
Total Irrigation Surplus/Shortage		4,417	1,149	-4,822	-12,136	-13,658	-14,886	-14,581
Mining Demand								
Red Basin		0	0	0	0	0	0	0
Total Mining Demand		0	0	0	0	0	0	0
Mining Supply								
Red Basin		0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Red Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	
Dairies Demand								
Red Basin		33	33	33	33	33	33	33
Total Dairies Demand		33	33	33	33	33	33	33
Dairies Supply								
Red Basin	Ogallala	33	33	33	33	33	33	33
Total Dairies Supply		33	33	33	33	33	33	33
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		284	292	301	310	320	330	341
Total Range & All Other Livestock Demand		284	292	301	310	320	330	341
Range & All Other Livestock Supply								
Red Basin	Local	284	292	301	310	320	330	341
Total Range & All Other Livestock Supply		284	292	301	310	320	330	341

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Table 4-2 Concluded

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		306	311	311	299	280	270	263
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		26,329	25,373	24,453	23,566	22,710	21,886	21,091
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		33	33	33	33	33	33	33
Range & All Other Livestock		284	292	301	310	320	330	341
Total County Demand		26,952	26,009	25,098	24,208	23,343	22,519	21,728
Total Supply	Unallocated	115	109	96	94	95	91	91
Municipal		421	76	89	84	72	70	69
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		30,746	26,522	19,631	11,430	9,052	7,000	6,510
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		33	33	33	33	33	33	33
Range & All Other Livestock		284	292	301	310	320	330	341
Total County Supply		31,599	27,032	20,150	11,951	9,572	7,524	7,044
Total Surplus/Shortage								
Municipal		115	-235	-222	-215	-208	-200	-194
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		4,417	1,149	-4,822	-12,136	-13,658	-14,886	-14,581
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		4,532	914	-5,044	-12,351	-13,866	-15,086	-14,775
Total Basin Demand								
Red								
Municipal		306	311	311	299	280	270	263
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		26,329	25,373	24,453	23,566	22,710	21,886	21,091
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		33	33	33	33	33	33	33
Range & All Other Livestock		284	292	301	310	320	330	341
Total Red Basin Demand		26,952	26,009	25,098	24,208	23,343	22,519	21,728
Total Basin Supply								
Red	Unallocated	115	109	96	94	95	91	91
Municipal		421	76	89	84	72	70	69
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		30,746	26,522	19,631	11,430	9,052	7,000	6,510
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		33	33	33	33	33	33	33
Range & All Other Livestock		284	292	301	310	320	330	341
Total Red Basin Supply		31,599	27,032	20,150	11,951	9,572	7,524	7,044
Total Basin Surplus/Shortage								
Red								
Municipal		115	-235	-222	-215	-208	-200	-194
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		4,417	1,149	-4,822	-12,136	-13,658	-14,886	-14,581
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		4,532	914	-5,044	-12,351	-13,866	-15,086	-14,775

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

Table 4-3.
Projected Water Demands, Supplies, and Needs
Castro County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	2,817,626	2,222,567	1,460,181	991,079	743,569	678,750	633,894
	Quantity Pumped[2]	Ogallala	163,591	110,256	72,609	45,405	25,992	23,784	20,890
	Supply	(Ogallala)[3]	163,591	110,256	72,609	45,405	25,992	23,784	20,890
	Local Surface	Stock Tanks and Windmills	149	151	176	178	181	185	188
	Other Surface		0	0	0	0	0	0	0
	Total Supply		163,740	110,406	72,785	45,584	26,174	23,969	21,078
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	5,984,144	4,673,280	2,778,583	1,263,919	479,975	375,623	263,380
	Quantity Pumped[2]	Ogallala	349,432	235,507	211,116	147,124	59,674	44,832	38,066
	Supply	(Ogallala)[3]	349,432	235,507	211,116	147,124	59,674	44,832	38,066
	Local Surface	Stock Tanks and Windmills	181	184	214	218	220	223	227
	Reclaimed Water[4]		4,031	4,031	4,031	4,031	4,031	4,031	4,031
	Total Supply		353,644	239,722	215,362	151,373	63,926	49,086	42,323
	County Total								
	Quantity in Storage[1]	Ogallala	8,801,770	6,895,847	4,238,764	2,254,998	1,223,544	1,054,373	897,274
	Quantity Pumped[2]	Ogallala	513,023	345,762	283,725	192,530	85,667	68,616	58,956
	Supply	(Ogallala)[3]	513,023	345,762	283,725	192,530	85,667	68,616	58,956
	Local Surface	Stock Tanks and Windmills	330	335	390	396	402	408	414
	Reclaimed Water[4]		4,031	4,031	4,031	4,031	4,031	4,031	4,031
	Total Supply		517,384	350,128	288,146	196,957	90,099	73,055	63,402
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Rural			247	263	278	285	288	286	281
	Subtotal		247	263	278	285	288	286	281
Brazos Basin									
Dimmitt			975	1,041	1,103	1,137	1,159	1,150	1,130
Hart			223	238	251	258	262	260	256
Rural			208	222	234	240	243	241	237
	Subtotal		1,406	1,501	1,588	1,635	1,664	1,651	1,623
Total Municipal Demand			1,653	1,764	1,866	1,920	1,952	1,937	1,904
Municipal Existing Supply									
Red Basin									
Rural		Ogallala	247	263	278	285	288	286	281
	Subtotal		247	263	278	285	288	286	281
Brazos Basin									
Dimmitt		Ogallala	975	1,041	1,103	0	0	0	0
Hart		Ogallala	223	238	251	258	262	0	0
Rural		Ogallala	208	222	234	240	243	241	237
	Subtotal		1,406	1,501	1,588	498	505	241	237
Total Municipal Existing Supply			1,653	1,764	1,866	783	793	527	518
Municipal Surplus/Shortage									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Dimmitt			0	0	0	-1,137	-1,159	-1,150	-1,130
Hart			0	0	0	0	0	-260	-256
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	-1,137	-1,159	-1,410	-1,386
Total Municipal Surplus/Shortage			0	0	0	-1,137	-1,159	-1,410	-1,386
Municipal New Supply Need									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0

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Table 4-3 Continued

Basin		Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Brazos Basin									
Dimmitt			0	0	0	1,137	1,159	1,150	1,130
Hart			0	0	0	0	0	260	256
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	1,137	1,159	1,410	1,386
Total Municipal New Supply Need			0	0	0	1,137	1,159	1,410	1,386
Industrial Demand									
Red Basin			95	112	121	128	136	142	152
Brazos Basin			1,637	1,923	2,082	2,213	2,337	2,445	2,617
Total Industrial Demand			1,732	2,035	2,203	2,341	2,473	2,587	2,769
Industrial Existing Supply									
Red Basin		Ogallala	95	112	121	128	136	142	152
Brazos Basin		Ogallala	1,637	1,923	2,082	2,213	2,337	2,445	2,617
Total Industrial Existing Supply			1,732	2,035	2,203	2,341	2,473	2,587	2,769
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Red Basin			166,251	159,877	153,748	147,853	142,184	136,733	131,491
Brazos Basin			337,541	324,598	312,154	300,186	288,677	277,609	266,966
Total Irrigation Demand			503,792	484,475	465,902	448,039	430,861	414,342	398,457
Irrigation Supply									
Red Basin		Ogallala	160,039	105,544	66,971	39,489	19,781	17,269	14,051
Brazos Basin		Ogallala	344,084	228,757	202,378	138,836	51,102	35,586	28,607
Brazos Basin		Reclaimed Water	4,031	4,031	4,031	4,031	4,031	4,031	4,031
Brazos Basin Subtotal			348,115	232,788	206,409	142,867	55,133	39,617	32,638
Total Irrigation Supply			508,153	338,332	273,380	182,356	74,914	56,886	46,689
Irrigation Surplus/Shortage									
Red Basin			-6,212	-54,333	-86,777	-108,364	-122,403	-119,464	-117,440
Brazos Basin			10,574	-91,810	-105,745	-157,319	-233,544	-237,992	-234,328
Total Irrigation Surplus/Shortage			4,361	-146,143	-192,522	-265,683	-355,947	-357,456	-351,768
Mining Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Mining Demand			0	0	0	0	0	0	0

Continued on next page

Table 4-3 Continued

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		3,145	3,834	4,299	4,563	4,845	5,143	5,461
Brazos Basin		2,225	2,712	3,040	3,228	3,427	3,638	3862.3212
Total Beef Feedlot Livestock Demand		5,370	6,546	7,339	7,791	8,272	8,782	9,323
Beef Feedlot Livestock Supply								
Red Basin	Ogallala	3,145	3,834	4,299	4,563	4,845	5,143	5,461
Brazos Basin	Ogallala	2,225	2,712	3,040	3,228	3,427	3,638	3,862
Total Beef Feedlot Livestock Supply		5,370	6,546	7,339	7,791	8,272	8,782	9,323
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		66	502	940	940	942	944	945
Brazos Basin		80	614	1,146	1,146	1,144	1,142	1,141
Total Dairies Demand		146	1,116	2,086	2,086	2,086	2,086	2,086
Dairies Supply								
Red Basin	Ogallala	66	502	940	940	942	944	945
Brazos Basin	Ogallala	80	614	1,146	1,146	1,144	1,142	1,141
Total Dairies Supply		146	1,116	2,086	2,086	2,086	2,086	2,086
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		149	151	176	178	181	185	188
Brazos Basin		181	184	214	218	220	223	227
Total Range & All Other Livestock Demand		330	335	390	396	402	408	414
Range & All Other Livestock Supply								
Red Basin	Local	149	151	176	178	181	185	188
Brazos Basin	Local	181	184	214	218	220	223	227
Total Range & All Other Livestock Supply		330	335	390	396	402	408	414
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		1,653	1,764	1,866	1,920	1,952	1,937	1,904
Industrial		1,732	2,035	2,203	2,341	2,473	2,587	2,769
Steam-Electric		0	0	0	0	0	0	0
Irrigation		503,792	484,475	465,902	448,039	430,861	414,342	398,457
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		5,370	6,546	7,339	7,791	8,272	8,782	9,323
Dairies		146	1,116	2,086	2,086	2,086	2,086	2,086
Range & All Other Livestock		330	335	390	396	402	408	414
Total County Demand		513,023	496,271	479,787	462,573	446,046	430,142	414,954
Total Supply								
Municipal		1,653	1,764	1,866	783	793	527	518
Industrial		1,732	2,035	2,203	2,341	2,473	2,587	2,769
Steam-Electric		0	0	0	0	0	0	0
Irrigation		508,153	338,332	273,380	182,356	74,914	56,886	46,689
Mining		0	0	0	0	0	0	0

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Table 4-3 Continued

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Beef Feedlot Livestock		5,370	6,546	7,339	7,791	8,272	8,782	9,323
Dairies		146	1,116	2,086	2,086	2,086	2,086	2,086
Range & All Other Livestock		330	335	390	396	402	408	414
Total County Supply		517,384	350,128	287,265	195,753	88,940	71,276	61,800
Total Surplus/Shortage								
Municipal		0	0	0	-1,137	-1,159	-1,410	-1,386
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		4,361	-146,143	-192,522	-265,683	-355,947	-357,456	-351,768
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		4,361	-146,143	-192,522	-266,820	-357,106	-358,866	-353,154
Total Basin Demand								
Red								
Municipal		247	263	278	285	288	286	281
Industrial		95	112	121	128	136	142	152
Steam-Electric		0	0	0	0	0	0	0
Irrigation		166,251	159,877	153,748	147,853	142,184	136,733	131,491
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		3,145	3,834	4,299	4,563	4,845	5,143	5,461
Dairies		66	502	940	940	942	944	945
Range & All Other Livestock		149	151	176	178	181	185	188
Total Red Basin Demand		169,952	164,739	159,562	153,948	148,576	143,433	138,518
Brazos								
Municipal		1,406	1,501	1,588	1,635	1,664	1,651	1,623
Industrial		1,637	1,923	2,082	2,213	2,337	2,445	2,617
Steam-Electric		0	0	0	0	0	0	0
Irrigation		337,541	324,598	312,154	300,186	288,677	277,609	266,966
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,225	2,712	3,040	3,228	3,427	3,638	3,862
Dairies		80	614	1,146	1,146	1,144	1,142	1,141
Range & All Other Livestock		181	184	214	218	220	223	227
Total Brazos Basin Demand		343,070	331,532	320,224	308,626	297,469	286,709	276,436
Total Basin Supply								
Red								
Municipal		247	263	278	285	288	286	281
Industrial		95	112	121	128	136	142	152
Steam-Electric		0	0	0	0	0	0	0
Irrigation		160,039	105,544	66,971	39,489	19,781	17,269	14,051
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		3,145	3,834	4,299	4,563	4,845	5,143	5,461
Dairies		66	502	940	940	942	944	945
Range & All Other Livestock		149	151	176	178	181	185	188
Total Red Basin Supply		163,740	110,406	72,785	45,584	26,173	23,969	21,078
Brazos								
Municipal		1,406	1,501	1,588	498	505	241	237
Industrial		1,637	1,923	2,082	2,213	2,337	2,445	2,617
Steam-Electric		0	0	0	0	0	0	0
Irrigation		348,115	232,788	206,409	142,867	55,133	39,617	32,638
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,225	2,712	3,040	3,228	3,427	3,638	3,862
Dairies		80	614	1,146	1,146	1,144	1,142	1,141
Range & All Other Livestock		181	184	214	218	220	223	227
Total Brazos Basin Supply		353,644	239,722	214,479	150,170	62,766	47,307	40,722
Total Basin Surplus/Shortage								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-6,212	-54,333	-86,777	-108,364	-122,403	-119,464	-117,440
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		-6,212	-54,333	-86,777	-108,364	-122,403	-119,464	-117,440

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Table 4-3 Concluded

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage (cont.)								
Brazos								
Municipal		0	0	0	-1,137	-1,159	-1,410	-1,386
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		10,574	-91,810	-105,745	-157,319	-233,544	-237,992	-234,328
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		10,574	-91,810	-105,745	-158,456	-234,703	-239,402	-235,714

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Dimmitt, Nazareth Water & Sewer Supply, City of Hart, and Chestar USA Dimmitt, Inc.. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projeciton period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-4. Projected Water Demands, Supplies, and Needs Cochran County Llano Estacado Region

Basin		Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	459,890	309,727	192,301	117,170	46,347	10,920	5,038
	Quantity Pumped[2]	Ogallala	77,961	44,285	43,420	36,681	33,797	12,126	12,157
	Supply	(Ogallala)[3]	77,961	44,285	43,420	36,681	33,797	12,126	12,157
	Local Surface	Stock Tanks and Windmills	45	46	64	67	69	70	70
	Reclaimed Water[4]		267	267	267	267	267	267	267
	Total Supply		78,274	44,599	43,751	37,015	34,132	12,463	12,495
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	2,118,814	1,524,384	1,116,691	696,573	301,008	70,788	32,667
	Quantity Pumped[2]	Ogallala	45,154	33,836	31,610	35,447	35,458	11,783	11,752
	Supply	(Ogallala)[3]	45,154	33,836	31,610	35,447	35,458	11,783	11,752
	Local Surface	Stock Tanks and Windmills	87	88	123	123	124	125	128
	Reclaimed Water[4]		27	27	27	27	27	27	27
	Total Supply		45,268	33,951	31,760	35,597	35,609	11,936	11,907
	County Total								
	Quantity in Storage[1]	Ogallala	2,578,704	1,834,111	1,308,992	813,743	347,354	81,708	37,705
	Quantity Pumped[2]	Ogallala	123,115	78,121	75,030	72,128	69,255	23,909	23,909
	Supply	(Ogallala)[3]	123,115	78,121	75,030	72,128	69,255	23,909	23,909
	Local Surface	Stock Tanks and Windmills	133	135	187	190	193	195	198
	Reclaimed Water[4]		294	294	294	294	294	294	294
	Total Supply		123,542	78,550	75,511	72,612	69,742	24,398	24,401
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Morton			499	535	560	565	547	521	496
Rural			172	183	191	192	185	176	167
	Subtotal		671	718	751	757	732	697	663
Colorado Basin									
Rural			92	98	102	103	99	95	90
	Subtotal		92	98	102	103	99	95	90
Total Municipal Demand			763	816	853	860	831	792	753
Municipal Existing Supply									
Brazos Basin									
Morton		Ogallala	499	535	0	0	0	0	0
Rural		Ogallala	172	183	191	192	185	176	167
	Subtotal		671	718	191	192	185	176	167
Colorado Basin									
Rural		Ogallala	92	98	102	103	99	95	90
	Subtotal		92	98	102	103	99	95	90
Total Municipal Existing Supply			763	816	293	295	284	271	257
Municipal Surplus/Shortage									
Brazos Basin									
Morton			0	0	-560	-565	-547	-521	-496
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	-560	-565	-547	-521	-496
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Surplus/Shortage			0	0	-560	-565	-547	-521	-496

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Table 4-4 Continued

Basin		Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Brazos Basin									
Morton			0	0	560	565	547	521	496
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	560	565	547	521	496
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	0	560	565	547	521	496
Industrial Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			76,790	73,825	70,978	68,239	65,604	63,071	60,636
Colorado Basin			43,195	41,527	39,925	38,384	36,902	35,478	34,108
Total Irrigation Demand			119,985	115,352	110,903	106,623	102,506	98,549	94,744
Irrigation Supply									
Brazos Basin		Ogallala	76,760	42,859	41,527	34,831	31,987	10,348	10,400
		Reclaimed Water	267	267	267	267	267	267	267
Brazos Basin Subtotal			77,027	43,126	41,794	35,098	32,254	10,615	10,667
Colorado Basin		Ogallala	43,358	32,290	30,486	34,492	34,720	11,262	11,406
		Reclaimed Water	27	27	27	27	27	27	27
Colorado Basin Subtotal			43,385	32,317	30,513	34,519	34,747	11,289	11,433
Total Irrigation Supply			120,412	75,443	72,307	69,617	67,001	21,904	22,100
Irrigation Surplus/Shortage									
Brazos Basin			237	-30,699	-29,184	-33,141	-33,350	-52,456	-49,969
Colorado Basin			190	-9,210	-9,412	-3,865	-2,155	-24,189	-22,675
Total Irrigation Surplus/Shortage			427	-39,909	-38,596	-37,006	-35,505	-76,645	-72,644

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Table 4-4 Continued

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Brazos Basin		16	14	10	8	6	4	2
Colorado Basin		1,704	1,448	1,022	852	639	426	256
Total Mining Demand		1,720	1,462	1,032	860	645	430	258
Mining Supply								
Brazos Basin	Ogallala	16	14	10	8	6	4	2
Colorado Basin	Ogallala	1,704	1,448	1,022	852	639	426	256
Total Mining Supply		1,720	1,462	1,032	860	645	430	258
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		514	627	703	746	792	841	893
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		514	627	703	746	792	841	893
Beef Feedlot Livestock Supply								
Brazos Basin	Ogallala	514	627	703	746	792	841	893
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		514	627	703	746	792	841	893
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	67	134	134	134	134	134
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	67	134	134	134	134	134
Dairies Supply								
Brazos Basin	Ogallala	0	67	134	134	134	134	134
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	67	134	134	134	134	134
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		45	46	64	67	69	70	70
Colorado Basin		87	88	123	123	124	125	128
Total Range & All Other Livestock Demand		133	135	187	190	193	195	198
Range & All Other Livestock Supply								
Brazos Basin	Local	45	46	64	67	69	70	70
Colorado Basin	Local	87	88	123	123	124	125	128
Total Range & All Other Livestock Supply		133	135	187	190	193	195	198
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		763	816	853	860	831	792	753
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		119,985	115,352	110,903	106,623	102,506	98,549	94,744
Mining		1,720	1,462	1,032	860	645	430	258
Beef Feedlot Livestock		514	627	703	746	792	841	893
Dairies		0	67	134	134	134	134	134
Range & All Other Livestock		133	135	187	190	193	195	198
Total County Demand		123,115	118,458	113,812	109,413	105,101	100,941	96,980

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Table 4-4 Continued

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		763	816	293	295	284	271	257
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		120,412	75,443	72,307	69,617	67,001	21,904	22,100
Mining		1,720	1,462	1,032	860	645	430	258
Beef Feedlot Livestock		514	627	703	746	792	841	893
Dairies		0	67	134	134	134	134	134
Range & All Other Livestock		133	135	187	190	193	195	198
Total County Supply		123,542	78,549	74,656	71,842	69,049	23,776	23,840
Total Surplus/Shortage								
Municipal		0	0	-560	-565	-547	-521	-496
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		427	-39,909	-38,596	-37,006	-35,505	-76,645	-72,644
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		427	-39,909	-39,156	-37,571	-36,052	-77,166	-73,140
Total Basin Demand								
Brazos								
Municipal		671	718	751	757	732	697	663
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		76,790	73,825	70,978	68,239	65,604	63,071	60,636
Mining		16	14	10	8	6	4	2
Beef Feedlot Livestock		514	627	703	746	792	841	893
Dairies		0	67	134	134	134	134	134
Range & All Other Livestock		45	46	64	67	69	70	70
Total Brazos Basin Demand		78,037	75,297	72,640	69,951	67,336	64,817	62,398
Colorado								
Municipal		92	98	102	103	99	95	90
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		43,195	41,527	39,925	38,384	36,902	35,478	34,108
Mining		1,704	1,448	1,022	852	639	426	256
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		87	88	123	123	124	125	128
Total Colorado Basin Demand		45,078	43,161	41,172	39,462	37,764	36,124	34,582
Total Basin Supply								
Brazos								
Municipal		671	718	191	192	185	176	167
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		77,027	43,126	41,794	35,098	32,254	10,615	10,667
Mining		16	14	10	8	6	4	2
Beef Feedlot Livestock		514	627	703	746	792	841	893
Dairies		0	67	134	134	134	134	134
Range & All Other Livestock		45	46	64	67	69	70	70
Total Brazos Basin Supply		78,274	44,598	42,896	36,245	33,439	11,840	11,933
Colorado								
Municipal		92	98	102	103	99	95	90
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		43,385	32,317	30,513	34,519	34,747	11,289	11,433
Mining		1,704	1,448	1,022	852	639	426	256
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		87	88	123	123	124	125	128
Total Colorado Basin Supply		45,268	33,951	31,760	35,597	35,609	11,936	11,907
Total Basin Surplus/Shortage								
Brazos								
Municipal		0	0	-560	-565	-547	-521	-496
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		237	-30,699	-29,184	-33,141	-33,350	-52,456	-49,969
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0

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Table 4-4 Concluded

Basin	Source	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		237	-30,699	-29,744	-33,706	-33,897	-52,977	-50,465
Colorado								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		190	-9,210	-9,412	-3,865	-2,155	-24,189	-22,675
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		190	-9,210	-9,412	-3,865	-2,155	-24,189	-22,675

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Morton, Girls Town USA, and City of Whiteface. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waster discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste

Table 4-5.
Projected Water Demands, Supplies, and Needs
Crosby County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	88,869	94,099	80,773	76,630	72,995	72,514	72,127
	Quantity Pumped[2]	Ogallala	1,391	1,307	1,256	1,204	1,158	1,101	1,078
	Supply	(Ogallala)[3]	1,391	1,307	1,256	1,204	1,158	1,101	1,078
	Local Surface	Stock Tanks and Windmills	3	3	3	4	4	4	4
	Other Surface		0	0	0	0	0	0	0
	Total Supply		1,394	1,310	1,259	1,208	1,161	1,105	1,082
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	10,860,146	10,518,753	10,004,335	9,903,661	9,079,445	8,965,722	8,874,426
	Quantity Pumped[2]	Ogallala	112,337	96,710	92,844	89,147	85,593	83,138	79,835
	Supply	(Ogallala)[3]	112,337	96,710	92,844	89,147	85,593	83,138	79,835
	Seymour Aquifer		483	483	483	474	474	474	474
	Local Surface	Stock Tanks and Windmills	292	298	303	310	318	325	332
	Other Surface	White River Reservoir	707	707	707	707	707	389	8
	Reclaimed Water[4]		583	583	583	583	583	583	583
	Total Supply		114,402	98,781	94,921	91,222	87,675	84,909	81,232
	County Total								
	Quantity in Storage[1]	Ogallala	10,949,015	10,612,852	10,085,108	9,980,291	9,152,440	9,038,236	8,946,553
	Quantity Pumped[2]	Ogallala	113,728	98,017	94,100	90,352	86,751	84,239	80,913
	Supply	(Ogallala)[3]	113,728	98,017	94,100	90,352	86,751	84,239	80,913
	Seymour Aquifer		483	483	483	474	474	474	474
	Local Surface	Stock Tanks and Windmills	295	301	307	314	321	329	336
	Other Surface	White River Reservoir	707	707	707	707	707	389	707
	Reclaimed Water[4]		583	583	583	583	583	583	583
	Total Supply		115,796	100,091	96,179	92,430	88,836	86,014	82,314
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Rural			1	1	1	1	1	1	1
	Subtotal		1	1	1	1	1	1	1
Brazos Basin									
Crosbyton			351	369	386	394	402	400	394
Lorenzo			260	275	288	296	302	301	296
Ralls			290	304	315	322	325	323	318
Rural			202	210	217	220	222	220	217
	Subtotal		1,103	1,158	1,206	1,232	1,251	1,244	1,225
Total Municipal Demand			1,104	1,159	1,207	1,233	1,252	1,245	1,226
Municipal Existing Supply									
Red Basin									
Rural		Ogallala	1	1	1	1	1	1	1
	Subtotal		1	1	1	1	1	1	1
Brazos Basin									
Crosbyton	1998 obtained 464 acft	White River Reservoir	389	389	389	389	389	389	8
		Ogallala	50	50	50	50	50	50	50
Crosbyton Subtotal			439	439	439	439	439	439	58
Lorenzo		Ogallala	260	275	288	259	233	209	188
Ralls	1994 obtained 352 acft	White River Reservoir	318	318	318	318	318	0	0
Rural		Ogallala	202	210	217	220	222	220	217
		Seymour	100	100	100	100	100	100	100
Rural Subtotal			302	310	317	320	322	320	317
	Subtotal		1,269	1,292	1,312	1,286	1,262	918	513
Total Municipal Existing Supply			1,270	1,293	1,313	1,287	1,263	919	514
Municipal Surplus/Shortage									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0

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Table 4-5 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal Surplus/Shortage (Cont.)									
Brazos Basin									
Crosbyton			88	70	53	45	37	39	-336
Lorenzo			0	0	0	-37	-69	-92	-108
Ralls			28	14	3	-4	-7	-323	-318
Rural			100	100	100	100	100	100	100
	Subtotal		216	184	156	104	61	-276	-662
Total Municipal Surplus/Shortage			216	184	156	104	61	-276	-662
Municipal New Supply Need									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Crosbyton			0	0	0	0	0	0	336
Lorenzo			0	0	0	37	69	92	108
Ralls			0	0	0	4	7	323	318
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	41	76	415	762
Total Municipal New Supply Need			0	0	0	41	76	415	762
Industrial Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			5	6	6	6	6	6	6
Total Industrial Demand			5	6	6	6	6	6	6
Industrial Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin		Ogallala	5	6	6	6	6	6	6
Total Industrial Existing Supply			5	6	6	6	6	6	6
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Shortage/Surplus			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Red Basin			2,243	2,152	2,066	1,982	1,903	1,826	1,752
Brazos Basin			109,892	105,465	101,215	97,138	93,223	89,469	85,866
Total Irrigation Demand			112,135	107,617	103,281	99,120	95,126	91,295	87,618
Irrigation Supply									
Red Basin		Ogallala	1,320	1,265	1,235	1,192	1,152	1,100	1,077
Brazos Basin		Ogallala	111,701	94,498	90,649	86,786	83,289	80,886	77,624
		Seymour	383	383	383	374	374	374	374
		Reclaimed Water	583	583	583	583	583	583	583
Brazos Basin Subtotal			112,667	95,464	91,615	87,743	84,246	81,843	78,581
Total Irrigation Supply			113,987	96,729	92,850	88,935	85,398	82,943	79,658

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Table 4-5 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Irrigation Surplus/Shortage								
Red Basin		-923	-887	-831	-790	-751	-726	-675
Brazos Basin		2,775	-10,001	-9,600	-9,395	-8,977	-7,626	-7,285
Total Irrigation Surplus/Shortage		1,852	-10,888	-10,431	-10,185	-9,728	-8,352	-7,960
Mining Demand								
Red Basin		70	41	20	11	5	0	0
Brazos Basin		119	71	34	20	8	0	0
Total Mining Demand		189	112	54	31	13	0	0
Mining Supply								
Red Basin	Ogallala	70	41	20	11	5	0	0
Brazos Basin	Ogallala	119	71	34	20	8	0	0
Total Mining Supply		189	112	54	31	13	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Red Basin	Ogallala	0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		3	3	3	4	4	4	4
Brazos Basin		292	298	303	310	318	325	332
Total Range & All Other Livestock Demand		295	301	307	314	321	329	336
Range & All Other Livestock Supply								
Red Basin	Local	3	3	3	4	4	4	4
Brazos Basin	Local	292	298	303	310	318	325	332
Total Range & All Other Livestock Supply		295	301	307	314	321	329	336
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		1,104	1,159	1,207	1,233	1,252	1,245	1,226
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		112,135	107,617	103,281	99,120	95,126	91,295	87,618
Mining		189	112	54	31	13	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		295	301	307	314	321	329	336
Total County Demand		113,728	109,195	104,855	100,704	96,718	92,875	89,186

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Table 4-5 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		1,270	1,293	1,313	1,287	1,263	919	514
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		113,987	96,729	92,850	88,935	85,398	82,943	79,658
Mining		189	112	54	31	13	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		295	301	307	314	321	329	336
Total County Supply		115,746	98,441	94,529	90,574	87,001	84,197	80,514
Total Surplus/Shortage								
Municipal		166	134	106	54	11	-326	-712
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,852	-10,888	-10,431	-10,185	-9,728	-8,352	-7,960
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		2,018	-10,754	-10,325	-10,131	-9,717	-8,678	-8,672
Total Basin Demand								
Red								
Municipal		1	1	1	1	1	1	1
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		2,243	2,152	2,066	1,982	1,903	1,826	1,752
Mining		70	41	20	11	5	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		3	3	3	4	4	4	4
Total Red Basin Demand		2,317	2,197	2,090	1,998	1,913	1,831	1,757
Brazos								
Municipal		1,103	1,158	1,206	1,232	1,251	1,244	1,225
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		109,892	105,465	101,215	97,138	93,223	89,469	85,866
Mining		119	71	34	20	8	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		292	298	303	310	318	325	332
Total Brazos Basin Demand		111,411	106,998	102,764	98,706	94,806	91,044	87,429
Total Basin Supply								
Red								
Municipal		1	1	1	1	1	1	1
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,320	1,265	1,235	1,192	1,152	1,100	1,077
Mining		70	41	20	11	5	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		3	3	3	4	4	4	4
Total Red Basin Supply		1,394	1,310	1,259	1,208	1,161	1,105	1,082
Brazos								
Municipal		1,269	1,292	1,312	1,286	1,262	918	513
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		112,667	95,464	91,615	87,743	84,246	81,843	78,581
Mining		119	71	34	20	8	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		292	298	303	310	318	325	332
Total Brazos Basin Supply		114,352	97,131	93,270	89,365	85,840	83,092	79,432
Total Basin Surplus/Shortage								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-923	-887	-831	-790	-751	-726	-675
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		-923	-887	-831	-790	-751	-726	-675

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Table 4-5 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage (Cont.)								
Brazos								
Municipal		166	134	106	54	11	-326	-712
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		2,775	-10,001	-9,600	-9,395	-8,977	-7,626	-7,285
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		2,941	-9,867	-9,494	-9,341	-8,966	-7,952	-7,997

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from City of Lorenzo, City of Ralls, City of Crosbyton, and the White River MWD. The quantity of reclaimed water availabe from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-6.
Projected Water Demands, Supplies, and Needs
Dawson County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	160,390	160,390	160,390	160,390	160,390	160,390	160,390
	Quantity Pumped[2]	Ogallala	19	19	19	19	18	18	17
	Supply	(Ogallala)[3]	19	19	19	19	18	18	17
	Local Surface	Stock Tanks and Windmills	1	1	2	1	2	2	2
	Other Surface		0	0	0	0	0	0	0
	Total Supply		21	20	21	20	20	20	19
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	7,106,402	7,041,932	7,041,932	7,041,932	7,041,932	7,041,932	7,041,932
	Quantity Pumped[2]	Ogallala	152,146	45,194	37,508	34,547	31,266	31,239	31,195
	Supply	(Ogallala)[3]	152,146	45,194	37,508	34,547	31,266	31,239	31,195
	Other Ground	Ogallala (CRMWA - Roberts Co.)	892	892	892	892	892	692	692
	Local Surface	Stock Tanks and Windmills	150	154	156	161	164	168	172
	Other Surface	Lake Meredith (CRMWA)	1,694	1,694	1,694	1,694	1,694	1,694	1694
	Total Supply		154,882	47,934	40,250	37,294	34,016	33,793	33,753
	County Total								
	Quantity in Storage[1]	Ogallala	7,266,792	7,202,322	7,202,322	7,202,322	7,202,322	7,202,322	7,202,322
	Quantity Pumped[2]	Ogallala	152,165	45,213	37,527	34,566	31,284	31,257	31,212
	Supply	(Ogallala)[3]	152,165	45,213	37,527	34,566	31,284	31,257	31,212
	Other Ground	Ogallala (CRMWA - Roberts Co.)	892	892	892	892	892	692	692
	Local Surface	Stock Tanks and Windmills	152	155	158	162	166	170	174
	Other Surface	Lake Meredith (CRMWA)	1,694	1,694	1,694	1,694	1,694	1,694	1,694
	Total Supply		154,903	47,954	40,271	37,314	34,036	33,813	33,772
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
O'Donnell (part)			17	17	17	17	17	17	16
Rural			18	18	18	19	18	18	17
	Subtotal		35	35	35	36	35	35	33
Colorado Basin									
Lamesa			2,486	2,540	2,573	2,602	2,603	2,529	2,433
Rural			605	610	612	616	607	587	565
	Subtotal		3,091	3,150	3,185	3,218	3,210	3,116	2,998
Total Municipal Demand			3,126	3,185	3,220	3,254	3,245	3,151	3,031
Municipal Existing Supply									
Brazos Basin									
Rural		Ogallala	18	18	18	19	18	18	17
	Subtotal		18	18	18	19	18	18	17
Colorado Basin									
Lamesa		Ogallala	628	565	508	457	411	370	333
		Lake Meredith (CRMWA)[4]	1,656	1,656	1,656	1,656	1,656	1,656	1,656
		Ogallala (CRMWA - Roberts Co.)[4]	872	872	872	872	872	672	672
Lamesa Subtotal			3,156	3,093	3,036	2,985	2,939	2,698	2,661
O'Donnell (part)		Lake Meredith (CRMWA)	38	38	38	38	38	38	38
		Ogallala (CRMWA - Roberts Co.)	20	20	20	20	20	20	20
O'Donnell (part) Subtotal			58	58	58	58	58	58	58
Rural		Ogallala	605	610	612	616	607	587	565
	Subtotal		3,819	3,761	3,706	3,659	3,604	3,343	3,284
Total Municipal Existing Supply			3,837	3,779	3,724	3,678	3,622	3,361	3,301
Municipal Surplus/Shortage									
Brazos Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Colorado Basin									
Lamesa			670	553	463	383	336	169	228
O'Donnell (part)			41	41	41	41	41	41	42
Rural			0	0	0	0	0	0	0
	Subtotal		711	594	504	424	377	210	270
Total Municipal Surplus/Shortage			711	594	504	424	377	210	270

Continued on next page

Table 4-6 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Brazos Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Colorado Basin									
Lamesa			0	0	0	0	0	0	0
O'Donnell (part)			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	0	0	0	0	0	0
Industrial Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			101	119	129	137	144	150	162
Total Industrial Demand			101	119	129	137	144	150	162
Industrial Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin		Ogallala	101	119	129	137	144	150	162
Total Industrial Existing Supply			101	119	129	137	144	150	162
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			1,460	1,378	1,300	1,227	1,158	1,093	1,031
Colorado Basin			144,579	136,425	128,736	121,478	114,628	108,167	102,071
Total Irrigation Demand			146,039	137,803	130,036	122,705	115,786	109,260	103,102
Irrigation Supply									
Brazos Basin		Ogallala	1	1	1	0	0	0	0
Colorado Basin		Ogallala	148,712	42,021	35,223	32,620	29,644	29,863	29,862
Total Irrigation Supply			148,713	42,022	35,224	32,620	29,644	29,863	29,862
Irrigation Surplus/Shortage									
Brazos Basin			-1,459	-1,377	-1,299	-1,227	-1,158	-1,093	-1,031
Colorado Basin			4,133	-94,404	-93,513	-88,858	-84,984	-78,304	-72,209
Total Irrigation Surplus/Shortage			2,674	-95,781	-94,812	-90,085	-86,142	-79,397	-73,240

Continued on next page

Table 4-6 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		2,728	1,624	779	455	195	0	0
Total Mining Demand		2,728	1,624	779	455	195	0	0
Mining Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin	Ogallala	2,728	1,624	779	455	195	0	0
Total Mining Supply		2,728	1,624	779	455	195	0	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		1	1	2	1	2	2	2
Colorado Basin		150	154	156	161	164	168	172
Total Range & All Other Livestock Demand		152	155	158	162	166	170	174
Range & All Other Livestock Supply								
Brazos Basin	Local	1	1	2	1	2	2	2
Colorado Basin	Local	150	154	156	161	164	168	172
Total Range & All Other Livestock Supply		152	155	158	162	166	170	174
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		3,126	3,185	3,220	3,254	3,245	3,151	3,031
Industrial		101	119	129	137	144	150	162
Steam-Electric		0	0	0	0	0	0	0
Irrigation		146,039	137,803	130,036	122,705	115,786	109,260	103,102
Mining		2,728	1,624	779	455	195	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		152	155	158	162	166	170	174
Total County Demand		152,146	142,886	134,322	126,713	119,536	112,731	106,469

Continued on next page

Table 4-6 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		3,837	3,779	3,724	3,678	3,622	3,361	3,301
Industrial		101	119	129	137	144	150	162
Steam-Electric		0	0	0	0	0	0	0
Irrigation		148,713	42,022	35,224	32,620	29,644	29,863	29,862
Mining		2,728	1,624	779	455	195	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		152	155	158	162	166	170	174
Total County Supply		155,531	47,699	40,014	37,052	33,771	33,544	33,499
Total Surplus/Shortage								
Municipal		711	594	504	424	377	210	270
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		2,674	-95,781	-94,812	-90,085	-86,142	-79,397	-73,240
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		3,385	-95,187	-94,308	-89,661	-85,765	-79,187	-72,970
Total Basin Demand								
Brazos								
Municipal		35	35	35	36	35	35	33
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,460	1,378	1,300	1,227	1,158	1,093	1,031
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		1	1	2	1	2	2	2
Total Brazos Basin Demand		1,496	1,414	1,337	1,264	1,195	1,130	1,066
Colorado								
Municipal		3,091	3,150	3,185	3,218	3,210	3,116	2,998
Industrial		101	119	129	137	144	150	162
Steam-Electric		0	0	0	0	0	0	0
Irrigation		144,579	136,425	128,736	121,478	114,628	108,167	102,071
Mining		2,728	1,624	779	455	195	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		150	154	156	161	164	168	172
Total Colorado Basin Demand		150,649	141,472	132,985	125,449	118,341	111,601	105,403
Total Basin Supply								
Brazos								
Municipal		18	18	18	19	18	18	17
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1	1	1	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		1	1	2	1	2	2	2
Total Brazos Basin Supply		21	20	21	20	20	20	19
Colorado								
Municipal		3,819	3,761	3,706	3,659	3,604	3,343	3,284
Industrial		101	119	129	137	144	150	162
Steam-Electric		0	0	0	0	0	0	0
Irrigation		148,712	42,021	35,223	32,620	29,644	29,863	29,862
Mining		2,728	1,624	779	455	195	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		150	154	156	161	164	168	172
Total Colorado Basin Supply		155,510	47,679	39,993	37,032	33,751	33,524	33,480

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Table 4-6 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Brazos								
Municipal		-17	-17	-17	-17	-17	-17	-16
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-1,459	-1,377	-1,299	-1,227	-1,158	-1,093	-1,031
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		-1,476	-1,394	-1,316	-1,244	-1,175	-1,110	-1,047
Colorado								
Municipal		728	611	521	441	394	227	286
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		4,133	-94,404	-93,513	-88,858	-84,984	-78,304	-72,209
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		4,861	-93,793	-92,992	-88,417	-84,590	-78,077	-71,923

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

Table 4-7.
Projected Water Demands, Supplies, and Needs
Deaf Smith County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Canadian Basin								
	Quantity in Storage[1]	Ogallala	2,599	1,798	894	684	684	684	684
	Quantity Pumped[2]	Ogallala	171	112	74	1	1	1	1
	Supply	(Ogallala)[3]	171	112	74	1	1	1	1
	Local Surface	Stock Tanks and Windmills	220	281	317	326	336	344	353
	Other Surface		0	0	0	0	0	0	0
	Total Supply		390	393	391	327	337	345	354
	Red Basin								
	Quantity in Storage[1]	Ogallala	7,849,168	6,645,748	5,230,088	4,162,529	3,383,183	3,152,241	2,999,333
	Quantity Pumped[2]	Ogallala	388,182	204,702	170,696	128,078	88,180	86,199	81,704
	Supply	(Ogallala)[3]	388,182	204,702	170,696	128,078	88,180	86,199	81,704
	Dockum Aquifer		930	720	578	7,502	7,576	7,602	7,602
	Local Surface	Stock Tanks and Windmills	2,859	2,931	3,035	3,174	3,319	3,474	3,636
	Reclaimed Water[4]		2,810	2,810	2,810	2,810	2,810	2,810	2,810
	Total Supply		394,781	211,163	177,119	141,564	101,885	100,085	95,752
	County Total								
	Quantity in Storage[1]	Ogallala	7,851,767	6,647,546	5,230,982	4,163,213	3,383,867	3,152,925	3,000,017
	Quantity Pumped[2]	Ogallala	388,353	204,814	170,770	128,079	88,181	86,200	81,705
	Supply	(Ogallala)[3]	388,353	204,814	170,770	128,079	88,181	86,200	81,705
	Dockum Aquifer		930	720	578	7,502	7,576	7,602	7,602
	Local Surface	Stock Tanks and Windmills	3,079	3,212	3,352	3,500	3,655	3,818	3,989
	Reclaimed Water[4]		2,810	2,810	2,810	2,810	2,810	2,810	2,810
	Total Supply		395,172	211,556	177,511	141,891	102,222	100,430	96,106
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Canadian Basin									
Rural			0	1	1	1	1	1	1
	Subtotal		0	1	1	1	1	1	1
Red Basin									
Hereford			3,564	3,634	3,694	3,751	3,788	3,801	3,813
Rural			572	743	932	1,100	1,243	1,286	1,305
	Subtotal		4,136	4,377	4,626	4,851	5,031	5,087	5,118
Total Municipal Demand			4,136	4,378	4,627	4,852	5,032	5,088	5,119
Municipal Existing Supply									
Canadian Basin									
Rural		Ogallala	0	1	1	1	1	1	1
	Subtotal		0	1	1	1	1	1	1
Red Basin									
Hereford[5]		Ogallala	3,099	3,274	3,405	0	0	0	0
		Dockum (Santa Rosa)	930	720	578	7,502	7,576	7,602	7,602
Hereford Subtotal			4,029	3,994	3,983	7,502	7,576	7,602	7,602
Rural		Ogallala	572	743	932	1,100	1,243	1,286	1,305
	Subtotal		4,601	4,737	4,915	8,602	8,819	8,888	8,907
Total Municipal Existing Supply			4,601	4,738	4,916	8,603	8,820	8,889	8,908
Municipal Surplus/Shortage									
Canadian Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Red Basin									
Hereford			465	360	289	3,751	3,788	3,801	3,789
Rural			0	0	0	0	0	0	0
	Subtotal		465	360	289	3,751	3,788	3,801	3,789
Total Municipal Surplus/Shortage			465	360	289	3,751	3,788	3,801	3,789

Continued on next page

Table 4-7 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Canadian Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Red Basin									
Hereford			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	0	0	0	0	0	0
Industrial Demand									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			1,234	1,454	1,594	1,710	1,821	1,917	2,055
Total Industrial Demand			1,234	1,454	1,594	1,710	1,821	1,917	2,055
Industrial Existing Supply									
Canadian Basin			0	0	0	0	0	0	0
Red Basin		Ogallala	1,234	1,454	1,594	1,710	1,821	1,917	2,055
Total Industrial Existing Supply			1,234	1,454	1,594	1,710	1,821	1,917	2,055
Industrial Surplus/Shortage									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			372,827	361,015	349,580	338,504	327,780	317,396	307,341
Total Irrigation Demand			372,827	361,015	349,580	338,504	327,780	317,396	307,341
Irrigation Supply									
Canadian Basin									
Red Basin		Ogallala	376,200	189,392	152,792	112,727	71,945	69,207	63,881
		Reclaimed Water	2,810	2,810	2,810	2,810	2,810	2,810	2,810
Red Basin Subtotal			379,010	192,202	155,602	115,537	74,755	72,017	66,691
Total Irrigation Supply			379,010	192,202	155,602	115,537	74,755	72,017	66,691
Irrigation Surplus/Shortage									
Canadian Basin			0	0	0	0	0	0	0
Red Basin			6,183	-168,813	-193,978	-222,967	-253,025	-245,379	-240,650
Total Irrigation Surplus/Shortage			6,183	-168,813	-193,978	-222,967	-253,025	-245,379	-240,650

Continued on next page

Table 4-7 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		0	0	0	0	0	0	0
Total Mining Demand		0	0	0	0	0	0	0
Mining Supply								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Total Beef Feedlot Livestock Demand		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Beef Feedlot Livestock Supply								
Canadian Basin		0	0	0	0	0	0	0
Red Basin	Ogallala	7,041	8,583	9,623	10,216	10,846	11,514	12,224
Total Beef Feedlot Livestock Supply		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Beef Feedlot Livestock Surplus/Shortage								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		36	1,131	2,225	2,225	2,225	2,225	2,225
Total Dairies Demand		36	1,131	2,225	2,225	2,225	2,225	2,225
Dairies Supply								
Canadian Basin		0	0	0	0	0	0	0
Red Basin	Ogallala	36	1,131	2,225	2,225	2,225	2,225	2,225
Total Dairies Supply		36	1,131	2,225	2,225	2,225	2,225	2,225
Dairies Surplus/Shortage								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Canadian Basin		220	281	317	326	336	344	353
Red Basin		2,859	2,931	3,035	3,174	3,319	3,474	3,636
Total Range & All Other Livestock Demand		3,079	3,212	3,352	3,500	3,655	3,818	3,989
Range & All Other Livestock Supply								
Canadian Basin	Local	220	281	317	326	336	344	353
Red Basin	Local	2,859	2,931	3,035	3,174	3,319	3,474	3,636
Total Range & All Other Livestock Supply		3,079	3,212	3,352	3,500	3,655	3,818	3,989
Range & All Other Livestock Surplus/Shortage								
Canadian Basin		0	0	0	0	0	0	0
Red Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		4,136	4,378	4,627	4,852	5,032	5,088	5,119
Industrial		1,234	1,454	1,594	1,710	1,821	1,917	2,055
Steam-Electric		0	0	0	0	0	0	0
Irrigation		372,827	361,015	349,580	338,504	327,780	317,396	307,341
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Dairies		36	1,131	2,225	2,225	2,225	2,225	2,225
Range & All Other Livestock		3,079	3,212	3,352	3,500	3,655	3,818	3,989
Total County Demand		388,353	379,773	371,001	361,006	351,358	341,958	332,953

Continued on next page

Table 4-7 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		4,601	4,738	4,916	8,603	8,820	8,889	8,908
Industrial		1,234	1,454	1,594	1,710	1,821	1,917	2,055
Steam-Electric		0	0	0	0	0	0	0
Irrigation		379,010	192,202	155,602	115,537	74,755	72,017	66,691
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Dairies		36	1,131	2,225	2,225	2,225	2,225	2,225
Range & All Other Livestock		3,079	3,212	3,352	3,500	3,655	3,818	3,989
Total County Supply		395,001	211,320	177,312	141,790	102,121	100,380	96,092
Total Surplus/Shortage								
Municipal		465	360	289	3,751	3,788	3,801	3,789
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		6,183	-168,813	-193,978	-222,967	-253,025	-245,379	-240,650
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		6,648	-168,453	-193,689	-219,216	-249,237	-241,578	-236,861
Total Basin Demand								
Canadian								
Municipal		0	1	1	1	1	1	1
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		0	0	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		220	281	317	326	336	344	353
Total Canadian Basin Demand		220	282	318	327	337	345	354
Red								
Municipal		4,136	4,377	4,626	4,851	5,031	5,087	5,118
Industrial		1,234	1,454	1,594	1,710	1,821	1,917	2,055
Steam-Electric		0	0	0	0	0	0	0
Irrigation		372,827	361,015	349,580	338,504	327,780	317,396	307,341
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Dairies		36	1,131	2,225	2,225	2,225	2,225	2,225
Range & All Other Livestock		2,859	2,931	3,035	3,174	3,319	3,474	3,636
Total Red Basin Demand		388,134	379,491	370,683	360,679	351,022	341,613	332,599
Total Basin Supply								
Canadian								
Municipal		0	1	1	1	1	1	1
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		0	0	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		220	281	317	326	336	344	353
Total Canadian Basin Supply		220	282	318	327	337	345	354
Red								
Municipal		4,601	4,737	4,915	8,602	8,819	8,888	8,907
Industrial		1,234	1,454	1,594	1,710	1,821	1,917	2,055
Steam-Electric		0	0	0	0	0	0	0
Irrigation		379,010	192,202	155,602	115,537	74,755	72,017	66,691
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		7,041	8,583	9,623	10,216	10,846	11,514	12,224
Dairies		36	1,131	2,225	2,225	2,225	2,225	2,225
Range & All Other Livestock		2,859	2,931	3,035	3,174	3,319	3,474	3,636
Total Red Basin Supply		394,781	211,038	176,994	141,463	101,785	100,035	95,738

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Table 4-7 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Canadian								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		0	0	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Canadian Basin Surplus/Shortage		0	0	0	0	0	0	0
Red								
Municipal		465	360	289	3,751	3,788	3,801	3,789
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		6,183	-168,813	-193,978	-222,967	-253,025	-245,379	-240,650
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		6,648	-168,453	-193,689	-219,216	-249,237	-241,578	-236,861

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from T.J. Powers & Co., Nutra-Feeds, Caviness Meat Packing Co., Hereford Grain Corp., Dick Barrett Produce, City of Hereford, M.W. Carrot Inc., M. Bradford Cattle Truck Washing, and Hereford Bi-Products. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held constant throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

[5] Hereford is obtaining a part of its municipal water from the Santa Rosa Formation. The information available indicates that the aquifer can supply the quantities shown here from the projection period.

Table 4-8. Projected Water Demands, Supplies, and Needs Dickens County Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	531,570	491,678	491,839	492,810	413,130	385,091	382,820
	Quantity Pumped[2]	Ogallala	4,626	2,662	2,575	2,503	2,217	2,159	2,108
	Supply	(Ogallala)[3]	4,626	2,662	2,575	2,503	2,217	2,159	2,108
	Seymour Aquifer		7,937	7,937	7,937	5,217	5,217	5,217	5,217
	Local Surface	Stock Tanks and Windmills	230	233	239	246	251	258	264
	Other Surface		0	0	0	0	0	0	0
	Total Supply		12,792	10,832	10,751	7,966	7,685	7,634	7,589
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	587,623	545,618	540,569	534,888	449,122	432,755	430,768
	Quantity Pumped[2]	Ogallala	6,199	3,585	3,468	3,366	3,481	3,390	3,312
	Supply	(Ogallala)[3]	6,199	3,585	3,468	3,366	3,481	3,390	3,312
	Seymour Aquifer		4,348	4,348	4,348	2,858	2,858	2,858	2,858
	Local Surface	Stock Tanks and Windmills	391	401	408	417	427	437	449
	Other Surface	White River Reservoir	275	271	267	263	260	106	0
	Total Supply		11,213	8,605	8,491	6,903	7,026	6,791	6,619
	County Total								
	Quantity in Storage[1]	Ogallala	1,119,192	1,037,297	1,032,409	1,027,698	862,252	817,846	813,589
	Quantity Pumped[2]	Ogallala	10,825	6,247	6,043	5,869	5,698	5,549	5,420
	Supply	(Ogallala)[3]	10,825	6,247	6,043	5,869	5,698	5,549	5,420
	Seymour Aquifer		12,285	12,285	12,285	8,075	8,075	8,075	8,075
	Local Surface	Stock Tanks and Windmills	620	634	648	662	678	695	712
	Other Surface	White River Reservoir	275	271	267	263	260	106	257
	Total Supply		24,005	19,437	19,243	14,869	14,711	14,425	14,207
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Rural			45	43	41	38	33	30	28
	Subtotal		45	43	41	38	33	30	28
Brazos Basin									
Dickens	Decision -- delete.								
Spur			275	271	267	263	260	257	257
Rural	Includes Dickens.		234	224	212	194	169	158	147
	Subtotal		509	495	479	457	429	415	404
Total Municipal Demand			554	538	520	495	462	445	432
Municipal Existing Supply									
Red Basin									
Rural		Ogallala	45	43	41	38	33	30	28
	Subtotal		45	43	41	38	33	30	28
Brazos Basin									
Dickens		Seymour							
Spur	1998 obtained 434 acft	White River Reservoir	275	271	267	263	260	106	0
Rural	Includes Dickens.	Ogallala + Seymour	325	310	293	274	247	234	221
	Subtotal		600	581	560	537	507	340	221
Total Municipal Existing Supply			645	624	601	575	540	370	249
Municipal Surplus/Shortage									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Dickens									
Spur			0	0	0	0	0	-151	-257
Rural			91	86	81	80	78	76	74
	Subtotal		91	86	81	80	78	-75	-183
Total Municipal Surplus/Shortage			91	86	81	80	78	-75	-183

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Table 4-8 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Dickens			0	0	0	0	0	0	0
Spur			0	0	0	0	0	151	257
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	151	257
Total Municipal New Supply Need			0	0	0	0	0	151	257
Industrial Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Red Basin			4,079	3,957	3,839	3,725	3,614	3,506	3,400
Brazos Basin			5,407	5,246	5,089	4,938	4,791	4,647	4,508
Total Irrigation Demand			9,486	9,203	8,928	8,663	8,405	8,153	7,908
Irrigation Supply									
Red Basin		Ogallala	4,581	2,619	2,534	2,465	2,184	2,129	2,080
Brazos Basin		Ogallala	5,709	3,177	3,128	3,065	3,222	3,156	3,091
Total Irrigation Supply			10,290	5,796	5,662	5,530	5,406	5,285	5,171
Irrigation Surplus/Shortage									
Red Basin			502	-1,338	-1,305	-1,260	-1,430	-1,377	-1,320
Brazos Basin			302	-2,069	-1,961	-1,873	-1,569	-1,491	-1,417
Total Irrigation Surplus/Shortage			804	-3,407	-3,266	-3,133	-2,999	-2,868	-2,737
Mining Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			165	98	47	27	12	0	0
Total Mining Demand			165	98	47	27	12	0	0

Continued on next page

Table 4-8 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin		Ogallala	165	98	47	27	12	0	0
Total Mining Supply			165	98	47	27	12	0	0
Mining Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Mining Surplus/Shortage			0	0	0	0	0	0	0
Beef Feedlot Livestock Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand			0	0	0	0	0	0	0
Beef Feedlot Livestock Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply			0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage			0	0	0	0	0	0	0
Dairies Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Dairies Demand			0	0	0	0	0	0	0
Dairies Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Dairies Supply			0	0	0	0	0	0	0
Dairies Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Dairies Surplus/Shortage			0	0	0	0	0	0	0
Range & All Other Livestock Demand									
Red Basin			230	233	239	246	251	258	264
Brazos Basin			391	401	408	417	427	437	449
Total Range & All Other Livestock Demand			620	634	648	662	678	695	712
Range & All Other Livestock Supply									
Red Basin		Local	230	233	239	246	251	258	264
Brazos Basin		Local	391	401	408	417	427	437	449
Total Range & All Other Livestock Supply			620	634	648	662	678	695	712
Range & All Other Livestock Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage			0	0	0	0	0	0	0
Total Demand									
Municipal	Dickens included in Co other		554	538	520	495	462	445	432
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			9,486	9,203	8,928	8,663	8,405	8,153	7,908
Mining			165	98	47	27	12	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			620	634	648	662	678	695	712
Total County Demand			10,825	10,473	10,143	9,847	9,557	9,293	9,052
Total Supply		Unallocated	12,285	12,285	12,285	8,075	8,075	8,075	8,075
Municipal			645	624	601	575	540	370	249
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			10,290	5,796	5,662	5,530	5,406	5,285	5,171
Mining			165	98	47	27	12	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			620	634	648	662	678	695	712
Total County Supply			24,005	19,437	19,243	14,869	14,711	14,425	14,207

Continued on next page

Table 4-8 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Surplus/Shortage									
Municipal			91	86	81	80	78	-75	-183
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			804	-3,407	-3,266	-3,133	-2,999	-2,868	-2,737
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total County Surplus/Shortage			895	-3,321	-3,185	-3,053	-2,921	-2,943	-2,920
Total Basin Demand									
Red									
Municipal			45	43	41	38	33	30	28
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			4,079	3,957	3,839	3,725	3,614	3,506	3,400
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			230	233	239	246	251	258	264
Total Red Basin Demand			4,354	4,233	4,119	4,009	3,898	3,794	3,692
Brazos									
Municipal			509	495	479	457	429	415	404
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			5,407	5,246	5,089	4,938	4,791	4,647	4,508
Mining			165	98	47	27	12	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			391	401	408	417	427	437	449
Total Brazos Basin Demand			6,472	6,240	6,023	5,839	5,659	5,499	5,361
Total Basin Supply									
Red	Unallocated		7,478	7,631	7,631	4,909	4,911	4,913	4,909
Municipal			45	43	41	38	33	30	28
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			4,581	2,619	2,534	2,465	2,184	2,129	2,080
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			230	233	239	246	251	258	264
Total Red Basin Supply			12,333	10,525	10,445	7,658	7,380	7,330	7,281
Brazos	Unallocated		4,807	4,654	4,654	3,166	3,164	3,162	3,166
Municipal			600	581	560	537	507	340	221
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			5,709	3,177	3,128	3,065	3,222	3,156	3,091
Mining			165	98	47	27	12	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			391	401	408	417	427	437	449
Total Brazos Basin Supply			11,672	8,911	8,797	7,211	7,331	7,095	6,927
Total Basin Surplus/Shortage									
Red									
Municipal			0	0	0	0	0	0	0
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			502	-1,338	-1,305	-1,260	-1,430	-1,377	-1,320
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage			502	-1,338	-1,305	-1,260	-1,430	-1,377	-1,320

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Table 4-8 Concluded)

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage (Cont.)								
Brazos								
Municipal		91	86	81	80	78	-75	-183
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		302	-2,069	-1,961	-1,873	-1,569	-1,491	-1,417
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		393	-1,983	-1,880	-1,793	-1,491	-1,566	-1,600

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

Table 4-9.
Projected Water Demands, Supplies, and Needs
Floyd County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	5,491,376	5,163,180	4,909,263	4,577,147	4,384,446	4,345,782	4,267,211
	Quantity Pumped[2]	Ogallala	101,292	52,505	32,434	25,205	21,096	20,270	19,510
	Supply	(Ogallala)[3]	101,292	52,505	32,434	25,205	21,096	20,270	19,510
	Local Surface	Stock Tanks and Windmills	253	259	266	271	279	288	296
	Other Surface		0	0	0	0	0	0	0
	Total Supply		101,545	52,764	32,700	25,476	21,375	20,558	19,806
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	7,520,632	6,668,927	6,488,195	5,912,120	5,379,850	5,241,354	5,142,280
	Quantity Pumped[2]	Ogallala	138,280	86,288	81,860	78,044	73,821	70,449	68,588
	Supply	(Ogallala)[3]	138,280	86,288	81,860	78,044	73,821	70,449	68,588
	Local Surface	Stock Tanks and Windmills	199	205	210	218	223	229	236
	Other Surface	Lake Mackenzie	362	0	0	0	0	0	0
	Reclaimed Water[4]		449	449	449	449	449	449	449
	Total Supply		139,290	86,942	82,519	78,711	74,493	71,127	69,273
	County Total								
	Quantity in Storage[1]	Ogallala	13,012,008	11,832,107	11,397,458	10,489,267	9,764,296	9,587,136	9,409,491
	Quantity Pumped[2]	Ogallala	239,572	138,793	114,294	103,249	94,917	90,719	88,098
	Supply	(Ogallala)[3]	239,572	138,793	114,294	103,249	94,917	90,719	88,098
	Local Surface	Stock Tanks and Windmills	452	464	476	489	502	517	532
	Other Surface	Lake Mackenzie	362	0	0	0	0	0	0
	Reclaimed Water[4]		449	449	449	449	449	449	449
	Total Supply		240,835	139,706	115,219	104,187	95,868	91,685	89,079
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Rural			103	106	107	106	104	100	95
	Subtotal		103	106	107	106	104	100	95
Brazos Basin									
Floydada			663	680	696	693	685	657	623
Lockney			237	242	244	240	234	224	212
Rural			178	183	185	183	180	172	163
	Subtotal		1,078	1,105	1,125	1,116	1,099	1,053	998
Total Municipal Demand			1,181	1,211	1,232	1,222	1,203	1,153	1,093
Municipal Existing Supply									
Red Basin									
Rural		Ogallala	103	106	107	106	104	100	95
	Subtotal		103	106	107	106	104	100	95
Brazos Basin									
Floydada		Ogallala	663	680	696	693	685	657	623
		Lake Mackenzie	212	0	0	0	0	0	0
Floydada Subtotal			875	680	696	693	685	657	623
Lockney		Ogallala	237	242	244	0	0	0	0
		Lake Mackenzie	150	0	0	0	0	0	0
Lockney Subtotal			387	242	244	0	0	0	0
Rural		Ogallala	178	183	185	183	180	172	163
	Subtotal		1,440	1,105	1,125	876	865	829	786
Total Municipal Existing Supply			1,543	1,211	1,232	982	969	929	881
Municipal Surplus/Shortage									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Floydada			212	0	0	0	0	0	0
Lockney			150	0	0	-240	-234	-224	-212
Rural			0	0	0	0	0	0	0
	Subtotal		362	0	0	-240	-234	-224	-212
Total Municipal Surplus/Shortage			362	0	0	-240	-234	-224	-212

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Table 4-9 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Floydada			0	0	0	0	0	0	0
Lockney			0	0	0	240	234	224	212
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	240	234	224	212
Total Municipal New Supply Need			0	0	0	240	234	224	212
Industrial Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin		Ogallala	0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Red Basin			106,659	102,411	98,332	94,415	90,654	87,044	83,577
Brazos Basin			130,361	125,168	120,184	115,397	110,800	106,387	102,150
Total Irrigation Demand			237,020	227,579	218,516	209,812	201,454	193,431	185,727
Irrigation Supply									
Red Basin		Ogallala	101,173	52,347	32,240	25,011	20,904	20,082	19,328
Brazos Basin		Ogallala	136,300	84,052	79,437	75,385	71,135	67,752	65,878
		Reclaimed Water	449	449	449	449	449	449	449
Brazos Basin Subtotal			136,749	84,501	79,886	75,834	71,584	68,201	66,327
Total Irrigation Supply			237,922	136,848	112,126	100,845	92,488	88,283	85,655
Irrigation Surplus/Shortage									
Red Basin			-5,486	-50,064	-66,092	-69,404	-69,750	-66,962	-64,249
Brazos Basin			6,388	-40,667	-40,298	-39,563	-39,216	-38,186	-35,823
Total Irrigation Surplus/Shortage			902	-90,731	-106,390	-108,967	-108,966	-105,148	-100,072

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Table 4-9 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Demand		0	0	0	0	0	0	0
Mining Supply								
Red Basin	Ogallala	0	0	0	0	0	0	0
Brazos Basin	Ogallala	0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		885	1,079	1,210	1,285	1,364	1,448	1,537
Total Beef Feedlot Livestock Demand		885	1,079	1,210	1,285	1,364	1,448	1,537
Beef Feedlot Livestock Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin	Ogallala	885	1,079	1,210	1,285	1,364	1,448	1,537
Total Beef Feedlot Livestock Supply		885	1,079	1,210	1,285	1,364	1,448	1,537
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		16	52	88	88	88	88	88
Brazos Basin		16	52	88	88	88	88	88
Total Dairies Demand		33	104	175	175	175	175	175
Dairies Supply								
Red Basin	Ogallala	16	52	88	88	88	88	88
Brazos Basin	Ogallala	16	52	88	88	88	88	88
Total Dairies Supply		33	104	175	175	175	175	175
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		253	259	266	271	279	288	296
Brazos Basin		199	205	210	218	223	229	236
Total Range & All Other Livestock Demand		452	464	476	489	502	517	532
Range & All Other Livestock Supply								
Red Basin	Local	253	259	266	271	279	288	296
Brazos Basin	Local	199	205	210	218	223	229	236
Total Range & All Other Livestock Supply		452	464	476	489	502	517	532
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		1,181	1,211	1,232	1,222	1,203	1,153	1,093
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		237,020	227,579	218,516	209,812	201,454	193,431	185,727
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		885	1,079	1,210	1,285	1,364	1,448	1,537
Dairies		33	104	175	175	175	175	175
Range & All Other Livestock		452	464	476	489	502	517	532
Total County Demand		239,572	230,437	221,609	212,983	204,699	196,724	189,064

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Table 4-9 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		1,543	1,211	1,232	982	969	929	881
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		237,922	136,848	112,126	100,845	92,488	88,283	85,655
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		885	1,079	1,210	1,285	1,364	1,448	1,537
Dairies		33	104	175	175	175	175	175
Range & All Other Livestock		452	464	476	489	502	517	532
Total County Supply		240,835	139,707	115,219	103,776	95,499	91,352	88,780
Total Surplus/Shortage								
Municipal		362	0	0	-240	-234	-224	-212
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		902	-90,731	-106,390	-108,967	-108,966	-105,148	-100,072
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		1,264	-90,731	-106,390	-109,207	-109,200	-105,372	-100,284
Total Basin Demand								
Red								
Municipal		103	106	107	106	104	100	95
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		106,659	102,411	98,332	94,415	90,654	87,044	83,577
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		16	52	88	88	88	88	88
Range & All Other Livestock		253	259	266	271	279	288	296
Total Red Basin Demand		107,032	102,828	98,792	94,880	91,125	87,520	84,055
Brazos								
Municipal		1,078	1,105	1,125	1,116	1,099	1,053	998
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		130,361	125,168	120,184	115,397	110,800	106,387	102,150
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		885	1,079	1,210	1,285	1,364	1,448	1,537
Dairies		16	52	88	88	88	88	88
Range & All Other Livestock		199	205	210	218	223	229	236
Total Brazos Basin Demand		132,540	127,610	122,817	118,103	113,574	109,204	105,009
Total Basin Supply								
Red								
Municipal		103	106	107	106	104	100	95
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		101,173	52,347	32,240	25,011	20,904	20,082	19,328
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		16	52	88	88	88	88	88
Range & All Other Livestock		253	259	266	271	279	288	296
Total Red Basin Supply		101,545	52,764	32,700	25,476	21,375	20,558	19,806
Brazos								
Municipal		1,440	1,105	1,125	876	865	829	786
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		136,749	84,501	79,886	75,834	71,584	68,201	66,327
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		885	1,079	1,210	1,285	1,364	1,448	1,537
Dairies		16	52	88	88	88	88	88
Range & All Other Livestock		199	205	210	218	223	229	236
Total Brazos Basin Supply		139,290	86,943	82,519	78,300	74,124	70,794	68,974

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Table 4-9 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-5,486	-50,064	-66,092	-69,404	-69,750	-66,962	-64,249
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		-5,486	-50,064	-66,092	-69,404	-69,750	-66,962	-64,249
Brazos								
Municipal		362	0	0	-240	-234	-224	-212
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		6,388	-40,667	-40,298	-39,563	-39,216	-38,186	-35,823
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		6,750	-40,667	-40,298	-39,803	-39,450	-38,410	-36,035

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from the City of Lockney and the City of Floydada. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste dicharge permit.

Table 4-10.
Projected Water Demands, Supplies, and Needs
Gaines County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	12,495,883	10,232,860	7,998,429	6,120,700	4,493,051	3,708,105	3,651,389
	Quantity Pumped[2]	Ogallala	424,778	335,917	275,995	241,173	213,273	188,235	165,735
	Supply	(Ogallala)[3]	424,778	335,917	275,995	241,173	213,273	188,235	165,735
	Local Surface	Stock Tanks and Windmills	296	304	312	320	329	338	348
	Other Surface		0	0	0	0	0	0	0
	Total Supply		425,074	336,221	276,307	241,493	213,602	188,573	166,083
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Colorado Basin									
Seagraves			416	449	482	502	513	506	499
Seminole			2,019	2,214	2,401	2,525	2,605	2,579	2,544
Rural			704	754	800	823	839	824	813
	Subtotal		3,139	3,417	3,683	3,850	3,957	3,909	3,856
Total Municipal Demand			3,139	3,417	3,683	3,850	3,957	3,909	3,856
Municipal Existing Supply									
Colorado Basin									
Seagraves		Ogallala	416	0	0	0	0	0	0
Seminole		Ogallala	2,019	2,214	2,401	2,525	2,605	2,579	2,544
Rural		Ogallala	704	754	800	823	839	824	813
	Subtotal		3,139	2,968	3,201	3,348	3,444	3,403	3,357
Total Municipal Existing Supply			3,139	2,968	3,201	3,348	3,444	3,403	3,357
Municipal Surplus/Shortage									
Colorado Basin									
Seagraves			0	-449	-482	-502	-513	-506	-499
Seminole			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	-449	-482	-502	-513	-506	-499
Total Municipal Surplus/Shortage			0	-449	-482	-502	-513	-506	-499
Municipal New Supply Need									
Colorado Basin									
Seagraves			0	449	482	502	513	506	499
Seminole			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	449	482	502	513	506	499
Total Municipal New Supply Need			0	449	482	502	513	506	499
Industrial Demand									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Colorado Basin		Ogallala	0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0

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Table 4-10 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Steam-Electric Existing Supply								
Colorado Basin		0	0	0	0	0	0	0
Total Steam-Electric Existing Supply		0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need								
Colorado Basin		0	0	0	0	0	0	0
Total Steam-Electric New Supply Need		0	0	0	0	0	0	0
Irrigation Demand								
Colorado Basin		414,772	393,170	372,693	353,283	334,884	317,442	300,908
Total Irrigation Demand		414,772	393,170	372,693	353,283	334,884	317,442	300,908
Irrigation Supply								
Colorado Basin	Ogallala	415,068	325,598	266,959	233,545	206,984	182,870	160,640
Total Irrigation Supply		415,068	325,598	266,959	233,545	206,984	182,870	160,640
Irrigation Surplus/Shortage								
Colorado Basin		296	-67,572	-105,734	-119,738	-127,900	-134,572	-140,268
Total Irrigation Surplus/Shortage		296	-67,572	-105,734	-119,738	-127,900	-134,572	-140,268
Mining Demand								
Colorado Basin		6,071	5,746	4,011	2,493	1,084	217	0
Total Mining Demand		6,071	5,746	4,011	2,493	1,084	217	0
Mining Supply								
Colorado Basin	Ogallala	6,071	5,746	4,011	2,493	1,084	217	0
Total Mining Supply		6,071	5,746	4,011	2,493	1,084	217	0
Mining Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Colorado Basin		500	609	683	725	770	817	868
Total Beef Feedlot Livestock Demand		500	609	683	725	770	817	868
Beef Feedlot Livestock Supply								
Colorado Basin	Ogallala	500	609	683	725	770	817	868
Total Beef Feedlot Livestock Supply		500	609	683	725	770	817	868
Beef Feedlot Livestock Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Colorado Basin		296	304	312	320	329	338	348
Total Range & All Other Livestock Demand		296	304	312	320	329	338	348
Range & All Other Livestock Supply								
Colorado Basin	Local	296	304	312	320	329	338	348
Total Range & All Other Livestock Supply		296	304	312	320	329	338	348
Range & All Other Livestock Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-10 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Demand								
Municipal		3,139	3,417	3,683	3,850	3,957	3,909	3,856
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		414,772	393,170	372,693	353,283	334,884	317,442	300,908
Mining		6,071	5,746	4,011	2,493	1,084	217	0
Beef Feedlot Livestock		500	609	683	725	770	817	868
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		296	304	312	320	329	338	348
Total County Demand		424,778	403,246	381,382	360,671	341,024	322,724	305,980
Total Supply								
Municipal		3,139	2,968	3,201	3,348	3,444	3,403	3,357
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		415,068	325,598	266,959	233,545	206,984	182,870	160,640
Mining		6,071	5,746	4,011	2,493	1,084	217	0
Beef Feedlot Livestock		500	609	683	725	770	817	868
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		296	304	312	320	329	338	348
Total County Supply		425,074	335,225	275,166	240,431	212,611	187,646	165,213
Total Surplus/Shortage								
Municipal		0	-449	-482	-502	-513	-506	-499
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		296	-67,572	-105,734	-119,738	-127,900	-134,572	-140,268
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		296	-68,021	-106,216	-120,240	-128,413	-135,078	-140,767
Total Basin Demand								
Colorado								
Municipal		3,139	3,417	3,683	3,850	3,957	3,909	3,856
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		414,772	393,170	372,693	353,283	334,884	317,442	300,908
Mining		6,071	5,746	4,011	2,493	1,084	217	0
Beef Feedlot Livestock		500	609	683	725	770	817	868
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		296	304	312	320	329	338	348
Total Colorado Basin Demand		424,778	403,246	381,382	360,671	341,024	322,724	305,980
Total Basin Supply								
Colorado								
Municipal		3,139	2,968	3,201	3,348	3,444	3,403	3,357
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		415,068	325,598	266,959	233,545	206,984	182,870	160,640
Mining		6,071	5,746	4,011	2,493	1,084	217	0
Beef Feedlot Livestock		500	609	683	725	770	817	868
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		296	304	312	320	329	338	348
Total Colorado Basin Supply		425,074	335,225	275,166	240,431	212,611	187,646	165,213
Total Basin Surplus/Shortage								
Colorado								
Municipal		0	-449	-482	-502	-513	-506	-499
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		296	-67,572	-105,734	-119,738	-127,900	-134,572	-140,268
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		296	-68,021	-106,216	-120,240	-128,413	-135,078	-140,767

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

Table 4-11. Projected Water Demands, Supplies, and Needs Garza County Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	662,851	643,700	643,700	643,700	643,700	643,700	643,700
	Quantity Pumped[2]	Ogallala	14,563	7,527	6,879	6,394	5,946	5,554	5,262
	Supply	(Ogallala)[3]	14,563	7,527	6,879	6,394	5,946	5,554	5,262
	Dockum Aquifer		136	136	136	136	136	136	136
	Local Surface	Stock Tanks and Windmills	355	363	423	432	442	453	465
	Other Surface	White River Reservoir	1,021	1,021	973	493	12	0	0
	Other Surface	Lake Alan Henry (WSD Contract)	0	22	22	22	22	22	22
	Slaton Contract	Part of Slaton CRMWA Supply	0	306	306	306	306	306	306
	Total Supply		16,075	9,375	8,739	7,783	6,864	6,471	6,191
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	0	0	0	0	0	0	0
	Quantity Pumped[2]	Ogallala	0	0	0	0	0	0	0
	Supply	(Ogallala)[3]	0	0	0	0	0	0	0
	Local Surface	Stock Tanks and Windmills	0	0	0	0	0	0	0
	Other Surface		0	0	0	0	0	0	0
	Total Supply		0	0	0	0	0	0	0
	County Total								
	Quantity in Storage[1]	Ogallala	662,851	643,700	643,700	643,700	643,700	643,700	643,700
	Quantity Pumped[2]	Ogallala	14,563	7,527	6,879	6,394	5,946	5,554	5,262
	Supply	(Ogallala)[3]	14,563	7,527	6,879	6,394	5,946	5,554	5,262
	Dockum Aquifer		136	136	136	136	136	136	136
	Local Surface	Stock Tanks and Windmills	355	363	423	432	442	453	465
	Other Surface	White River Reservoir	1,021	1,021	973	493	12	0	0
	Other Surface	Lake Alan Henry (WSD Contract)	0	22	22	22	22	22	22
	Slaton Contract	Part of Slaton CRMWA Supply	0	306	306	306	306	306	306
	Total Supply		16,075	9,375	8,739	7,783	6,864	6,471	6,191
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Post			623	631	642	616	579	549	512
Lake Alan Henry WSD	Shift from Rural		0	22	22	22	22	22	22
Rural			154	134	134	128	119	110	101
	Subtotal		777	787	798	766	720	681	635
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Demand			777	787	798	766	720	681	635
Municipal Existing Supply									
Brazos Basin									
Post	1989 obtained 674 acft	White River Reservoir	1,021	1,021	973	493	12	0	0
Post		Slaton (CRMWA Source)	0	306	306	306	306	306	306
Post Subtotal			1,021	1,327	1,279	799	318	306	306
Lake Alan WSD		Lubbock (Lake Alan Henry)	0	0	0	0	0	0	0
Rural		Ogallala	154	134	134	128	119	110	101
		Dockum	36	36	36	36	36	36	36
Rural Subtotal			190	170	170	164	155	146	137
	Subtotal		1,211	1,497	1,449	963	473	452	443
Colorado Basin									
Rural		Ogallala	0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Existing Supply			1,211	1,497	1,449	963	473	452	443

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Table 4-11 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal Surplus/Shortage									
Brazos Basin									
Post			398	696	637	183	-261	-243	-206
Lake Alan Henry WSD			0	-22	-22	-22	-22	-22	-22
Rural			36	36	36	36	36	36	36
	Subtotal		434	710	651	197	-247	-229	-192
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Surplus/Shortage			434	710	651	197	-247	-229	-192
Municipal New Supply Need									
Brazos Basin									
Post			0	0	0	0	261	243	206
Lake Alan Henry WSD			0	22	22	22	22	22	22
Rural			0	0	0	0	0	0	0
	Subtotal		0	22	22	22	283	265	228
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	22	22	22	283	265	228
Industrial Demand									
Brazos Basin			2	2	2	2	2	2	2
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Demand			2	2	2	2	2	2	2
Industrial Existing Supply									
Brazos Basin		Ogallala	2	2	2	2	2	2	2
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			2	2	2	2	2	2	2
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			12,165	11,451	10,783	10,148	9,556	8,997	8,471
Colorado Basin			0	0	0	0	0	0	0
Total Irrigation Demand			12,165	11,451	10,783	10,148	9,556	8,997	8,471
Irrigation Supply									
Brazos Basin		Ogallala	13,143	6,639	6,382	6,053	5,735	5,442	5,159
		Dockum	100	100	100	100	100	100	100
Brazos Basin Subtotal			13,243	6,739	6,482	6,153	5,835	5,542	5,259
Colorado Basin			0	0	0	0	0	0	0
Total Irrigation Supply			13,243	6,739	6,482	6,153	5,835	5,542	5,259
Irrigation Surplus/Shortage									
Brazos Basin			1,078	-4,712	-4,301	-3,995	-3,721	-3,455	-3,212
Colorado Basin			0	0	0	0	0	0	0
Total Irrigation Surplus/Shortage			1,078	-4,712	-4,301	-3,995	-3,721	-3,455	-3,212

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Table 4-11 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Brazos Basin		1,264	752	361	211	90	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Demand		1,264	752	361	211	90	0	0
Mining Supply								
Brazos Basin	Ogallala	1,264	752	361	211	90	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Supply		1,264	752	361	211	90	0	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		355	363	423	432	442	453	465
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Demand		355	363	423	432	442	453	465
Range & All Other Livestock Supply								
Brazos Basin	Local	355	363	423	432	442	453	465
Colorado Basin	Local	0	0	0	0	0	0	0
Total Range & All Other Livestock Supply		355	363	423	432	442	453	465
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		777	787	798	766	720	681	635
Industrial		2	2	2	2	2	2	2
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,165	11,451	10,783	10,148	9,556	8,997	8,471
Mining		1,264	752	361	211	90	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		355	363	423	432	442	453	465
Total County Demand		14,563	13,355	12,367	11,559	10,810	10,133	9,573

Continued on next page

Table 4-11 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		1,211	1,497	1,449	963	473	452	443
Industrial		2	2	2	2	2	2	2
Steam-Electric		0	0	0	0	0	0	0
Irrigation		13,243	6,739	6,482	6,153	5,835	5,542	5,259
Mining		1,264	752	361	211	90	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		355	363	423	432	442	453	465
Total County Supply		16,075	9,353	8,717	7,761	6,842	6,449	6,169
Total Surplus/Shortage								
Municipal		434	710	651	197	-247	-229	-192
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,078	-4,712	-4,301	-3,995	-3,721	-3,455	-3,212
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		1,512	-4,002	-3,650	-3,798	-3,968	-3,684	-3,404
Total Basin Demand								
Brazos								
Municipal		777	787	798	766	720	681	635
Industrial		2	2	2	2	2	2	2
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,165	11,451	10,783	10,148	9,556	8,997	8,471
Mining		1,264	752	361	211	90	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		355	363	423	432	442	453	465
Total Brazos Basin Demand		14,563	13,355	12,367	11,559	10,810	10,133	9,573
Colorado								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		0	0	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Demand		0	0	0	0	0	0	0
Total Basin Supply								
Brazos								
Municipal		1,211	1,497	1,449	963	473	452	443
Industrial		2	2	2	2	2	2	2
Steam-Electric		0	0	0	0	0	0	0
Irrigation		13,243	6,739	6,482	6,153	5,835	5,542	5,259
Mining		1,264	752	361	211	90	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		355	363	423	432	442	453	465
Total Brazos Basin Supply		16,075	9,353	8,717	7,761	6,842	6,449	6,169
Colorado								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		0	0	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Supply		0	0	0	0	0	0	0

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Table 4-11 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Brazos								
Municipal		434	710	651	197	-247	-229	-192
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,078	-4,712	-4,301	-3,995	-3,721	-3,455	-3,212
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		1,512	-4,002	-3,650	-3,798	-3,968	-3,684	-3,404
Colorado								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		0	0	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		0	0	0	0	0	0	0

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

Table 4-12. Projected Water Demands, Supplies, and Needs Hale County Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	29,446	18,450	16,419	6,085	5,484	5,410	5,342
	Quantity Pumped[2]	Ogallala	3,499	829	0	0	0	0	0
	Supply	(Ogallala)[3]	3,499	829	0	0	0	0	0
	Local Surface	Stock Tanks and Windmills	1	1	1	1	1	1	1
	Other Surface		0	0	0	0	0	0	0
	Total Supply		3,500	830	1	1	1	1	1
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	9,837,572	8,174,441	5,575,536	3,645,123	2,458,242	2,158,654	1,881,355
	Quantity Pumped[2]	Ogallala	374,974	348,301	302,704	206,807	127,551	98,721	89,136
	Supply	(Ogallala)[3]	374,974	348,301	302,704	206,807	127,551	98,721	89,136
	Other Ground	Ogallala (CRMWA - Roberts Co.)	1,476	1,476	1,476	1,476	1,476	1,076	1,076
	Local Surface	Stock Tanks and Windmills	324	331	340	349	358	368	379
	Other Surface	Lake Meredith (CRMWA)	2,805	2,805	2,805	2,805	2,805	2,805	2,805
	Reclaimed Water[4]		5,477	5,477	5,477	5,477	5,477	5,477	5,477
	Total Supply		385,056	358,391	312,802	216,914	137,667	108,447	98,873
	County Total								
	Quantity in Storage[1]	Ogallala	9,867,018	8,192,891	5,591,955	3,651,208	2,463,726	2,164,064	1,886,697
	Quantity Pumped[2]	Ogallala	378,473	349,130	302,704	206,807	127,551	98,721	89,136
	Supply	(Ogallala)[3]	378,473	349,130	302,704	206,807	127,551	98,721	89,136
	Other Ground	Ogallala (CRMWA - Roberts Co.)	1,476	1,476	1,476	1,476	1,476	1,076	1,476
	Local Surface	Stock Tanks and Windmills	325	333	341	350	359	369	380
	Other Surface	Lake Meredith (CRMWA)	2,805	2,805	2,805	2,805	2,805	2,805	2,805
	Reclaimed Water[4]		5,477	5,477	5,477	5,477	5,477	5,477	5,477
	Total Supply		388,556	359,221	312,803	216,915	137,668	108,448	98,874
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Abernathy (part)			461	486	508	526	531	525	514
Hale Center			446	470	493	509	513	507	498
Petersburg			276	289	304	313	316	312	306
Plainview			4,078	4,288	4,490	4,605	4,635	4,577	4,488
Rural			1,109	1,144	1,187	1,207	1,203	1,184	1,161
	Subtotal		6,370	6,677	6,982	7,160	7,198	7,105	6,967
Total Municipal Demand			6,370	6,677	6,982	7,160	7,198	7,105	6,967
Municipal Existing Supply									
Red Basin									
Rural		Ogallala	0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Abernathy (part)		Ogallala	461	486	0	0	0	0	0
Hale Center		Ogallala	446	470	493	0	0	0	0
Petersburg		Ogallala	276	289	304	313	316	0	0
Plainview		Ogallala	11,855	10,721	9,696	8,769	7,930	7,172	6,486
		Lake Meredith (CRMWA)	2,805	2,805	2,805	2,805	2,805	2,805	2,805
		Ogallala (CRMWA - Roberts Co.)	1,476	1,476	1,476	1,476	1,476	1,076	1,076
Plainview Subtotal			16,136	15,002	13,977	13,050	12,211	11,053	10,367
Rural		Ogallala	1,109	1,144	1,187	1,207	1,203	1,184	1,161
	Subtotal		18,428	17,391	15,961	14,570	13,730	12,237	11,528
Total Municipal Existing Supply			18,428	17,391	15,961	14,570	13,730	12,237	11,528

Continued on next page

Table 4-12 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal Surplus/Shortage									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Abernathy (part)			0	0	-508	-526	-531	-525	-514
Hale Center			0	0	0	-509	-513	-507	-498
Petersburg			0	0	0	0	0	-312	-306
Plainview			12,058	10,714	9,487	8,445	7,576	6,476	5,879
Rural			0	0	0	0	0	0	0
	Subtotal		12,058	10,714	8,979	7,410	6,532	5,132	4,561
Total Municipal Surplus/Shortage			12,058	10,714	8,979	7,410	6,532	5,132	4,561
Municipal New Supply Need									
Red Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Brazos Basin									
Abernathy (part)			0	0	508	526	531	525	514
Hale Center			0	0	0	509	513	507	498
Petersburg			0	0	0	0	0	312	306
Plainview			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	508	1,035	1,044	1,344	1,318
Total Municipal New Supply Need			0	0	508	1,035	1,044	1,344	1,318
Industrial Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			2,605	2,993	3,188	3,339	3,482	3,604	3,840
Total Industrial Demand			2,605	2,993	3,188	3,339	3,482	3,604	3,840
Industrial Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin		Ogallala	2,605	2,993	3,188	3,339	3,482	3,604	3,840
Total Industrial Existing Supply			2,605	2,993	3,188	3,339	3,482	3,604	3,840
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Red Basin			3,677	3,555	3,437	3,323	3,213	3,107	3,004
Brazos Basin			364,023	351,961	340,300	329,026	318,124	307,583	297,392
Total Irrigation Demand			367,700	355,516	343,737	332,349	321,337	310,690	300,396

Continued on next page

Table 4-12 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Irrigation Supply								
Red Basin	Ogallala	3,499	829	0	0	0	0	0
Brazos Basin	Ogallala	356,749	328,274	282,806	187,518	108,995	80,722	71,826
	Reclaimed Water	5,477	5,477	5,477	5,477	5,477	5,477	5,477
Brazos Basin Subtotal		362,226	333,751	288,283	192,995	114,472	86,199	77,303
Total Irrigation Supply		365,725	334,580	288,283	192,995	114,472	86,199	77,303
Irrigation Surplus/Shortage								
Red Basin		-178	-2,726	-3,437	-3,323	-3,213	-3,107	-3,004
Brazos Basin		-1,797	-18,210	-52,017	-136,031	-203,652	-221,384	-220,089
Total Irrigation Surplus/Shortage		-1,975	-20,936	-55,454	-139,354	-206,865	-224,491	-223,093
Mining Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		258	88	34	19	0	0	0
Total Mining Demand		258	88	34	19	0	0	0
Mining Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin	Ogallala	258	88	34	19	0	0	0
Total Mining Supply		258	88	34	19	0	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Total Beef Feedlot Livestock Demand		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Beef Feedlot Livestock Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin	Ogallala	1,185	1,445	1,620	1,720	1,826	1,939	2,058
Total Beef Feedlot Livestock Supply		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		29	391	753	753	753	753	753
Total Dairies Demand		29	391	753	753	753	753	753
Dairies Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		29	391	753	753	753	753	753
Total Dairies Supply		29	391	753	753	753	753	753
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		1	1	1	1	1	1	1
Brazos Basin		324	331	340	349	358	368	379
Total Range & All Other Livestock Demand		325	333	341	350	359	369	380
Range & All Other Livestock Supply								
Red Basin	Local	1	1	1	1	1	1	1
Brazos Basin	Local	324	331	340	349	358	368	379
Total Range & All Other Livestock Supply		325	333	341	350	359	369	380
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-12 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Demand								
Municipal		6,370	6,677	6,982	7,160	7,198	7,105	6,967
Industrial		2,605	2,993	3,188	3,339	3,482	3,604	3,840
Steam-Electric		0	0	0	0	0	0	0
Irrigation		367,700	355,516	343,737	332,349	321,337	310,690	300,396
Mining		258	88	34	19	0	0	0
Beef Feedlot Livestock		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Dairies		29	391	753	753	753	753	753
Range & All Other Livestock		325	333	341	350	359	369	380
Total County Demand		378,473	367,443	356,656	345,690	334,956	324,460	314,394
Total Supply								
Municipal		18,428	17,391	15,961	14,570	13,730	12,237	11,528
Industrial		2,605	2,993	3,188	3,339	3,482	3,604	3,840
Steam-Electric		0	0	0	0	0	0	0
Irrigation		365,725	334,580	288,283	192,995	114,472	86,199	77,303
Mining		258	88	34	19	0	0	0
Beef Feedlot Livestock		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Dairies		29	391	753	753	753	753	753
Range & All Other Livestock		325	333	341	350	359	369	380
Total County Supply		388,556	357,221	310,181	213,746	134,623	105,101	95,862
Total Surplus/Shortage								
Municipal		12,058	10,714	8,979	7,410	6,532	5,132	4,561
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-1,975	-20,936	-55,454	-139,354	-206,865	-224,491	-223,093
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		10,083	-10,222	-46,475	-131,944	-200,333	-219,359	-218,532
Total Basin Demand								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		3,677	3,555	3,437	3,323	3,213	3,107	3,004
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		1	1	1	1	1	1	1
Total Red Basin Demand		3,678	3,556	3,438	3,324	3,214	3,108	3,005
Brazos								
Municipal		6,370	6,677	6,982	7,160	7,198	7,105	6,967
Industrial		2,605	2,993	3,188	3,339	3,482	3,604	3,840
Steam-Electric		0	0	0	0	0	0	0
Irrigation		364,023	351,961	340,300	329,026	318,124	307,583	297,392
Mining		258	88	34	19	0	0	0
Beef Feedlot Livestock		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Dairies		29	391	753	753	753	753	753
Range & All Other Livestock		324	331	340	349	358	368	379
Total Brazos Basin Demand		374,794	363,887	353,217	342,366	331,741	321,352	311,389
Total Basin Supply								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		3,499	829	0	0	0	0	0
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		1	1	1	1	1	1	1
Total Red Basin Supply		3,500	830	1	1	1	1	1
Brazos								
Municipal		18,428	17,391	15,961	14,570	13,730	12,237	11,528
Industrial		2,605	2,993	3,188	3,339	3,482	3,604	3,840
Steam-Electric		0	0	0	0	0	0	0
Irrigation		362,226	333,751	288,283	192,995	114,472	86,199	77,303
Mining		258	88	34	19	0	0	0
Beef Feedlot Livestock		1,185	1,445	1,620	1,720	1,826	1,939	2,058
Dairies		29	391	753	753	753	753	753
Range & All Other Livestock		324	331	340	349	358	368	379
Total Brazos Basin Supply		385,055	356,391	310,179	213,745	134,622	105,100	95,861

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Table 4-12 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-178	-2,726	-3,437	-3,323	-3,213	-3,107	-3,004
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		-178	-2,726	-3,437	-3,323	-3,213	-3,107	-3,004
Brazos								
Municipal		12,058	10,714	8,979	7,410	6,532	5,132	4,561
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-1,797	-18,210	-52,017	-136,031	-203,652	-221,384	-220,089
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		10,261	-7,496	-43,038	-128,621	-197,120	-216,252	-215,528

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The value is the sum of reclaimed water from the City of Petersburg, City of Abernathy, City of Hale Center, City of Plainview, City of Edmonson, Excel Corp., John's Washout, Azteca Milling Co., Southern Cotton Oil Mill, Panhandle Processing Co., and Walker Brothers Produce. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated at 75 percent of the maximum waste discharge permit.

Table 4-13.
Projected Water Demands, Supplies, and Needs
Hockley County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	4,445,678	4,012,574	3,520,944	3,122,056	2,822,881	2,814,561	2,768,066
	Quantity Pumped[2]	Ogallala	163,639	96,889	79,415	67,208	55,876	53,945	50,540
	Supply	(Ogallala)[3]	163,639	96,889	79,415	67,208	55,876	53,945	50,540
	Other Ground	Ogallala (CRMWA - Roberts Co.)	1,116	1,116	1,116	1,116	1,116	688	688
	Local Surface	Stock Tanks and Windmills	221	226	273	280	286	292	299
	Other Surface	Lake Meredith (CRMWA)	2,120	2,120	2,120	2,120	2,120	2,120	2,120
	Reclaimed Water[5]		1,359	1,359	1,359	1,359	1,359	1,359	1,359
	Total Supply		168,455	101,711	84,283	72,083	60,756	58,405	55,006
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	1,034,833	980,634	911,792	843,370	792,366	776,547	765,041
	Quantity Pumped[2]	Ogallala	20,274	12,761	10,678	8,807	8,186	7,686	7,689
	Supply	(Ogallala)[3]	20,274	12,761	10,678	8,807	8,186	7,686	7,689
	Local Surface	Stock Tanks and Windmills	44	45	55	55	56	57	59
	Reclaimed Water[5]		162	162	162	162	162	162	162
	Total Supply		20,480	12,968	10,895	9,024	8,404	7,904	7,909
	County Total								
	Quantity in Storage[1]	Ogallala	5,480,511	4,993,208	4,432,736	3,965,426	3,615,247	3,591,108	3,533,107
	Quantity Pumped[2]	Ogallala	183,913	109,650	90,093	76,015	64,062	61,631	58,229
	Supply	(Ogallala)[3]	183,913	109,650	90,093	76,015	64,062	61,631	58,229
	Other Ground	Ogallala (CRMWA - Roberts Co.)	1,116	1,116	1,116	1,116	1,116	688	688
	Local Surface	Stock Tanks and Windmills	265	271	328	335	342	349	357
	Other Surface	Lake Meredith (CRMWA)	2,120	2,120	2,120	2,120	2,120	2,120	2,120
	Reclaimed Water[5]		1,521	1,521	1,521	1,521	1,521	1,521	1,521
	Total Supply		188,935	114,679	95,178	81,107	69,160	66,309	62,915
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Anton			250	263	270	272	268	256	243
Levelland			2,219	2,310	2,362	2,369	2,322	2,216	2,107
Ropesville			85	89	91	91	89	85	81
Smyer			67	69	70	70	68	65	62
Rural			814	840	855	853	831	791	753
	Subtotal		3,435	3,571	3,648	3,655	3,578	3,413	3,246
Colorado Basin									
Sundown			325	341	350	353	347	332	316
Rural			40	41	42	42	41	39	37
	Subtotal		365	382	392	395	388	371	353
Total Municipal Demand			3,800	3,953	4,040	4,050	3,966	3,784	3,599
Municipal Existing Supply									
Brazos Basin									
Anton		Ogallala	250	0	0	0	0	0	0
Levelland		Ogallala	0	0	0	0	0	0	0
		Lake Meredith (CRMWA)[4]	2,120	2,120	2,120	2,120	2,120	2,120	2,120
		Ogallala (CRMWA - Roberts Co.)[4]	1,116	1,116	1,116	1,116	1,116	688	688
Levelland Subtotal			3,236	3,236	3,236	3,236	3,236	2,808	2,808
Ropesville		Ogallala	85	89	91	0	0	0	0
Smyer		Ogallala	67	69	70	70	68	65	0
Rural		Ogallala	814	840	855	853	831	791	753
	Subtotal		4,452	4,234	4,252	4,159	4,135	3,664	3,561
Colorado Basin									
Sundown		Ogallala	325	341	0	0	0	0	0
Rural		Ogallala	40	41	42	42	41	39	37
	Subtotal		365	382	42	42	41	39	37
Total Municipal Existing Supply			4,817	4,616	4,294	4,201	4,176	3,703	3,598

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Table 4-13 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal Surplus/Shortage									
Brazos Basin									
Anton			0	-263	-270	-272	-268	-256	-243
Levelland			1,017	926	874	867	914	592	701
Ropesville			0	0	0	-91	-89	-85	-81
Smyer			0	0	0	0	0	0	-62
Rural			0	0	0	0	0	0	0
	Subtotal		1,017	663	604	504	557	251	315
Colorado Basin									
Sundown			0	0	-350	-353	-347	-332	-316
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	-350	-353	-347	-332	-316
Total Municipal Surplus/Shortage			1,017	663	254	151	210	-81	-1
Municipal New Supply Need									
Brazos Basin									
Anton			0	263	270	272	268	256	243
Levelland			0	0	0	0	0	0	0
Ropesville			0	0	0	91	89	85	81
Smyer			0	0	0	0	0	0	62
Rural			0	0	0	0	0	0	0
	Subtotal		0	263	270	363	357	341	386
Colorado Basin									
Sundown			0	0	350	353	347	332	316
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	350	353	347	332	316
Total Municipal New Supply Need			0	263	620	716	704	673	702
Industrial Demand									
Brazos Basin			53	61	65	68	71	73	78
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Demand			53	61	65	68	71	73	78
Industrial Existing Supply									
Brazos Basin		Ogallala	53	61	65	68	71	73	78
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			53	61	65	68	71	73	78
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			157,496	151,336	145,420	139,735	134,269	129,019	123,974
Colorado Basin			17,500	16,815	16,158	15,526	14,919	14,335	13,775
Total Irrigation Demand			174,996	168,151	161,578	155,261	149,188	143,354	137,749

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Table 4-13 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Irrigation Supply								
Brazos Basin	Ogallala	158,685	92,646	75,787	64,034	53,365	51,864	48,407
	Reclaimed Water	1,359	1,359	1,359	1,359	1,359	1,359	1,359
Brazos Basin Subtotal		160,044	94,005	77,146	65,393	54,724	53,223	49,766
Colorado Basin	Ogallala	18,835	11,583	9,715	7,865	7,506	7,180	7,237
	Reclaimed Water	162	162	162	162	162	162	162
Colorado Basin Subtotal		18,997	11,745	9,877	8,027	7,668	7,342	7,399
Total Irrigation Supply		179,041	105,750	87,023	73,420	62,392	60,565	57,165
Irrigation Surplus/Shortage								
Brazos Basin		2,548	-57,331	-68,274	-74,342	-79,545	-75,796	-74,208
Colorado Basin		1,497	-5,070	-6,281	-7,499	-7,251	-6,993	-6,376
Total Irrigation Surplus/Shortage		4,045	-62,401	-74,555	-81,841	-86,796	-82,789	-80,584
Mining Demand								
Brazos Basin		3,302	2,358	1,510	981	378	19	0
Colorado Basin		1,114	796	509	331	127	6	0
Total Mining Demand		4,416	3,154	2,019	1,312	505	25	0
Mining Supply								
Brazos Basin	Ogallala	3,302	2,358	1,510	981	378	19	0
Colorado Basin	Ogallala	1,114	796	509	331	127	6	0
Total Mining Supply		4,416	3,154	2,019	1,312	505	25	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		343	418	468	497	528	561	595
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		343	418	468	497	528	561	595
Beef Feedlot Livestock Supply								
Brazos Basin	Ogallala	343	418	468	497	528	561	595
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		343	418	468	497	528	561	595
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		221	226	273	280	286	292	299
Colorado Basin		44	45	55	55	56	57	59
Total Range & All Other Livestock Demand		265	271	328	335	342	349	357
Range & All Other Livestock Supply								
Brazos Basin	Local	221	226	273	280	286	292	299
Colorado Basin	Local	44	45	55	55	56	57	59
Total Range & All Other Livestock Supply		265	271	328	335	342	349	357
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-13 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Demand								
Municipal		3,800	3,953	4,040	4,050	3,966	3,784	3,599
Industrial		53	61	65	68	71	73	78
Steam-Electric		0	0	0	0	0	0	0
Irrigation		174,996	168,151	161,578	155,261	149,188	143,354	137,749
Mining		4,416	3,154	2,019	1,312	505	25	0
Beef Feedlot Livestock		343	418	468	497	528	561	595
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		265	271	328	335	342	349	357
Total County Demand		183,873	176,008	168,498	161,523	154,600	148,146	142,378
Total Supply								
Municipal		4,817	4,616	4,294	4,201	4,176	3,703	3,598
Industrial		53	61	65	68	71	73	78
Steam-Electric		0	0	0	0	0	0	0
Irrigation		179,041	105,750	87,023	73,420	62,392	60,565	57,165
Mining		4,416	3,154	2,019	1,312	505	25	0
Beef Feedlot Livestock		343	418	468	497	528	561	595
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		265	271	328	335	342	349	357
Total County Supply		188,935	114,270	94,197	79,833	68,014	65,276	61,793
Total Surplus/Shortage								
Municipal		1,017	663	254	151	210	-81	-1
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		4,045	-62,401	-74,555	-81,841	-86,796	-82,789	-80,584
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		5,062	-61,738	-74,301	-81,690	-86,586	-82,870	-80,585
Total Basin Demand								
Brazos								
Municipal		3,435	3,571	3,648	3,655	3,578	3,413	3,246
Industrial		53	61	65	68	71	73	78
Steam-Electric		0	0	0	0	0	0	0
Irrigation		157,496	151,336	145,420	139,735	134,269	129,019	123,974
Mining		3,302	2,358	1,510	981	378	19	0
Beef Feedlot Livestock		343	418	468	497	528	561	595
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		221	226	273	280	286	292	299
Total Brazos Basin Demand		164,850	157,970	151,385	145,216	139,110	133,377	128,192
Colorado								
Municipal		365	382	392	395	388	371	353
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		17,500	16,815	16,158	15,526	14,919	14,335	13,775
Mining		1,114	796	509	331	127	6	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		44	45	55	55	56	57	59
Total Colorado Basin Demand		19,023	18,038	17,114	16,307	15,490	14,769	14,187
Total Basin Supply								
Brazos								
Municipal		4,452	4,234	4,252	4,159	4,135	3,664	3,561
Industrial		53	61	65	68	71	73	78
Steam-Electric		0	0	0	0	0	0	0
Irrigation		160,044	94,005	77,146	65,393	54,724	53,223	49,766
Mining		3,302	2,358	1,510	981	378	19	0
Beef Feedlot Livestock		343	418	468	497	528	561	595
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		221	226	273	280	286	292	299
Total Brazos Basin Supply		168,415	101,302	83,715	71,378	60,122	57,832	54,299
Colorado								
Municipal		365	382	42	42	41	39	37
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		18,997	11,745	9,877	8,027	7,668	7,342	7,399
Mining		1,114	796	509	331	127	6	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		44	45	55	55	56	57	59
Total Colorado Basin Supply		20,520	12,968	10,483	8,455	7,892	7,444	7,495

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Table 4-13 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Brazos								
Municipal		1,017	663	604	504	557	251	315
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		2,548	-57,331	-68,274	-74,342	-79,545	-75,796	-74,208
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		3,565	-56,668	-67,670	-73,838	-78,988	-75,545	-73,893
Colorado								
Municipal		0	0	-350	-353	-347	-332	-316
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,497	-5,070	-6,281	-7,499	-7,251	-6,993	-6,376
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		1,497	-5,070	-6,631	-7,852	-7,598	-7,325	-6,692

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

[5] Value is the sum of reclaimed water from the City of Anton, City of Levelland, Bowman Enterprises, City of Smyer, City of Ropesville, City of Sundown, and United Cotton Growers Coop & Whitharrel Water Supply Corp. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-14.
Projected Water Demands, Supplies, and Needs
Lamb County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	8,246,693	6,944,619	5,155,582	3,861,385	2,953,511	2,743,521	2,533,373
	Quantity Pumped[2]	Ogallala	402,158	267,764	210,668	156,745	109,741	91,026	81,651
	Supply	(Ogallala)[3]	402,158	267,764	210,668	156,745	109,741	91,026	81,651
	Local Surface	Stock Tanks and Windmills	472	491	510	531	552	575	599
	Reclaimed Water[4]		7,199	7,199	7,199	7,199	7,199	7,199	7,199
	Total Supply		409,829	275,454	218,377	164,475	117,492	98,801	89,449
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Amherst			163	168	176	182	185	183	181
Earth			248	257	268	277	283	280	276
Littlefield			1,480	1,530	1,602	1,660	1,694	1,676	1,655
Olton			474	492	512	532	542	536	529
Sudan			218	226	236	244	249	246	243
Rural			766	794	830	861	880	872	861
	Subtotal		3,349	3,467	3,624	3,756	3,833	3,793	3,745
Total Municipal Demand			3,349	3,467	3,624	3,756	3,833	3,793	3,745
Municipal Existing Supply									
Brazos Basin									
Amherst		Ogallala	163	168	0	0	0	0	0
Earth		Ogallala	248	257	268	277	0	0	0
Littlefield		Ogallala	1,480	1,530	1,602	1,660	1,694	1,676	1,655
Olton		Ogallala	474	492	512	532	542	536	529
Sudan		Ogallala	218	226	0	0	0	0	0
Rural		Ogallala	766	794	830	861	880	872	861
	Subtotal		3,349	3,467	3,212	3,330	3,116	3,084	3,045
Total Municipal Existing Supply			3,349	3,467	3,212	3,330	3,116	3,084	3,045
Municipal Surplus/Shortage									
Brazos Basin									
Amherst			0	0	-176	-182	-185	-183	-181
Earth			0	0	0	0	-283	-280	-276
Littlefield			0	0	0	0	0	0	0
Olton			0	0	0	0	0	0	0
Sudan			0	0	-236	-244	-249	-246	-243
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	-412	-426	-717	-709	-700
Total Municipal Surplus/Shortage			0	0	-412	-426	-717	-709	-700
Municipal New Supply Need									
Brazos Basin									
Amherst			0	0	176	182	185	183	181
Earth			0	0	0	0	283	280	276
Littlefield			0	0	0	0	0	0	0
Olton			0	0	0	0	0	0	0
Sudan			0	0	236	244	249	246	243
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	412	426	717	709	700
Total Municipal New Supply Need			0	0	412	426	717	709	700
Industrial Demand									
Brazos Basin			426	490	519	541	562	580	618
Total Industrial Demand			426	490	519	541	562	580	618
Industrial Existing Supply									
Brazos Basin		Ogallala	426	490	519	541	562	580	618
Total Industrial Existing Supply			426	490	519	541	562	580	618

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Table 4-14 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Industrial Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Industrial Surplus/Shortage		0	0	0	0	0	0	0
Industrial New Supply Need								
Brazos Basin		0	0	0	0	0	0	0
Total Industrial New Supply Need		0	0	0	0	0	0	0
Steam-Electric Demand								
Brazos Basin		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Total Steam-Electric Demand		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Steam-Electric Existing Supply								
Brazos Basin	Ogallala	17,990	17,827	17,663	20,651	24,292	28,731	34,142
Total Steam-Electric Existing Supply		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Steam-Electric Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need								
Brazos Basin		0	0	0	0	0	0	0
Total Steam-Electric New Supply Need		0	0	0	0	0	0	0
Irrigation Demand								
Brazos Basin		377,893	363,313	349,294	335,816	322,858	310,401	298,425
Total Irrigation Demand		377,893	363,313	349,294	335,816	322,858	310,401	298,425
Irrigation Supply								
Brazos Basin	Ogallala	378,365	241,858	183,504	126,292	75,489	52,404	37,640
	Reclaimed Water	7,199	7,199	7,199	7,199	7,199	7,199	7,199
Total Irrigation Supply		385,564	249,057	190,703	133,491	82,688	59,603	44,839
Irrigation Surplus/Shortage								
Brazos Basin		7,671	-114,256	-158,591	-202,325	-240,170	-250,798	-253,586
Total Irrigation Surplus/Shortage		7,671	-114,256	-158,591	-202,325	-240,170	-250,798	-253,586
Mining Demand								
Brazos Basin		88	52	25	15	6	0	0
Total Mining Demand		88	52	25	15	6	0	0
Mining Supply								
Brazos Basin	Ogallala	88	52	25	15	6	0	0
Total Mining Supply		88	52	25	15	6	0	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Total Beef Feedlot Livestock Demand		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Beef Feedlot Livestock Supply								
Brazos Basin	Ogallala	1,328	1,619	1,815	1,927	2,046	2,172	2,306
Total Beef Feedlot Livestock Supply		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		612	1,552	2,492	2,492	2,492	2,492	2,492
Total Dairies Demand		612	1,552	2,492	2,492	2,492	2,492	2,492
Dairies Supply								
Brazos Basin	Ogallala	612	1,552	2,492	2,492	2,492	2,492	2,492
Total Dairies Supply		612	1,552	2,492	2,492	2,492	2,492	2,492
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-14 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Range & All Other Livestock Demand								
Brazos Basin		472	491	510	529	553	577	598
Total Range & All Other Livestock Demand		472	491	510	529	553	577	598
Range & All Other Livestock Supply								
Brazos Basin	Local	472	491	510	529	553	577	598
Total Range & All Other Livestock Supply		472	491	510	529	553	577	598
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		3,349	3,467	3,624	3,756	3,833	3,793	3,745
Industrial		426	490	519	541	562	580	618
Steam-Electric		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Irrigation		377,893	363,313	349,294	335,816	322,858	310,401	298,425
Mining		88	52	25	15	6	0	0
Beef Feedlot Livestock		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Dairies		612	1,552	2,492	2,492	2,492	2,492	2,492
Range & All Other Livestock		472	491	510	529	553	577	598
Total County Demand		402,158	388,811	375,942	365,727	356,642	348,746	342,326
Total Supply								
Municipal		3,349	3,467	3,212	3,330	3,116	3,084	3,045
Industrial		426	490	519	541	562	580	618
Steam-Electric		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Irrigation		385,564	249,057	190,703	133,491	82,688	59,603	44,839
Mining		88	52	25	15	6	0	0
Beef Feedlot Livestock		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Dairies		612	1,552	2,492	2,492	2,492	2,492	2,492
Range & All Other Livestock		472	491	510	529	553	577	598
Total County Supply		409,829	274,555	216,939	162,976	115,755	97,239	88,040
Total Surplus/Shortage								
Municipal		0	0	-412	-426	-717	-709	-700
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		7,671	-114,256	-158,591	-202,325	-240,170	-250,798	-253,586
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		7,671	-114,256	-159,003	-202,751	-240,887	-251,507	-254,286
Total Basin Demand								
Brazos								
Municipal		3,349	3,467	3,624	3,756	3,833	3,793	3,745
Industrial		426	490	519	541	562	580	618
Steam-Electric		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Irrigation		377,893	363,313	349,294	335,816	322,858	310,401	298,425
Mining		88	52	25	15	6	0	0
Beef Feedlot Livestock		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Dairies		612	1,552	2,492	2,492	2,492	2,492	2,492
Range & All Other Livestock		472	491	510	529	553	577	598
Total Brazos Basin Demand		402,158	388,811	375,942	365,727	356,642	348,746	342,326
Total Basin Supply								
Brazos								
Municipal		3,349	3,467	3,212	3,330	3,116	3,084	3,045
Industrial		426	490	519	541	562	580	618
Steam-Electric		17,990	17,827	17,663	20,651	24,292	28,731	34,142
Irrigation		385,564	249,057	190,703	133,491	82,688	59,603	44,839
Mining		88	52	25	15	6	0	0
Beef Feedlot Livestock		1,328	1,619	1,815	1,927	2,046	2,172	2,306
Dairies		612	1,552	2,492	2,492	2,492	2,492	2,492
Range & All Other Livestock		472	491	510	529	553	577	598
Total Brazos Basin Supply		409,829	274,555	216,939	162,976	115,755	97,239	88,040

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Table 4-14 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Brazos								
Municipal		0	0	-412	-426	-717	-709	-700
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		7,671	-114,256	-158,591	-202,325	-240,170	-250,798	-253,586
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		7,671	-114,256	-159,003	-202,751	-240,887	-251,507	-254,286

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from Southwestern Public Service Tolk, City of Littlefield, Plains Cotton Growers, City of Earth, Springlake-Earth ISD, City of Sudan, City of Olton, Southwestern Public Service Plant X, City of Springlake, and City of Amherst. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-15.
Projected Water Demands, Supplies, and Needs
Lubbock County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	7,439,809	6,632,577	5,611,743	4,952,167	4,159,806	4,141,607	4,114,001
	Quantity Pumped[2]	Ogallala	298,052	163,283	131,367	110,204	88,545	85,490	80,557
	Supply	(Ogallala)[3]	298,052	163,283	131,367	110,204	88,545	85,490	80,557
	Other Ground	Ogallala (CRMWA - Roberts Co.)	15,453	16,648	16,647	14,262	11,878	10,215	10,215
	Bailey County	Ogallala	8,092	8,353	8,516	8,530	8,407	8,470	8,383
	Local Surface	Stock Tanks and Windmills	258	265	272	280	289	298	308
	Other Surface	Lake Meredith (CRMWA)	28,948	24,174	24,174	24,174	24,174	24,174	24,174
	Other Surface	Lake Alan Henry	0	22,478	22,478	22,478	22,478	22,478	22,478
	Reclaimed Water (Lubbock-Electric Power)[4]		5,776	5,221	4,440	5,191	6,106	7,222	8,582
	Reclaimed Water (Lubbock-Irrigation)[4]		7,958	9,166	10,354	9,639	8,415	7,457	5,880
	Reclaimed Water[7]		4,209	4,209	4,209	4,209	4,209	4,209	4,209
	Total Supply		368,746	253,797	222,457	198,967	174,499	170,012	164,785
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Abernathy (part)			153	171	182	188	186	190	186
Idalou			288	289	288	281	274	273	272
Lubbock	Includes Reese Center	(Seven acre-feet per year)	40,460	41,765	42,580	42,652	42,033	42,349	41,915
New Deal			126	149	165	173	173	178	173
Ransom Canyon			310	440	569	698	825	953	1,004
Shallowater			311	344	367	377	371	379	371
Slaton			931	907	889	870	849	837	836
Wolfforth			412	1,468	1,758	1,822	1,884	1,962	2,006
Rural			3,417	3,006	3,051	3,053	2,909	2,907	2,744
	Subtotal		46,408	48,539	49,849	50,114	49,504	50,028	49,507
Total Municipal Demand			46,408	48,539	49,849	50,114	49,504	50,028	49,507
Municipal Existing Supply									
Brazos Basin									
Abernathy (part)		Ogallala	153	171	0	0	0	0	0
Idalou		Ogallala	288	289	288	281	0	0	0
Lubbock		Lake Meredith (CRMWA)[5]	27,712	22,808	22,679	22,550	22,423	22,295	22,244
		Ogallala (CRMWA - Roberts Co.)[5]	14,823	16,018	16,017	13,632	11,248	10,065	10,065
		Lake Alan Henry	0	0	0	0	0	0	0
		Ogallala (Bailey County)[6]	8,092	8,353	8,516	8,530	8,407	8,470	8,383
Lubbock Subtotal	Includes Reese Center		50,627	47,179	47,212	44,712	42,078	40,830	40,692
New Deal		Slaton (CRMWA)	126	153	153	153	153	153	153
Ransom Canyon		Lubbock (Lake Meredith)	310	440	569	698	825	953	1,004
Shallowater		Lubbock (Lake Meredith)	187	187	187	187	187	187	187
		Ogallala	311	0	0	0	0	0	0
Shallowater Subtotal			498	187	187	187	187	187	187
Slaton	1,198	Lake Meredith (CRMWA)[5]	739	739	739	739	739	739	739
	630	Ogallala (CRMWA - Roberts Co.)[5]	630	630	630	630	630	150	150
Slaton Subtotal	1,828		1,369	1,369	1,369	1,369	1,369	889	889
Wolfforth		Ogallala	412	371	334	300	270	243	219
Rural		Ogallala	3,417	3,006	3,051	3,053	2,909	2,907	2,744
	Subtotal		57,200	53,165	53,163	50,753	47,791	46,162	45,888
Total Municipal Existing Supply			57,200	53,165	53,163	50,753	47,791	46,162	45,888
Municipal Surplus/Shortage									
Brazos Basin									
Abernathy (part)			0	0	-182	-188	-186	-190	-186
Idalou			0	0	0	0	-274	-273	-272
Lubbock			10,167	5,414	4,632	2,060	45	-1,519	-1,223
New Deal			0	4	-12	-20	-20	-25	-20
Ransom Canyon			0	0	0	0	0	0	0
Shallowater			187	-157	-180	-190	-184	-192	-184
Slaton		To Post	438	462	480	499	520	52	53
Wolfforth			0	-1,097	-1,424	-1,522	-1,614	-1,719	-1,787
Rural			0	0	0	0	0	0	0
	Subtotal		10,792	4,626	3,314	639	-1,713	-3,866	-3,619
Total Municipal Surplus/Shortage			10,792	4,626	3,314	639	-1,713	-3,866	-3,619

Continued on next page

Table 4-15 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Brazos Basin									
Abernathy (part)			0	0	182	188	186	190	186
Idalou			0	0	0	0	274	273	272
Lubbock			0	0	0	0	0	1,519	1,223
New Deal			0	0	12	20	20	25	20
Ransom Canyon			0	0	0	0	0	0	0
Shallowater			0	157	180	190	184	192	184
Slaton			0	0	0	0	0	0	0
Wolfforth			0	1,097	1,424	1,522	1,614	1,719	1,787
Rural			0	0	0	0	0	0	0
	Subtotal		0	1,254	1,798	1,920	2,278	3,918	3,672
Total Municipal New Supply Need			0	1,254	1,798	1,920	2,278	3,918	3,672
Industrial Demand									
Brazos Basin			1,566	1,881	2,103	2,291	2,472	2,625	2,836
Total Industrial Demand			1,566	1,881	2,103	2,291	2,472	2,625	2,836
Industrial Existing Supply									
Brazos Basin		Ogallala	1,566	1,881	2,103	2,291	2,472	2,625	2,836
Total Industrial Existing Supply			1,566	1,881	2,103	2,291	2,472	2,625	2,836
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			5,776	5,221	4,440	5,191	6,106	7,222	8,582
Total Steam-Electric Demand			5,776	5,221	4,440	5,191	6,106	7,222	8,582
Steam-Electric Existing Supply									
Brazos Basin		Reclaimed Water (From Lubbock)	5,776	5,221	4,440	5,191	6,106	7,222	8,582
Total Steam-Electric Existing Supply			5,776	5,221	4,440	5,191	6,106	7,222	8,582
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			242,978	229,267	216,397	204,248	192,782	181,961	171,747
Total Irrigation Demand			242,978	229,267	216,397	204,248	192,782	181,961	171,747
Irrigation Supply									
Brazos Basin		Ogallala	290,713	149,228	116,139	95,080	73,499	70,102	65,351
		Reclaimed Water (Lubbock) [4]	7,958	9,166	10,354	9,639	8,415	7,457	5,880
		Reclaimed Water [7]	4,209	4,209	4,209	4,209	4,209	4,209	4,209
Total Irrigation Supply			302,880	162,603	130,702	108,928	86,123	81,768	75,440
Irrigation Surplus/Shortage									
Brazos Basin			59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Total Irrigation Surplus/Shortage			59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Mining Demand									
Brazos Basin			352	209	101	59	25	0	0
Total Mining Demand			352	209	101	59	25	0	0
Mining Supply									
Brazos Basin		Ogallala	352	209	101	59	25	0	0
Total Mining Supply			352	209	101	59	25	0	0
Mining Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Mining Surplus/Shortage			0	0	0	0	0	0	0

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Table 4-15 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Beef Feedlot Livestock Demand								
Brazos Basin		714	870	976	1,036	1,100	1,168	1,240
Total Beef Feedlot Livestock Demand		714	870	976	1,036	1,100	1,168	1,240
Beef Feedlot Livestock Supply								
Brazos Basin	Ogallala	714	870	976	1,036	1,100	1,168	1,240
Total Beef Feedlot Livestock Supply		714	870	976	1,036	1,100	1,168	1,240
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		258	265	272	280	289	298	308
Total Range & All Other Livestock Demand		258	265	272	280	289	298	308
Range & All Other Livestock Supply								
Brazos Basin	Local	258	265	272	280	289	298	308
Total Range & All Other Livestock Supply		258	265	272	280	289	298	308
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		46,408	48,539	49,849	50,114	49,504	50,028	49,507
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		242,978	229,267	216,397	204,248	192,782	181,961	171,747
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total County Demand		298,052	286,253	274,138	263,219	252,278	243,302	234,220
Total Supply								
Municipal		57,200	53,165	53,163	50,753	47,791	46,162	45,888
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		302,880	162,603	130,702	108,928	86,123	81,768	75,440
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total County Supply		368,746	224,214	191,757	168,539	143,905	139,242	134,293
Total Surplus/Shortage								
Municipal		10,792	4,626	3,314	639	-1,713	-3,866	-3,619
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		70,694	-62,039	-82,381	-94,681	-108,373	-104,060	-99,927
Total Basin Demand								
Brazos								
Municipal		46,408	48,539	49,849	50,114	49,504	50,028	49,507
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		242,978	229,267	216,397	204,248	192,782	181,961	171,747
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total Brazos Basin Demand		298,052	286,253	274,138	263,219	252,278	243,302	234,220

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Table 4-15 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Supply								
Brazos								
Municipal		57,200	53,165	53,163	50,753	47,791	46,162	45,888
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		302,880	162,603	130,702	108,928	86,123	81,768	75,440
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total Brazos Basin Supply		368,746	224,214	191,757	168,539	143,905	139,242	134,293
Total Basin Surplus/Shortage								
Brazos								
Municipal		10,792	4,626	3,314	639	-1,713	-3,866	-3,619
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		70,694	-62,039	-82,381	-94,681	-108,373	-104,060	-99,927

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Total supply of reclaimed water is estimated at 50 percent of Lubbock's projected municipal water use shown as Lubbock municipal water demand. Reclaimed water is used for steam-electric power generation, with the remaineder used to irrigate hay and forage crops in Lubbock and Lynn Counties. Of the total, 6,496 acft/yr is shown as being transferred to Lynn County. See Table 4-16.

[5] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

[6] The total groundwater supply available to Lubbock in Bailey County is 16,000 acft/yr, however, the City of Lubbock's policy is to obtain 20 percent of annual supply from Bailey County, which increases from an estimated 8,092 acft/yr in 2000 to an estimated 8,383 acft/yr in 2060.

[7] Value is the sum of reclaimed water from the City of Idalou, City of Wolfforth, City of New Deal, City of Slaton, City of Shallowater, SPS, Environmental Protection Services of Lubbock, Acid Delinting Inc., Texas Winery Inc., Town & Country Mobile Home Park, Paymaster Oil Mill, Lubbock, Cooper ISD, Ransom, Canyon, Plains Coop Oil Mill, and Gifford Hill American. The quantity of reclaimed water from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held constant throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-16.
Projected Water Demands, Supplies, and Needs
Lynn County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	3,528,278	3,372,428	3,382,679	3,377,853	3,375,361	3,384,834	3,393,991
	Quantity Pumped[2]	Ogallala	120,425	120,425	120,425	120,425	120,425	120,425	120,425
	Supply	(Ogallala)[3]	120,425	120,425	120,425	120,425	120,425	120,425	120,425
	Edwards-Trinity (High Plains) Aquifer		4,944	4,160	3,580	2,802	2,335	2,065	2,065
	Other Ground	Ogallala (CRMWA - Roberts Co.)	184	184	184	184	184	110	110
	Local Surface	Stock Tanks and Windmills	128	132	136	139	144	149	153
	Other Surface	Lake Meredith (CRMWA)	350	350	350	350	350	350	350
	Reclaimed Water (Lubbock-Irrigation)[5]		6,496	6,496	6,496	6,496	6,496	6,496	6,496
	Reclaimed Water[6]		346	346	346	346	346	346	346
	Total Supply		132,873	132,093	131,517	130,742	130,280	129,940	129,945
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	258,301	273,551	272,424	277,251	279,742	270,270	261,112
	Quantity Pumped[2]	Ogallala	1,141	491	473	462	467	422	381
	Supply	(Ogallala)[3]	1,141	491	473	462	467	422	381
	Other Ground	Ogallala (CRMWA - Roberts Co.)	91	91	91	91	91	61	61
	Local Surface	Stock Tanks and Windmills	11	11	11	12	12	13	14
	Other Surface	Lake Meredith (CRMWA)	173	173	173	173	173	173	173
	Total Supply		1,417	767	748	738	744	669	628
	County Total								
	Quantity in Storage[1]	Ogallala	3,786,579	3,645,979	3,655,103	3,655,103	3,655,103	3,655,103	3,655,103
	Quantity Pumped[2]	Ogallala	121,566	120,916	120,897	120,886	120,892	120,847	120,805
	Supply	(Ogallala)[3]	121,566	120,916	120,897	120,886	120,892	120,847	120,805
	Edwards-Trinity (High Plains) Aquifer		4,944	4,160	3,580	2,802	2,335	2,065	2,065
	Other Ground	Ogallala (CRMWA - Roberts Co.)	275	275	275	275	275	171	171
	Local Surface	Stock Tanks and Windmills	140	143	147	152	156	161	166
	Other Surface	Lake Meredith	523	523	523	523	523	523	523
	Reclaimed Water (Lubbock-Irrigation)		6,496	6,496	6,496	6,496	6,496	6,496	6,496
	Reclaimed Water[6]		346	346	346	346	346	346	346
	Total Supply		134,290	132,860	132,265	131,480	131,023	130,609	130,573
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
O'Donnell (part)			139	144	146	142	138	130	121
Tahoka			473	492	504	490	478	453	421
Wilson			65	67	68	65	63	60	55
Rural			290	299	301	292	282	267	249
	Subtotal		967	1,002	1,019	989	961	910	846
Colorado Basin									
Rural			6	7	7	6	6	6	6
	Subtotal		6	7	7	6	6	6	6
Total Municipal Demand			973	1,009	1,026	995	967	916	852
Municipal Existing Supply									
Brazos Basin									
O'Donnell (part)		Lake Meredith (CRMWA)	173	173	173	173	173	173	173
		Ogallala (CRMWA - Roberts Co.)	91	91	91	91	91	61	61
O'Donnell (part) Subtotal			264	264	264	264	264	234	234
Tahoka		Ogallala	0	0	0	0	0	0	0
		Lake Meredith (CRMWA)[4]	350	350	350	350	350	350	350
		Ogallala (CRMWA - Roberts Co.)[4]	184	184	184	184	184	110	110
Tahoka Subtotal			534	534	534	534	534	460	460
Wilson		Ogallala	65	67	0	0	0	0	0
Rural		Ogallala	290	299	301	292	282	267	249
		Edwards-Trinity (High Plains)	100	100	100	100	100	100	100
Rural Subtotal			390	399	401	392	382	367	349
	Subtotal		1,253	1,264	1,199	1,190	1,180	1,061	1,043
Colorado Basin									
Rural		Ogallala	6	7	7	6	6	6	6
	Subtotal		6	7	7	6	6	6	6
Total Municipal Existing Supply			1,259	1,271	1,206	1,196	1,186	1,067	1,049

Continued on next page

Table 4-16 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal Surplus/Shortage									
Brazos Basin									
Tahoka			61	42	30	44	56	7	39
Wilson			0	0	-68	-65	-63	-60	-55
Rural			100	100	100	100	100	100	100
O'Donnell (part)			125	120	118	122	126	104	113
	Subtotal		286	262	180	201	219	151	197
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Surplus/Shortage			286	262	180	201	219	151	197
Municipal New Supply Need									
Brazos Basin									
Tahoka			0	0	0	0	0	0	0
Wilson			0	0	68	65	63	60	55
Rural			0	0	0	0	0	0	0
O'Donnell (part)			0	0	0	0	0	0	0
	Subtotal		0	0	68	65	63	60	55
Colorado Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	0	68	65	63	60	55
Industrial Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			119,289	112,870	106,796	101,054	95,614	90,473	85,610
Colorado Basin			1,083	1,025	970	918	868	822	777
Total Irrigation Demand			120,372	113,895	107,766	101,972	96,482	91,295	86,387
Irrigation Supply									
Brazos Basin		Ogallala	120,004	120,020	119,912	119,948	119,981	120,017	120,049
		Edwards-Trinity (High Plains)	4,844	4,060	3,480	2,702	2,235	1,965	1,965
		Reclaimed Water (Lubbock) [5]	6,496	6,496	6,496	6,496	6,496	6,496	6,496
		Reclaimed Water [6]	346	346	346	346	346	346	346
Brazos Basin Subtotal			131,690	130,922	130,234	129,492	129,058	128,824	128,856
Colorado Basin		Ogallala	1,120	475	462	454	460	416	375
Total Irrigation Supply			132,810	131,397	130,696	129,946	129,518	129,240	129,231

Continued on next page

Table 4-16 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Irrigation Surplus/Shortage								
Brazos Basin		12,401	18,052	23,438	28,438	33,444	38,351	43,246
Colorado Basin		37	-550	-508	-464	-408	-406	-402
Total Irrigation Surplus/Shortage		12,438	17,502	22,930	27,974	33,036	37,945	42,844
Mining Demand								
Brazos Basin		66	39	19	11	5	0	0
Colorado Basin		15	9	4	2	1	0	0
Total Mining Demand		81	48	23	13	6	0	0
Mining Supply								
Brazos Basin	Ogallala	66	39	19	11	5	0	0
Colorado Basin	Ogallala	15	9	4	2	1	0	0
Total Mining Supply		81	48	23	13	6	0	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		128	132	136	139	144	149	153
Colorado Basin		11	11	11	12	12	13	14
Total Range & All Other Livestock Demand		140	143	147	152	156	161	166
Range & All Other Livestock Supply								
Brazos Basin	Local	128	132	136	139	144	149	153
Colorado Basin	Local	11	11	11	12	12	13	14
Total Range & All Other Livestock Supply		140	143	147	152	156	161	166
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		973	1,009	1,026	995	967	916	852
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		120,372	113,895	107,766	101,972	96,482	91,295	86,387
Mining		81	48	23	13	6	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		140	143	147	152	156	161	166
Total County Demand		121,566	115,095	108,962	103,132	97,611	92,372	87,405

Continued on next page

Table 4-16 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		1,259	1,271	1,206	1,196	1,186	1,067	1,049
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		132,810	131,397	130,696	129,946	129,518	129,240	129,231
Mining		81	48	23	13	6	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		140	143	147	152	156	161	166
Total County Supply		134,290	132,860	132,072	131,306	130,867	130,468	130,446
Total Surplus/Shortage								
Municipal		286	262	180	201	219	151	197
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,438	17,502	22,930	27,974	33,036	37,945	42,844
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		12,724	17,764	23,110	28,175	33,255	38,096	43,041
Total Basin Demand								
Brazos								
Municipal		967	1,002	1,019	989	961	910	846
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		119,289	112,870	106,796	101,054	95,614	90,473	85,610
Mining		66	39	19	11	5	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		128	132	136	139	144	149	153
Total Brazos Basin Demand		120,450	114,043	107,970	102,193	96,724	91,532	86,609
Colorado								
Municipal		6	7	7	6	6	6	6
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,083	1,025	970	918	868	822	777
Mining		15	9	4	2	1	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		11	11	11	12	12	13	14
Total Colorado Basin Demand		1,115	1,052	992	938	887	841	797
Total Basin Supply								
Brazos								
Municipal		1,253	1,264	1,199	1,190	1,180	1,061	1,043
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		131,690	130,922	130,234	129,492	129,058	128,824	128,856
Mining		66	39	19	11	5	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		128	132	136	139	144	149	153
Total Brazos Basin Supply		133,137	132,357	131,588	130,832	130,387	130,034	130,052
Colorado								
Municipal		6	7	7	6	6	6	6
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,120	475	462	454	460	416	375
Mining		15	9	4	2	1	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		11	11	11	12	12	13	14
Total Colorado Basin Supply		1,153	503	484	474	480	435	394
Total Basin Surplus/Shortage								
Brazos								
Municipal		286	262	180	201	219	151	197
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,401	18,052	23,438	28,438	33,444	38,351	43,246
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		12,687	18,314	23,618	28,639	33,663	38,502	43,443

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Table 4-16 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage (Cont.)								
Colorado								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		37	-550	-508	-464	-408	-406	-402
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		37	-550	-508	-464	-408	-406	-402

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in oder to use its full supply from CRMWA.

[5] The quantity is that experienced in 2003, and is 96 percent of the premitted value for the project.

[6] Value is the sum of reclaimed water from the City of Wilson, City of Tahoka, and City of O'Donnell. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-17.
Projected Water Demands, Supplies, and Needs
Motley County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	355,295	282,644	231,003	180,893	132,340	85,257	39,482
	Quantity Pumped[2]	Ogallala	10,200	5,717	5,565	5,411	5,254	5,115	4,991
	Supply	(Ogallala)[3]	10,200	5,717	5,565	5,411	5,254	5,115	4,991
	Seymour Aquifer		18,817	18,817	18,817	13,507	13,507	13,507	13,507
	Other Aquifer		239	234	224	207	187	174	166
	Local Surface	Stock Tanks and Windmills	625	636	647	659	671	684	698
	Other Surface		0	0	0	0	0	0	0
	Total Supply		29,881	25,404	25,253	19,784	19,619	19,480	19,362
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Matador			239	234	224	207	187	174	166
Rural			148	143	136	123	108	98	93
	Subtotal		387	377	360	330	295	272	259
Total Municipal Demand			387	377	360	330	295	272	259
Municipal Existing Supply									
Red Basin									
Matador		Other Aquifer	239	234	224	207	187	174	166
Rural		Ogallala	148	143	136	123	108	98	93
	Subtotal		387	377	360	330	295	272	259
Total Municipal Existing Supply			387	377	360	330	295	272	259
Municipal Surplus/Shortage									
Red Basin									
Matador			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal Surplus/Shortage			0	0	0	0	0	0	0
Municipal New Supply Need									
Red Basin									
Matador			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Total Municipal New Supply Need			0	0	0	0	0	0	0
Industrial Demand									
Red Basin			5	6	6	6	6	6	6
Total Industrial Demand			5	6	6	6	6	6	6
Industrial Existing Supply									
Red Basin		Ogallala	5	6	6	6	6	6	6
Total Industrial Existing Supply			5	6	6	6	6	6	6
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0

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Table 4-17 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Steam-Electric Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need								
Red Basin		0	0	0	0	0	0	0
Total Steam-Electric New Supply Need		0	0	0	0	0	0	0
Irrigation Demand								
Red Basin		9,168	8,894	8,628	8,372	8,121	7,877	7,641
Total Irrigation Demand		9,168	8,894	8,628	8,372	8,121	7,877	7,641
Irrigation Supply								
Red Basin	Ogallala	10,032	5,559	5,419	5,279	5,139	5,011	4,892
	Seymour	2,065	2,003	1,943	1,885	1,828	1,774	1,724
Total Irrigation Supply		12,097	7,562	7,362	7,164	6,967	6,785	6,616
Irrigation Surplus/Shortage								
Red Basin		2,929	-1,332	-1,266	-1,208	-1,154	-1,092	-1,025
Total Irrigation Surplus/Shortage		2,929	-1,332	-1,266	-1,208	-1,154	-1,092	-1,025
Mining Demand								
Red Basin		15	9	4	3	1	0	0
Total Mining Demand		15	9	4	3	1	0	0
Mining Supply								
Red Basin	Ogallala	15	9	4	3	1	0	0
Total Mining Supply		15	9	4	3	1	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Red Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Red Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		625	636	647	659	671	684	698
Total Range & All Other Livestock Demand		625	636	647	659	671	684	698
Range & All Other Livestock Supply								
Red Basin	Local	625	636	647	659	671	684	698
Total Range & All Other Livestock Supply		625	636	647	659	671	684	698
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-17 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Demand								
Municipal		387	377	360	330	295	272	259
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		9,168	8,894	8,628	8,372	8,121	7,877	7,641
Mining		15	9	4	3	1	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		625	636	647	659	671	684	698
Total County Demand		10,200	9,922	9,645	9,370	9,094	8,839	8,604
Total Supply	Unallocated	16,752	16,814	16,874	11,622	11,679	11,733	11,783
Municipal		387	377	360	330	295	272	259
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,097	7,562	7,362	7,164	6,967	6,785	6,616
Mining		15	9	4	3	1	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		625	636	647	659	671	684	698
Total County Supply		29,881	25,404	25,253	19,784	19,619	19,480	19,362
Total Surplus/Shortage								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		2,929	-1,332	-1,266	-1,208	-1,154	-1,092	-1,025
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		2,929	-1,332	-1,266	-1,208	-1,154	-1,092	-1,025
Total Basin Demand								
Red								
Municipal		387	377	360	330	295	272	259
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		9,168	8,894	8,628	8,372	8,121	7,877	7,641
Mining		15	9	4	3	1	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		625	636	647	659	671	684	698
Total Red Basin Demand		10,200	9,922	9,645	9,370	9,094	8,839	8,604
Total Basin Supply								
Red	Unallocated	16,752	16,814	16,874	11,622	11,679	11,733	11,783
Municipal		387	377	360	330	295	272	259
Industrial		5	6	6	6	6	6	6
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,097	7,562	7,362	7,164	6,967	6,785	6,616
Mining		15	9	4	3	1	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		625	636	647	659	671	684	698
Total Red Basin Supply		13,129	8,590	8,379	8,162	7,940	7,747	7,579
Total Basin Surplus/Shortage								
Red								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		2,929	-1,332	-1,266	-1,208	-1,154	-1,092	-1,025
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		2,929	-1,332	-1,266	-1,208	-1,154	-1,092	-1,025

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

Table 4-18.
Projected Water Demands, Supplies, and Needs
Parmer County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	655,566	490,328	370,958	328,543	297,091	281,282	268,726
	Quantity Pumped[2]	Ogallala	135,705	76,545	26,066	19,901	36,235	37,658	35,109
	Supply	(Ogallala)[3]	135,705	76,545	26,066	19,901	36,235	37,658	35,109
	Local Surface	Stock Tanks and Windmills	273	286	298	309	324	341	356
	Reclaimed Water[4]		2,486	2,486	2,486	2,486	2,486	2,486	2,486
	Total Supply		138,464	79,316	28,850	22,697	39,045	40,485	37,951
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	1,120,024	738,596	361,646	184,032	139,200	135,555	132,695
	Quantity Pumped[2]	Ogallala	289,384	182,317	60,373	31,879	15,545	14,122	16,671
	Supply	(Ogallala)[3]	289,384	182,317	60,373	31,879	15,545	14,122	16,671
	Local Surface	Stock Tanks and Windmills	530	551	575	601	626	651	680
	Reclaimed Water[4]		401	401	401	401	401	401	401
	Total Supply		290,315	183,269	61,349	32,881	16,572	15,174	17,752
	County Total								
	Quantity in Storage[1]	Ogallala	1,775,591	1,228,925	732,604	512,575	436,291	416,838	401,421
	Quantity Pumped[2]	Ogallala	425,089	258,862	86,439	51,780	51,780	51,780	51,780
	Supply	(Ogallala)[3]	425,089	258,862	86,439	51,780	51,780	51,780	51,780
	Local Surface	Stock Tanks and Windmills	803	837	873	910	950	992	1,036
	Reclaimed Water[4]		2,887	2,887	2,887	2,887	2,887	2,887	2,887
	Total Supply		428,779	262,586	90,199	55,577	55,617	55,659	55,703
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin									
Friona			803	835	872	879	870	838	791
Rural			106	110	113	112	110	106	100
	Subtotal		909	945	985	991	980	944	891
Brazos Basin									
Bovina			309	321	334	335	330	317	300
Farwell			370	388	405	410	408	393	371
Rural			287	297	305	304	298	286	270
	Subtotal		966	1,006	1,044	1,049	1,036	996	941
Total Municipal Demand			1,875	1,951	2,029	2,040	2,016	1,940	1,832
Municipal Existing Supply									
Red Basin									
Friona		Ogallala	803	835	872	0	0	0	0
Rural		Ogallala	106	110	113	112	110	106	100
	Subtotal		909	945	985	112	110	106	100
Brazos Basin									
Bovina		Ogallala	309	321	334	335	330	317	300
Farwell		Ogallala	370	388	0	0	0	0	0
Rural		Ogallala	287	297	305	304	298	286	270
	Subtotal		966	1,006	639	639	628	603	570
Total Municipal Existing Supply			1,875	1,951	1,624	751	738	709	670
Municipal Surplus/Shortage									
Red Basin									
Friona			0	0	0	-879	-870	-838	-791
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	-879	-870	-838	-791
Brazos Basin									
Bovina			0	0	0	0	0	0	0
Farwell			0	0	-405	-410	-408	-393	-371
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	-405	-410	-408	-393	-371
Total Municipal Surplus/Shortage			0	0	-405	-1,289	-1,278	-1,231	-1,162

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Table 4-18 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Red Basin									
Friona			0	0	0	879	870	838	791
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	879	870	838	791
Brazos Basin									
Bovina			0	0	0	0	0	0	0
Farwell			0	0	405	410	408	393	371
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	405	410	408	393	371
Total Municipal New Supply Need			0	0	405	1,289	1,278	1,231	1,162
Industrial Demand									
Red Basin			2,070	2,427	2,617	2,772	2,921	3,051	3,261
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Demand			2,070	2,427	2,617	2,772	2,921	3,051	3,261
Industrial Existing Supply									
Red Basin		Ogallala	2,070	2,427	2,617	2,772	2,921	3,051	3,261
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			2,070	2,427	2,617	2,772	2,921	3,051	3,261
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Red Basin			120,480	119,201	117,935	116,683	115,444	114,219	113,006
Brazos Basin			294,969	291,836	288,738	285,673	282,640	279,639	276,670
Total Irrigation Demand			415,449	411,037	406,673	402,356	398,084	393,858	389,676
Irrigation Supply									
Red Basin		Ogallala	130,668	70,171	18,355	11,954	28,090	29,312	26,461
		Reclaimed Water	2,486	2,486	2,486	2,486	2,486	2,486	2,486
Red Basin Subtotal			133,154	72,657	20,841	14,440	30,576	31,798	28,947
Brazos Basin		Ogallala	285,584	177,297	54,335	25,598	9,027	7,376	9,696
		Reclaimed Water	401	401	401	401	401	401	401
Brazos Basin Subtotal			285,985	177,698	54,736	25,999	9,428	7,777	10,097
Total Irrigation Supply			419,139	250,355	75,577	40,439	40,004	39,575	39,044
Irrigation Surplus/Shortage									
Red Basin			12,674	-46,544	-97,094	-102,243	-84,868	-82,421	-84,059
Brazos Basin			-8,984	-114,138	-234,002	-259,674	-273,212	-271,862	-266,573
Total Irrigation Surplus/Shortage			3,690	-160,682	-331,096	-361,917	-358,080	-354,283	-350,632

Continued on next page

Table 4-18 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Demand		0	0	0	0	0	0	0
Mining Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		2,046	2,494	2,797	2,968	3,153	3,347	3,553
Brazos Basin		2,817	3,434	3,849	4,087	4,338	4,606	4,890
Total Beef Feedlot Livestock Demand		4,863	5,928	6,646	7,056	7,491	7,953	8,443
Beef Feedlot Livestock Supply								
Red Basin	Ogallala	2,046	2,494	2,797	2,968	3,153	3,347	3,553
Brazos Basin	Ogallala	2,817	3,434	3,849	4,087	4,338	4,606	4,890
Total Beef Feedlot Livestock Supply		4,863	5,928	6,646	7,056	7,491	7,953	8,443
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		12	387	763	763	763	763	763
Brazos Basin		17	581	1,144	1,144	1,144	1,144	1,144
Total Dairies Demand		29	968	1,906	1,906	1,906	1,906	1,906
Dairies Supply								
Red Basin	Ogallala	12	387	763	763	763	763	763
Brazos Basin	Ogallala	17	581	1,144	1,144	1,144	1,144	1,144
Total Dairies Supply		29	968	1,906	1,906	1,906	1,906	1,906
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		273	286	298	309	324	341	356
Brazos Basin		530	551	575	601	626	651	680
Total Range & All Other Livestock Demand		803	837	873	910	950	992	1,036
Range & All Other Livestock Supply								
Red Basin	Local	273	286	298	309	324	341	356
Brazos Basin	Local	530	551	575	601	626	651	680
Total Range & All Other Livestock Supply		803	837	873	910	950	992	1,036
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		1,875	1,951	2,029	2,040	2,016	1,940	1,832
Industrial		2,070	2,427	2,617	2,772	2,921	3,051	3,261
Steam-Electric		0	0	0	0	0	0	0
Irrigation		415,449	411,037	406,673	402,356	398,084	393,858	389,676
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		4,863	5,928	6,646	7,056	7,491	7,953	8,443
Dairies		29	968	1,906	1,906	1,906	1,906	1,906
Range & All Other Livestock		803	837	873	910	950	992	1,036
Total County Demand		425,089	423,148	420,744	417,040	413,368	409,700	406,154

Continued on next page

Table 4-18 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		1,875	1,951	1,624	751	738	709	670
Industrial		2,070	2,427	2,617	2,772	2,921	3,051	3,261
Steam-Electric		0	0	0	0	0	0	0
Irrigation		419,139	250,355	75,577	40,439	40,004	39,575	39,044
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		4,863	5,928	6,646	7,056	7,491	7,953	8,443
Dairies		29	968	1,906	1,906	1,906	1,906	1,906
Range & All Other Livestock		803	837	873	910	950	992	1,036
Total County Supply		428,779	262,466	89,244	53,835	54,010	54,186	54,360
Total Surplus/Shortage								
Municipal		0	0	-405	-1,289	-1,278	-1,231	-1,162
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		3,690	-160,682	-331,096	-361,917	-358,080	-354,283	-350,632
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		3,690	-160,682	-331,501	-363,206	-359,358	-355,514	-351,794
Total Basin Demand								
Red								
Municipal		909	945	985	991	980	944	891
Industrial		2,070	2,427	2,617	2,772	2,921	3,051	3,261
Steam-Electric		0	0	0	0	0	0	0
Irrigation		120,480	119,201	117,935	116,683	115,444	114,219	113,006
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,046	2,494	2,797	2,968	3,153	3,347	3,553
Dairies		12	387	763	763	763	763	763
Range & All Other Livestock		273	286	298	309	324	341	356
Total Red Basin Demand		125,790	125,740	125,394	124,486	123,584	122,664	121,830
Brazos								
Municipal		966	1,006	1,044	1,049	1,036	996	941
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		294,969	291,836	288,738	285,673	282,640	279,639	276,670
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,817	3,434	3,849	4,087	4,338	4,606	4,890
Dairies		17	581	1,144	1,144	1,144	1,144	1,144
Range & All Other Livestock		530	551	575	601	626	651	680
Total Brazos Basin Demand		299,299	297,408	295,350	292,554	289,784	287,036	284,325
Total Basin Supply								
Red	Unallocated	459	6	306	308	306	304	308
Municipal		909	945	985	112	110	106	100
Industrial		2,070	2,427	2,617	2,772	2,921	3,051	3,261
Steam-Electric		0	0	0	0	0	0	0
Irrigation		133,154	72,657	20,841	14,440	30,576	31,798	28,947
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,046	2,494	2,797	2,968	3,153	3,347	3,553
Dairies		12	387	763	763	763	763	763
Range & All Other Livestock		273	286	298	309	324	341	356
Total Red Basin Supply		138,464	79,196	28,300	21,364	37,846	39,405	36,980
Brazos								
Municipal		966	1,006	639	639	628	603	570
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		285,985	177,698	54,736	25,999	9,428	7,777	10,097
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,817	3,434	3,849	4,087	4,338	4,606	4,890
Dairies		17	581	1,144	1,144	1,144	1,144	1,144
Range & All Other Livestock		530	551	575	601	626	651	680
Total Brazos Basin Supply		290,315	183,269	60,944	32,471	16,164	14,781	17,381

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Table 4-18 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Red								
Municipal		0	0	0	-879	-870	-838	-791
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		12,674	-46,544	-97,094	-102,243	-84,868	-82,421	-84,059
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		12,674	-46,544	-97,094	-103,122	-85,738	-83,259	-84,850
Brazos								
Municipal		0	0	-405	-410	-408	-393	-371
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-8,984	-114,138	-234,002	-259,674	-273,212	-271,862	-266,573
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		-8,984	-114,138	-234,407	-260,084	-273,620	-272,255	-266,944

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Value is the sum of reclaimed water from Excel Corp., City of Friona, City of Farwell, City of Bovina, and Lazabuddie Utility & Water Supply. The quantity of reclaimed water available from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value was held level throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Table 4-19.
Projected Water Demands, Supplies, and Needs
Swisher County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Red Basin								
	Quantity in Storage[1]	Ogallala	6,819,588	6,377,657	5,725,090	5,127,016	4,605,948	4,378,512	4,174,484
	Quantity Pumped[2]	Ogallala	109,814	93,170	84,809	75,784	66,827	64,355	63,614
	Supply	(Ogallala)[3]	109,814	93,170	84,809	75,784	66,827	64,355	63,614
	Dockum Aquifer (Santa Rosa Formation)		846	846	846	846	846	846	846
	Local Surface	Stock Tanks and Windmills	421	435	475	493	512	531	551
	Other Surface	Lake Mackenzie	417	0	0	0	0	0	0
	Total Supply		111,498	94,451	86,131	77,123	68,184	65,732	65,011
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	749,269	438,658	111,975	29,204	16,981	13,621	9,933
	Quantity Pumped[2]	Ogallala	66,489	59,724	23,582	2,488	1,098	533	531
	Supply	(Ogallala)[3]	66,489	59,724	23,582	2,488	1,098	533	531
	Local Surface	Stock Tanks and Windmills	168	167	141	139	136	133	132
	Other Surface		0	0	0	0	0	0	0
	Total Supply		66,657	59,891	23,723	2,626	1,234	666	662
	County Total								
	Quantity in Storage[1]	Ogallala	7,568,857	6,816,315	5,837,065	5,156,220	4,622,929	4,392,133	4,184,417
	Quantity Pumped[2]	Ogallala	176,303	152,893	108,391	78,271	67,924	64,888	64,145
	Supply	(Ogallala)[3]	176,303	152,893	108,391	78,271	67,924	64,888	64,145
	Dockum Aquifer (Santo Rosa Formation)		846	846	846	846	846	846	846
	Local Surface	Stock Tanks and Windmills	589	603	617	632	648	664	682
	Other Surface	Lake Mackenzie	417	0	0	0	0	0	0
	Total Supply		178,155	154,342	109,854	79,749	69,418	66,398	65,673
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Red Basin	HAPPY in Region A		6	11	17	22	27	33	38
Happy			107	109	110	111	110	108	103
Kress (Part)			80	82	82	83	81	79	76
Tulia			1,020	1,050	1,065	1,072	1,064	1,038	993
Rural			207	211	211	211	207	202	193
	Subtotal		1,414	1,452	1,468	1,477	1,462	1,427	1,365
Brazos Basin									
Kress (Part)	New listing		21	22	22	22	22	21	20
Rural			41	41	42	41	41	40	38
	Subtotal		62	63	64	63	63	61	58
Total Municipal Demand			1,476	1,515	1,532	1,540	1,525	1,488	1,423
Municipal Existing Supply									
Red Basin	HAPPY in Region A	Ogallala	6	11	17	22	27	33	38
Happy		Ogallala	107	109	110	111	110	108	103
Kress (Part)		Ogallala	80	0	0	0	0	0	0
Tulia[4]		Ogallala	302	317	324	328	324	311	288
		Dockum (Santa Rosa Formation)	302	316	324	328	324	311	288
		Lake Mackenzie	417	0	0	0	0	0	0
Tulia Subtotal			1,020	633	648	655	647	621	576
Rural		Ogallala	207	211	211	211	207	202	193
	Subtotal		1,414	953	969	977	964	931	872
Brazos Basin									
Kress (Part)	New listing	Ogallala	21	0	0	0	0	0	0
Rural		Ogallala	41	41	42	41	41	40	38
	Subtotal		62	41	42	41	41	40	38
Total Municipal Existing Supply			1,476	994	1,011	1,018	1,005	971	910

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Table 4-19 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal Surplus/Shortage									
Red Basin									
Happy			0	0	0	0	0	0	0
Kress			0	-82	-82	-83	-81	-79	-76
Tulia			0	-417	-417	-417	-417	-417	-417
Rural			0	0	0	0	0	0	0
	Subtotal		0	-499	-499	-500	-498	-496	-493
Brazos Basin									
Kress (Part)	New listing		0	-22	-22	-22	-22	-21	-20
Rural			0	0	0	0	0	0	0
	Subtotal		0	-22	-22	-22	-22	-21	-20
Total Municipal Surplus/Shortage			0	-521	-521	-522	-520	-517	-513
Municipal New Supply Need									
Red Basin									
Happy			0	0	0	0	0	0	0
Kress			0	82	82	83	81	79	76
Tulia			0	417	417	417	417	417	417
Rural			0	0	0	0	0	0	0
	Subtotal		0	499	499	500	498	496	493
Brazos Basin									
Kress (Part)	New listing		0	22	22	22	22	21	20
Rural			0	0	0	0	0	0	0
	Subtotal		0	22	22	22	22	21	20
Total Municipal New Supply Need			0	521	521	522	520	517	513
Industrial Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Demand			0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Existing Supply			0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Red Basin			0	0	0	0	0	0	0
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0

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Table 4-19 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Irrigation Demand								
Red Basin		97,872	97,313	93,233	96,205	95,655	95,108	94,565
Brazos Basin		73,834	73,412	70,333	72,575	72,161	71,749	71,338
Total Irrigation Demand		171,706	170,725	163,566	168,780	167,816	166,857	165,903
Irrigation Supply								
Red Basin	Ogallala	106,610	88,407	79,768	70,625	61,539	58,928	58,043
Brazos Basin	Ogallala	66,397	59,563	23,353	2,259	870	307	308
Total Irrigation Supply		173,007	147,970	103,121	72,884	62,409	59,235	58,351
Irrigation Surplus/Shortage								
Red Basin		8,738	-8,906	-13,465	-25,580	-34,116	-36,180	-36,522
Brazos Basin		-7,437	-13,849	-46,980	-70,316	-71,291	-71,442	-71,030
Total Irrigation Surplus/Shortage		1,301	-22,755	-60,445	-95,896	-105,407	-107,622	-107,552
Mining Demand								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Demand		0	0	0	0	0	0	0
Mining Supply								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Supply		0	0	0	0	0	0	0
Mining Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Red Basin		2,499	3,047	3,416	3,626	3,850	4,087	4,339
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		2,499	2,499	2,499	2,499	2,499	2,499	2,499
Beef Feedlot Livestock Supply								
Red Basin	Ogallala	2,499	3,047	3,416	3,626	3,850	4,087	4,339
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		2,499	3,047	3,416	3,626	3,850	4,087	4,339
Beef Feedlot Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Red Basin		3	11	18	18	18	18	18
Brazos Basin		29	97	165	165	165	165	165
Total Dairies Demand		33	108	183	183	183	183	183
Dairies Supply								
Red Basin	Ogallala	3	11	18	18	18	18	18
Brazos Basin	Ogallala	29	97	165	165	165	165	165
Total Dairies Supply		33	108	183	183	183	183	183
Dairies Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Red Basin		421	435	475	493	512	531	551
Brazos Basin		168	167	141	139	136	133	132
Total Range & All Other Livestock Demand		589	603	617	632	648	664	682
Range & All Other Livestock Supply								
Red Basin	Local	421	435	475	493	512	531	551
Brazos Basin	Local	168	167	141	139	136	133	132
Total Range & All Other Livestock Supply		589	603	617	632	648	664	682
Range & All Other Livestock Surplus/Shortage								
Red Basin		0	0	0	0	0	0	0
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-19 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Demand								
Municipal		1,476	1,515	1,532	1,540	1,525	1,488	1,423
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		171,706	170,725	163,566	168,780	167,816	166,857	165,903
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,499	2,499	2,499	2,499	2,499	2,499	2,499
Dairies		33	108	183	183	183	183	183
Range & All Other Livestock		589	603	617	632	648	664	682
Total County Demand		176,303	175,450	168,398	173,635	172,671	171,692	170,691
Total Supply	Unallocated	545	680	522	518	523	536	558
Municipal		1,476	994	1,011	1,018	1,005	971	910
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		173,007	147,970	103,121	72,884	62,409	59,235	58,351
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,499	3,047	3,416	3,626	3,850	4,087	4,339
Dairies		33	108	183	183	183	183	183
Range & All Other Livestock		589	603	617	632	648	664	682
Total County Supply		178,149	153,401	108,870	78,862	68,617	65,676	65,023
Total Surplus/Shortage								
Municipal		0	-521	-521	-522	-520	-517	-513
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		1,301	-22,755	-60,445	-95,896	-105,407	-107,622	-107,552
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	547	916	1,127	1,351	1,588	1,840
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		1,301	-22,728	-60,050	-95,291	-104,577	-106,552	-106,226
Total Basin Demand								
Red								
Municipal		1,414	1,452	1,468	1,477	1,462	1,427	1,365
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		97,872	97,313	93,233	96,205	95,655	95,108	94,565
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,499	3,047	3,416	3,626	3,850	4,087	4,339
Dairies		3	11	18	18	18	18	18
Range & All Other Livestock		421	435	475	493	512	531	551
Total Red Basin Demand		102,209	102,258	98,610	101,820	101,497	101,172	100,838
Brazos								
Municipal		62	63	64	63	63	61	58
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		73,834	73,412	70,333	72,575	72,161	71,749	71,338
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		29	97	165	165	165	165	165
Range & All Other Livestock		168	167	141	139	136	133	132
Total Brazos Basin Demand		74,094	73,740	70,704	72,942	72,525	72,109	71,693
Total Basin Supply								
Red	Unallocated	545	680	522	518	523	536	558
Municipal		1,414	953	969	977	964	931	872
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		106,610	88,407	79,768	70,625	61,539	58,928	58,043
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		2,499	3,047	3,416	3,626	3,850	4,087	4,339
Dairies		3	11	18	18	18	18	18
Range & All Other Livestock		421	435	475	493	512	531	551
Total Red Basin Supply		111,492	93,532	85,168	76,258	67,405	65,031	64,381
Brazos								
Municipal		62	41	42	41	41	40	38
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		66,397	59,563	23,353	2,259	870	307	308
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		29	97	165	165	165	165	165
Range & All Other Livestock		168	167	141	139	136	133	132
Total Brazos Basin Supply		66,657	59,869	23,701	2,604	1,211	645	642

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Table 4-19 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Red								
Municipal		0	-499	-499	-500	-498	-496	-493
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		8,738	-8,906	-13,465	-25,580	-34,116	-36,180	-36,522
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage		8,738	-9,405	-13,964	-26,080	-34,614	-36,676	-37,015
Brazos								
Municipal		0	-22	-22	-22	-22	-21	-20
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-7,437	-13,849	-46,980	-70,316	-71,291	-71,442	-71,030
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		-7,437	-13,871	-47,003	-70,338	-71,314	-71,464	-71,051

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] Tulia is obtaining a part of its municipal water from the Santa Rosa formation. The information available indicates that the aquifer can supply the quantities shown here for the projection period.

Table 4-20.
Projected Water Demands, Supplies, and Needs
Terry County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	447,345	424,035	403,426	383,304	435,139	400,547	374,030
	Quantity Pumped[2]	Ogallala	8,237	6,069	5,756	5,461	4,704	4,713	4,719
	Supply	(Ogallala)[3]	8,237	6,069	5,756	5,461	4,704	4,713	4,719
	Local Surface	Stock Tanks and Windmills	4	7	10	8	12	10	7
	Other Surface		0	0	0	0	0	0	0
	Total Supply		8,241	6,075	5,766	5,469	4,717	4,723	4,725
		Ogallala							
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	4,129,436	3,737,389	3,397,878	3,179,834	2,993,744	3,120,368	3,245,025
	Quantity Pumped[2]	Ogallala	158,282	113,165	86,251	67,983	54,595	54,570	54,553
	Supply	(Ogallala)[3]	158,282	113,165	86,251	67,983	54,595	54,570	54,553
	Other Ground	Ogallala (CRMWA - Roberts Co.)	879	879	879	879	879	879	879
	Local Surface	Stock Tanks and Windmills	115	115	114	119	118	124	130
	Other Surface	Lake Meredith (CRMWA)	1,670	1,670	1,670	1,670	1,670	1,670	1,670
	Total Supply		160,946	115,829	88,915	70,652	57,262	57,243	57,232
	County Total								
	Quantity in Storage[1]	Ogallala	4,576,781	4,161,424	3,801,304	3,563,138	3,428,883	3,520,915	3,619,055
	Quantity Pumped[2]	Ogallala	166,519	119,234	92,007	73,445	59,299	59,283	59,271
	Supply	(Ogallala)[3]	166,519	119,234	92,007	73,445	59,299	59,283	59,271
	Other Ground	Ogallala (CRMWA - Roberts Co.)	879	879	879	879	879	879	879
	Local Surface	Stock Tanks and Windmills	119	121	124	127	130	134	137
	Other Surface	Lake Meredith (CRMWA)	1,670	1,670	1,670	1,670	1,670	1,670	1,670
	Total Supply		169,187	121,904	94,681	76,121	61,979	61,966	61,958
Data LERWPG		Ogallala							
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Rural			13	14	14	15	16	15	15
	Subtotal		13	14	14	15	16	15	15
Colorado Basin									
Brownfield			2,593	2,747	2,905	3,047	3,181	3,185	3,167
Meadow			70	73	75	78	80	79	79
Rural			362	376	393	407	419	418	415
	Subtotal		3,025	3,196	3,373	3,532	3,680	3,682	3,661
Total Municipal			3,038	3,210	3,387	3,547	3,696	3,697	3,676
Municipal Existing Supply									
Brazos Basin									
Rural		Ogallala	13	14	14	15	16	15	15
	Subtotal		13	14	14	15	16	15	15
Colorado Basin									
Brownfield		Ogallala	295	267	241	218	197	178	161
		Lake Meredith (CRMWA)[4]	1,670	1,670	1,670	1,670	1,670	1,670	1,670
		Ogallala (CRMWA - Roberts Co.)[4]	879	879	879	879	879	879	879
Brownfield Subtotal			2,844	2,816	2,790	2,767	2,746	2,727	2,710
Meadow		Ogallala	70	73	75	78	80	79	79
Rural		Ogallala	362	376	393	407	419	418	415
	Subtotal		3,276	3,265	3,258	3,252	3,245	3,224	3,204
Total Municipal	Existing Supply		3,289	3,279	3,272	3,267	3,261	3,239	3,219
Municipal Surplus/Shortage									
Brazos Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Colorado Basin									
Brownfield			251	69	-115	-280	-435	-458	-457
Meadow			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		251	69	-115	-280	-435	-458	-457
Total Municipal	Surplus/Shortage		251	69	-115	-280	-435	-458	-457

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Table 4-20 Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Brazos Basin									
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	0	0	0	0	0
Colorado Basin									
Brownfield			0	0	115	280	435	458	457
Meadow			0	0	0	0	0	0	0
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	115	280	435	458	457
Total Municipal	New Supply Need		0	0	115	280	435	458	457
Industrial Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			1	1	1	1	1	1	1
Total Industrial	Demand		1	1	1	1	1	1	1
Industrial Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin		Ogallala	1	1	1	1	1	1	1
Total Industrial	Existing Supply		1	1	1	1	1	1	1
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial	Surplus/Shortage		0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Industrial	New Supply Need		0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric	Demand		0	0	0	0	0	0	0
Steam-Electric Existing Supply									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric	Existing Supply		0	0	0	0	0	0	0
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric	Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Colorado Basin			0	0	0	0	0	0	0
Total Steam-Electric	New Supply Need		0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			10,157	9,636	9,142	8,674	8,229	7,807	7,407
Colorado Basin			192,984	183,089	173,702	164,797	156,348	148,332	140,726
Total Irrigation	Demand		203,141	192,725	182,844	173,471	164,577	156,139	148,133
Irrigation Supply									
Brazos Basin		Ogallala	8,224	6,055	5,742	5,446	4,688	4,698	4,704
Colorado Basin		Ogallala	156,624	111,815	85,001	66,685	53,238	53,277	53,281
Total Irrigation	Supply		164,848	117,870	90,743	72,132	57,926	57,975	57,984
Irrigation Surplus/Shortage									
Brazos Basin			-1,933	-3,581	-3,400	-3,228	-3,541	-3,109	-2,703
Colorado Basin			-36,360	-71,274	-88,701	-98,112	-103,110	-95,055	-87,445
Total Irrigation	Surplus/Shortage		-38,293	-74,855	-92,101	-101,339	-106,651	-98,164	-90,149

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Table 4-20 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Mining Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		930	554	266	155	66	0	0
Total Mining Demand		930	554	266	155	66	0	0
Mining Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin	Ogallala	930	554	266	155	66	0	0
Total Mining Supply		930	554	266	155	66	0	0
Mining Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	80	159	159	159	159	159
Total Dairies Demand		0	80	159	159	159	159	159
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin	Ogallala	0	80	159	159	159	159	159
Total Dairies Supply		0	80	159	159	159	159	159
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		4	7	10	8	12	10	7
Colorado Basin		115	115	114	119	118	124	130
Total Range & All Other Livestock Demand		119	121	124	127	130	134	137
Range & All Other Livestock Supply								
Brazos Basin	Local	4	7	10	8	12	10	7
Colorado Basin	Local	115	115	114	119	118	124	130
Total Range & All Other Livestock Supply		119	121	124	127	130	134	137
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		3,038	3,210	3,387	3,547	3,696	3,697	3,676
Industrial		1	1	1	1	1	1	1
Steam-Electric		0	0	0	0	0	0	0
Irrigation		203,141	192,725	182,844	173,471	164,577	156,139	148,133
Mining		930	554	266	155	66	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	80	159	159	159	159	159
Range & All Other Livestock		119	121	124	127	130	134	137
Total County Demand		207,229	196,691	186,781	177,460	168,629	160,130	152,106

Continued on next page

Table 4-20 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Supply								
Municipal		3,289	3,279	3,272	3,267	3,261	3,239	3,219
Industrial		1	1	1	1	1	1	1
Steam-Electric		0	0	0	0	0	0	0
Irrigation		164,848	117,870	90,743	72,132	57,926	57,975	57,984
Mining		930	554	266	155	66	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	80	159	159	159	159	159
Range & All Other Livestock		119	121	124	127	130	134	137
Total County Supply		169,187	121,904	94,566	75,841	61,544	61,508	61,501
Total Surplus/Shortage								
Municipal		251	69	-115	-280	-435	-458	-457
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-38,293	-74,855	-92,101	-101,339	-106,651	-98,164	-90,149
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		-38,042	-74,787	-92,215	-101,619	-107,085	-98,621	-90,605
Total Basin Demand								
Brazos								
Municipal		13	14	14	15	16	15	15
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		10,157	9,636	9,142	8,674	8,229	7,807	7,407
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		4	7	10	8	12	10	7
Total Brazos Basin Demand		10,174	9,657	9,166	8,697	8,257	7,832	7,429
Colorado								
Municipal		3,025	3,196	3,373	3,532	3,680	3,682	3,661
Industrial		1	1	1	1	1	1	1
Steam-Electric		0	0	0	0	0	0	0
Irrigation		192,984	183,089	173,702	164,797	156,348	148,332	140,726
Mining		930	554	266	155	66	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	80	159	159	159	159	159
Range & All Other Livestock		115	115	114	119	118	124	130
Total Colorado Basin Demand		197,055	187,034	177,616	168,763	160,372	152,298	144,677
Total Basin Supply								
Brazos								
Municipal		13	14	14	15	16	15	15
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		8,224	6,055	5,742	5,446	4,688	4,698	4,704
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		4	7	10	8	12	10	7
Total Brazos Basin Supply		8,241	6,075	5,766	5,469	4,717	4,723	4,725
Colorado								
Municipal		3,276	3,265	3,258	3,252	3,245	3,224	3,204
Industrial		1	1	1	1	1	1	1
Steam-Electric		0	0	0	0	0	0	0
Irrigation		156,624	111,815	85,001	66,685	53,238	53,277	53,281
Mining		930	554	266	155	66	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	80	159	159	159	159	159
Range & All Other Livestock		115	115	114	119	118	124	130
Total Colorado Basin Supply		160,946	115,829	88,800	70,372	56,827	56,785	56,775

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Table 4-20 Concluded

Basin	Source	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Surplus/Shortage								
Brazos								
Municipal		0	0	0	0	0	0	0
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-1,933	-3,581	-3,400	-3,228	-3,541	-3,109	-2,703
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		-1,933	-3,581	-3,400	-3,228	-3,541	-3,109	-2,703
Colorado								
Municipal		251	69	-115	-280	-435	-458	-457
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		-36,360	-71,274	-88,701	-98,112	-103,110	-95,055	-87,445
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		-36,109	-71,206	-88,816	-98,392	-103,545	-95,513	-87,902

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

[4] The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

Table 4-21.
Projected Water Demands, Supplies, and Needs
Yoakum County
Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Colorado Basin								
	Quantity in Storage[1]	Ogallala	4,381,613	3,620,371	3,017,014	2,457,580	1,939,772	1,457,384	1,005,116
	Quantity Pumped[2]	Ogallala	133,881	103,958	99,734	95,204	91,342	88,062	85,269
	Supply	(Ogallala)[3]	133,881	103,958	99,734	95,204	91,342	88,062	85,269
	Local Surface	Stock Tanks and Windmills	214	218	273	278	282	288	293
	Other Surface		0	0	0	0	0	0	0
	Total Supply		134,095	104,176	100,007	95,482	91,624	88,350	85,562
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Colorado Basin									
Denver City			955	1,043	1,126	1,172	1,220	1,181	1,141
Plains			378	416	448	468	488	473	457
Rural			264	286	305	314	323	312	302
	Subtotal		1,597	1,745	1,879	1,954	2,031	1,966	1,900
Total Municipal Demand			1,597	1,745	1,879	1,954	2,031	1,966	1,900
Municipal Existing Supply									
Colorado Basin									
Denver City		Ogallala	955	1,043	1,126	0	0	0	0
Plains		Ogallala	378	416	0	0	0	0	0
Rural		Ogallala	264	286	305	314	323	312	302
	Subtotal		1,597	1,745	1,431	314	323	312	302
Total Municipal Existing Supply			1,597	1,745	1,431	314	323	312	302
Municipal Surplus/Shortage									
Colorado Basin									
Denver City			0	0	0	-1,172	-1,220	-1,181	-1,141
Plains			0	0	-448	-468	-488	-473	-457
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	-448	-1,640	-1,708	-1,654	-1,598
Total Municipal Surplus/Shortage			0	0	-448	-1,640	-1,708	-1,654	-1,598
Municipal New Supply Need									
Colorado Basin									
Denver City			0	0	0	1,172	1,220	1,181	1,141
Plains			0	0	448	468	488	473	457
Rural			0	0	0	0	0	0	0
	Subtotal		0	0	448	1,640	1,708	1,654	1,598
Total Municipal New Supply Need			0	0	448	1,640	1,708	1,654	1,598
Industrial Demand									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Demand			0	0	0	0	0	0	0
Industrial Existing Supply									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Existing Supply			0	0	0	0	0	0	0
Industrial Surplus/Shortage									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	
Industrial New Supply Need									
Colorado Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Colorado Basin			1,852	2,597	3,718	4,346	5,113	6,047	7,186
Total Steam-Electric Demand			1,852	2,597	3,718	4,346	5,113	6,047	7,186

Continued on next page

Table 4-21 Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Steam-Electric Existing Supply								
Colorado Basin	Ogallala	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Total Steam-Electric Existing Supply		1,852	2,597	3,718	4,346	5,113	6,047	7,186
Steam-Electric Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage		0	0	0	0	0	0	0
Steam-Electric New Supply Need								
Colorado Basin		0	0	0	0	0	0	0
Total Steam-Electric New Supply Need		0	0	0	0	0	0	0
Irrigation Demand								
Colorado Basin		127,059	120,979	115,187	109,674	104,426	99,427	94,668
Total Irrigation Demand		127,059	120,979	115,187	109,674	104,426	99,427	94,668
Irrigation Supply								
Colorado Basin	Ogallala	127,273	97,200	92,443	87,806	83,873	79,993	76,183
Total Irrigation Supply		127,273	97,200	92,443	87,806	83,873	79,993	76,183
Irrigation Surplus/Shortage								
Colorado Basin		214	-23,779	-22,744	-21,868	-20,553	-19,434	-18,485
Total Irrigation Surplus/Shortage		214	-23,779	-22,744	-21,868	-20,553	-19,434	-18,485
Mining Demand								
Colorado Basin		3,159	2,416	1,524	706	204	56	0
Total Mining Demand		3,159	2,416	1,524	706	204	56	0
Mining Supply								
Colorado Basin	Ogallala	3,159	2,416	1,524	706	204	56	0
Total Mining Supply		3,159	2,416	1,524	706	204	56	0
Mining Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Mining Surplus/Shortage		0	0	0	0	0	0	0
Beef Feedlot Livestock Demand								
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Demand		0	0	0	0	0	0	0
Beef Feedlot Livestock Supply								
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Supply		0	0	0	0	0	0	0
Beef Feedlot Livestock Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Colorado Basin		214	218	273	278	282	288	293
Total Range & All Other Livestock Demand		214	218	273	278	282	288	293
Range & All Other Livestock Supply								
Colorado Basin	Local	214	218	273	278	282	288	293
Total Range & All Other Livestock Supply		214	218	273	278	282	288	293
Range & All Other Livestock Surplus/Shortage								
Colorado Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0

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Table 4-21 Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Demand								
Municipal		1,597	1,745	1,879	1,954	2,031	1,966	1,900
Industrial		0	0	0	0	0	0	0
Steam-Electric		1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation		127,059	120,979	115,187	109,674	104,426	99,427	94,668
Mining		3,159	2,416	1,524	706	204	56	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		214	218	273	278	282	288	293
Total County Demand		133,881	127,955	122,581	116,958	112,056	107,784	104,047
Total Supply								
Municipal		1,597	1,745	1,431	314	323	312	302
Industrial		0	0	0	0	0	0	0
Steam-Electric		1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation		127,273	97,200	92,443	87,806	83,873	79,993	76,183
Mining		3,159	2,416	1,524	706	204	56	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		214	218	273	278	282	288	293
Total County Supply		134,095	104,176	99,389	93,450	89,795	86,696	83,964
Total Surplus/Shortage								
Municipal		0	0	-448	-1,640	-1,708	-1,654	-1,598
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		214	-23,779	-22,744	-21,868	-20,553	-19,434	-18,485
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		214	-23,779	-23,192	-23,508	-22,261	-21,088	-20,083
Total Basin Demand								
Colorado								
Municipal		1,597	1,745	1,879	1,954	2,031	1,966	1,900
Industrial		0	0	0	0	0	0	0
Steam-Electric		1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation		127,059	120,979	115,187	109,674	104,426	99,427	94,668
Mining		3,159	2,416	1,524	706	204	56	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		214	218	273	278	282	288	293
Total Colorado Basin Demand		133,881	127,955	122,581	116,958	112,056	107,784	104,047
Total Basin Supply								
Colorado								
Municipal		1,597	1,745	1,431	314	323	312	302
Industrial		0	0	0	0	0	0	0
Steam-Electric		1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation		127,273	97,200	92,443	87,806	83,873	79,993	76,183
Mining		3,159	2,416	1,524	706	204	56	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		214	218	273	278	282	288	293
Total Colorado Basin Supply		134,095	104,176	99,389	93,450	89,795	86,696	83,964
Total Basin Surplus/Shortage								
Colorado								
Municipal		0	0	-448	-1,640	-1,708	-1,654	-1,598
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		214	-23,779	-22,744	-21,868	-20,553	-19,434	-18,485
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage		214	-23,779	-23,192	-23,508	-22,261	-21,088	-20,083

[1] Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

[2] Ibid.

[3] Supply means quantity of water available from the Ogallala Aquifer in the year projected.

Table 4-22.
Projected Water Demands, Supplies, and Needs
River Basin and Llano Estacado Region Summaries
Llano Estacado Region

		Total in	Total in	Projections					
Basin		**1990**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
		(acft)	**(acft)**	**(acft)**	**(acft)**	**(acft)**	**(acft)**	**(acft)**	**(acft)**
Canadian Basin Demand									
Municipal			0	1	1	1	1	1	1
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			0	0	0	0	0	0	0
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			220	281	317	326	336	344	353
Total Canadian Basin Demand			220	282	318	327	337	345	354
Canadian Basin Supply									
Municipal			0	1	1	1	1	1	1
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			0	0	0	0	0	0	0
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			220	281	317	326	336	344	353
Total Canadian Basin Supply			220	282	318	327	337	345	354
Canadian Basin Surplus/Shortage [1]									
Municipal			0	0	0	0	0	0	0
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			0	0	0	0	0	0	0
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total Canadian Basin Surplus/Shortage [1]			0	0	0	0	0	0	0
Red Basin Demand									
Municipal			7,548	7,875	8,177	8,378	8,474	8,417	8,301
Industrial			3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric			0	0	0	0	0	0	0
Irrigation			909,585	883,748	855,251	834,628	811,278	788,702	766,868
Mining			85	50	24	14	6	0	0
Beef Feedlot Livestock			14,731	17,958	20,134	21,374	22,693	24,091	25,576
Dairies			166	2,116	4,067	4,066	4,068	4,070	4,072
Range & All Other Livestock			5,100	5,227	5,442	5,645	5,863	6,095	6,335
Total Red Basin Demand			940,619	920,973	897,432	878,721	857,266	836,492	816,626
Red Basin Supply	Unallocated		25,349	25,240	25,429	17,452	17,514	17,577	17,649
Municipal			8,128	7,501	7,745	10,535	10,686	10,684	10,612
Industrial			3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric			0	0	0	0	0	0	0
Irrigation			932,228	549,954	386,184	287,354	226,910	217,108	203,342
Mining			85	50	24	14	6	0	0
Beef Feedlot Livestock			14,731	17,958	20,134	21,374	22,693	24,091	25,576
Dairies			166	2,116	4,067	4,066	4,068	4,070	4,072
Range & All Other Livestock			5,100	5,227	5,442	5,645	5,863	6,095	6,335
Total Red Basin Supply			989,190	612,044	453,362	351,055	292,623	284,742	273,061

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Table 4-22 Continued

Basin		Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Red Basin Surplus/Shortage [1]									
Municipal			580	-374	-432	2,157	2,212	2,267	2,311
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			22,643	-333,794	-469,067	-547,274	-584,368	-571,594	-563,526
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage [1]			23,223	-334,168	-469,499	-545,117	-582,156	-569,327	-561,215
Brazos Basin Demand									
Municipal			68,459	71,507	73,666	74,273	73,627	73,602	72,383
Industrial			6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric			23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation			2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
Mining			5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock			10,983	13,388	15,009	15,936	16,917	17,960	19,067
Dairies			1,017	4,453	7,887	7,887	7,885	7,883	7,882
Range & All Other Livestock			4,088	4,210	4,446	4,575	4,717	4,856	5,001
Total Brazos Basin Demand			2,617,622	2,537,185	2,455,853	2,382,742	2,309,766	2,241,818	2,177,683
Brazos Basin Supply	Unallocated		4,807	4,654	4,654	3,166	3,164	3,162	3,166
Municipal			93,648	88,663	86,165	80,541	75,960	71,345	69,549
Industrial			6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric			23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation			2,572,639	1,772,643	1,412,335	1,091,947	806,169	698,976	652,349
Mining			5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock			10,983	13,388	15,009	15,936	16,917	17,960	19,067
Dairies			1,017	4,452	7,887	7,887	7,885	7,883	7,882
Range & All Other Livestock			4,088	4,210	4,446	4,575	4,717	4,856	5,001
Total Brazos Basin Supply			2,723,137	1,922,399	1,563,021	1,240,031	955,006	849,837	810,102
Brazos Basin Surplus/Shortage [1]									
Municipal			25,189	17,156	12,499	6,268	2,333	-2,257	-2,834
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			75,519	-636,597	-909,985	-1,152,145	-1,360,256	-1,392,887	-1,367,913
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage [1]			100,707	-619,441	-897,486	-1,145,877	-1,357,923	-1,395,144	-1,370,747
Colorado Basin Demand									
Municipal			11,315	11,995	12,621	13,058	13,371	13,145	12,864
Industrial			102	120	130	138	145	151	163
Steam-Electric			1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation			941,172	893,030	847,371	804,060	762,975	724,003	687,033
Mining			15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock			500	609	683	725	770	817	868
Dairies			0	80	159	159	159	159	159
Range & All Other Livestock			918	936	1,045	1,068	1,086	1,113	1,144
Total Colorado Basin Demand			971,580	921,959	873,842	828,548	785,935	746,140	709,673
Colorado Basin Supply									
Municipal			12,294	12,226	11,747	10,724	10,762	10,422	10,280
Industrial			102	120	130	138	145	151	163
Steam-Electric			1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation			911,179	621,171	520,478	463,656	416,615	365,050	339,172
Mining			15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock			500	609	683	725	770	817	868
Dairies			0	80	159	159	159	159	159
Range & All Other Livestock			918	936	1,045	1,068	1,086	1,113	1,144
Total Colorado Basin Supply			942,566	650,331	546,075	485,810	436,966	384,465	359,228

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Table 4-22 Concluded

Basin		Total in 1990 (acft)	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Colorado Basin Surplus/Shortage [1]									
Municipal			979	231	-874	-2,334	-2,609	-2,723	-2,584
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			-29,993	-271,859	-326,893	-340,404	-346,360	-358,953	-347,861
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage [1]			-29,014	-271,629	-327,767	-342,738	-348,969	-361,675	-350,444
Llano Estacado Region Demand									
Municipal			87,322	91,378	94,465	95,710	95,473	95,165	93,549
Industrial			10,064	11,778	12,749	13,540	14,296	14,945	15,999
Steam-Electric			25,618	25,645	25,821	30,188	35,511	42,000	49,910
Irrigation			4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163
Mining			21,436	16,324	10,280	6,359	2,852	728	258
Beef Feedlot Livestock			26,215	31,955	35,826	38,035	40,380	42,869	45,512
Dairies			1,183	6,648	12,112	12,112	12,112	12,112	12,112
Range & All Other Livestock			10,326	10,653	11,250	11,614	12,001	12,408	12,833
Total Llano Estacado Region Demand			4,530,041	4,380,400	4,227,446	4,090,338	3,953,303	3,824,795	3,704,336
Llano Estacado Region Supply									
	Unallocated		30,156	29,894	30,083	20,617	20,677	20,739	20,815
Municipal			114,070	108,391	105,658	101,801	97,409	92,452	90,443
Industrial			10,064	11,778	12,749	13,540	14,296	14,945	15,999
Steam-Electric			25,618	25,645	25,821	30,188	35,511	42,000	49,910
Irrigation			4,416,046	2,943,768	2,318,996	1,842,957	1,449,693	1,281,135	1,194,864
Mining			21,436	16,324	10,280	6,359	2,852	728	258
Beef Feedlot Livestock			26,215	31,955	35,826	38,035	40,380	42,869	45,512
Dairies			1,183	6,648	12,112	12,112	12,112	12,112	12,112
Range & All Other Livestock			10,326	10,653	11,250	11,614	12,001	12,408	12,833
Total Llano Estacado Region Supply			4,655,113	3,185,056	2,562,776	2,077,223	1,684,932	1,519,388	1,442,745
Llano Estacado Region Surplus/Shortage [1]									
Municipal			26,748	17,013	11,193	6,091	1,936	-2,713	-3,106
Industrial			0	0	0	0	0	0	0
Steam-Electric			0	0	0	0	0	0	0
Irrigation			68,169	-1,242,250	-1,705,946	-2,039,823	-2,290,985	-2,323,433	-2,279,299
Mining			0	0	0	0	0	0	0
Beef Feedlot Livestock			0	0	0	0	0	0	0
Dairies			0	0	0	0	0	0	0
Range & All Other Livestock			0	0	0	0	0	0	0
Total Llano Estacado Region Surplus/Shortage			94,916	-1,225,237	-1,694,753	-2,033,732	-2,289,048	-2,326,146	-2,282,406

Notes:

[1] The values listed in this section of the table are not necessarily additive due to the fact that demands and supplies are not necessarily located in close proximity to each other.

It is important to note that the computations of supply and demand have been based upon county level data, and therefore show the county balance of shortage or surplus. This method of analysis may show a county or a user group within the county as having a surplus of water when individuals of user groups have shortages (i.e., the surplus water is neither in a location nor an ownership such that it can be obtained by users who need it). This condition most likely applies to each user group of each county, and cannot be addressed unless plans are developed for each individual water user.

4.2 Water Needs Projections for Wholesale Water Providers

For purposes of this regional planning project, and in accordance with TWDB Rules, water supply projections and needs projections are tabulated for each Wholesale Water Provider of the Llano Estacado Water Planning (Table 4-23 and Appendix F). For each Wholesale Water Provider the water demands were brought forward from Section 2, Population and Water Demand Projections (Table 2-22), and water supplies were brought forward from Section 3, Water Supply Projections for the Planning Region.

Of the four Wholesale Water Providers of the region, all four are projected to have a water shortage during the planning period (Table 4-23). More detailed information on projected demands, supplies, and needs for each WWP is provided in Appendix G.

4.3 Socioeconomic Impacts of Not Meeting Projected Water Needs

Section 357.7(a)(4) of the rules for the development of regional water plans requires that the social and economic impacts of not meeting regional water supply needs be evaluated by the Regional Water Planning Groups (RWPGs). The TWDB conducted the required analysis of the impacts of the identified needs for the Llano Estacado Region using the same methodology that was used for all other regions. The results of this analysis are presented for information purposes. These results give an indication of the significance of having an adequate water supply, and should be viewed by individuals and public policymakers in that light. The results of the social and economic impact analyses have not been used in any other way in the development of this water plan, since the TWDB Regional Water Planning Rules specified that the RWPG was to develop a water plan to meet the projected needs (shortages) of each water user group unless it was determined that it was not feasible to meet one or more of the projected needs.

The projected total water demands for the Llano Estacado Region decrease from 4.38 million acft in 2010 to 4.09 million acft in 2030, and 3.70 million acft in 2060 (Tables 2-19 and 4-24). Under historic drought of record water supply conditions, and with no water management strategies in place, water needs (shortages) are projected to be 1.26 million acft/yr in 2010, increasing to 2.08 million acft/yr in 2030 and to 2.34 million acft/yr by 2060 (Table 4-24).

Table 4-23.
Projected Water Demands, Supplies and Needs for Wholesale Water Providers Llano Estacado Water Planning Region

Wholesale Providers	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Canadian River Municipal Water Authority (CRMWA)							
CRMWA Customer Demands		103,855	104,269	104,434	104,391	103,924	103,388
Supplies to Region O		53,645	53,515	51,001	48,490	45,567	45,516
Supplies to Region A		49,003	49,020	46,405	43,789	41,615	41,615
Surplus/Shortages (Needs)		-1,207	-1,734	-7,028	-12,112	-16,742	-16,257
City of Lubbock							
CRMWA Supply	42,535	38,826	38,696	36,182	33,671	32,360	32,309
Bailey County Supply	8,092	8,353	8,516	8,530	8,407	8,470	8,383
Lake Alan Henry Supply	0	0	0	0	0	0	0
Total Supply	50,627	47,179	47,212	44,712	42,078	40,830	40,692
Projected Demands (Lubbock and Customers)	41,910	44,363	44,330	44,541	44,043	44,495	44,105
Surplus/Shortages (Needs)	8,717	2,816	2,882	171	-1,965	-3,665	-3,413
Mackenzie Municipal Water Authority (MMWA)							
Lake Mackenzie supply	864	0	0	0	0	0	0
Projected Demands	2,046	2,100	2,133	2,128	2,098	2,030	1,936
Surplus/Shortages (Needs)	-1,182	-2,100	-2,133	-2,128	-2,098	-2,030	-1,936
White River Municipal Water District (WRMWD)							
White River Lake Supply	2,003	1,999	1,947	1,463	979	495	8
Groundwater Supply							
Total Supply	2,003	1,999	1,947	1,463	979	495	8
Projected Municipal Demands	3,164	2,545	2,080	1,872	1,689	1,537	1,489
Projected Mining and Industrial Demands	1,625	970	470	277	123	8	8
Total Demands	4,789	3,515	2,550	2,149	1,812	1,545	1,497
Surplus/Shortages (Needs)	-2,786	-1,516	-603	-686	-833	-1,050	-1,489
Information below is from Region A							<><><>
CRMWA Supplies to REGION A							
SOUTHWESTERN PUBLIC SERVICE		905	0	0	0	0	0
AMARILLO	42,964	40,532	41,454	38,839	36,223	34,049	34,049
BORGER	700	3,000	3,000	3,000	3,000	3,000	3,000
PAMPA	3,499	4,566	4,566	4,566	4,566	4,566	4,566
REGION A CRMWA Supply TOTALS	47,163	49,003	49,020	46,405	43,789	41,615	41,615
CRMWA Supplies to REGION O							
BROWNFIELD	1,571	2,549	2,549	2,549	2,549	2,549	2,549
LAMESA	1,647	2,528	2,528	2,528	2,528	2,328	2,328
LEVELLAND	1,842	3,236	3,236	3,236	3,236	2,808	2,808
LUBBOCK	37,182	38,826	38,696	36,182	33,671	32,360	32,309
O'DONNELL DAWSON CO	20	58	58	58	58	58	58
O'DONNELL LYNN CO	145	264	264	264	264	234	234
PLAINVIEW	3,291	4,281	4,281	4,281	4,281	3,881	3,881
SLATON	914	1,369	1,369	1,369	1,369	889	889
TAHOKA	379	534	534	534	534	460	460
REGION O CRMWA SUPPLY TOTALS	46,991	53,645	53,515	51,001	48,490	45,567	45,516
Meredith Safe Yield	69,750	63,750	63,750	63,750	63,750	63,750	63,750
Groundwater	40,000	40,000	40,000	35,000	30,000	35,031	25,031
CRMWA Total (Determined by Pipeline Capacity)	109,750	103,750	103,750	98,750	93,750	98,781	88,781

Table 4-24.
Projected Municipal and Irrigation Water Needs (Shortages) and Socioeconomic Impacts of Failing to Meet Projected Water Needs (Shortages)
Llano Estacado Water Planning Region

Counties	Units	Years					
		2010	2020	2030	2040	2050	2060
Projected Municipal Water Needs (shortages)							
Bailey	acft/yr	0	0	0	0	0	0
Briscoe	acft/yr	235	222	215	208	200	194
Castro	acft/yr	0	0	1,137	1,159	1,410	1,386
Cochran	acft/yr	0	560	565	547	521	496
Crosby	acft/yr	0	0	41	76	415	762
Dawson	acft/yr	0	0	0	0	0	0
Deaf Smith	acft/yr	0	0	0	0	0	0
Dickens	acft/yr	0	0	0	0	151	257
Floyd	acft/yr	0	0	240	234	244	212
Gaines	acft/yr	449	482	502	513	506	499
Garza	acft/yr	22	22	22	283	265	228
Hale	acft/yr	0	508	1,035	1,044	1,344	1,318
Hockley	acft/yr	263	620	716	704	673	702
Lamb	acft/yr	0	412	426	717	709	700
Lubbock	acft/yr	1,254	1,798	1,920	2,278	3,918	3,672
Lynn	acft/yr	0	68	65	63	60	55
Motley	acft/yr	0	0	0	0	0	0
Parmer	acft/yr	0	405	1,289	1,278	1,231	1,162
Swisher	acft/yr	521	521	522	520	517	513
Terry	acft/yr	0	115	280	435	458	457
Yoakum	acft/yr	0	448	1,640	1,708	1,654	1,598
Total Municipal Needs (Shortages)	**acft/yr**	**2,744**	**6,181**	**10,615**	**11,767**	**14,276**	**14,211**

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Table 4-24 continued

Counties	Units	Years					
		2010	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Irrigation Water Needs (shortages)							
Bailey	acft/yr	85,285	92,076	92,835	94,094	94,354	93,597
Briscoe	acft/yr	0	4,822	12,136	13,651	14,886	14,581
Castro	acft/yr	146,143	192,522	265,683	355,947	357,456	351,768
Cochran	acft/yr	39,909	38,596	37,006	35,505	76,645	72,644
Crosby	acft/yr	10,888	10,431	10,185	9,728	8,353	7,960
Dawson	acft/yr	95,781	94,812	90,085	86,142	79,397	73,240
Deaf Smith	acft/yr	168,813	193,978	222,967	253,025	245,379	240,650
Dickens	acft/yr	3,407	3,266	3,133	2,999	2,868	2,737
Floyd	acft/yr	90,731	106,390	108,967	108,966	105,148	100,072
Gaines	acft/yr	67,572	105,734	119,738	127,900	134,572	140,268
Garza	acft/yr	4,712	4,301	3,995	3,721	3,455	3,212
Hale	acft/yr	20,936	55,454	139,354	206,865	224,491	223,093
Hockley	acft/yr	62,401	74,555	81,841	86,796	82,789	80,584
Lamb	acft/yr	114,256	158,591	202,325	240,170	250,798	253,586
Lubbock	acft/yr	66,665	85,695	95,320	106,660	100,194	96,308
Lynn	acft/yr	0	0	0	0	0	0
Motley	acft/yr	1,332	1,266	1,208	1,154	1,092	1,025
Parmer	acft/yr	160,682	331,096	361,917	358,080	354,283	350,632
Swisher	acft/yr	22,755	60,445	95,896	105,407	107,622	107,552
Terry	acft/yr	74,855	92,101	101,339	106,651	98,164	90,149
Yoakum	acft/yr	23,779	22,744	21,868	20,553	19,434	18,485
Total Irrigation Needs (Shortages)	**acft/yr**	**1,260,902**	**1,728,875**	**2,067,798**	**2,324,014**	**2,361,380**	**2,322,143**
Projected Total Water Demands (Table 4-22)	**acft/yr**	**4,380,400**	**4,227,446**	**4,090,338**	**3,953,303**	**3,824,795**	**3,704,336**
Projected Total Water Supplies (Table 4-22)	**acft/yr**	**3,185,430**	**2,562,776**	**2,077,223**	**1,684,932**	**1,519,388**	**1,442,745**
Projected Needs (Sum of Municipal and Irrigation Shortages)	**acft/yr**	**1,263,646**	**1,735,056**	**2,078,413**	**2,335,781**	**2,375,656**	**2,336,354**

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Table 4-24 continued

Counties	Units	Years					
		2010	**2020**	**2030**	**2040**	**2050**	**2060**
Socioeconomic Impacts of Shortages							
Irrigated Agriculture Water User Group							
Projected Needs (Shortages)	acft/yr	1,260,902	1,728,875	2,067,798	2,643,604	2,361,380	2,322,143
Sales (gross value)	$ Million/Yr	194.24	310.39	522.60	680.36	740.90	757.34
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	71.81	119.01	195.66	252.41	274.65	280.53
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	6.32	10.69	17.64	22.75	24.74	35.28
Jobs Lost	Number	2,910	4,800	10,980	9,900	10,750	10,980
Municipal Water User Group							
Projected Needs (Shortages)	acft/yr	2,744	6,181	11,147	12,309	15,142	13,260
Water Intensive Commercial Businesses							
Sales (gross value)	$ Million/Yr	63.08	88.89	95.84	97.65	99.65	99.17
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	29.35	41.9	45.15	46.02	47.72	46.68
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	3.41	4.72	5.76	5.88	6.77	6.63
Jobs Lost	Number	1,420	2,025	2,180	2,225	2,310	2,260
Horticulture Industry							
Sales (gross value)	$ Million/Yr	3.25	7.23	13.85	15.28	15.84	15.44
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	1.71	3.81	7.30	8.06	8.35	9.14
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	0.06	0.13	0.26	0.28	0.29	0.28
Jobs Lost	Number	90	205	390	430	450	440
Residential and Non-Water Intensive Commercial Users							
Expenses to Deal with Water shortages	$ Million/Yr	0.13	10.5	24.47	55.57	49.17	51.15

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Table 4-24 concluded

Counties	Units	Years					
		2010	2020	2030	2040	2050	2060
Water Utilities							
Revenue Losses	$ Million/Yr	2.79	6.1	11.49	12.46	12.85	12.55
Utility Tax Losses	$ Million/Yr	0.05	0.11	0.2	0.22	0.23	0.22
Regional Totals							
Projected Needs (Shortages)	acft/yr	1,247,401	1,715,918	2,060,306	2,318,554	2,356,613	2,318,266
Sales, Expenses to HH & Comm, & Util Revenue (gross value)	$ Million/Yr	263.49	423.11	668.25	861.32	918.41	935.65
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	102.87	164.72	248.11	306.49	330.72	336.35
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	9.84	15.65	23.86	29.13	32.03	42.41
Jobs Lost	Number	4,420	7,030	13,550	12,555	13,510	13,680
Social Impacts							
Population Losses	Number	5,310	8,470	14,830	10,720	11,540	11,700
School Enrollment Declines	Number	1,245	1,995	3,590	2,320	2,495	2,530

Source: Norvel, Stuart and Kevin Kluge, Office of Water Resources Planning, “Socioeconomic Impacts of Unmet Water Needs in the Llano Estacado Water Planning Area,” Texas Water Development Board, Austin, Texas, March 2005.

The projected water needs (shortages) of the region amount to about 29 percent of the projected demand in 2010, increasing to 51 percent of demand in 2030, and 63 percent in and 2060 (Table 4-24). This means that by 2030 the region would be able to supply only about 51 percent of the projected water demands unless supply development or other water management strategies are implemented.

The LERWPG identified 37 municipal water user groups which showed an unmet need during drought-of-record water supply conditions (Tables 4-24 and 4.4-3). In addition, of the 21 counties of the Llano Estacado Region, 20 have irrigation water user groups with projected water needs (shortages). The quantities of projected needs (shortages) are listed by county in Table 4-24 and Appendix C. For example, the projected municipal needs for cities of Castro County are 1,137 acft/yr in 2030, 1,159 acft/yr in 2040, 1,410 acft/yr in 2050, and 1,386 acft/yr in 2060 (Table 4-24). The projected needs for irrigation in Bailey County are 85,285 acft/yr in 2010, 92,835 acft/yr in 2030, and 93,597 acft/yr in 2060(Table 4-24).

The detailed results of the social and economic analyses of not meeting the projected water needs (shortages) are summarized in Table 4-24, and are shown in detail in Appendix C. Estimates are presented for effects upon gross business, personal income, taxes, jobs lost, and population and school enrollment effects of not meeting projected water needs.

Economic Impacts: It is estimated that due to projected water shortages, value of production (sales) losses by irrigated agriculture, commercial establishments, the horticulture industry, and expenses to households are $263.49 million/yr in 2010, $668.25 million/yr in 2030, and $935.65 million/yr in 2060 (Table 4-24). Due to this effect upon production, personal income losses in 2010 are estimated at $102.87 million/yr, $248.11/yr in 2030, and $336.35/yr in 2060 (Table 4-24). Losses in tax payments to local, state, and federal governments are estimated at $9.84 million/yr in 2010, $23.86 million/yr in 2030, and $42.41 million in 2060 (Table 4-24). In 2010, irrigation accounts for about 73 percent of the totals, and increases to 78 percent in 2030 and to 80 percent in 2060.

Population and School Enrollment: The estimated effects of unmet water shortages upon the population of the region are 5,310 in 2010, 14,830 in 2030, and 11,700 in 2060 (Table 4-24). School enrollment is projected to be 1,245 less in 2010, 3,590 less in 2030, and 2,530 less in 2060 (Table 4-24).

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4.4 Water Management Strategies for the Llano Estacado Region

4.4.1 Water Conservation

A significant water planning option is to increase water conservation and thereby reduce freshwater use within the planning area. The general methods to accomplish this objective are to: (1) reduce per capita water use in the municipal water use category; (2) recycle and reuse industrial water and substitute reclaimed water (treated municipal and industrial wastewater) for use in some industries, steam-electric power generation, and irrigation; and (3) improve irrigation efficiencies to reduce the quantity of water use in agriculture per acre irrigated. BMPs for water conservation, as identified by the Water Conservation Implementation Task Force, will be used in the water conservation water management strategy.[1] In addition, estimates will be made of the water conservation potentials and associated costs of water conservation.

4.4.1.1 Municipal Water Conservation

For regional water planning purposes, municipal water use is defined as residential and commercial water use. Municipal water is primarily for drinking, sanitation, cleaning, cooling, fire protection, and landscape watering for residential, commercial, and institutional establishments. Such water is supplied by both public and private utilities, and in areas not served by water utilities, is supplied by individual households. A key parameter of municipal water use within a typical city or water service area is the number of gallons used per person per day (per capita water use). The objective of municipal water conservation programs is to reduce the per capita water use parameter without adversely affecting the quality of life of the people involved. This can be achieved through:

- Use of low flow plumbing fixtures (e.g., toilets, shower heads, and faucets that are designed for low quantities of flow per unit of use);
- The selection and use of more efficient water-using appliances (e.g., clothes washers and dishwashers);
- Modifying and/or installing lawn and landscaping systems to use grass and plants that require less water;
- Repair of plumbing and water-using appliances to reduce leaks; and
- Modification of personal behavior that controls the use of plumbing fixtures, appliances, and lawn watering methods.

[1] Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board (TWDB), Special Report, Austin, Texas, November 2004.

In 1991, the Texas Legislature enacted Senate Bill 587, which established minimum standards for plumbing fixtures sold within Texas.[2] The bill became effective on January 1, 1992, and allowed for wholesalers and retailers to clear existing inventories of pre-standards plumbing fixtures by January 1, 1993. The standards for new plumbing fixtures, as specified by Senate Bill 587, are shown in Table 4.4-1. The TCEQ has promulgated rules requiring the labeling of both plumbing fixtures and water-using appliances sold in Texas. The labels must specify the rates of flow for plumbing fixtures and lawn sprinklers, and the amounts of water used per cycle for clothes washers and dishwashers.[3]

Table 4.4-1.
Standards for Plumbing Fixtures

Fixture	***Standard***
Wall-mounted Flushometer Toilets	2.00 gallons per flush
All Other Toilets	1.60 gallons per flush
Shower Heads	2.75 gallons per minute at 80 psi
Urinals	1.00 gallons per flush
Faucet Aerators	2.20 gallons per minute at 80 psi
Drinking Water Fountains	Shall be self-closing

The TWDB has estimated that the effect of the new plumbing fixtures in dwellings, offices, and public places will be a reduction in per capita water use of 18 gpcd, in comparison to what would have occurred with previous generations of plumbing fixtures (Table 4.4-2).[4]

In 2001, amendments to the Texas Water Code by the Texas Legislature established the Water Conservation Implementation Task Force and included requirements that Regional Water Planning Groups consider water conservation and drought management measures for each water user group with a projected need (water shortage). The legislation directed that The Water Conservation Implementation Task Force identify and describe Water Conservation BMPs and

[2] Senate Bill 587, Texas Legislature, Regular Session, 1991, Austin, Texas.
[3] Chapter 290, 30 TAC Sections 290.251, 290.253 - 290.256, 290.260, 290.265, 290.266, Water Hygiene, Texas Register, Page 9935, December 24, 1993.
[4] "Water Conservation Impacts on Per Capita Water Use," Water Planning Information, TWDB, Austin, Texas, 1992.

Table 4.4-2.
Water Conservation Potentials of Low-Flow Plumbing Fixtures[1]

Plumbing Fixture	Water Savings (gpcd)
Toilets – 1.6 gallons per flush	11.5
Shower Heads – 2.75 gallons per minute	4.0
Faucet Aerators – 2.2 gallons per minute	2.0
Urinals – 1.0 gallons per minute	0.3
Drinking Fountains (self-closing)	0.1
Total	17.9 (18 gpcd)

[1] Texas Water Development Board, 1992.

provide a BMP Guide for use by Regional Water Planning Groups in the development of the 2006 Regional Water Plans.[5] The list of BMPs for municipal water users is as follows:

1. System Water Audit and Water Loss;
2. Water Conservation Pricing;
3. Prohibition on Wasting Water;
4. Showerhead, Aerator, and Toilet Flapper Retrofit;
5. Residential Ultra-Low-Flow Toilet Replacement Programs;
6. Residential Clothes Washer Incentive Program;
7. School Education;
8. Water Survey for Single-Family and Multi-Family Customers;
9. Landscape Irrigation Conservation and Incentives;
10. Water-Wise Landscape Design and Conversion Programs;
11. Athletic Field Conservation;
12. Golf Course Conservation;
13. Metering of all New Connections and Retrofitting of Existing Connections;
14. Wholesale Agency Assistance Programs;
15. Conservation Coordinator;
16. Reuse of Reclaimed Water;
17. Public Information;
18. Rainwater Harvesting and Condensate Reuse;
19. New Construction Graywater;
20. Park Conservation; and
21. Conservation Programs for Industrial, Commercial, and Institutional Accounts.

[5] Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board, Special Report, Austin, Texas, November, 2004.

In addition to the list of BMPs, the Water Conservation Implementation Task Force recommended that a standardized methodology be used for determining per capita per day (gpcd) municipal water use in order to allow consistent evaluations of effectiveness of water conservation measures among cities that are located in the different climates and parts of Texas. The Task force further recommended gpcd targets and goals that should be considered by retail public water suppliers when developing water conservation plans required by the state, as follows:

- All public water suppliers that are required to prepare and submit water conservation plans should establish targets for water conservation, including specific goals for per capita water use and for water loss programs using appropriate water conservation BMPs; and
- Municipal Water Conservation Plans required by the state shall include per capita water use goals, with targets and goals established by an entity giving consideration to a minimum annual reduction of 1 percent in total per capita water, based upon a 5-year moving average, until such time as the entity achieves a total per capita water use of 140 gpcd or less.

For purposes of developing the 2006 Llano Estacado Regional Water Plan, the LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs (shortages) and that had per capita water use in year 2000 that was greater than the Llano Estacado Region average per capita water use in 2000. The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 Region average municipal water use of 172 gpcd. (The Llano Estacado Region total municipal water use in 2000 was 87,322 acft; total population in 2000 was 453,997, giving a calculated Regional average municipal water use in 2000 of 172 gpcd (87,322/453,997)).[6]

The 72 municipal WUGs of Region O are listed in Table 4.4-3 in the order of low to high per capita water use in 2000, together with projected per capita water use with expected effects of low flow plumbing fixtures upon per capita water use in 2010, 2020, 2030, 2040, 2050, and 2060 (i.e., the projected water conservation effects of low flow plumbing fixtures). It is important to note that the per capita water use, as shown in Table 4.4-3, was used in making the municipal water demand projections, thereby including the potential water conservation or water demand reduction potentials of low flow plumbing fixtures in the projected water demands for

[6] Texas per capita water use in year 2000 was 173 gpcd.

the municipal WUGs of the Region. The projected municipal water needs (shortages) were calculated for each WUG by subtracting projected municipal water demands from existing municipal water supplies, with the low flow plumbing fixtures water conservation taken into account. For the Region, there are 36 municipal WUGs and one water supply district that are projected to have water needs (shortages) during the projection period. The names of WUGs with projected needs are shaded in Table 4.4-3, with the projected date of need shown in the right-hand column of the table (Table 4.4-3).

The projected per capita water use for municipal WUGS of Region O for the water conservation goal of reducing per capita water use by 1 percent per year from the year 2000 level until the year 2000 region average of 172 gpcd is reached is shown in Table 4.4-4 in comparison to the projected per capita water use with low flow plumbing fixtures (Table 4.4-4). This comparison shows that the low flow plumbing fixtures water conservation effects are greater than the effects of the goal to reduce per capita water use by 1 percent per year for municipal WUGs numbered 1 through 45 (Table 4.4-4). That is to say that for those WUGs having per capita water use in the year 2000 of 176 gpcd or less, low flow plumbing fixtures are capable of meeting or exceeding the goal of reducing per capita municipal water use by 1 percent per year until the year 2000 Region average of 172 gpcd is reached. Therefore, additional water conservation for the first 45 WUGs listed in Table 4.4-4 is not given further consideration. However, water conservation in addition to that expected from low flow plumbing fixtures must be considered for WUGs 46 through 72 of Table 4.4-5 that have projected needs. The quantity of additional water conservation needed to reach the Region O goal, in gallons per person per day ranges from 3 gpcd for Tulia in 2010 to 118 gpcd for Seminole in 2060 (Table 4.4-5). A part of the additional water needed to meet the goal can be reached through plumbing fixtures and clothes washers retrofit (Table 4.4-5). For example, all of the additional conservation needed for numbers 46 through 55 (Tulia through Abernathy) can be met through plumbing fixtures and clothes washers retrofit, and a part of that needed for the remaining WUGs of the list can be met through plumbing fixtures retrofit (Table 4.4-5). However, the remaining conservation needed will have to be obtained on other ways. For purposes of the regional water plan, lawn and landscape irrigation conservation is included to accomplish the remainder of the conservation needed to meet the goals.

Table 4.4-3.
Municipal Water User Groups
Projected Per Capita Water Use with Low Flow Plumbing Fixtures
Llano Estacado Water Planning Region

	Water User Group*	County **	Per Capita Water Use With Low Flow Plumbing Fixtures							Year of Projected Need
			2000 gpcd	2010 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	
1	MEADOW	TERRY	95	92	88	86	83	82	82	
2	COUNTY-OTHER	GAINES	101	97	94	91	89	88	88	
3	LOCKNEY	FLOYD	103	100	96	93	90	89	89	2030
4	WILSON	LYNN	109	106	102	99	96	95	95	2010
5	COUNTY-OTHER	LUBBOCK	110	106	104	101	99	98	98	
6	KRESS	SWISHER	110	107	104	102	99	98	98	2010
7	COUNTY-OTHER	DAWSON	113	110	107	105	102	101	101	
8	COUNTY-OTHER	CROSBY	115	110	107	104	101	100	100	
9	COUNTY-OTHER	HALE	115	110	107	104	101	100	100	
10	RALLS	CROSBY	115	111	108	106	103	102	102	2030
11	COUNTY-OTHER	GARZA	118	115	111	109	106	104	104	
12	IDALOU	LUBBOCK	119	116	113	109	106	105	105	2040
13	COUNTY-OTHER	LYNN	120	116	112	109	106	105	105	
14	COUNTY-OTHER	PARMER	120	117	113	110	107	106	106	
15	COUNTY-OTHER	SWISHER	121	118	114	111	108	107	107	
16	COUNTY-OTHER	FLOYD	123	120	116	113	110	109	109	
17	COUNTY-OTHER	HOCKLEY	124	119	116	113	110	109	109	
18	COUNTY-OTHER	YOAKUM	125	121	118	115	112	111	111	
19	SMYER	HOCKLEY	125	119	116	113	110	109	109	2050
20	COUNTY-OTHER	TERRY	128	123	120	117	114	113	113	
21	COUNTY-OTHER	DEAFSMITH	129	122	118	116	115	114	114	
22	SHALLOWATER	LUBBOCK	133	128	125	123	120	119	119	2010
23	SLATON	LUBBOCK	136	132	129	126	123	121	121	
24	O'DONNELL	DAWSON	138	134	130	127	124	123	123	
25	COUNTY-OTHER	BAILEY	143	138	135	132	129	128	128	
26	WOLFFORTH	LUBBOCK	144	140	137	135	133	132	132	2010
27	TAHOKA	LYNN	145	142	139	136	133	132	132	
28	SILVERTON	BRISCOE	146	143	140	137	134	132	132	2010
29	ROPESVILLE	HOCKLEY	147	143	140	137	134	133	133	2020
30	BOVINA	PARMER	147	144	141	138	135	134	134	
31	COUNTY-OTHER	DICKENS	149	147	144	142	140	138	138	
32	COUNTY-OTHER	CASTRO	150	146	143	140	137	136	136	
33	POST	GARZA	150	146	143	140	137	136	136	
34	LEVELLAND	HOCKLEY	154	149	146	143	140	139	139	
35	HAPPY	SWISHER	156	152	148	146	143	142	142	
36	COUNTY-OTHER	BRISCOE	158	154	151	148	145	143	143	2010
37	COUNTY-OTHER	COCHRAN	159	155	152	149	146	145	145	

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Table 4.4-3 Concluded

	Water User Group*	County **	Per Capita Water Use With Low Flow Plumbing Fixtures							Year of Projected Need
			2000 gpcd	2010 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	
38	SEAGRAVES	GAINES	159	154	151	148	145	144	144	2010
39	NEW DEAL	LUBBOCK	159	154	152	150	148	147	147	2020
40	FLOYDADA	FLOYD	161	157	153	150	147	146	146	
41	PLAINVIEW	HALE	163	159	156	153	150	149	149	
42	HART	CASTRO	166	162	159	156	153	152	152	2040
43	CROSBYTON	CROSBY	167	162	159	156	153	152	152	
44	LORENZO	CROSBY	169	165	162	160	157	156	156	2040
45	HALE CENTER	HALE	176	172	169	167	164	163	163	2030
46	TULIA	SWISHER	178	175	171	168	165	164	164	
47	LUBBOCK	LUBBOCK	181	177	174	171	168	167	167	
48	AMHERST	LAMB	184	180	177	174	171	170	170	2010
49	OLTON	LAMB	185	182	178	176	173	172	172	2020
50	ANTON	HOCKLEY	186	182	179	176	173	172	172	2010
51	FRIONA	PARMER	186	182	179	176	173	172	172	2010
52	SUDAN	LAMB	187	184	181	178	175	174	174	2010
53	COUNTY-OTHER	MOTLEY	193	189	186	183	180	178	178	
54	MULESHOE	BAILEY	193	189	186	183	180	179	179	
55	ABERNATHY	HALE	193	189	185	183	180	179	179	2010
56	SUNDOWN	HOCKLEY	193	188	185	182	179	178	178	2010
57	PETERSBURG	HALE	195	190	187	184	181	180	180	2050
58	MORTON	COCHRAN	198	194	191	188	185	184	184	2010
59	DIMMITT	CASTRO	199	194	191	188	185	184	184	2020
60	EARTH	LAMB	200	196	192	189	186	185	185	2030
61	LITTLEFIELD	LAMB	203	199	196	193	190	189	189	
62	DENVER CITY	YOAKUM	214	209	206	203	200	199	199	2020
63	HEREFORD	DEAFSMITH	218	215	211	208	205	204	204	
64	LAMESA	DAWSON	223	220	216	213	210	209	209	2010
65	SPUR	DICKENS	226	222	219	216	213	211	211	
66	COUNTY-OTHER	LAMB	230	226	222	219	216	215	215	
67	PLAINS	YOAKUM	233	229	225	223	220	219	219	2010
68	FARWELL	PARMER	242	239	235	232	229	228	228	2010
69	BROWNFIELD	TERRY	244	239	236	233	230	229	229	2010
70	RANSOM CANYON	LUBBOCK	274	269	266	264	262	261	261	
71	MATADOR	MOTLEY	288	285	282	279	276	274	274	
72	SEMINOLE	GAINES	305	300	297	294	291	290	290	

* Listed in order of low to high per capita water use. If no date shown in right column, WUG has no projected need.

** Some water user groups are located in more than one county and more than one river basin. The county in which the major part of the service area is located is listed in the table.

Table 4.4-4.
Municipal Water User Groups
Projected Per Capita Water Use with Low Flow Plumbing Fixtures and
Regional Planning Goal to Reduce Per Capita Water Use by One Percent per Year*
Llano Estacado Water Planning Region

County Number	Water User Group	County	Water Use with Low Flow Plumbing Fixtures**							Water Use with Goal to Reduce by 1% per Year*					
			2000 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
1	Meadow	Terry	95	92	88	86	83	82	82	95	95	95	95	95	95
2	County-Other	Gaines	101	97	94	91	89	88	88	101	101	101	101	101	101
3	Lockney	Floyd	103	100	96	93	90	89	89	103	103	103	103	103	103
4	Wilson	Lynn	109	106	102	99	96	95	95	109	109	109	109	109	109
5	County-Other	Lubbock	110	106	104	101	99	98	98	110	110	110	110	110	110
6	Kress	Swisher	110	107	104	102	99	98	98	110	110	110	110	110	110
7	County-Other	Dawson	113	110	107	105	102	101	101	113	113	113	113	113	113
8	County-Other	Crosby	115	110	107	104	101	100	100	115	115	115	115	115	115
9	County-Other	Hale	115	110	107	104	101	100	100	115	115	115	115	115	115
10	Ralls	Crosby	115	111	108	106	103	102	102	115	115	115	115	115	115
11	County-Other	Garza	118	115	111	109	106	104	104	118	118	118	118	118	118
12	Idalou	Lubbock	119	116	113	109	106	105	105	119	119	119	119	119	119
13	County-Other	Lynn	120	116	112	109	106	105	105	120	120	120	120	120	120
14	County-Other	Parmer	120	117	113	110	107	106	106	120	120	120	120	120	120
15	County-Other	Swisher	121	118	114	111	108	107	107	121	121	121	121	121	121
16	County-Other	Floyd	123	120	116	113	110	109	109	123	123	123	123	123	123
17	County-Other	Hockley	124	119	116	113	110	109	109	124	124	124	124	124	124
18	County-Other	Yoakum	125	121	118	115	112	111	111	125	125	125	125	125	125
19	Smyer	Hockley	125	119	116	113	110	109	109	125	125	125	125	125	125
20	County-Other	Terry	128	123	120	117	114	113	113	128	128	128	128	128	128
21	County-Other	Deaf Smith	129	122	118	116	115	114	114	129	129	129	129	129	129
22	Shallowater	Lubbock	133	128	125	123	120	119	119	133	133	133	133	133	133

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Table 4.4-4 Continued

County Number	Water User Group	County	Water Use with Low Flow Plumbing Fixtures** 2000 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	Water Use with Goal to Reduce by 1% per Year* 2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
23	Slaton	Lubbock	136	132	129	126	123	121	121	136	136	136	136	136	136
24	O'Donnell	Dawson	138	134	130	127	124	123	123	138	138	138	138	138	138
25	County-Other	Bailey	143	138	135	132	129	128	128	143	143	143	143	143	143
26	Wolfforth	Lubbock	144	140	137	135	133	132	132	144	144	144	144	144	144
27	Tahoka	Lynn	145	142	139	136	133	132	132	145	145	145	145	145	145
28	Silverton	Briscoe	146	143	140	137	134	132	132	146	146	146	146	146	146
29	Ropesville	Hockley	147	143	140	137	134	133	133	147	147	147	147	147	147
30	Bovina	Parmer	147	144	141	138	135	134	134	147	147	147	147	147	147
31	County-Other	Dickens	149	147	144	142	140	138	138	149	149	149	149	149	149
32	County-Other	Castro	150	146	143	140	137	136	136	150	150	150	150	150	150
33	Post	Garza	150	146	143	140	137	136	136	150	150	150	150	150	150
34	Levelland	Hockley	154	149	146	143	140	139	139	154	154	154	154	154	154
35	Happy	Swisher	156	152	148	146	143	142	142	156	156	156	156	156	156
36	County-Other	Briscoe	158	154	151	148	145	143	143	158	158	158	158	158	158
37	County-Other	Cochran	159	155	152	149	146	145	145	159	159	159	159	159	159
38	Seagraves	Gaines	159	154	151	148	145	144	144	159	159	159	159	159	159
39	New Deal	Lubbock	159	154	152	150	148	147	147	159	159	159	159	159	159
40	Floydada	Floyd	161	157	153	150	147	146	146	161	161	161	161	161	161
41	Plainview	Hale	163	159	156	153	150	149	149	163	163	163	163	163	163
42	Hart	Castro	166	162	159	156	153	152	152	166	166	166	166	166	166
43	Crosbyton	Crosby	167	162	159	156	153	152	152	167	167	167	167	167	167
44	Lorenzo	Crosby	169	165	162	160	157	156	156	169	169	169	169	169	169
45	Hale Center	Hale	176	172	169	167	164	163	163	172	172	172	172	172	172
46	Tulia	Swisher	178	175	171	168	165	164	164	172	172	172	172	172	172
47	Lubbock	Lubbock	181	177	174	171	168	167	167	172	172	172	172	172	172
48	Amherst	Lamb	184	180	177	174	171	170	170	172	172	172	172	172	172
49	Olton	Lamb	185	182	178	176	173	172	172	172	172	172	172	172	172
50	Anton	Hockley	186	182	179	176	173	172	172	172	172	172	172	172	172

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Table 4.4-4 Concluded

County Number	Water User Group	County	Water Use with Low Flow Plumbing Fixtures**							Water Use with Goal to Reduce by 1% per Year*					
			2000 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
51	Friona	Parmer	186	182	179	176	173	172	172	172	172	172	172	172	172
52	Sudan	Lamb	187	184	181	178	175	174	174	172	172	172	172	172	172
53	County-Other	Motley	193	189	186	183	180	178	178	175	172	172	172	172	172
54	Muleshoe	Bailey	193	189	186	183	180	179	179	175	172	172	172	172	172
55	Abernathy	Hale	193	189	185	183	180	179	179	175	172	172	172	172	172
56	Sundown	Hockley	193	188	185	182	179	178	178	175	172	172	172	172	172
57	Petersburg	Hale	195	190	187	184	181	180	180	176	172	172	172	172	172
58	Morton	Cochran	198	194	191	188	185	184	184	179	172	172	172	172	172
59	Dimmitt	Castro	199	194	191	188	185	184	184	180	172	172	172	172	172
60	Earth	Lamb	200	196	192	189	186	185	185	181	172	172	172	172	172
61	Littlefield	Lamb	203	199	196	193	190	189	189	184	172	172	172	172	172
62	Denver City	Yoakum	214	209	206	203	200	199	199	194	175	172	172	172	172
63	Hereford	Deaf Smith	218	215	211	208	205	204	204	197	178	172	172	172	172
64	Lamesa	Dawson	223	220	216	213	210	209	209	202	182	172	172	172	172
65	Spur	Dickens	226	222	219	216	213	211	211	204	185	172	172	172	172
66	County-Other	Lamb	230	226	222	219	216	215	215	208	188	172	172	172	172
67	Plains	Yoakum	233	229	225	223	220	219	219	211	191	172	172	172	172
68	Farwell	Parmer	242	239	235	232	229	228	228	219	198	179	172	172	172
69	Brownfield	Terry	244	239	236	233	230	229	229	221	200	180	172	172	172
70	Ransom Canyon	Lubbock	274	269	266	264	262	261	261	248	224	203	183	172	172
71	Matador	Motley	288	285	282	279	276	274	274	260	236	213	193	174	172
72	Seminole	Gaines	305	300	297	294	291	290	290	276	249	226	204	185	172

* Goal is to reduce per capita water use for WUGs with gpcd greater than regional average of 172 gpcd to year 2000 regional average of 172 gpcd.
** Per Capita Water Use in gallons per person per day (gpcd).
*** Listed in order of low to high per capita water use in year 2000. The 33 WUGs whose names are highlighted are projected to have needs (shortages) during the planning period.
**** Some Water User Groups are located in more than one county and more than one river basin. The county in which the major part of the service area is located is named in this table.

Table 4.4-5.
Additional Municipal Water User Group Water Conservation Needed to Meet Goals of Reducing Per Capita Water Use to Year 2000 Regional Average of 172 gpcd
Llano Estacado Water Planning Region

County Number	Water User Group	County	Year 2000 (gpcd)	Plumbing Fixtures Potential (gpcd)	Additional Water Conservation Needed to Meet Region O Goals						Additional Water Conservation Potentials of Plumbing Fixture Retrofit					
					2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
1	Meadow	Terry	95	18	0	0	0	0	0	0	0	0	0	0	0	0
2	County-Other	Gaines	101	18	0	0	0	0	0	0	0	0	0	0	0	0
3	Lockney	Floyd	103	18	0	0	0	0	0	0	0	0	0	0	0	0
4	Wilson	Lynn	109	18	0	0	0	0	0	0	0	0	0	0	0	0
5	County-Other	Lubbock	110	18	0	0	0	0	0	0	0	0	0	0	0	0
6	Kress	Swisher	110	18	0	0	0	0	0	0	0	0	0	0	0	0
7	County-Other	Dawson	113	18	0	0	0	0	0	0	0	0	0	0	0	0
8	County-Other	Crosby	115	18	0	0	0	0	0	0	0	0	0	0	0	0
9	County-Other	Hale	115	18	0	0	0	0	0	0	0	0	0	0	0	0
10	Ralls	Crosby	115	18	0	0	0	0	0	0	0	0	0	0	0	0
11	County-Other	Garza	118	18	0	0	0	0	0	0	0	0	0	0	0	0
12	Idalou	Lubbock	119	18	0	0	0	0	0	0	0	0	0	0	0	0
13	County-Other	Lynn	120	18	0	0	0	0	0	0	0	0	0	0	0	0
14	County-Other	Parmer	120	18	0	0	0	0	0	0	0	0	0	0	0	0
15	County-Other	Swisher	121	18	0	0	0	0	0	0	0	0	0	0	0	0
16	County-Other	Floyd	123	18	0	0	0	0	0	0	0	0	0	0	0	0
17	County-Other	Hockley	124	18	0	0	0	0	0	0	0	0	0	0	0	0
18	County-Other	Yoakum	125	18	0	0	0	0	0	0	0	0	0	0	0	0
19	Smyer	Hockley	125	18	0	0	0	0	0	0	0	0	0	0	0	0
20	County-Other	Terry	128	18	0	0	0	0	0	0	0	0	0	0	0	0
21	County-Other	Deaf Smith	129	18	0	0	0	0	0	0	0	0	0	0	0	0
22	Shallowater	Lubbock	133	18	0	0	0	0	0	0	0	0	0	0	0	0

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Table 4.4-5 Continued

County Number	Water User Group	County	Year 2000 (gpcd)	Plumbing Fixtures Potential (gpcd)	Additional Water Conservation Needed to Meet Region O Goals						Additional Water Conservation Potentials of Plumbing Fixture Retrofit					
					2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
23	Slaton	Lubbock	136	18	0	0	0	0	0	0	0	0	0	0	0	0
24	O'Donnell	Dawson	138	18	0	0	0	0	0	0	0	0	0	0	0	0
25	County-Other	Bailey	143	18	0	0	0	0	0	0	0	0	0	0	0	0
26	Wolfforth	Lubbock	144	18	0	0	0	0	0	0	0	0	0	0	0	0
27	Tahoka	Lynn	145	18	0	0	0	0	0	0	0	0	0	0	0	0
28	Silverton	Briscoe	146	18	0	0	0	0	0	0	0	0	0	0	0	0
29	Ropesville	Hockley	147	18	0	0	0	0	0	0	0	0	0	0	0	0
30	Bovina	Parmer	147	18	0	0	0	0	0	0	0	0	0	0	0	0
31	County-Other	Dickens	149	18	0	0	0	0	0	0	0	0	0	0	0	0
32	County-Other	Castro	150	18	0	0	0	0	0	0	0	0	0	0	0	0
33	Post	Garza	150	18	0	0	0	0	0	0	0	0	0	0	0	0
34	Levelland	Hockley	154	18	0	0	0	0	0	0	0	0	0	0	0	0
35	Happy	Swisher	156	18	0	0	0	0	0	0	0	0	0	0	0	0
36	County-Other	Briscoe	158	18	0	0	0	0	0	0	0	0	0	0	0	0
37	County-Other	Cochran	159	18	0	0	0	0	0	0	0	0	0	0	0	0
38	Seagraves	Gaines	159	18	0	0	0	0	0	0	0	0	0	0	0	0
39	New Deal	Lubbock	159	18	0	0	0	0	0	0	0	0	0	0	0	0
40	Floydada	Floyd	161	18	0	0	0	0	0	0	0	0	0	0	0	0
41	Plainview	Hale	163	18	0	0	0	0	0	0	0	0	0	0	0	0
42	Hart	Castro	166	18	0	0	0	0	0	0	0	0	0	0	0	0
43	Crosbyton	Crosby	167	18	0	0	0	0	0	0	0	0	0	0	0	0
44	Lorenzo	Crosby	169	18	0	0	0	0	0	0	0	0	0	0	0	0
45	Hale Center	Hale	176	18	0	0	0	0	0	0	0	0	0	0	0	0
46	Tulia	Swisher	178	18	3	0	0	0	0	0	3	0	0	0	0	0
47	Lubbock	Lubbock	181	18	5	2	0	0	0	0	5	2	0	0	0	0
48	Amherst	Lamb	184	18	8	5	2	0	0	0	8	5	2	0	0	0
49	Olton	Lamb	185	18	10	6	4	1	0	0	10	6	4	1	0	0
50	Anton	Hockley	186	18	10	7	4	1	0	0	10	7	4	1	0	0

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Table 4.4-5 Concluded

County Number	Water User Group	County	Year 2000 (gpcd)	Plumbing Fixtures Potential (gpcd)	Additional Water Conservation Needed to Meet Region O Goals						Additional Water Conservation Potentials of Plumbing Fixture Retrofit					
					2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
51	Friona	Parmer	186	18	10	7	4	1	0	0	10	7	4	1	0	0
52	Sudan	Lamb	187	18	12	9	6	3	2	2	12	9	3	3	3	2
53	County-Other	Motley	193	18	14	14	11	8	6	6	14	11	8	5	3	3
54	Muleshoe	Bailey	193	18	14	14	11	8	7	7	14	11	8	5	4	4
55	Abernathy	Hale	193	18	14	13	11	8	7	7	14	10	8	5	4	4
56	Sundown	Hockley	193	18	13	13	10	7	6	6	13	10	7	4	3	3
57	Petersburg	Hale	195	18	14	15	12	9	8	8	13	10	7	4	3	3
58	Morton	Cochran	198	18	15	19	16	13	12	12	14	11	8	5	4	4
59	Dimmitt	Castro	199	18	14	19	16	13	12	12	13	10	7	4	3	3
60	Earth	Lamb	200	18	15	20	17	14	13	13	14	10	7	4	3	3
61	Littlefield	Lamb	203	18	15	24	21	18	17	17	14	11	8	5	4	4
62	Denver City	Yoakum	214	18	15	31	31	28	27	27	13	10	7	4	3	3
63	Hereford	Deaf Smith	218	18	18	33	36	33	32	32	15	11	8	5	4	4
64	Lamesa	Dawson	223	18	18	34	41	38	37	37	15	11	8	5	4	4
65	Spur	Dickens	226	18	18	34	44	41	39	39	14	11	8	5	3	3
66	County-Other	Lamb	230	18	18	34	47	44	43	43	14	10	7	4	3	3
67	Plains	Yoakum	233	18	18	34	51	48	47	47	14	10	8	5	4	4
68	Farwell	Parmer	242	18	20	37	53	57	56	56	15	11	8	5	4	4
69	Brownfield	Terry	244	18	18	36	53	58	57	57	13	10	7	4	3	3
70	Ransom Canyon	Lubbock	274	18	21	42	61	79	89	89	13	10	8	6	5	5
71	Matador	Motley	288	18	25	46	66	83	100	102	15	12	9	6	4	4
72	Seminole	Gaines	305	18	24	48	68	87	105	118	13	10	7	4	3	3

* Listed in order of low to high per capita water use in year 2000.

The water conservation water management strategy for municipal WUGs numbered 46 through 72 of Table 4.4-5 is based upon plumbing fixtures and clothes washers retrofit, and lawn and landscape irrigation water conservation (BMPs numbered 5, 6, and 9 listed above), and costs of water conservation measures, as reported in, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas," TWDB, GDS Associates, Austin, Texas, July 2003. The underlying methods and assumptions are as follows:

1. Indoor plumbing fixtures and clothes washer water conservation potentials are 18 gpcd. (Note: a part of the plumbing fixtures potential has already been included in the per capita water use projections shown in Table 4.4-3; the computations presented below apply only to the additional potential not included in the water demand projections.);
2. Outdoor (lawn and landscape) water conservation potentials are used to accomplish additional conservation needed to meet the regional goals; and
3. Cost of municipal water conservation is as follows:
   - Plumbing fixture and clothes washer retrofit[7]
     1. Rural areas .... $561 per acft
     2. Suburban areas .... $542 per acft
     3. Urban areas .... $520 per acft
   - Lawn watering and landscape water conservation............ $400 per acft

The calculated water demand reduction (municipal water conservation) from plumbing and clothes washer retrofit and lawn and landscape irrigation for Tulia is 18 acft/yr in 2010, and zero thereafter, since by 2010 the goal of reducing per capita water use to the region average of 172 gpcd is projected to have been reached (Table 4.4-6). For Seminole, the projected reduction in demand through the water conservation water management strategy is 178 acft/yr in 2010, 384 acft/yr in 2020, 588 acft/yr in 2030, and 1,035 acft/yr in 2060 (Table 4.4-6). Values for each of the WUGs can be viewed in Table 4.4-6, and will not be repeated here.

The municipal water conservation water management strategy is estimated to meet 2,858 acft/yr of municipal water needs in Region O in 2010, 3,412 acft/yr in 2020, 3,616 acft/yr in 2030, and 4,020 acft/yr in 2060 (Table 4.4-6). The values for each WUG having a projected need will be used as a water management strategy to meet a part of the WUG's projected water needs (shortages) in the Regional Water Plan, with the associated cost for the water conservation water management strategy as shown in Table 4.4-7. Estimated cost of the water conservation

[7] GDS Associates, "Quantifying the Effectiveness of Various Water Conservation Techniques in Texas; Appendix VI, Region L," TWDB, Austin, Texas, July 2003.

Table 4.4-6.
Water Conservation Potentials of
Plumbing Retrofit, Clothes Washer Retrofit, and Lawn Watering
Llano Estacado Water Planning Region

Water User Group		County	Water Conservation Potentials from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
1	Meadow	Terry	0	0	0	0	0	0
2	County-Other	Gaines	0	0	0	0	0	0
3	Lockney	Floyd	0	0	0	0	0	0
4	Wilson	Lynn	0	0	0	0	0	0
5	County-Other	Lubbock	0	0	0	0	0	0
6	Kress	Swisher	0	0	0	0	0	0
7	County-Other	Dawson	0	0	0	0	0	0
8	County-Other	Crosby	0	0	0	0	0	0
9	County-Other	Hale	0	0	0	0	0	0
10	Ralls	Crosby	0	0	0	0	0	0
11	County-Other	Garza	0	0	0	0	0	0
12	Idalou	Lubbock	0	0	0	0	0	0
13	County-Other	Lynn	0	0	0	0	0	0
14	County-Other	Parmer	0	0	0	0	0	0
15	County-Other	Swisher	0	0	0	0	0	0
16	County-Other	Floyd	0	0	0	0	0	0
17	County-Other	Hockley	0	0	0	0	0	0
18	County-Other	Yoakum	0	0	0	0	0	0
19	Smyer	Hockley	0	0	0	0	0	0
20	County-Other	Terry	0	0	0	0	0	0
21	County-Other	Deaf Smith	0	0	0	0	0	0
22	Shallowater	Lubbock	0	0	0	0	0	0
23	Slaton	Lubbock	0	0	0	0	0	0
24	O'Donnell	Dawson	0	0	0	0	0	0
25	County-Other	Bailey	0	0	0	0	0	0
26	Wolfforth	Lubbock	0	0	0	0	0	0
27	Tahoka	Lynn	0	0	0	0	0	0
28	Silverton	Briscoe	0	0	0	0	0	0
29	Ropesville	Hockley	0	0	0	0	0	0
30	Bovina	Parmer	0	0	0	0	0	0
31	County-Other	Dickens	0	0	0	0	0	0
32	County-Other	Castro	0	0	0	0	0	0

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Table 4.4-6 Concluded

Water User Group		County	Water Conservation Potentials from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
33	Post	Garza	0	0	0	0	0	0
34	Levelland	Hockley	0	0	0	0	0	0
35	Happy	Swisher	0	0	0	0	0	0
36	County-Other	Briscoe	0	0	0	0	0	0
37	County-Other	Cochran	0	0	0	0	0	0
38	Seagraves	Gaines	0	0	0	0	0	0
39	New Deal	Lubbock	0	0	0	0	0	0
40	Floydada	Floyd	0	0	0	0	0	0
41	Plainview	Hale	0	0	0	0	0	0
42	Hart	Castro	0	0	0	0	0	0
43	Crosbyton	Crosby	0	0	0	0	0	0
44	Lorenzo	Crosby	0	0	0	0	0	0
45	Hale Center	Hale	0	0	0	0	0	0
46	Tulia	Swisher	18	0	0	0	0	0
47	Lubbock	Lubbock	1,180	489	0	0	0	0
48	Amherst	Lamb	7	5	2	0	0	0
49	Olton	Lamb	27	17	12	3	0	0
50	Anton	Hockley	14	11	6	2	0	0
51	Friona	Parmer	46	34	20	5	0	0
52	Sudan	Lamb	15	12	8	4	3	3
53	County-Other	Motley						
54	Muleshoe	Bailey	79	81	67	51	44	44
55	Abernathy	Hale	50	48	43	32	28	27
56	Sundown	Hockley	24	25	19	14	11	11
57	Petersburg	Hale	21	24	20	16	14	14
58	Morton	Cochran	41	56	48	38	34	32
59	Dimmitt	Castro	75	110	97	81	75	74
60	Earth	Lamb	20	28	25	21	20	17
61	Littlefield	Lamb	118	196	181	161	151	149
62	Denver City	Yoakum	77	169	179	171	160	155
63	Hereford	Deaf Smith	302	572	649	610	596	598
64	Lamesa	Dawson	212	400	501	471	448	431
65	Spur	Dickens	21	42	54	50	48	48
66	County-Other	Lamb						
67	Plains	Yoakum	33	68	106	107	102	98
68	Farwell	Parmer	33	64	94	101	97	91
69	Brownfield	Terry	211	448	687	802	793	788
70	Ransom Canyon	Lubbock	35	90	162	248	325	342
71	Matador	Motley	20	37	49	57	63	62
72	Seminole	Gaines	178	384	588	778	938	1,035
Total			**2,858**	**3,412**	**3,616**	**3,822**	**3,949**	**4,020**

Table 4.4-7.
Costs of Plumbing Fixture and Clothes Washer Retrofit and Lawn Watering Water Conservation Llano Estacado Water Planning Region

Water User Group		County	Estimated Costs of Water Conservation from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (dollars)	2020 (dollars)	2030 (dollars)	2040 (dollars)	2050 (dollars)	2060 (dollars)
1	Meadow	Terry	0	0	0	0	0	0
2	County-Other	Gaines	0	0	0	0	0	0
3	Lockney	Floyd	0	0	0	0	0	0
4	Wilson	Lynn	0	0	0	0	0	0
5	County-Other	Lubbock	0	0	0	0	0	0
6	Kress	Swisher	0	0	0	0	0	0
7	County-Other	Dawson	0	0	0	0	0	0
8	County-Other	Crosby	0	0	0	0	0	0
9	County-Other	Hale	0	0	0	0	0	0
10	Ralls	Crosby	0	0	0	0	0	0
11	County-Other	Garza	0	0	0	0	0	0
12	Idalou	Lubbock	0	0	0	0	0	0
13	County-Other	Lynn	0	0	0	0	0	0
14	County-Other	Parmer	0	0	0	0	0	0
15	County-Other	Swisher	0	0	0	0	0	0
16	County-Other	Floyd	0	0	0	0	0	0
17	County-Other	Hockley	0	0	0	0	0	0
18	County-Other	Yoakum	0	0	0	0	0	0
19	Smyer	Hockley	0	0	0	0	0	0
20	County-Other	Terry	0	0	0	0	0	0
21	County-Other	Deaf Smith	0	0	0	0	0	0
22	Shallowater	Lubbock	0	0	0	0	0	0
23	Slaton	Lubbock	0	0	0	0	0	0
24	O'Donnell	Dawson	0	0	0	0	0	0
25	County-Other	Bailey	0	0	0	0	0	0
26	Wolfforth	Lubbock	0	0	0	0	0	0
27	Tahoka	Lynn	0	0	0	0	0	0
28	Silverton	Briscoe	0	0	0	0	0	0
29	Ropesville	Hockley	0	0	0	0	0	0
30	Bovina	Parmer	0	0	0	0	0	0
31	County-Other	Dickens	0	0	0	0	0	0
32	County-Other	Castro	0	0	0	0	0	0
33	Post	Garza	0	0	0	0	0	0
34	Levelland	Hockley	0	0	0	0	0	0
35	Happy	Swisher	0	0	0	0	0	0

Continued on next page

Table 4.4-7 Concluded

	Water User Group	County	Estimated Costs of Water Conservation from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (dollars)	2020 (dollars)	2030 (dollars)	2040 (dollars)	2050 (dollars)	2060 (dollars)
36	County-Other	Briscoe	0	0	0	0	0	0
37	County-Other	Cochran	0	0	0	0	0	0
38	Seagraves	Gaines	0	0	0	0	0	0
39	New Deal	Lubbock	0	0	0	0	0	0
40	Floydada	Floyd	0	0	0	0	0	0
41	Plainview	Hale	0	0	0	0	0	0
42	Hart	Castro	0	0	0	0	0	0
43	Crosbyton	Crosby	0	0	0	0	0	0
44	Lorenzo	Crosby	0	0	0	0	0	0
45	Hale Center	Hale	0	0	0	0	0	0
46	Tulia	Swisher	10,101	0	0	0	0	0
47	Lubbock	Lubbock	613,515	254,508	0	0	0	0
48	Amherst	Lamb	4,193	2,787	1,173	0	0	0
49	Olton	Lamb	15,163	9,679	6,787	1,759	0	0
50	Anton	Hockley	8,113	5,925	3,469	868	0	0
51	Friona	Parmer	25,727	19,130	11,206	2,821	0	0
52	Sudan	Lamb	8,265	6,594	3,959	2,396	1,817	1,568
53	County-Other	Motley						
54	Muleshoe	Bailey	44,053	42,868	34,469	25,293	21,831	21,430
55	Abernathy	Hale	27,248	24,686	21,580	15,566	13,449	13,182
56	Sundown	Hockley	13,688	12,884	9,935	6,682	5,377	5,112
57	Petersburg	Hale	11,503	12,377	10,078	7,411	6,390	6,267
58	Morton	Cochran	22,707	27,460	23,105	17,744	15,416	14,666
59	Dimmitt	Castro	41,337	53,182	45,521	36,599	33,021	32,441
60	Earth	Lamb	10,882	13,391	11,614	9,491	8,594	8,479
61	Littlefield	Lamb	64,725	92,969	83,321	71,384	66,031	65,173
62	Denver City	Yoakum	41,299	76,513	78,094	72,252	66,984	64,710
63	Hereford	Deaf Smith	161,472	259,950	282,905	258,767	250,525	251,263
64	Lamesa	Dawson	112,521	181,203	216,082	198,426	186,904	179,828
65	Spur	Dickens	11,331	18,807	23,019	20,968	19,601	19,601
66	County-Other	Lamb						
67	Plains	Yoakum	17,369	30,599	45,256	44,414	41,992	40,576
68	Farwell	Parmer	16,995	28,613	39,744	42,015	39,726	37,532
69	Brownfield	Terry	108,354	199,174	289,463	329,799	323,839	322,040
70	Ransom Canyon	Lubbock	16,898	38,910	67,875	101,807	132,633	139,628
71	Matador	Motley	10,028	16,265	20,641	23,283	25,752	25,161
72	Seminole	Gaines	86,784	166,714	244,685	317,131	379,477	418,268
Total			**1,504,270**	**1,595,187**	**1,573,981**	**1,606,877**	**1,639,359**	**1,666,924**

water management strategy for the Region is $1,504,270 in 2010, and increases to $1,666,924 in 2060 (Table 4.4-7). Cost per acft in year 2010 is approximately $526, and in 2060 is approximately $415.

4.4.1.2 Irrigation Water Conservation

Background: Of the approximately 7.3 million acres of cropland in production in the Llano Estacado Water Planning Region, approximately 60 percent are farmed without irrigation and 40 percent are irrigated. For the most part, the irrigated acreages are those that have saturated sections of the Ogallala Formation underlying them that are thick enough to provide an adequate quantity of water to justify drilling, equipping, and pumping irrigation wells. Such wells supply water that is used to supplement precipitation for crop production.

Dryland and irrigation farmers in the area attempt to maximize the use of the precipitation they receive on their farms. Precipitation will support selected crops (dryland cotton, dryland grain sorghum, and dryland wheat) resulting in yields adequate to return a profit in about six of ten years. With increased precipitation or supplemental irrigation, yields of these crops can be increased by 30 percent to more than 300 percent and other crops can be produced, i.e., cotton requires about 5 inches of water to grow the plant, then for each additional inch of water the cotton plants will produce from 30 to 50 pounds of lint per acre depending on soil fertility and the timing of the receipt of additional water. Grain sorghum and wheat also require a similar amount of water to grow the plant, and the yields produced have a direct relationship to the total amount of water available during the growing season. The water supply can be a combination of stored soil moisture and precipitation or irrigation water received during the growing season.

Projected Irrigation Water Demand, Irrigation Water Supply, and Irrigation Water Needs (Shortages): The projected irrigation water demands from Section 2, projected supplies of water available for irrigation use from Section 3, and projected irrigation water needs (shortages) from Section 4 for the counties of the Llano Estacado Region are summarized in Table 4.4-8. The TWDB irrigation water demand projections for the Llano Estacado Water Planning Region show a decline from the estimated level of use in year 2000 of 4,347,877 acft/yr to 4,024,942 acft/yr in 2020, and 3,474,163 acft/yr in 2060 (Table 4.4-8). Projected irrigation water supplies available decline from 2,943,768 acft/yr in year 2010 to 1,842,957 acft/yr in 2030,

Table 4.4-8
Projected Irrigation Water Demands, Irrigation Water Supplies, and Irrigation Water Needs (Shortages)

County	Irrigation in Use		Projections					
	1990 (acft)	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Bailey								
Demand	220,775	182,865	178,478	174,197	170,018	165,939	161,958	158,071
Supply			93,193	82,121	77,183	71,845	67,604	64,474
Shortages			85,285	92,076	92,835	94,094	94,354	93,597
Briscoe								
Demand	39,592	26,329	25,373	24,453	23,566	22,710	21,886	21,091
Supply			26,522	19,631	11,430	9,052	7,000	6,510
Shortages			0	4,822	12,136	13,658	14,886	14,581
Castro								
Demand	351,189	503,792	484,475	465,902	448,039	430,861	414,342	398,457
Supply			338,332	273,380	182,356	74,914	56,886	46,689
Shortages			146,143	192,522	265,683	355,947	357,456	351,768
Cochran								
Demand	32,679	119,985	115,352	110,903	106,623	102,506	98,549	94,744
Supply			75,443	72,307	69,617	67,001	21,904	22,100
Shortages			39,909	38,596	37,006	35,505	76,645	72,644
Crosby								
Demand	105,634	112,135	107,617	103,281	99,120	95,126	91,295	87,618
Supply			96,729	92,850	88,935	85,398	82,943	79,658
Shortages			10,888	10,431	10,185	9,728	8,352	7,960
Dawson								
Demand	39,097	146,039	137,803	130,036	122,705	115,786	109,260	103,102
Supply			42,022	35,224	32,620	29,644	29,863	29,862
Shortages			95,781	94,812	90,085	86,142	79,397	73,240
Deaf Smith								
Demand	285,459	372,827	361,015	349,580	338,504	327,780	317,396	307,341
Supply			192,202	155,602	115,537	74,755	72,017	66,691
Shortages			168,813	193,978	222,967	253,025	245,379	240,650
Dickens								
Demand	4,779	9,486	9,203	8,928	8,663	8,405	8,153	7,908
Supply			5,796	5,662	5,530	5,406	5,285	5,171
Shortages			3,407	3,266	3,133	2,999	2,868	2,737

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Table 4.4-8 Continued

County	Irrigation in Use		Projections					
	1990 (acft)	2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Floyd								
Demand	131,706	237,020	227,579	218,516	209,812	201,454	193,431	185,727
Supply			136,848	112,126	100,845	92,488	88,283	85,655
Shortages			90,731	106,390	108,967	108,966	105,148	100,072
Gaines								
Demand	392,950	414,772	393,170	372,693	353,283	334,884	317,442	300,908
Supply			325,598	266,959	233,545	206,984	182,870	160,640
Shortages			67,572	105,734	119,738	127,900	134,572	140,268
Garza								
Demand	4,383	12,165	11,451	10,783	10,148	9,556	8,997	8,471
Supply			6,739	6,482	6,153	5,835	5,542	5,259
Shortages			4,712	4,301	3,995	3,721	3,455	3,212
Hale								
Demand	461,931	367,700	355,516	343,737	332,349	321,337	310,690	300,396
Supply			334,580	288,283	192,995	114,472	86,199	77,303
Shortages			20,936	55,454	139,354	206,865	224,491	223,093
Hockley								
Demand	92,968	174,996	168,151	161,578	155,261	149,188	143,354	137,749
Supply			105,750	87,023	73,420	62,392	60,565	57,165
Shortages			62,401	74,555	81,841	86,796	82,789	80,584
Lamb								
Demand	351,050	377,893	363,313	349,294	335,816	322,858	310,401	298,425
Supply			249,057	190,703	133,491	82,688	59,603	44,839
Shortages			114,256	158,591	202,325	240,170	250,798	253,586
Lubbock								
Demand	230,717	242,978	229,267	216,397	204,248	192,782	181,961	171,747
Supply			162,603	130,702	108,928	86,123	81,768	75,440
Shortages			66,665	85,695	95,320	106,660	100,194	96,308
Lynn								
Demand	39,988	120,372	113,895	107,766	101,972	96,482	91,295	86,387
Supply			131,397	130,696	129,946	129,518	129,240	129,231
Shortages			-17,502	-22,930	-27,974	-33,036	-37,945	-42,844

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Table 4.4-8 Concluded

County	*Irrigation in Use* 1990 (acft)	2000 (acft)	*Projections* 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Motley								
Demand	3,883	9,168	8,894	8,628	8,372	8,121	7,877	7,641
Supply			7,562	7,362	7,164	6,967	6,785	6,616
Shortages			1,332	1,266	1,208	1,154	1,092	1,025
Parmer								
Demand	475,000	415,449	411,037	406,673	402,356	398,084	393,858	389,676
Supply			250,355	75,577	40,439	40,004	39,575	39,044
Shortages			160,682	331,096	361,917	358,080	354,283	350,632
Swisher								
Demand	139,650	171,706	170,725	163,566	168,780	167,816	166,857	165,903
Supply			147,970	103,121	72,884	62,409	59,235	58,351
Shortages			22,755	60,445	95,896	105,407	107,622	107,552
Terry								
Demand	131,901	203,141	192,725	182,844	173,471	164,577	156,139	148,133
Supply			117,870	90,743	72,132	57,926	57,975	57,984
Shortages			74,855	92,101	101,339	106,651	98,164	90,149
Yoakum								
Demand	122,409	127,059	120,979	115,187	109,674	104,426	99,427	94,668
Supply			97,200	92,443	87,806	83,873	79,993	76,183
Shortages			23,779	22,744	21,868	20,553	19,434	18,485
Region Total								
Demand	3,657,740	4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163
Supply			2,943,768	2,318,996	1,842,957	1,449,693	1,281,135	1,194,864
Shortages *			1,260,901	1,728,876	2,067,797	2,324,021	2,361,378	2,322,143

* Sum of shortages for counties, excludnig Lynn County which has a projected surplus.

and 1,194,864 acft/yr in 2060 (Table 4.4-8) resulting in a projected irrigation water shortage of 1,260,901 acft/yr in 2010, and 2,322,143 acft/yr in 2060 (Table 4.4-8 and Figure 4.4-1). For each of the counties of the region except Lynn County, irrigation water shortages are projected to begin immediately and continue to 2060. Lynn County has a projected irrigation water supply that is greater than projected irrigation water demand in the quantity of about 17,502 acft/yr in 2010, and increases to about 42,844 acft/yr in 2060 (Table 4.4-8).

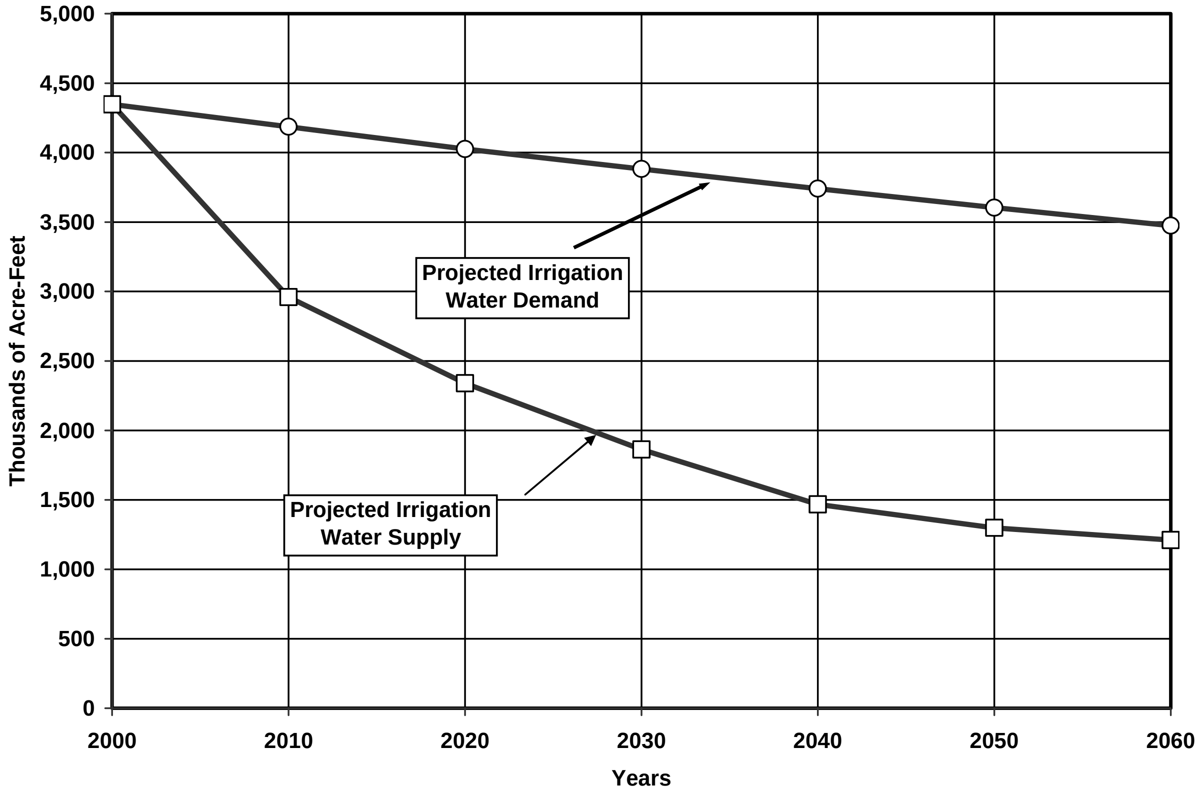


Figure 4.4-1. Projected Irrigation Water Demand and Supply — Region O

TWDB Rules for regional water planning require Regional Water Planning Groups to consider water conservation and drought management measures for each water user group with a need (projected water shortage). In addition, the Rules direct that water conservation BMPs, as identified by the Water Conservation Implementation Task Force, be considered in the development of the water conservation water management strategy. Since 20 of the 21 counties of the Region are projected to have irrigation needs (shortages), the LEWPG is required to consider irrigation water conservation as a water management strategy for the regional water plan.

Irrigation Water Conservation Best Management Practices: The Water Conservation Implementation Task Force list of BMPs for irrigation is as follows:

1. Irrigation Scheduling;
2. Volumetric Measurement of Irrigation Water Use;
3. Crop Residue Management and Conservation Tillage;
4. On-farm Irrigation Audit;
5. Furrow Dikes;
6. Land Leveling;

7. Contour Farming;
8. Conversion of Supplemental Irrigated Farmland to Dry-Land Farmland;
9. Brush Control/Management;
10. Lining of On-Farm Irrigation Ditches;
11. Replacement of On-/farm Irrigation Ditches with Pipelines;
12. Low Pressure Center Pivot Sprinkler Irrigation Systems;
13. Drip/Micro-Irrigation System;
14. Gated and Flexible Pipe for Field Water Distribution Systems;
15. Surge Flow Irrigation for Field Water Distribution Systems;
16. Linear Move Sprinkler Irrigation Systems;
17. Lining of District Irrigation Canals;
18. Replacement of District Irrigation Canals and Lateral Canals with Pipelines;
19. Tailwater Recovery and Use System; and
20. Nursery Production Systems.

Irrigation Farming Practices in the Llano Estacado Water Planning Region: In the interests of improving irrigation water use efficiency which works to assist in maintaining levels of agricultural production on individual farms as well as the regional totals, and in the interests of irrigation farming survival, many irrigation farmers of Region O have implemented the most efficient, practical irrigation application methods and farming practices available, while some have not.[8] For example, many of the BMPs listed above, were developed and/or implemented on a widespread basis over the past 50 years by researchers and farmers located in Region O, including:

1. Contour Farming;
2. Tailwater Recovery and Use;
3. Replacement of On-farm Irrigation Ditches with Pipelines;
4. Gated and Flexible Pipe for Field Water Distribution;
5. Low Pressure Center Pivot Sprinkler Irrigation Systems (LEPA and LESA);
6. Surge Flow Irrigation for Field Water Distribution Systems;
7. Furrow Dikes, Chiseling, and Deep Ripping;
8. Crop Residue Management and Conservation Tillage;
9. Linear Move Sprinkler Irrigation Systems;
10. Drip/Micro-Irrigation Systems; and
11. Volumetric Measuring.

Some of the BMPs identified by the Water Conservation Implementation Task Force are not applicable for use in Region O; e.g.; brush management, irrigation district canal lining or replacement, and nursery production systems. Principal methods of irrigation water conservation

[8] It is important to note that farming operations are carried out within existing Federal Government Farm Programs that have specifications and conditions that require farmers to maintain consistency of farming practices in order to qualify for program benefits. For example, the objectives of the Environmental Quality Incentives Program (EQIP) include increasing the efficiency of irrigation water use.

on irrigation farms of Region O are: (1) low elevation spray application systems; (2) low-energy precision application systems (LEPA); (3) surge irrigation; (4) furrow diking, chiseling, and deep ripping; (5) soil moisture monitoring, (6) irrigation scheduling; and (7) crop residue management and conservation tillage. In comparison to the irrigation method (furrow or flood irrigation) of releasing the water into the furrows at the ends of the rows and allowing it to flow across the fields until each furrow has been saturated throughout its entire length, the use of sprinklers, LEPA, surge valves, furrow diking, and irrigation scheduling improves application efficiency within the irrigated fields and thereby reduces the total quantity of water needed to produce an irrigated crop. The major irrigation water conservation techniques that are in use at the present time by irrigation farmers in the Llano Estacado Region are described briefly below.

Low Elevation Spray Application Sprinklers: Center pivot and lateral move low elevation/pressure sprinklers (LESA) spray water downward above the crops as the sprinkler systems move across the fields. Low-pressure sprinklers improve irrigation application efficiency in comparison to furrow irrigation by reducing water requirements per acre in the 10 to 15 percent range, while LEPA combined with furrow diking can reduce water requirements per acre by 30 to 40 percent. Use of LESA and LEPA, together with furrow dikes allow irrigation farmers to produce equivalent yields per acre at lower energy and labor costs of irrigation (i.e., it has been demonstrated that LESA and LEPA systems improve production and profitability of irrigation farming.

Low Energy Precision Application Systems: LEPA systems involve a sprinkler system that has been modified to discharge water directly into furrows at low pressure, thus reducing evaporation losses. When used in conjunction with furrow dikes, which hold both precipitation and sprinkler applied water behind small mounds of earth within the furrows, LEPA systems can accomplish the irrigation objective with less water than is required for the furrow irrigation and pressurized sprinkler methods. (Note: Furrow dikes are described below)

Surge Irrigation: Surge irrigation is an irrigation method in which water is released from pipes located at the head of the furrows as in the furrow irrigation method. The difference between furrow irrigation and surge irrigation is that surge valves allow the flow into the furrows for a period of time (usually 30 minutes to an hour) and then switch the water stream into the adjoining furrows for a period of time. This allows the water to soak into the furrow length that has just been wetted while the neighboring furrow is being watered. On the next cycle, the water stream is switched back to the original furrow where it is discharged into the previously wetted furrow section. On the second, third, and subsequent cycles, the water stream flows over the previously wetted sections much faster and with less deep percolation than if the stream of water had been continuously discharged into the furrow until the entire length had been wetted. In short, the alternation between rows reduces soil intake rates and increases advance rate across the fields, thereby reducing deep percolation. Although surge valves and furrow dikes cannot be used within the same row or furrow, furrow dikes and surge valves are sometimes used in alternate furrows

Furrow Dikes, Chiseling and Deep Ripping: Furrow dikes are small mounds of soil mechanically installed a few feet apart in the furrow. Furrow dikes are constructed by towing the furrow diking implement behind chisels, planters or cultivators when these operations are performed. These mounds of soil create small reservoirs that capture precipitation and hold it until it soaks into the soil instead of running down the furrow and out the end of the field. This practice can conserve (capture) as much as 100 percent of rainfall runoff, and furrow dikes are used to prevent irrigation runoff under sprinkler systems. This maintains high irrigation uniformity and increases irrigation application efficiencies. Capturing and holding precipitation that would have drained from the fields replaces required irrigation water on irrigated fields; and on dryland cropland it maximizes the benefits of precipitation for use by dryland crops. In addition, furrow diking may help increase recharge to the Ogallala Aquifer during periods when rainfall is in excess of the plant root zone soil water holding capacity. Furrow diking requires special tillage equipment and costs $3.00 to $5.00 per acre to install.

Crop Residue Management and Conservation Tillage: Crop residue management and conservation tillage practices are being used by both irrigation and dryland farmers in Region O in an effort to control costs and, to the extent possible to improve efficiency of both precipitation and applied irrigation water. Conservation tillage includes systems of planting and tillage that cover 30 percent or more of the soil surface, or leaves 1,000 pounds per acre of flat small grain residue equivalent, with crop residue, after planting, to reduce soil and wind erosion. No-till and strip till, where the soil is left undisturbed from harvest to planting, except for strips up to one-third of the row width; ridge-till, where the soil is left undisturbed from harvest to planting, except for strips up to one-third of the row width, with planting completed on the ridge, and residue is left on the surface between the ridges; and mulch-till, where full-width tillage trips, which disturbs all of the soil surface, and is done prior to and/or during planting, are among the leading types of conservation tillage practices. These tillage practices appear to be lowering overall costs of crop production by reducing the number of seedbed preparation and cultivation trips required across the fields, but it is not clear that they are reducing the quantities of irrigation water that need to be applied. It is thought, however, that these tillage practices will increase water use efficiency by increasing yields per acre, other things equal, including seeding, fertilizer, and irrigation water application rates.

In addition to the practices listed and described above, soil moisture monitoring and irrigation scheduling are used by individual producers. Soil moisture monitoring is the periodic measurement of soil moisture content. Its purpose is to indicate when and how much irrigation water needs to be applied to meet crop needs. Irrigation scheduling is the practice of applying irrigation water to crops in quantities that the crop can efficiently use, when the crop needs it, and in amounts that are not in excess of the soil water holding capacity.

Irrigation Water Conservation Water Management Strategy for the Llano Estacado Regional Water Plan: Irrigation water use data available from the Texas Water Development Board show that irrigation application rates were in the range of about 1.0 to 1.45 acft per acre per year during the 1990s, with the lowest rate being 0.80 acft/acre in 1992, and the highest being 1.45 acft/acre in 1998, a very dry year (Table 4.4-9).

Table 4.4-9
Irrigated Acreages and Irrigation Water Use – 1990 to 2000
Llano Estacado Region

Years	*Acres Irrigated*	*Irrigation Water Use*			*Growing Season Rainfall (inches)*	*Irrigation plus Rainfall (inches)*
		(acft/yr)	*acft/acre/yr*	*Acre Inches/acre/yr*		
1990	2,876,792	3,657,740	1.27	15.26	9.87	25.13
1991	3,049,177	3,031,115	0.99	11.93	16.45	28.38
1992	3,540,785	2,825,480	0.80	9.58	17.04	26.61
1993	3,027,835	4,132,229	1.36	16.38	10.68	27.05
1994	3,144,604	4,001,063	1.27	15.27	12.34	27.61
1995	3,240,764	4,193,017	1.29	15.53	16.30	31.82
1996	3,228,610	4,376,814	1.36	16.27	15.16	31.43
1997	3,162,448	4,118,124	1.30	15.63	18.75	34.38
1998	3,107,166	4,504,575	1.45	17.40	5.74	23.14
1999	3,292,624	3,711,833	1.13	13.53	17.58	31.11
2000	3,292,722	4,347,877	1.32	15.85	10.09	25.94

The Natural Resource Conservation Service (NRCS) reported that in 2004, there were 3.23 million irrigated acres in the Llano Estacado Water Planning Region.[9] Using year 2004 infrared orthographic imagery and ESRI ArchView 9.0, the High Plains Underground Water Conservation District No. 1, showed that in the Llano Estacado Region in 2004, there were 17,489 center pivots irrigating approximately 2.32 million acres, or 71.88 percent of irrigated acres in the region in 2004 (Table 4.4-10).[10] In 2004, five counties (Dawson, Gaines, Motley, Terry, and Yoakum) had center pivot systems and/or drip irrigation on nearly 100 percent of the irrigated acreage of the counties (Table 4.4-10). However, 908,851 irrigated acres the region are not being irrigated using efficient center pivot or drip systems, and numerous farmers are not using other available water conservation practices, as identified and recommended by the Water Conservation Implementation Task Force and the Llano Estacado Regional Water Planning Group (Table 4.4-10). Efforts should continue to be made to educate, inform, and assist producers to implement all practical, site specific water conservation practices and strategies.

The LERWPG recommends the continued use of the BMPs described above. In addition, the Group recommends voluntary implementation of volumetric measurement of irrigation water used, drip/micro-irrigation systems, remote sensing and irrigation scheduling; and variable rate irrigation application, other newly developed water conservation methods that are demonstrated to be practical and profitable, and improvements to existing strategies that may be made.

In addition, it is the recommendation of the LERWPG, that irrigation water conservation strategies currently being practiced in much of the region be extended and applied to additional irrigated acreages not now receiving the most efficient irrigation practices, and that irrigation farmers of the Llano Estacado Water Planning Region practice irrigation water conservation farming to the extent feasible, on a site specific basis. However, in order to accomplish the maximum estimated potential irrigation conservation, in many instances, it will be necessary to install efficient irrigation application equipment, such as LEPA and/or LESA systems on acreages that have not yet been equipped with such systems. When used in conjunction with furrow dikes and deep chiseling, which hold both precipitation and sprinkler applied water within the furrows, this water management strategy has the potential to meet a part of the projected irrigation shortages in the region, and are evaluated as water conservation water

[9] "Resource Data and Concerns, Zone 1," NRCS, U. S. Department of Agriculture, January 2005.
[10] Center Pivot Inventory, High Plains Underground Water Conservation District No. 1. October 2005.

Table 4.4-10
Total Acres Irrigated, Acres Irrigated Using Center Pivots, and Potential Acres to Which Center Pivots can be Added
Llano Estacado Region

County	Total Acres Irrigated (2004)	Total Number of Center Pivots[4] (2004)	Irrigated Acres Using Pivots (2004)	Percent of Total Acres Irrigated with Pivots (2004)	Potential Acres to which Pivots Might be Applied
Bailey [1]	130,786	768	92,598	70.80	38,188
Briscoe [2]	29,725	110	13,216	44.46	16,509
Castro [1]	312,014	1,378	218,174	69.92	93,840
Cochran [1]	108,561	615	81,849	75.39	26,712
Crosby [1]	134,000	551	74,712	55.76	59,288
Dawson [3]	74,487	595	72,250	97.00	2,237
Deaf Smith [1]	229,120	845	134,741	58.81	94,379
Dickens [2]	8,364	44	4,166	49.81	4,198
Floyd [1]	191,835	541	79,587	41.49	112,248
Gaines [1]	291,700	2,108	291,700	100.00	0
Garza [2]	13,531	35	4,457	32.94	9,074
Hale [1]	310,765	1,631	221,739	71.35	89,026
Hockley [1]	158,306	931	109,440	69.13	48,866
Lamb [1]	233,824	1,737	207,064	88.56	26,760
Lubbock [1]	181,600	743	94,691	52.14	86,909
Lynn [1]	91,896	497	61,053	66.44	30,843
Motley [2]	5,500	53	5,500	100.00	0
Parmer [1]	256,935	1,788	217,754	84.75	39,181
Swisher [1]	190,961	371	65,628	34.37	125,333
Terry [3]	171,000	1,409	167,500	97.95	3,500
Yoakum [3]	107,385	739	105,625	98.36	1,760
Total	3,232,295	17,489	2,323,444	71.88	908,851

1 Source: "Resource Data and Concerns, Zone 1," Natural Resource Conservation Service, U.S. Department of Agriculture, January, 2005.
2 Source: Center Pivot Survey, HPUWCD, 1998.
3 Source: Mesa, South Plains, and Sandy Land UWCDs, respectively.
4 Source: "2005 Center Pivot Inventory," High Plains Underground Water Conservation District, Lubbock, Texas.

management strategies for the regional water plan (Table 4.4-11). For example, an analysis of 86 loans by the High Plains Underground Water Conservation District No. 1, Lubbock, Texas that financed the installation of LEPA on 10,320 acres showed that average water savings were 0.61 acre-feet per acre. If the 908,851 acres of the region that are now being irrigated without this type of equipment were to be equipped with center pivots, it is estimated that the potential water conservation is 554,399 acft/yr in 2010 (Table 4-4-11). The projected potential irrigation water conservation for the region is 449,063 acft/yr in 2030, and declines to 327,367 acft/yr in 2060 due to projected declining well yields as the saturate thickness of the aquifer declines. The estimated potential quantities of water from this irrigation water conservation strategy for Bailey County are 23,295 acft/yr in 2010, 18,869 acft/yr in 2030, and 13,755 acft/yr in 2060 (Table 4.4-13). This irrigation water conservation water management strategy could reduce the Bailey County irrigation water shortage in 2010 from 85,285 acft/yr to 61,990 acft/yr, and in 2030 from 92,835 acft/yr to 73,966 acft/yr (Table 4.4-13). The projected irrigation shortages (needs), potential irrigation water conservation, and projected shortages after irrigation conservation quantities are taken into account are shown for each county in Table 4.4-13, and will not be stated here in the text.

Estimated capital cost to install LEPA and/or LESA types of center pivots on the presently unequipped 908,851 irrigated acres of the region is approximately $353.51 million (Table 4.4-11). The annual repayment cost of such an investment, amortized over 25 years (expected life of pivot systems), at 6% is approximately $27.62 million (Table 4.4-11), with capital cost per acre-foot of water saved increasing from $50 in 2010 to $62 in 2030, and $84/acft in 2060 (Table 4.4-12). With the more efficient irrigation application methods of this irrigation water conservation strategy, less water would be pumped per acre irrigated, thereby reducing farm production costs by at least the value of the energy that would have been needed to pump the water saved. Although this is a significant benefit to the irrigation water conservation strategy, data are not available with which to estimate its value. However, it is recognized and acknowledged as one of the major sources of income with which to make the payments to meet the capital costs of the irrigation water conservation strategy.

The irrigation water conservation strategy could potentially reduce the regional shortage from 1,260,901 acft/yr in 2010, to 848,556 acft/yr, a reduction of approximately 33 percent, and in 2060 by 327,367 acft/yr from 2,322,143 acft/yr to 2,019,337 acft/yr (Table 4.4-13). The estimated potential quantities of irrigation water conservation for the region are shown in Table 4.4-13 and Figure 4.4-2.

Table 4.4-11.
Estimates of Irrigation Water Conservation Potentials
Llano Estacado Region

	Applicable Acreage	Conservation Potential Per Acre[1] (acft)	Estimated Conservation in Year 2010 (acft/yr)	Total Cost to Install LEPA[2] (million dollars)	Annual Costs Amortized 25 Years @6% (million dollars)
Bailey	38,188	0.61	23,295	14.85	1.16
Briscoe	16,509	0.61	10,070	6.42	0.50
Castro	93,840	0.61	57,242	36.50	2.85
Cochran	26,712	0.61	16,294	10.39	0.81
Crosby	59,288	0.61	36,166	23.06	1.81
Dawson	2,237	0.61	1,365	0.87	0.07
Deaf Smith	94,379	0.61	57,571	36.71	2.87
Dickens	4,198	0.61	2,561	1.63	0.13
Floyd	112,248	0.61	68,471	43.66	3.41
Gaines	0	0.61	0	0.00	0.00
Garza	9,074	0.61	5,535	3.53	0.27
Hale	89,026	0.61	54,306	34.63	2.71
Hockley	48,866	0.61	29,808	19.01	1.49
Lamb	26,760	0.61	16,324	10.41	0.81
Lubbock	86,909	0.61	53,014	33.81	2.64
Lynn	30,843	0.61	18,814	12.00	0.94
Motley	0	0.61	0	0.00	0.00
Parmer	39,181	0.61	23,900	15.24	1.19
Swisher	125,333	0.61	76,453	48.75	3.81
Terry	3,500	0.61	2,135	1.36	0.10
Yoakum	1,760	0.61	1,074	0.68	0.05
Total	908,851	0.61	554,398	353.51	27.62

1 Average water savings per acre, as calculated from 86 water conservation equipment loans administered by the High Plains Underground Water Conservation District No. 1, Lubbock, Texas, 2005
2 Estimated at $389 per acre.

Table 4.4-12.
Estimates of Projected Irrigation Water Conservation Potentials[1]
And Cost Per Acre-Foot
Llano Estacado Region

	2010 acft/yr	*2020 acft/yr*	*2030 acft/yr*	*2040 acft/yr*	*2050 acft/yr*	*2060 acft/yr*
Bailey	23,295	20,965	18,869	16,982	15,284	13,755
Briscoe	10,070	9,063	8,157	7,341	6,607	5,947
Castro	57,242	51,518	46,366	41,730	37,557	33,801
Cochran	16,294	14,665	13,198	11,879	10,691	9,622
Crosby	36,166	32,549	29,294	26,365	23,728	21,355
Dawson	1,365	1,228	1,105	995	895	806
Deaf Smith	57,571	51,814	46,633	41,969	37,772	33,995
Dickens	2,561	2,305	2,074	1,867	1,680	1,512
Floyd	68,471	61,624	55,462	49,916	44,924	40,432
Gaines	0	0	0	0	0	0
Garza	5,535	4,982	4,483	4,035	3,632	3,268
Hale	54,306	48,875	43,988	39,589	35,630	32,067
Hockley	29,808	26,827	24,145	21,730	19,557	17,601
Lamb	16,324	14,691	13,222	11,900	10,710	9,639
Lubbock	53,014	47,713	42,942	38,648	34,783	31,305
Lynn	18,814	16,933	15,240	13,716	12,344	11,110
Motley	0	0	0	0	0	0
Parmer	23,900	21,510	19,359	17,423	15,681	14,113
Swisher	76,453	68,808	61,927	55,734	50,161	45,145
Terry	2,135	1,922	1,729	1,556	1,401	1,261
Yoakum	1,074	966	870	783	704	634
Total	554,398	498,958	449,063	404,158	363,741	327,368
Cost Per Acre-Foot[1]	**$ 50**	**$ 55**	**$ 62**	**$ 68**	**$ 76**	**$ 84**

[1] Projections are based upon estimates that well yields will decline one percent per year. Since water conservation potentials are 0.61 acre-feet per acre, and the well yield decline of one percent per year projection is applied throughout the region, the cost per acre-foot estimate is the same for each county, and increases at each projected decade because annual costs per year remain the same while the quantity of water saved each year declines.

Table 4.4-13.
Projected Irrigation Water Needs(Shortages) with Irrigation Water Conservation
Llano Estacado Region

County	Projections					
	2010 (acft/yr)	**2020 (acft/yr)**	**2030 (acft/yr)**	**2040 (acft/yr)**	**2050 (acft/yr)**	**2060 (acft/yr)**
Bailey County						
Projected Irrigation Need (Shortage)	85,285	92,076	92,835	94,094	94,354	93,597
Irrigation Conservation Potentials *	23,295	20,965	18,869	16,982	15,284	13,755
Projected Shortage with Irrigation Conservation	61,990	71,111	73,966	77,112	79,070	79,842
Briscoe County						
Projected Irrigation Need (Shortage)	0	4,822	12,136	13,658	14,886	14,581
Irrigation Conservation Potentials *	10,070	9,063	8,157	7,341	6,607	5,947
Projected Shortage with Irrigation Conservation	0	0	3,979	6,317	8,279	8,634
Castro County						
Projected Irrigation Need (Shortage)	146,143	192,522	265,683	355,947	357,456	351,768
Irrigation Conservation Potentials *	57,242	51,518	46,366	41,730	37,557	33,801
Projected Shortage with Irrigation Conservation	88,901	141,004	219,317	314,217	319,899	317,967
Cochran County						
Projected Irrigation Need (Shortage)	39,909	38,596	37,006	35,505	76,645	72,644
Irrigation Conservation Potentials *	16,294	14,665	13,198	11,879	10,691	9,622
Projected Shortage with Irrigation Conservation	23,615	23,931	23,808	23,626	65,954	63,023
Crosby County						
Projected Irrigation Need (Shortage)	10,888	10,431	10,185	9,728	8,352	7,960
Irrigation Conservation Potentials *	36,166	32,549	29,294	26,365	23,728	21,355
Projected Shortage with Irrigation Conservation	0	0	0	0	0	0
Dawson County						
Projected Irrigation Need (Shortage)	95,781	94,812	90,085	86,142	79,397	73,240
Irrigation Conservation Potentials *	1,365	1,228	1,105	995	895	806
Projected Shortage with Irrigation Conservation	94,416	93,584	88,980	85,147	78,502	72,434
Deaf Smith County						
Projected Irrigation Need (Shortage)	168,813	193,978	222,967	253,025	245,379	240,650
Irrigation Conservation Potentials *	57,571	51,814	46,633	41,969	37,772	33,995
Projected Shortage with Irrigation Conservation	111,242	142,164	176,334	211,056	207,607	206,655
Dickens County						
Projected Irrigation Need (Shortage)	3,407	3,266	3,133	2,999	2,868	2,737
Irrigation Conservation Potentials *	2,561	2,305	2,074	1,867	1,680	1,512
Projected Shortage with Irrigation Conservation	846	961	1,059	1,132	1,188	1,225

Continued on next page

Table 4.4-13 (continued)

County	Projections					
	2010 (acft/yr)	**2020 (acft/yr)**	**2030 (acft/yr)**	**2040 (acft/yr)**	**2050 (acft/yr)**	**2060 (acft/yr)**
Floyd County						
Projected Irrigation Need (Shortage)	90,731	106,390	108,967	108,966	105,148	100,072
Irrigation Conservation Potentials *	68,471	61,624	55,462	49,916	44,924	40,432
Projected Shortage with Irrigation Conservation	22,259	44,766	53,505	59,050	60,224	59,641
Gaines County						
Projected Irrigation Need (Shortage)	67,572	105,734	119,738	127,900	134,572	140,268
Irrigation Conservation Potentials *	0	0	0	0	0	0
Projected Shortage with Irrigation Conservation	67,572	105,734	119,738	127,900	134,572	140,268
Garza County						
Projected Irrigation Need (Shortage)	4,712	4,301	3,995	3,721	3,455	3,212
Irrigation Conservation Potentials *	5,535	4,982	4,483	4,035	3,632	3,268
Projected Shortage with Irrigation Conservation	0	0	0	0	0	0
Hale County						
Projected Irrigation Need (Shortage)	20,936	55,454	139,354	206,865	224,491	223,093
Irrigation Conservation Potentials *	54,306	48,875	43,988	39,589	35,630	32,067
Projected Shortage with Irrigation Conservation	0	6,579	95,366	167,276	188,861	191,026
Hockley County						
Projected Irrigation Need (Shortage)	62,401	74,555	81,841	86,796	82,789	80,584
Irrigation Conservation Potentials *	29,808	26,827	24,145	21,730	19,557	17,601
Projected Shortage with Irrigation Conservation	32,593	47,728	57,696	65,066	63,232	62,983
Lamb County						
Projected Irrigation Need (Shortage)	114,256	158,591	202,325	240,170	250,798	253,586
Irrigation Conservation Potentials *	16,324	14,691	13,222	11,900	10,710	9,639
Projected Shortage with Irrigation Conservation	97,932	143,900	189,103	228,270	240,088	243,947
Lubbock County						
Projected Irrigation Need (Shortage)	66,665	85,695	95,320	106,660	100,194	96,308
Irrigation Conservation Potentials *	53,014	47,713	42,942	38,648	34,783	31,305
Projected Shortage with Irrigation Conservation	13,650	37,982	52,378	68,012	65,411	65,003
Lynn County						
Projected Irrigation Need (Shortage)	0	0	0	0	0	0
Irrigation Conservation Potentials *	18,814	16,933	15,240	13,716	12,344	11,110
Projected Shortage with Irrigation Conservation	0	0	0	0	0	0

Continued on next page

Table 4.4-13 (continued)

County	*Projections* 2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
Motley County						
Projected Irrigation Need (Shortage)	1,332	1,266	1,208	1,154	1,092	1,025
Irrigation Conservation Potentials *	0	0	0	0	0	0
Projected Shortage with Irrigation Conservation	1,332	1,266	1,208	1,154	1,092	1,025
Parmer County						
Projected Irrigation Need (Shortage)	160,682	331,096	361,917	358,080	354,283	350,632
Irrigation Conservation Potentials *	23,900	21,510	19,359	17,423	15,681	14,113
Projected Shortage with Irrigation Conservation	136,782	309,585	342,557	340,657	338,602	336,519
Swisher County						
Projected Irrigation Need (Shortage)	22,755	60,445	95,896	105,407	107,622	107,552
Irrigation Conservation Potentials *	76,453	68,808	61,927	55,734	50,161	45,145
Projected Shortage with Irrigation Conservation	0	0	33,969	49,673	57,461	62,408
Terry County						
Projected Irrigation Need (Shortage)	74,855	92,101	101,339	106,651	98,164	90,149
Irrigation Conservation Potentials *	2,135	1,922	1,729	1,556	1,401	1,261
Projected Shortage with Irrigation Conservation	72,720	90,179	99,610	105,094	96,763	88,888
Yoakum County						
Projected Irrigation Need (Shortage)	23,779	22,744	21,868	20,553	19,434	18,485
Irrigation Conservation Potentials *	1,074	966	870	783	704	634
Projected Shortage with Irrigation Conservation	22,705	21,778	20,998	19,770	18,730	17,851
Llano Estacado Region**						
Projected Irrigation Need (Shortage)	1,260,901	1,728,876	2,067,797	2,324,021	2,361,378	2,322,143
Irrigation Conservation Potentials *	554,399	498,959	449,063	404,157	363,741	327,367
Projected Shortage with Irrigation Conservation	848,556	1,282,251	1,653,571	1,950,530	2,025,534	2,019,337

* Potential conservation is estimated to be reduced by 1 percent per year due to reduced well yields because of thinning of the saturated hicknesses within the aquifer. This is the same estimate used in the water supply computations.

**Sum of the county rows for the Llano Estacado Region.

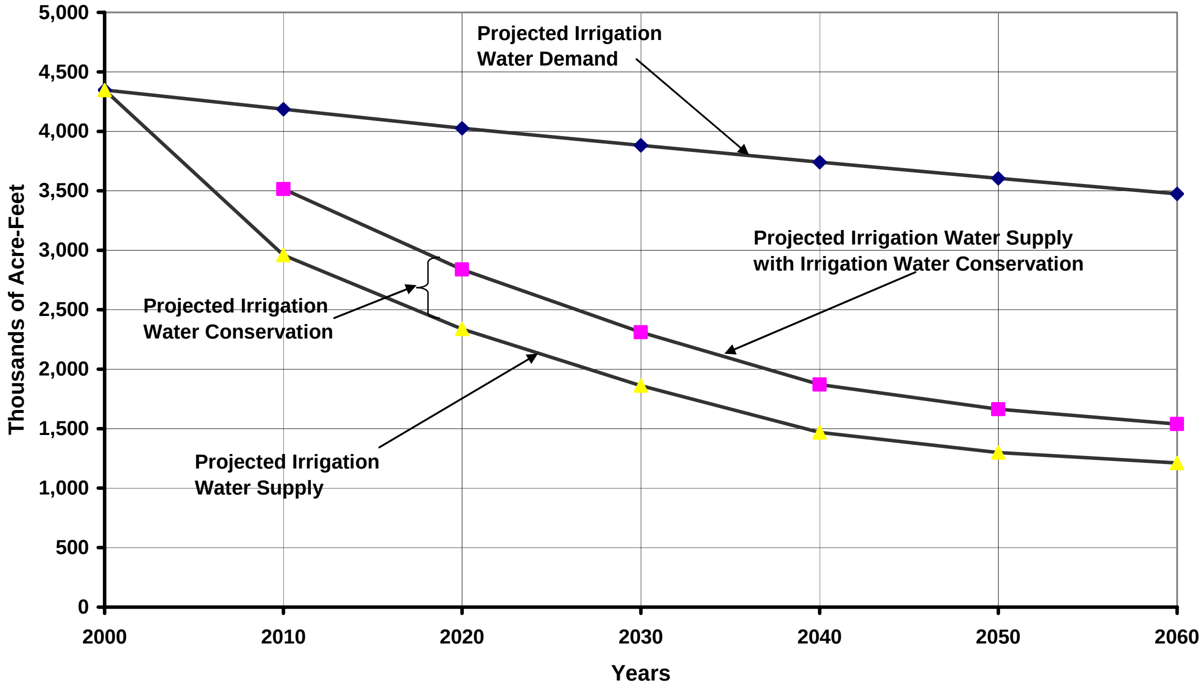


Figure 4.4-2. Projected Irrigation Water Demand, Supply and Supply with Irrigation Water Conservation

The Llano Estacado Regional Water Plan includes the recommendation that Llano Estacado Region irrigation farmers continue to use irrigation water conservation BMPs, and further recommends that all irrigation farmers of the Region adopt the previously described BMPs and consider and adopt, where practical, new irrigation water conservation methods that become available in the future. The LERWPG especially recommends the adoption of any successful management strategies that result from the Texas Alliance for Water Conservation Demonstration Project located in Floyd and Hale Counties. The Texas Alliance for Water Conservation Demonstration Project is an 8-year study to identify and quantify the best agricultural projection practices and technologies to reduce groundwater pumpage from the Ogallala Aquifer, while maintaining agricultural production and economic opportunities. The use of irrigation BMPs in the past has increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region, and the longevity of the aquifer. Such contributions are, in effect, operating to offset a part of the irrigation water shortages that have occurred in the past, and are projected to occur in the future as the Ogallala aquifer water levels decline.

The Region O Water Planning Group recognizes that the High Plains Ogallala aquifer with any appreciable pumping, is not sustainable, however with the implementation of water conservation strategies, the longevity of the Ogallala can be appreciably extended. Ground water is an exceedingly valuable asset to all of the Region O landowners and water rights holders, whether agricultural, municipal or industrial, and justifies implementation of all currently available water conservation strategies and technologies, including refinements thereto, and all strategies which may be developed in the future. We believe water in the ground is like money in a bank and such should be spent wisely.

4.4.2 Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Supply

4.4.2.1 Description of Option

Most municipal water systems in the Llano Estacado Region obtain water from the Ogallala Aquifer for all or part of their supply. This source is strongly preferred since it is readily available at a comparatively reasonable cost, in most cases it is the only available local supply, and it is suitable as a public supply with minimal treatment (disinfection only). The water management strategy identified as one way to meet the needs of cities of the Llano Estacado Region that overlie the Ogallala Aquifer is to obtain additional supplies from the aquifer beneath the area surrounding or near to the city. This option is evaluated as to the approximate distance to additional water supplies; the dates at which additional supplies are projected to be needed; and the costs of land, wells, and conveyance facilities to obtain the needed supplies. The results are presented in Section 4.4.2.2.

4.4.2.2 Available Supply from the Ogallala Aquifer to Meet Projected Needs of Cities

Staff members of the High Plains UWCD No. 1 made an analysis of the existing saturated thickness of the water-bearing formation of each city's well field(s) and the saturated thickness of the aquifer in areas surrounding each city. The volumes of groundwater in storage in each city's well field(s) in 1995 were calculated from saturated thickness maps. Of the 51 cities in the Llano Estacado Region for which the TWDB has made water use projections, and that are projected to obtain all or part of their supply from the Ogallala Aquifer, 31 were projected to need additional supplies during the planning period (Lake Alan Henry Water Supply District also needs water)(Section 4.1 and Figure 4.4-3). Of the 31 cities with projected needs, Brownfield has indicated that additional supply is to be obtained from CRMWA. In addition, Plainview, located in Hale County, although not projected to need additional water supplies, is included in this option due to the City's plan to drill additional wells in the near future. The City of Lubbock has also indicated an interest in participating in the development of additional groundwater supplies from the Ogallala Aquifer including the augmentation of water supplies through the linear well fields along existing water transmission lines.

For those cities obtaining water from both groundwater and surface water sources, the projected surface water supplies were estimated from water use data supplied by the respective surface water suppliers, and groundwater was used for the remaining supply to meet the total projected demand. As was determined in the analyses, in all but three cases adequate saturated formation exists within a 2- to 5-mile radius of each city, respectively, to locate new well fields. For the other three, the distances are between 6 and 14 miles. The method of estimating costs and the data and assumptions used in evaluation of this water management strategy are presented in Section 4.2.2.4. The new wells would be sized to meet the peak day demands of the city. As was done elsewhere in this study, calculations were based upon the assumption that the yields of new wells will decline 1 percent per year as the saturated thickness of the aquifer declines due to pumping. New wells would be located as close to the city as feasible.

4.4.2.3 Environmental Issues

The implementation of this option to supply cities with water to meet future needs is not expected to have significant, if any, adverse environmental effects. Wells will likely be located on property that has previously been altered by agriculture, and pipelines will be located in county and state road rights-of-way. In cases where these conditions are not met, field inspection of potential well sites and pipeline rights-of-way can be done, and well sites and pipeline routes can be selected to avoid sensitive wildlife habitat, plant communities, and/or cultural resources.

4.4.2.4 Engineering and Costing

A representative set of costs for wells, pipelines, and land was developed (Table 4.4-14). For cost estimating purposes, it was assumed that pumps would be sized to provide the needed pressure to move the water from the well to the distribution system without additional storage at the well site and without the need for booster pumps along the pipelines. It was estimated that the

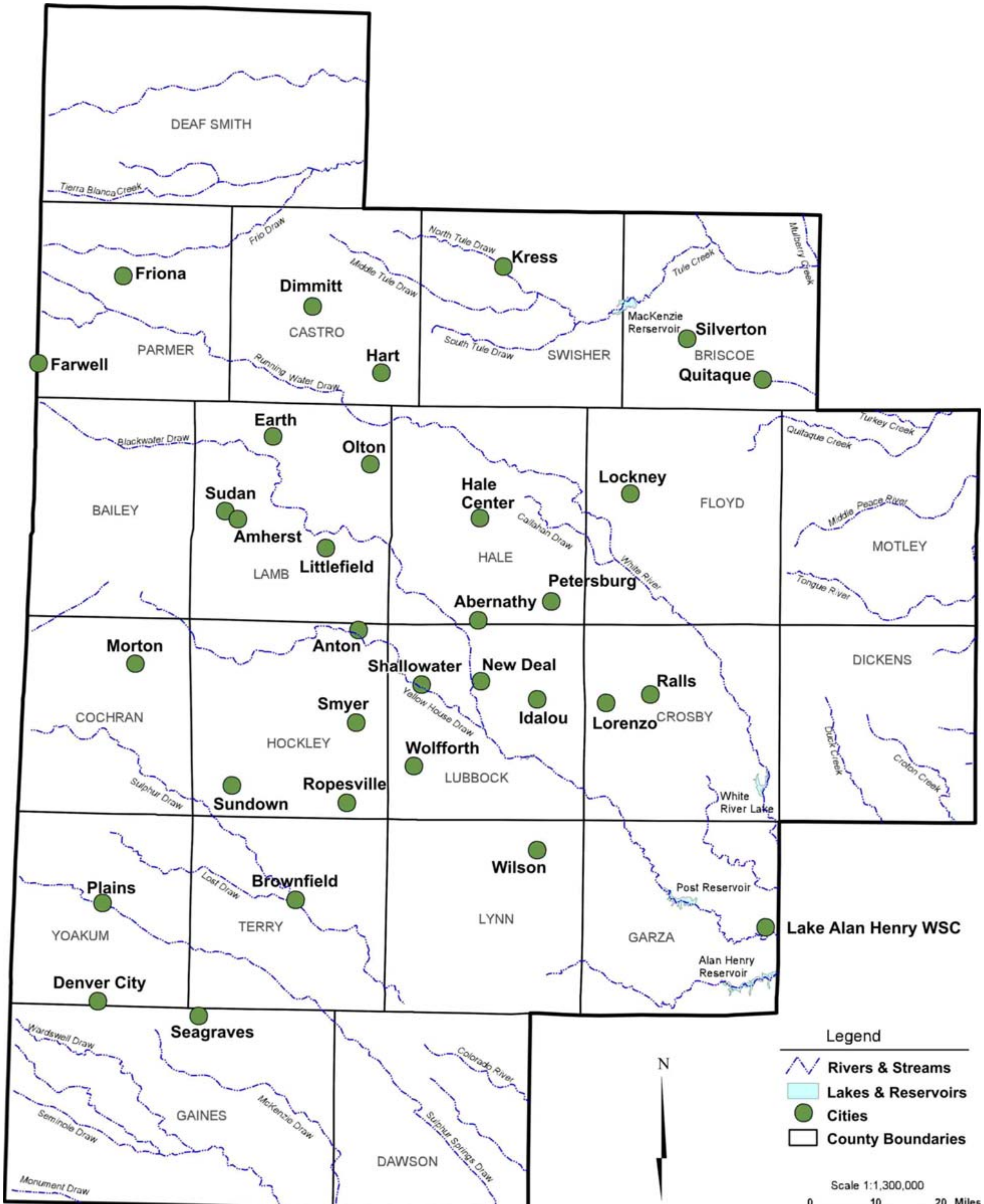


Figure 4.4-3. Cities Projected to Need Additional Water Supply

Table 4.4-14.
Representative Costs — Llano Estacado Region

Item	*Cost*[1]
4-inch well and related equipment (Ogallala)	$54,000
6-inch well and related equipment (Ogallala)	$81,000
4-inch PVC pipe	$13 per foot
6-inch PVC pipe	$19 per foot
8-inch PVC pipe	$26 per foot
10-inch PVC pipe	$32 per foot
12-inch PVC pipe	$37 per foot
14-inch PVC pipe	$41 per foot
16-inch PVC pipe	$47 per foot
18-inch PVC pipe	$52 per foot
Land[2]	$1,500 per acre

[1] All costs are in Second Quarter 2002 prices.
[2] Assumed 40 acres purchased per well needed.

city would need to purchase 40 acres of land per well needed. In calculating pipeline costs, it was assumed that a single pipeline sized to carry all of the projected additional supply would be used to transport water from the well field to the city's distribution system, with smaller pipelines connecting individual wells to the main transmission pipeline, and that transmission pipelines would be located in existing rights-of-way along county roads, eliminating the costs of purchasing land for new rights-of-way. It was further assumed that interest during construction would not be needed, since construction periods would be of short duration; i.e.; a few months.

Using the data and cost assumptions shown in Table 4.4-14, 10 percent of the total capital costs for engineering and contingencies, and 1 percent of pipeline and 1.5 percent of well capital costs for operation and maintenance, financing wells and transmission pipelines for 30 years at 6 percent annual interest, and power costs of $0.06 per kWh, costs were computed for this water management strategy to meet the projected needs of each of the cities of the region that can obtain additional water supply from the Ogallala Aquifer (Tables 4.4-15 through 4.4-47). A summary sheet is presented for each city that is estimated to need additional water supplies. The summary shows the approximate date at which new wells will be needed, the distance to potentially available supply, the capacity needed, and the costs for land, wells and equipment, and pipelines. The costs are expressed as total capital costs, annual debt service, annual operation and maintenance, including power costs, cost per acft, and cost per 1,000 gallons of water (Tables 4.4-15 through 4.4-47). The individual city plans are provided on the following tables.

Table 4.4-15.
City of Abernathy Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hale and Lubbock Counties

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr) [1]		0	0	674	700	706	704	690
New Water Supplies (acft/yr) [2]	*Year Needed*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Well #1	2011			193	174	157	141	127
Well #2	2015			428	385	346	312	280
Well #3	2015			202	182	164	147	132
Well #4	2025				202	182	164	147
Well #5	2042						196	176
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	823	942	848	959	863
Total Surplus/Deficit		0	0	149	242	142	255	173

Well	*Capacity (acft/yr)*	*Pipeline Length[3] (miles)*	*Land Costs[4]*	*Well Costs[4]*	*Pipeline Costs[4]*	*Total Capital Costs[4]*	*Engineering & Contingency Costs[4]*	*Annual Debt Service[5]*	*Annual O&M Costs[4]*	*Annual Cost of Water ($/acft)[4]*	*Annual Cost of Water ($/1,000 gallons)[4]*
Well #1	425	10	$60,000	$54,000	$1,953,600	$2,067,600	$206,760	$165,232	$31,029	$462	$1.42
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #4	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #5	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.1
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 30 years.

Table 4.4-16.
City of Amherst Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lamb County

				2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]				0	0	176	182	185	183	181
New Water Supplies (acft/yr)[2]			**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
		Well #1	2012			196	176	158	143	128
		Well #2	2025				202	182	164	147
		Well #3								
		Well #4								
		Well #5								
		Well #6								
		Well #7								
		Well #8								
		Well #9								
		Well #10								
			Total New Supplies	0	0	196	378	340	306	275
			Total Surplus/Deficit	0	0	20	196	155	123	94

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	5	$60,000	$54,000	$501,600	$615,600	$61,560	$49,196	$16,509	$155	$0.47
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities , in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the c ity's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingen cy costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-17.
City of Anton Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hockley County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	263	270	272	268	256	243
New Water Supplies (acft/yr)[2]	***Year Needed***	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Well #1	2006		204	184	165	149	134	120
Well #2	2006		204	184	165	149	134	120
Well #3	2015			202	182	164	147	132
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	408	569	512	461	415	373
Total Surplus/Deficit		0	145	299	240	193	159	130

Well	***Capacity (acft/yr)***	***Pipeline Length***[3] ***(miles)***	***Land Costs***[4]	***Well Costs***[4]	***Pipeline Costs***[4]	***Total Capital Costs***[4]	***Engineering & Contingency Costs***[4]	***Annual Debt Service***[5]	***Annual O&M Costs***[4]	***Annual Cost of Water ($/acft)***[4]	***Annual Cost of Water ($/1,000 gallons)***[4]
Well #1	425	4	$60,000	$54,000	$549,120	$663,120	$66,312	$52,993	$16,984	$165	$0.51
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-18.
City of Bovina Projected Water Needs and Water Management Strategy
Llano Estacado Region – Parmer County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	334	335	330	317	300	
New Water Supplies (acft/yr)[2]			**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
		Well #1	2015			202	182	164	147	132	
		Well #2	2015			202	182	164	147	132	
		Well #3	2025				202	182	164	147	
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	404	565	509	458	412	
			Total Surplus/Deficit	0	0	70	230	179	141	112	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	3	$60,000	$54,000	$411,840	$525,840	$52,584	$42,023	$15,611	$136	$0.42
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 30 years.

Table 4.4-19.
City of Denver City Projected Water Needs and Water Management Strategy
Llano Estacado Region – Yoakum County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	854	903	878	849	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2021				193	174	157	141	
		Well #2	2023				419	377	339	305	
		Well #3	2025				428	385	346	312	
		Well #4	2027				437	393	354	318	
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	0	1,476	1,328	1,195	1,076	
Total Surplus/Deficit				0	0	0	622	425	317	227	
Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	14	$60,000	$54,000	$2,735,040	$2,849,040	$284,904	$227,681	$38,843	$627	$1.92
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #4	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 30 years.

Table 4.4-20.
City of Dimmitt Projected Water Needs and Water Management Strategy
Llano Estacado Region – Castro County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	986	1,021	1,019	1,001	
New Water Supplies (acft/yr)[2]			*Year Needed*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*	
		Well #1	2017			437	393	354	318	286	
		Well #2	2019			446	401	361	325	292	
		Well #3	2021				410	369	332	299	
		Well #4	2042						414	373	
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	882	1,203	1,083	1,389	1,250	
Total Surplus/Deficit				0	0	882	217	62	370	249	
Well	*Capacity (acft/yr)*	*Pipeline Length*[3] *(miles)*	*Land Costs*[4]	*Well Costs*[4]	*Pipeline Costs*[4]	*Total Capital Costs*[4]	*Engineering & Contingency Costs*[4]	*Annual Debt Service*[5]	*Annual O&M Costs*[4]	*Annual Cost of Water ($/acft)*[4]	*Annual Cost of Water ($/1,000 gallons)*[4]
Well #1	900	11	$60,000	$81,000	$2,381,280	$2,522,280	$252,228	$201,568	$47,273	$276	$0.85
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #4	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engine ering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-21.
City of Earth Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lamb County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	0	0	0	247	245	242
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2031					193	174	157
Well #2	2034					200	180	162
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	0	0	393	354	318
Total Surplus/Deficit		0	0	0	0	146	109	76

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	3	$60,000	$54,000	$300,960	$414,960	$41,496	$33,162	$14,503	$112	$0.34
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individua l wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-22.
City of Farwell Projected Water Needs and Water Management Strategy
Llano Estacado Region – Parmer County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	296	237	214	207	195	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2015			202	182	164	147	132	
		Well #2	2015			202	182	164	147	132	
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	404	363	327	294	265	
			Total Surplus/Deficit	0	0	108	126	113	87	70	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	3	$60,000	$54,000	$300,960	$414,960	$41,496	$33,162	$14,503	$112	$0.34
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-23. City of Friona Projected Water Needs and Water Management Strategy Llano Estacado Region – Parmer County

Projected Total Municipal Need (acft/yr)[1]				2000	2010	2020	2030	2040	2050	2060	
				0	0	0	859	865	838	791	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2010			108	98	88	79	71	
		Well #2	2018			441	397	357	321	289	
		Well #3	2023				419	377	339	305	
		Well #4	2023				419	377	339	305	
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	549	1,332	1,198	1,079	971	
Total Surplus/Deficit				0	0	549	473	333	241	180	
Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4, 6]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	241	4	$60,000	$54,000	$781,440	$895,440	$89,544	$71,559	$14,903	$359	$1.10
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #4	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system w ith smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the tot al capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-24.
City of Hale Center Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hale County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	0	0	509	513	507	498
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2021				410	369	332	299
Well #2	2023				198	178	160	144
Well #3	2031					193	174	157
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	0	607	740	666	599
Total Surplus/Deficit		0	0	0	98	227	159	101

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	2	$60,000	$81,000	$337,920	$478,920	$47,892	$38,273	$26,839	$72	$0.22
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 30 years.

Table 4.4-25. City of Hart Projected Water Needs and Water Management Strategy Llano Estacado Region – Castro County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr) [1]				0	0	0	0	0	260	256	
New Water Supplies (acft/yr) [2]			**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
		Well #1	2041						193	174	
		Well #2	2043						198	178	
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	0	0	0	391	352	
			Total Surplus/Deficit	0	0	0	0	0	131	96	
Well	**Capacity (acft/yr)**	**Pipeline Length[3] (miles)**	**Land Costs[4]**	**Well Costs[4]**	**Pipeline Costs[4]**	**Total Capital Costs[4]**	**Engineering & Contingency Costs[4]**	**Annual Debt Service[5]**	**Annual O&M Costs[4]**	**Annual Cost of Water ($/acft)[4]**	**Annual Cost of Water ($/1,000 gallons)[4]**
Well #1	425	2	$60,000	$54,000	$200,640	$314,640	$31,464	$25,144	$13,499	$91	$0.28
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital c osts. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-26.
City of Idalou Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lubbock County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	0	0	0	274	273	272
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2031					410	369	332
Well #2								
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	0	0	410	369	332
Total Surplus/Deficit		0	0	0	0	136	96	60

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	4	$60,000	$81,000	$401,280	$542,280	$54,228	$43,336	$27,437	$79	$0.24
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-27.
City of Kress Projected Water Needs and Water Management Strategy
Llano Estacado Region – Swisher County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	104	104	105	103	100	96	
New Water Supplies (acft/yr)[2]			***Year Needed***	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***	
		Well #1	2006		204	184	165	149	134	120	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	204	184	165	149	134	120	
			Total Surplus/Deficit	0	100	80	60	46	34	24	

Well	*Capacity (acft/yr)*	*Pipeline Length*[3] *(miles)*	*Land Costs*[4]	*Well Costs*[4]	*Pipeline Costs*[4]	*Total Capital Costs*[4]	*Engineering & Contingency Costs*[4]	*Annual Debt Service*[5]	*Annual O&M Costs*[4]	*Annual Cost of Water ($/acft)*[4]	*Annual Cost of Water ($/1,000 gallons)*[4]
Well #1	425	6	$60,000	$54,000	$411,840	$525,840	$52,584	$42,023	$15,611	$136	$0.42
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-28.
City of Littlefield Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lamb County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	0	0	0	0	
New Water Supplies (acft/yr)[2]			Year Needed								
		Well #1	2010		450	405	365	328	295	266	
		Well #2	2010		450	405	365	328	295	256	
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	900	810	729	656	590	531	
Total Surplus/Deficit				0	900	810	729	656	590	531	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	3	$60,000	$81,000	$506,880	$647,880	$64,788	$51,775	$28,529	$89	$0.27
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-29.
City of Lockney Projected Water Needs and Water Management Strategy
Llano Estacado Region – Floyd County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	0	0	240	234	224	212
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2021				410	369	332	299
Well #2								
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	0	410	369	332	299
Total Surplus/Deficit		0	0	0	170	135	108	87

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	2	$60,000	$81,000	$137,280	$278,280	$27,828	$22,239	$24,833	$52	$0.16
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-30.
Cities of Lorenzo and Ralls Projected Water Needs and Water Management Strategy
Llano Estacado Region – Crosby County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	37	69	92	108	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2021				206	185	167	150	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	0	206	185	167	150	
			Total Surplus/Deficit	0	0	0	169	116	75	42	
Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	2	$60,000	$54,000	$137,280	$251,280	$25,128	$20,081	$12,866	$78	$0.24
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to tra nsport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distri bution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-31.
City of Morton Projected Water Needs and Water Management Strategy
Llano Estacado Region – Cochran County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	0	491	493	485	464	442
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2015			428	385	346	312	280
Well #2	2015			428	385	346	312	280
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	855	770	693	623	561
Total Surplus/Deficit		0	0	364	277	208	159	119

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	3	$60,000	$81,000	$506,880	$647,880	$64,788	$51,775	$28,529	$89	$0.27
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-32.
City of New Deal Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lubbock County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	12	20	20	25	20	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2011			193	174	157	141	127	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	193	174	157	141	127	
Total Surplus/Deficit				0	0	181	154	137	116	107	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	4	$60,000	$54,000	$274,560	$388,560	$38,856	$31,052	$14,239	$107	$0.33
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-33.
City of Olton Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lamb County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	520	539	536	529	
New Water Supplies (acft/yr)[2]			**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
		Well #1	2021				410	369	332	299	
		Well #2	2025				428	385	346	312	
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	0	837	753	678	610	
			Total Surplus/Deficit	0	0	0	317	214	142	81	
Well	**Capacity (acft/yr)**	**Pipeline Length[3] (miles)**	**Land Costs[4]**	**Well Costs[4]**	**Pipeline Costs[4]**	**Total Capital Costs[4]**	**Engineering & Contingency Costs[4]**	**Annual Debt Service[5]**	**Annual O&M Costs[4]**	**Annual Cost of Water ($/acft)[4]**	**Annual Cost of Water ($/1,000 gallons)[4]**
Well #1	900	3	$60,000	$81,000	$506,880	$647,880	$64,788	$51,775	$28,529	$89	$0.27
Well #2	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineerin g and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-34.
City of Petersburg Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hale County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	0	0	301	296	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2041						410	369	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	0	0	0	410	369	
Total Surplus/Deficit				0	0	0	0	0	109	73	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	1	$60,000	$81,000	$100,320	$241,320	$24,132	$19,285	$24,463	$49	$0.15
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-35.
City of Plains Projected Water Needs and Water Management Strategy
Llano Estacado Region – Yoakum County

	Year Needed	2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr) [1]		0	0	331	272	286	279	269
New Water Supplies (acft/yr) [2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2012			414	373	335	302	272
Well #2	2016			204	184	165	149	134
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	618	556	501	451	405
Total Surplus/Deficit		0	0	287	284	215	172	136

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	3	$60,000	$81,000	$411,840	$552,840	$55,284	$44,180	$27,578	$80	$0.24
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to tran sport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distrib ution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-36.
City of Plainview Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hale County

Projected Total Municipal Need (acft/yr)[1]				2000	2010	2020	2030	2040	2050	2060	
				0	0	0	0	0	0	0	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2010		500	450	405	365	328	295	
		Well #2	2010		500	450	405	365	328	295	
		Well #3	2010		500	450	405	365	328	295	
		Well #4	2010		500	450	405	365	328	295	
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	2,000	1,800	1,620	1,458	1,312	1,181	
Total Surplus/Deficit				0	2,000	1,800	1,620	1,458	1,312	1,181	
Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4,6]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	1000			$120,000		$120,000	$12,000	$9,590	$26,817	$36	$0.11
Well #2	1000			$120,000		$120,000	$12,000	$9,590	$26,817	$36	$0.11
Well #3	1000			$120,000		$120,000	$12,000	$9,590	$26,817	$36	$0.11
Well #4	1000			$120,000		$120,000	$12,000	$9,590	$26,817	$36	$0.11
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.
6 Costs for each well were provided by the City of Plainview. There are no land or pipeline costs associated with these wells.

Table 4.4-37.
City of Quitaque Projected Water Needs and Water Management Strategy
Llano Estacado Region – Briscoe County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	107	94	92	93	89	86
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2006		204	183	165	148	134	120
Well #2								
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	204	183	165	148	134	120
Total Surplus/Deficit		0	97	89	73	55	45	34

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	12	$60,000	$54,000	$823,680	$937,680	$93,768	$74,935	$19,730	$223	$0.68
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-38.
City of Ropesville Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hockley County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	0	91	89	85	81	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2021				193	174	157	141	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	0	193	174	157	141	
Total Surplus/Deficit				0	0	0	102	85	72	60	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	2	$60,000	$54,000	$137,280	$251,280	$25,128	$20,081	$12,866	$78	$0.24
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines conne cting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M cost s include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-39.
City of Seagraves Projected Water Needs and Water Management Strategy
Llano Estacado Region – Gaines County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	449	482	502	513	506	499	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2006		432	389	350	315	283	255	
		Well #2	2010		213	191	172	155	139	125	
		Well #3	2019			210	189	170	153	138	
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	645	790	711	640	576	519	
			Total Surplus/Deficit	0	196	308	209	127	70	20	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	4	$60,000	$81,000	$675,840	$816,840	$81,684	$65,278	$30,218	$106	$0.33
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% o f the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-40.
City of Shallowater Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lubbock County

Projected Total Municipal Need (acft/yr)[1]				**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
				0	157	180	190	184	192	184	
New Water Supplies (acft/yr)[2]			**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
		Well #1	2006		432	389	350	315	283	255	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	432	389	350	315	283	255	
			Total Surplus/Deficit	0	275	209	160	131	91	71	
Well	**Capacity (acft/yr)**	**Pipeline Length[3] (miles)**	**Land Costs[4]**	**Well Costs[4]**	**Pipeline Costs[4]**	**Total Capital Costs[4]**	**Engineering & Contingency Costs[4]**	**Annual Debt Service[5]**	**Annual O&M Costs[4]**	**Annual Cost of Water ($/acft)[4]**	**Annual Cost of Water ($/1,000 gallons)[4]**
Well #1	900	2	$60,000	$81,000	$200,640	$341,640	$34,164	$27,302	$25,466	$59	$0.18
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

[1] Value represents total municipal need after conservation.
[2] The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
[3] Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
[4] All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
[5] Debt service calculated as 6 percent for 30 years.

Table 4.4-41.
City of Silverton Projected Water Needs and Water Management Strategy
Llano Estacado Region – Briscoe County

				2000	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*	
Projected Total Municipal Need (acft/yr) [1]				0	128	126	123	115	111	108	
New Water Supplies (acft/yr) [2]			*Year Needed*	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*	
		Well #1	2006		204	183	165	148	134	120	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	204	183	165	148	134	120	
			Total Surplus/Deficit	0	76	57	42	33	23	12	

Well	*Capacity (acft/yr)*	*Pipeline Length[3] (miles)*	*Land Costs*[4]	*Well Costs*[4]	*Pipeline Costs*[4]	*Total Capital Costs*[4]	*Engineering & Contingency Costs*[4]	*Annual Debt Service*[5]	*Annual O&M Costs*[4]	*Annual Cost of Water ($/acft)* [4]	*Annual Cost of Water ($/1,000 gallons)* [4]
Well #1	425	12	$60,000	$54,000	$823,680	$937,680	$93,768	$74,935	$19,730	$223	$0.68
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system wi th smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the tota l capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-42.
City of Smyer Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hockley County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	0	0	0	0	0	62
New Water Supplies (acft/yr)[2]	**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Well #1	2051							193
Well #2								
Well #3								
Well #4								
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	0	0	0	0	0	193
Total Surplus/Deficit		0	0	0	0	0	0	131

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	1	$60,000	$54,000	$68,640	$182,640	$18,264	$14,596	$12,179	$63	$0.19
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-43.
City of Sudan Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lamb County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr) [1]				0	0	225	232	245	245	243	
New Water Supplies (acft/yr) [2]			**Year Needed**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	
		Well #1	2016			432	389	350	315	283	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	432	389	350	315	283	
			Total Surplus/Deficit	0	0	207	157	105	70	40	

Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	4	$60,000	$81,000	$401,280	$542,280	$54,228	$43,336	$27,473	$79	$0.24
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-44.
City of Sundown Projected Water Needs and Water Management Strategy
Llano Estacado Region – Hockley County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	320	328	328	315	300	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2016			204	184	165	149	134	
		Well #2	2018			208	187	169	152	137	
		Well #3	2023				198	178	160	144	
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	0	412	569	512	461	415	
			Total Surplus/Deficit	0	0	92	241	184	146	115	
Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	425	2	$60,000	$54,000	$274,560	$388,560	$38,856	$31,052	$14,239	$107	$0.33
Well #2	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #3	425	0.5	$60,000	$54,000	$34,320	$148,320	$14,832	$11,853	$11,836	$56	$0.17
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-45.
City of Tulia Projected Water Needs and Water Management Strategy
Llano Estacado Region – Swisher County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	417	417	416	416	416	417	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2006		432	389	350	315	283	255	
		Well #2			432	389	350	315	283	255	
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
			Total New Supplies	0	864	778	700	630	567	510	
			Total Surplus/Deficit	0	447	361	384	214	151	93	
Well	Capacity (acft/yr)	Pipeline Length[3] (miles)	Land Costs[4]	Well Costs[4]	Pipeline Costs[4]	Total Capital Costs[4]	Engineering & Contingency Costs[4]	Annual Debt Service[5]	Annual O&M Costs[4]	Annual Cost of Water ($/acft)[4]	Annual Cost of Water ($/1,000 gallons)[4]
Well #1	900	4	$60,000	$81,000	$675,840	$816,840	$81,684	$65,278	$80,218	$106	$0.33
Well #2	900	0.5	$60,000	$81,000	$34,320	$175,320	$17,532	$14,011	$23,803	$42	$0.13
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.

Table 4.4-46.
City of Wilson Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lynn County

				2000	2010	2020	2030	2040	2050	2060	
Projected Total Municipal Need (acft/yr)[1]				0	0	68	65	63	60	55	
New Water Supplies (acft/yr)[2]			Year Needed	2000	2010	2020	2030	2040	2050	2060	
		Well #1	2011			193	174	157	141	127	
		Well #2									
		Well #3									
		Well #4									
		Well #5									
		Well #6									
		Well #7									
		Well #8									
		Well #9									
		Well #10									
Total New Supplies				0	0	193	174	157	141	127	
Total Surplus/Deficit				0	0	125	109	94	81	72	
Well	**Capacity (acft/yr)**	**Pipeline Length[3] (miles)**	**Land Costs[4]**	**Well Costs[4]**	**Pipeline Costs[4]**	**Total Capital Costs[4]**	**Engineering & Contingency Costs[4]**	**Annual Debt Service[5]**	**Annual O&M Costs[4]**	**Annual Cost of Water ($/acft)[4]**	**Annual Cost of Water ($/1,000 gallons)[4]**
Well #1	425	2	$60,000	$54,000	$137,280	$251,280	$25,128	$20,081	$12,866	$78	$0.24
Well #2											
Well #3											
Well #4											
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.

2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.

3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.

4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.

5 Debt service calculated as 6 percent for 30 years.

Table 4.4-47.
City of Wolfforth Projected Water Needs and Water Management Strategy
Llano Estacado Region – Lubbock County

		2000	2010	2020	2030	2040	2050	2060
Projected Total Municipal Need (acft/yr)[1]		0	1,097	1,424	1,522	1,614	1,719	1,787
New Water Supplies (acft/yr)[2]	***Year Needed***	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Well #1[6]	2007		1,164	1,048	943	849	764	687
Well #2	2011			193	174	157	141	127
Well #3[7]	2019			891	802	722	650	585
Well #4	2047						437	393
Well #5								
Well #6								
Well #7								
Well #8								
Well #9								
Well #10								
Total New Supplies		0	1,164	2,132	1,919	1,727	1,991	1,792
Total Surplus/Deficit		0	67	708	397	113	272	5

Well	*Capacity (acft/yr)*	*Pipeline Length*[3] *(miles)*	*Land Costs*[4]	*Well Costs*[4]	*Pipeline Costs*[4]	*Total Capital Costs*[4]	*Engineering & Contingency Costs*[4]	*Annual Debt Service*[5]	*Annual O&M Costs*[4]	*Annual Cost of Water ($/acft)*[4]	*Annual Cost of Water ($/1,000 gallons)*[4]
Well #1[6]	2,400	0.06	$0	$480,000	$6,019	$486,019	$48,602	$38,840	$57,786	$40	$0.12
Well #2	425	2	$60,000	$54,000	$274,560	$388,560	$38,856	$31,052	$14,239	$107	$0.33
Well #3[7]	1,800	2.75	$1,920,000	$216,000	$396,000	$2,532,000	$253,200	$202,345	$52,319	$141	$0.43
Well #4	900	0.5	$60,000	$81,000	$50,160	$191,160	$19,116	$15,277	$23,962	$44	$0.13
Well #5											
Well #6											
Well #7											
Well #8											
Well #9											
Well #10											

1 Value represents total municipal need after conservation.
2 The new water supplies presented are average annual quantities, in acre-feet per year; assuming well yields decline 1 percent per year as saturation of the aquifer thins.
3 Assumes that a single pipeline sized to carry all of the projected additional supply will be used to transport water from the well field to the city's distribution system with smaller pipelines connecting individual wells to the main transmission pipeline.
4 All costs are in 2nd Quarter 2002 prices. Costs are for potable water delivered to the city's distribution system. Engineering and Contingency costs are 10% of the total capital costs. O&M costs include power costs.
5 Debt service calculated as 6 percent for 30 years.
6 Represents six wells converted from irrigation use to municipal use. Costs associated with this development have been provided by the city.
7 Represents four wells developed on a recently purchased property. Costs associated with this development have be en provided by the city.

4.4.3 Water Supply from Lake Alan Henry, Groundwater Sources, and Reclaimed Water

Lake Alan Henry, (TCEQ Permit 4146) located in the southeastern corner of Garza County, on the Double Mountain Fork of the Brazos River, owned by the City of Lubbock is a potential water management strategy for the Lake Alan Henry Water Supply District and the City of Lubbock. Each water management strategy is described and evaluated below.

4.4.3.1 Lake Alan Henry Water Supply District Water Management Strategy

4.4.3.1.1 Description of Option

This water management strategy includes construction of the following water supply facilities at Lake Alan Henry (Figure 4.4-4):

1. Raw water intake on the north side of Lake Alan Henry near the dam on property to be acquired by the project sponsor(s) for that purpose;
2. Raw water pipeline from the water intake to a water treatment plant located on the north side of Lake Alan Henry;
3. Water treatment plant on the north side of Lake Alan Henry in Garza County;
4. Treated water ground storage tank at the water treatment plant;
5. Treated water pipeline from the treated water storage tank to serve the following developments on the north side of Lake Alan Henry:
   a. Community of Justiceburg;
   b. Justiceburg Recreation Vehicle Park;
   c. Grubs Recreation Vehicle Park;
   d. North Ridge Recreation Vehicle Park;
   e. North Ridge Development; and
   f. Other areas within the Lake Alan Henry Water Supply District; and
6. Treated water pipeline from the treated water ground storage tank across the Brazos River downstream of the dam, and extended to supply treated water to the following developments located near Lake Alan Henry in Garza and Kent Counties:
   a. Rio Brazos Development;
   b. West Rio Brazos Development;
   c. Rio Brazos Recreation Vehicle Park;
   d. Community of Polar; and
   e. Other Areas within the Lake Alan Henry Water Supply District.

The quantity of water needed and the size of the facilities are based upon information about potential numbers of connections, people per connection, and daily water use rates shown in Table 4.4-41. (Note: Only the Community of Justiceburg has resident population that is

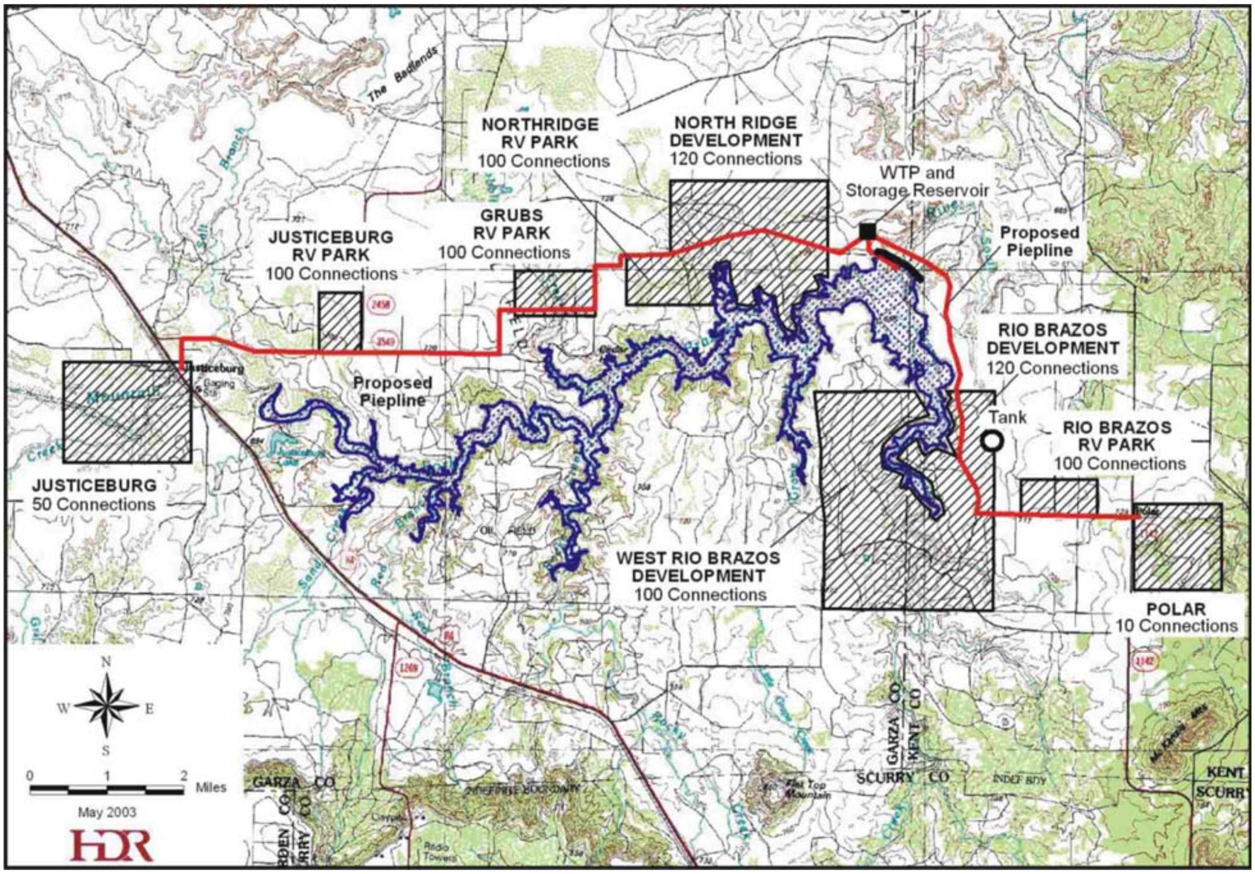


Figure 4.4-4. Lake Alan Henry Water Supply District Project

included in the regional population and water demand projections. The remaining service areas have mostly transient populations and therefore need water only when people are present. However, this water management strategy is sized to meet the projected needs at full developed occupancy of communities and developments listed in Table 4.4-48.)

4.4.3.1.2 Quantity of Water Available

The quantity needed for this option is 270 acft/yr and would be obtained from Lake Alan Henry via a water supply contract between Lubbock and the Lake Alan Henry Water Supply District. Lake Alan Henry has an estimated firm yield of 22,500 acft/yr, of which the quantity needed to supply this water management strategy is presently available, and will be available for the 50-year planning horizon (see section 3.2.4).

Table 4.4-48.
Potential Population and Water Demand
Lake Alan Henry Water Supply District System[1]

Name of Development	Maximum Number of Connections	Population with Maximum Number of Connections	GPCD[2] Use Rate	Water Demand (acft/yr)
North Side of Lake				
Justiceburg Community	50	150	118	19.83
Justiceburg RV Park	100	300	45	15.12
Grubs RV Park	100	300	45	15.12
North Ridge RV Park	120	360	45	18.15
North Ridge Development	100	300	118	39.65
Subtotal	**470**	**1,410**	**—**	**107.87**
South Side of Lake				
Rio Brazos Development	200	600	118	79.31
West Rio Brazos Development	120	360	118	47.58
Rio Brazos RV Park	200	600	45	30.24
Polar Community	10	30	118	3.97
Subtotal	**530**	**1,590**	**—**	**161.10**
Total		**3,000**	**—**	**268.97**
Quantity of Water (Million Gallons per Day) Average Use				0.25
Peaking Factor of 2.0; Peak Day Demand (Million Gallons per Day)				0.50

[1] It is intended that other areas within the Lake Alan Henry Water Supply District can be served, as needed.
[2] GPCD is gallons per person per day.

4.4.3.1.3 Environmental Issues

Water is to be obtained from Lake Alan Henry (TCEQ Permit 4146). The environmental issues associated with this option are for pipeline rights-of-way and sites for the water treatment plant and storage facilities. Since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

4.4.3.1.4 Engineering and Costing

Costs for this option include costs of:

- Land and rights-of-way;
- Raw water intake facilities (intake, pumps, and pipeline to water treatment plant);
- Surface water treatment plant;
- Treated water ground storage tank;
- Treated water pipelines, pumps and pump stations;
- Raw water;
- Engineering;
- Environmental and archeological studies,
- Permitting, and mitigation, if any; and
- Interest during construction.

The following assumptions and conditions were used in the costing of this option.

- The 270 acft of water can be obtained from Lake Alan Henry, which has an adequate yield to meet this demand.
- The cost for raw water from Lake Alan Henry is $587/acft.
- Cost of land for water treatment plant, pump stations, and storage tank is $275/acre.
- Cost of land for pipeline easements is $275/acre.
- The surface water treatment plant would have a capacity of 0.5 MGD and is sized to meet peak daily demands of the water users at build-out of all areas listed in Table 4-1.
- The pipelines are sized to meet peak daily water demands of the water users at build-out of all areas listed in Table 4.4-48.
- The costs given are for treated water delivered to the end users' respective locations, but do not include costs of distributing the treated water within the respective communities and subdivisions.
- Engineering, legal costs, and contingencies are calculated as 30 percent of the construction costs for the pipelines and 35 percent for all other facilities.
- Environmental and archeological studies, mitigation, and permitting costs are calculated as 100 percent of the land cost.
- Interest during construction is calculated at an annual rate of 6 percent with a 4 percent annual rate of return on funds balances during construction, which is estimated to be for a period of 2 (two) years.

The total project construction cost for this option was estimated at $5,613,000 (Table 4.4-49). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $408,000 for debt service (Table 4.4-49). Annual operation and maintenance (O&M) costs total $188,000 (Table 4.4-49). The total annual cost, including debt service, raw water cost, O&M cost, and power cost, is $757,000 (Table 4.4-49). For an annual delivery of 270 acft of treated water at the treated water storage tanks ready for distribution to end users the calculated cost per acft is $2,804 or $8.60 per thousand gallons (Table 4.4-49).

Table 4.4-49.
Cost Estimate for
Lake Alan Henry Water Supply District Project
Llano Estacado and Brazos G Regions
Second Quarter 2002 Prices

Item	Estimated Cost
Capital Costs	
Intake, Pump, and Pump Station (0.5 MGD)	$ 401,000
Water Treatment Plant (0.5 MGD modular upflow clarifier)	802,000
Transmission Pump, and Pump Station (0.5 MGD)	287,000
Treated Water Storage Tank (1 MGD)	726,000
Transmission Pipelines (6 inch diameter; 7.1 miles)	727,000
Transmission Pipelines (4 inch diameter; 7.3 miles)	603,000
Transmission Pipelines (2 inch diameter; 3.5 miles)	224,000
Highway and Stream Crossings (4 minor and 1 major streams, and 1 road crossing)	121,000
Total Capital Cost	**$3,891,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	$1,278,000
Environmental Studies and Permitting (100% 0f land costs)	14,000
Land and Surveying for Pipelines (43 acres @ $275 per acre)	12,900
Land for Treatment Plant, Pump Stations, and Storage Tank (4 acres @ $275/acre)	1,100
Interest During Construction (2 years @ 4%)	416,000
Total Project Cost	**$5,613,000**
Annual Costs	
Debt Service (6 percent for 30 years)	$408,000
Intake, Pipeline, and Pump Station Operation and Maintenance	41,000
Water Treatment Plant Operation and Maintenance	147,000
Cost of Raw Water (270 acft/yr @ $587 per acft)[1]	158,000
Pumping Energy Costs (56,350 kWh @ $0.06/kWh)	3,400
Total Annual Cost[1]	**$757,000**
Quantity of Water (acft/yr)	**270**
Annual Cost of Water ($ per acft)[2]	**2,804**
Annual Cost of Water ($ per 1,000 gallons)[2]	**8.60**

[1] Cost of raw water at Lake Alan Henry is $587 per acft.
[2] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

4.4.3.1.5 Implementation Issues

Implementation of this option will require financing, rights-of-way and sites for facilities, state and federal permits for the raw water intake, stream crossings, environmental and cultural resources studies, and mitigation for any environmental and cultural resources that might be affected.

4.4.3.2 Lake Alan Henry Supply to City of Lubbock

4.4.3.2.1 Description of Option

This Water Management strategy includes the construction of a pipeline from Lake Alan Henry to the City of Lubbock, plus construction of a new 24-MGD surface water treatment plant located near the southeast corner of Lubbock (Figure 4.4-5). The treated water would be an additional source for the City and its wholesale customers within the Lubbock service area.

4.4.3.2.2 Quantity of Water Available

The quantity available for this option is 22,230 acft/yr, which is the portion of the 22,500 acft/yr yield of Lake Alan Henry after subtracting the 270 acft/yr for the Lake Alan Henry Water District.

4.4.3.2.3 Environmental Issues

Water is to be obtained from Lake Alan Henry (TCEQ Permit 4146). The environmental issues associated with this option are for pipeline rights-of-way and sites for water treatment plant and storage facilities. Since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

4.4.3.2.4 Costing

Costs of this water management strategy include costs of the raw water transmission pipeline, surface water treatment plant, engineering, land acquisition, environmental studies and mitigation, if needed, and interest during construction. The following assumptions and conditions were used in the costing of this option.

- The project would be sized to use 22,230 acft/yr of Lake Alan Henry’s 22,500 acft/yr firm yield.
- The new surface water treatment plant would have a capacity of 24 MGD.

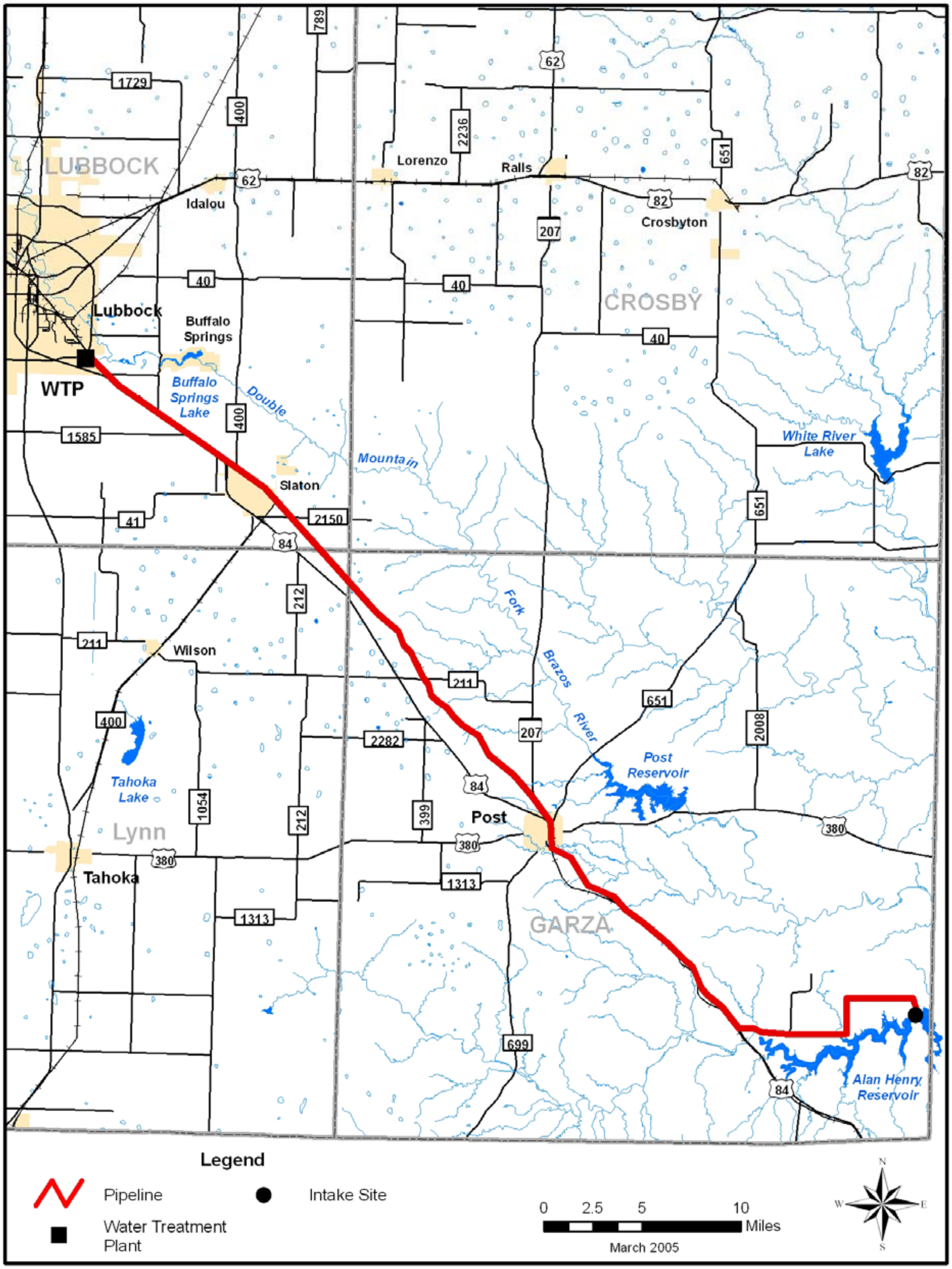


Figure 4.4-5. Lake Alan Henry to Lubbock Pipeline

- Cost of land for pipeline easements is $8,712 per acre. Cost of land for pump stations, intake structures, and storage tanks is $450 per acre. Cost of land for a water treatment plant is $3,000 per acre.
- The cost calculations are for treated water at the new water treatment plant and do not include costs associated with transporting the treated water from the water treatment plant to the end users.
- Cost of raw water from Lake Alan Henry reservoir is $325/acft.
- Capital costs for the pipeline, pump stations, and water treatment plant were based upon a 2001 cost estimate of this water transmission and treatment project for Lubbock by Black and Veatch; the 2001 costs were adjusted to Second Quarter 2002 prices.
- Engineering, legal costs, and contingencies are calculated as 30 percent of the construction costs for pipelines and 35 percent for all other facilities.
- Environmental and archeological studies, mitigation, and permitting costs are calculated as 100 percent of the land cost.
- Interest during construction is calculated with a 6 percent interest rate and a 4 percent annual rate of return for a period of 2 years.

The total project cost for this option was estimated at $174,909,000 (Table 4.4-50). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $12,707,000 for debt service (Table 4.4-50). Annual O&M costs total $3,282,000 (Table 4.4-50). The total annual cost, including debt service, O&M, raw water, and power, totals $26,584,000 (Table 4.4-50). For an annual delivery of 22,230 acft/yr, the resulting cost of treated water at the water treatment plant is $1,196 per acft (Table 4.4-50).

4.4.3.2.5 Implementation Issues

Implementation of this option will require the development of a regional water supply system, including customers and terms and conditions between customers and the regional supplier. The regional supplier will need to arrange financing, obtain rights-of-way and sites for facilities, secure state and federal permits for stream crossings, perform environmental and cultural resources studies, and provide mitigation for any environmental and cultural resources that might be affected.

Table 4.4-50.
Cost Estimate Summary for
Lake Alan Henry Pipeline
Llano Estacado Region
Second Quarter 2002 Prices

Item	***Estimated Cost***
Capital Costs	
Intake and Pump Station	$4,361,000
Transmission Pipeline (42 in dia., 65 miles)	68,794,000
Transmission Pumps Stations	12,004,000
Water Treatment Plant (24 MGD)	33,858,000
Total Capital Cost	**$119,017,000**
Engineering, Legal Costs and Contingencies	$32,216,000
Environmental Studies and Permitting	1,657,000
Land Acquisition and Surveying (332 acres)	3,062,000
Interest During Construction (2 years)	12,957,000
Total Project Cost	**$174,909,000**
Annual Costs	
Debt Service (6 percent for 30 years)	$12,707,000
Intake, Pipeline, and Pump Station Operation and Maintenance	1,097,000
Water Treatment Plant Operation and Maintenance	2,185,000
Water Purchase Cost ($325/acft)	7,225,000
Pumping Energy Costs (84,761,700 kWh @ $0.06/kWh)	3,370,000
Total Annual Cost	**$26,584,000**
Available Project Yield (acft/yr)	**22,230**
Annual Cost of Water ($ per acft)[1]	**$1,196**
Annual Cost of Water ($ per 1,000 gallons)[1]	**$3.67**

[1] Reported Annual Cost of Water is for treated water at the water treatment plant and does not include costs associated with distribution within municipal systems.

4.4.3.3 City of Lubbock Well Field

4.4.3.3.1 Description of Option

This water management strategy includes a well field located in the southern part of the City of Lubbock near 82nd Street and Memphis Avenue, collection lines, and a membrane water treatment plant, which would supply an existing city pump station at the location. Total capacity of the project would be approximately 5 MGD or 5,600 acft/yr, and would include the following:

- 1. 16 wells each having a capacity of 250 gpm;
- 2. 10,000 feet of 8-inch collection line; and
- 3. One membrane type water treatment plant with capacity of 5.0 MGD.

4.4.3.3.2 Quantity of Water Available

Evaluations by the City of Lubbock indicate that this water management strategy will yield 5,600 acft of water per year.

4.4.3.3.3 Environmental Issues

The environmental issues associated with this water management strategy are for pipeline rights-of-way and sites for pumping plants and the water treatment plant. Since the project is located within the City of Lubbock, there are no known wildlife habitat or cultural resources that would be affected.

4.4.3.3.4 Engineering and Costing

Costs for this option include the following:

- 16 wells at 250 gpm per well;
- 10,000 feet of 8-inch diameter collection pipelines;
- One 5.0-MGD membrane water treatment;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The implementation of this option to supply additional water to the City of Lubbock is not expected to have significant, if any, adverse environmental effects. Wells will be located on city owned property that has previously been altered by urban use, and the raw water transmission pipeline will be located in existing rights-of-way.

The total project cost for this option was estimated to be $7,718,000 (Table 4.4-51). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $561,000 for debt service. Annual operation and maintenance costs total $1,072,000, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $1,644,000. For an annual quantity of 5,600 acft/yr of treated water ready for delivery to customers, the cost is $294 per acft, or $0.90 per 1,000 gallons (Table 4.4-51).

Table 4.4-51.
Cost Estimate Summary for
City of Lubbock Well Field
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	*Estimated Cost*
Capital Costs[1]	
Transmission Pipeline (8 inch diameter; 2 miles)	$ 156,000
Water Treatment Plant (5.0 MGD)	3,900,000
Well Field (16 wells; 250 gpm)	1,444,000
Total Capital Cost[1]	**$5,500,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	1,912,000
Land Surveying for Pipelines & Water Treatment Plant (11 acres)	9,000
Interest During Construction (1 year @ 4%)	297,000
Total Project Cost	**$7,718,000**
Annual Costs	
Debt Service (6 percent for 30 years)	$ 561,000
Intake, Pipeline, and Pump Station Operation and Maintenance	55,000
Water Treatment Plant Operation and Maintenance	1,017,000
Pumping Energy Costs (187,210 kWh @ $0.06/kWh)	11,000
Total Annual Cost	**$1,644,000**
Quantity of Water (acft/yr)	**5,600**
Annual Cost of Water ($ per acft)[2]	**294**
Annual Cost of Water ($ per 1,000 gallons)[2]	**0.90**

[1] Total Cost data provided by the City of Lubbock on 2/25/2005. Costs for individual elements made from total costs.
[2] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

4.4.3.4 Lubbock Expand Capacity of Bailey County Well Field

4.4.3.4.1 Description of Option

This water management strategy expands the existing City of Lubbock Bailey County Well Field, and includes collection lines to connect the new wells to the existing pipeline from Bailey County to the City of Lubbock. This water management strategy would add 15 new wells (three each in years 2005, 2006, and 2007. Total capacity of the project would be approximately 5 million gallons per day or 5,600 acft/yr, and would include the following:

- 1. 15 wells each having a capacity of 231 gpm; and
- 2. Collection lines from the new wells to the existing Bailey County pipeline.

4.4.3.4.2 Quantity of Water Available

Evaluations by the City of Lubbock indicate that this water management strategy will yield 5,600 acft of water per year.

4.4.3.4.3 Environmental Issues

The environmental issues associated with this water management strategy are for pipeline rights-of-way and sites for pumping plants. Since the project is located within an existing well field, there are no known wildlife habitat or cultural resources that would be affected.

4.4.3.4.4 Engineering and Costing

Costs for this option include the following:

- 15 wells at 231 gpm per well;
- Collection pipelines;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated to be $2,541,000 (Table 4.4-52). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $185,000 for debt service. Annual operation and maintenance costs total $17,000, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $213,000. For an annual quantity of 5,600 acft/yr of treated water ready for delivery to customers, the cost is $38 per acft, or $0.12 per 1,000 gallons (Table 4.4-52).

Table 4.4-52.
Cost Estimate Summary for
Lubbock Expanding Capacity of Bailey County Well Field
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	Estimated Cost
Capital Costs[1]	
Collection Pipeline(s)	$180,000
Well Field (15 wells; 231 gpm)	1,500,000
Total Capital Cost[1]	**$1,680,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	$588,000
Interest During Construction (3 years @ 4 percent)	273,000
Total Project Cost	**$2,541,000**
Annual Costs	
Debt Service (6 percent for 30 years)	$185,000
Pipeline and Well Operation and Maintenance	17,000
Pumping Energy Costs (187,210 kWh @ $0.06/kWh)	11,000
Total Annual Cost	**$213,000**
Quantity of Water (acft/yr)	**5,600**
Annual Cost of Water ($ per acft)[2]	**38**
Annual Cost of Water ($ per 1,000 gallons)[2]	**0.12**

[1] Total Cost data provided by the City of Lubbock on 2/25/2005. Costs for individual elements made from total costs.
[2] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

4.4.3.3.6 Implementation Issues

The implementation of this option to supply additional water to the City of Lubbock is not expected to have significant, if any, adverse environmental effects. Wells will be located on property that has previously been altered by the existing well field.

4.4.3.5 CRMWA Expand Capacity of Groundwater Supply

4.4.3.5.1 Description of Option

This water management strategy procures additional groundwater rights in the vicinity of the CRMWA's Roberts County well field and transmission line, and replaces lost groundwater capacity as water levels decline. Currently, the additional quantity of water needed is estimated to be 46,659 aft/yr in order to reach full capacity of the existing CRMWA transmission system of 71,659 aft/yr, and to replace lost capacity. Therefore, this water management strategy will need to acquire an adequate quantity of groundwater water rights to produce 31,659 aft/yr, and drill additional wells to replace 15,000 acft/yr of lost capacity. The additional capacity is scheduled to be in operation by 2008. In addition to the foregoing strategy, Region O recommends for evaluation as a potential future strategy, the procurement of additional groundwater rights in the vicinity of CRMWA's Roberts County well field and transmission line and possibly other areas overlying the Ogallala Aquifer and the construction of a second pipeline for the delivery of the additional groundwater to CRMWA's customers. Any water management strategy will need to acquire an adequate quantity of groundwater water rights while complying with all applicable water conservation district rules and coordinating with other water planning regions, as appropriate.

4.4.3.5.2 Quantity of Water Available

With respect to the strategy of procuring additional groundwater rights to maximize the capacity of CRMWA's existing transmission system, the concept of a supplemental linear well field, both in Regions A and O, will be evaluated for inclusion in future water plans. Based upon information available to the members of CRMWA, landowners in the vicinity of the CRMWA Roberts County well field and transmission line own and are willing to sell or perhaps lease water rights in sufficient quantities to implement this water management strategy.

4.4.3.5.3 Environmental Issues

The environmental issues associated with this water management strategy are for pipeline rights-of-way and sites for pumping plants and storage facilities. Since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

4.4.3.5.4 Engineering and Costing

Costs for this option include the following:

- Water rights;
- Well fields, and wells;
- Collection pipelines and pumping plants;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated to be $79,398,000 (Table 4.4-53). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $5,768,000 for debt service. Annual operation and maintenance costs total $733,000, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $10,255,800. For an annual quantity of 46,659 acft/yr of treated water delivered to the CRMWA Roberts County transmission line ready for delivery to customers, the cost is $220 per acft, or $0.67 per 1,000 gallons (Table 4.4-53).

Table 4.4-53.
Cost Estimate Summary for
CRMWA Expanding Capacity of Groundwater System *
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	*Estimated Cost*
Capital Costs[1]	
Water Rights	$29,075,000
Collection Pipeline(s)	2,800,000
Well Field(s) and Wells	28,200,000
Total Capital Cost[1]	**$60,075,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	$10,710,000
Interest During Construction (3 years @ 4 percent)	8,613,000
Total Project Cost	**$79,398,000**
Annual Costs	
Debt Service (6 percent for 30 years)	$5,768,000
Pipeline and Well Operation and Maintenance	733,000
Pumping Energy Costs (35,391,000 kWh @ $0.06/kWh)[2]	3,754,000
Total Annual Cost	**$10,255,800**
Quantity of Water (acft/yr)	**46,659**
Annual Cost of Water ($ per acft)[3]	**220**
Annual Cost of Water ($ per 1,000 gallons)[3]	**0.67**

1 Total Cost data provided by the Region A on March 15, 2006.
2 Assumes wells are at a depth of 800 ft and pump 90 percent of the year.
3 Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.
* Costs are for water delivered to the CRMWA Roberts County transmission line, and do not include costs to move the water from there to member cities.

4.4.3.5.5 Implementation Issues

The implementation of this option to supply additional water to the CRMWA customers is not expected to have significant, if any, adverse environmental effects.

4.4.3.6 Lubbock Brackish Groundwater Desalination

4.4.3.6.1 Description of Option

This water management strategy would develop wells in the Trinity and Dockum Group of aquifers for subsequent treatment and use as drinking water. Wells would be developed in Bailey and Lubbock Counties. The proposed system would be developed in groups of four wells to produce an estimated 4 million gallons per day (MGD) of groundwater. Each well group would have an associated well collection, treatment and reject water disposal system. Each 4-well group is estimated to produce about 3,360 acre-feet per year (acft/yr) of potable water. It is intended that well groups with treatment and disposal systems will be brought on line, as the water is needed.

4.4.3.6.2 Quantity of Water Available

Evaluations by the City of Lubbock indicate that this water management strategy of 4 wells will yield a dependable, reliable during drought of record conditions supply of 3,360 acft of water per year for each of the projection dates.

4.4.3.6.3 Environmental Issues

The environmental issues associated with this water management strategy are for pipeline rights-of-way and sites for pumping plants. Since the project is located within an existing well field or city property, there are no known wildlife habitat or cultural resources that would be affected. Brine concentrate disposal will be through deep well injection.

4.4.3.6.4 Engineering and Costing

Costs for this option (4 well group) include the following:

- 4 wells at approximately 1,040 gpm per well;
- Collection pipelines;
- Reverse osmosis water treatment plant(s);
- Brine concentrate injection wells;
- Brine concentrate transmission pipelines;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

Table 4.4-54.
Cost Estimate Summary for
Lubbock Brackish Groundwater Desalination
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	*Estimated Cost*
Capital Costs[1]	
Supply Wells (4 wells; 1,040 gpm)	$2,400,000
Collection Pipeline(s) (10,560 ft; 12 in diameter)	316,800
Water Treatment Plant (Reverse Osmosis)	1,600,000
Building and Support Facilities	900,000
Sitework	25,000
Concentrate Injection Wells (2; 0.5 MGD)	700,000
Concentrate Transmission Pipelines ((2,640 ft; 8 in diameter)	52,800
Total Construction Cost[1]	**$5,994,600**
Feasibility Studies	300,000
Pilot Studies	600,000
Total Capital Cost[1]	**$6,894,600**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies)	$2,079,630
Interest During Construction (3 years @ 4 percent)	1,077,000
Total Project Cost	**$10,051,230**
Annual Costs	
Debt Service (6 percent for 30 years)	730,211
Pipeline and Well Operation and Maintenance (1% of capital cost for pipelines; 1.5% for wells and Water Treatment Plant)	121,335
Membrane Replacement and Disinfection	63,832
Pumping Energy Costs (13,064,664 kWh @ $0.06/kWh)	783,879
Total Annual Cost	**$1,699,257**
Quantity of Water (acft/yr)	**3,360**
Annual Cost of Water ($ per acft)[2]	**506**
Annual Cost of Water ($ per 1,000 gallons)[2]	**1.55**

1 Cost data provided by the City of Lubbock on 10/10/2005.
2 Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

The total project cost for this option was estimated to be $6,894,600 (Table 4.4-54). Financing the project for 30 years at 6 percent annual interest results in an annual expense of $730,211 for debt service. Annual operation and maintenance costs, including energy totals $969,046, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $1,699,257. For an annual quantity of 3,360 acft/yr of treated water ready for delivery to customers, the cost is $506 per acft, or $1.55 per 1,000 gallons (Table 4.4-54).

4.4.3.6.5 Implementation Issues

The implementation of this option to supply additional water to the City of Lubbock is not expected to have significant, if any, adverse environmental effects. Wells will be located on property that has previously been altered by existing well fields or urban development.

This WMS uses brackish ground water from an aquifer which has not been used in this local area in the past. Information available indicates that use of brackish water from this source will have no effect upon water resources of the state, nor other WMSs of the Region O Plan.

4.4.3.7 Lubbock Jim Bertram Lake System (JBLS) Expansion

4.4.3.7.1 Description of Option[11]

This planning strategy would allow use of Lubbock's "developed water resources," including storm water collected within the City of Lubbock and transferred and discharged into the Yellowhouse Canyon, groundwater from the Lubbock Land Application Site, and treated wastewater (source of treated wastewater is groundwater and water from CRMWA) discharged into Yellowhouse Canyon. To achieve this, Lakes 7 and/or 8 from the Canyon Lakes System (now called the Jim Bertram Lake System) would be built to capture, store, and divert water (Figure 4.4-6). This water would be treated at a new water treatment facility located southeast of Lubbock. At some point in the future, water from Lake Alan Henry would also be treated at the same facility. This water would be transported to the south and southwest areas of Lubbock's service area. Key components of this system are:

- Lake 7: Storage Capacity: 20,700 AF
  Pump station & pipeline capacity: 4.65 MGD
  Pipeline length: 21,200 feet
  Pipeline diameter: 36 inches
- Lake 8: Storage Capacity: 49,900 AF
  Pump station & pipeline capacity: 26.7 MGD
  Pipeline length: 37,000 feet
  Pipeline diameter: 90 inches
- Water Treatment Plant: Capacity: 21 MGD (initially)
- Transmission main: Length: 79,200 feet
  Diameter: 66 inches

4.4.3.7.2 Quantity of Water Available

Water potentially available for impoundment in the proposed Lake 7 and Lake 8 was estimated using Run 3 of the Brazos River Basin Water Availability Model (Brazos WAM) developed by the Texas Commission on Environmental Quality (TCEQ)[12]. The model utilizes a timeframe from January 1940 through December 1997 hydrologic period

[11] "Lubbock, Texas; Feasibility Report on the Canyon Lakes Project," Freese, Nichols and Endress, Fort Worth, Texas, 1969.
[12] HDR Engineering, Inc., "Water Availability in the Brazos River Basin and San Jacinto-Brazos Coastal Basin," Texas Natural Resource Conservation Commission (now TCEQ), December 1991.

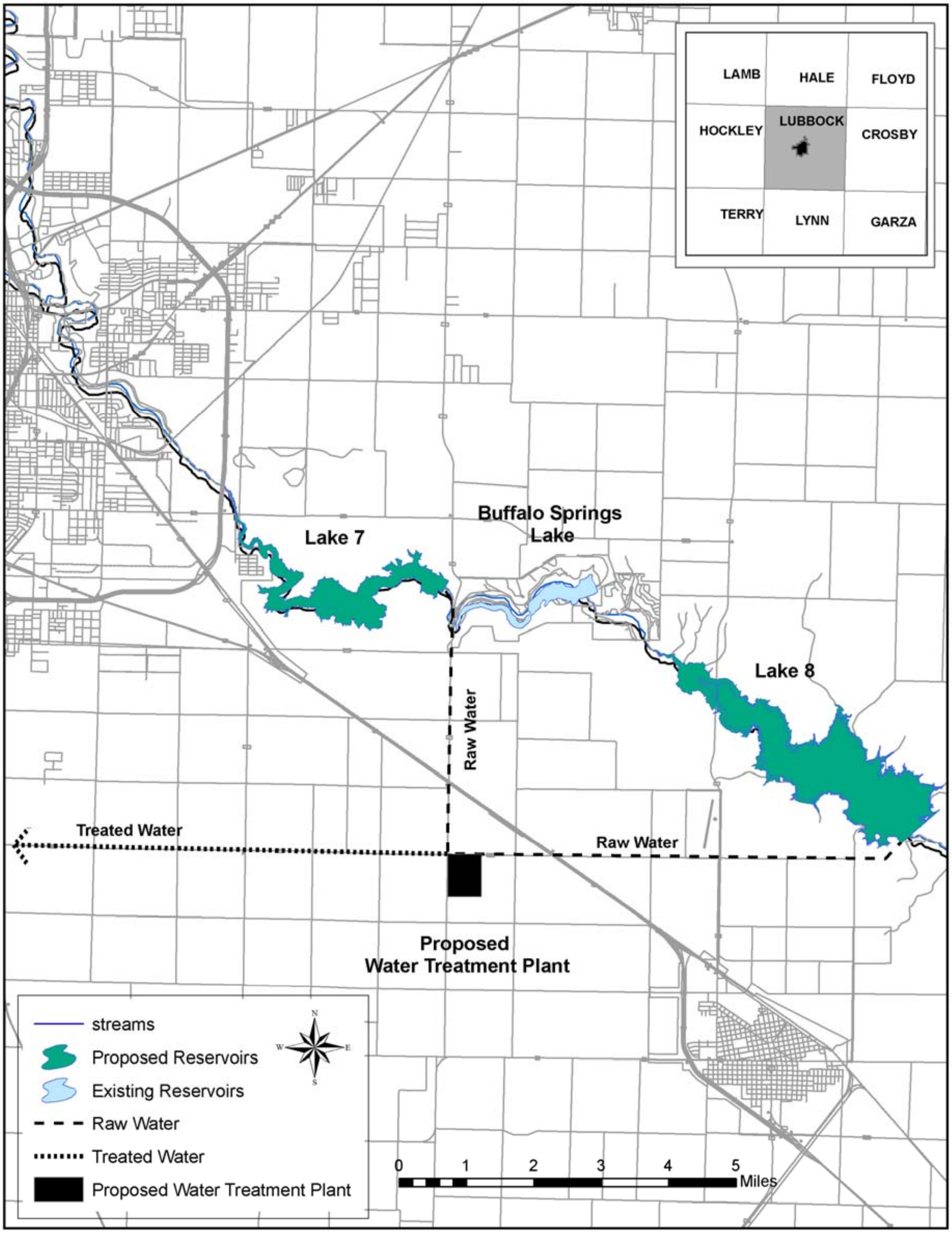


Figure 4.4-6. Lubbock Jim Bertram Lake System (JBLS) Expansion

of record to estimate water available to existing and potential water rights. The model assumes that existing perpetual water rights are fully utilized, reservoir storage capacity is as originally permitted, and wastewater treatment plant effluent is fully reused (zero return flows). The City of Lubbock has estimated that 22.9 million gallons per day (MGD) of effluent will be available in the future that can be dedicated to developing water supply from the reservoirs. These return flows are in excess of the 9 MGD for which the City has recently applied to the TCEQ for reuse authorization. The 22.9 MGD (25,648 acft/yr) of return flows were input into the Brazos WAM and used in conjunction with available unappropriated flows to develop firm yield estimates for Lakes 7 and 8. Other sources of developed water were not considered in the analysis, but could be used to augment firm supplies and also provide interruptible supplies in excess of the firm yield estimates presented herein.

Available unappropriated streamflows was determined by the Brazos WAM without causing increased shortages to existing downstream rights. Firm yield was computed subject to the reservoirs having to pass natural inflows to meet Consensus Criteria for Environmental Flow Needs (CCEFN) instream flow requirements. The streamflow statistics used to determine the Consensus Criteria pass-through requirements for the reservoirs are shown in Table 4.4-55. Only natural unappropriated flows were subjected to the CCEFN requirements; the return flows were not.

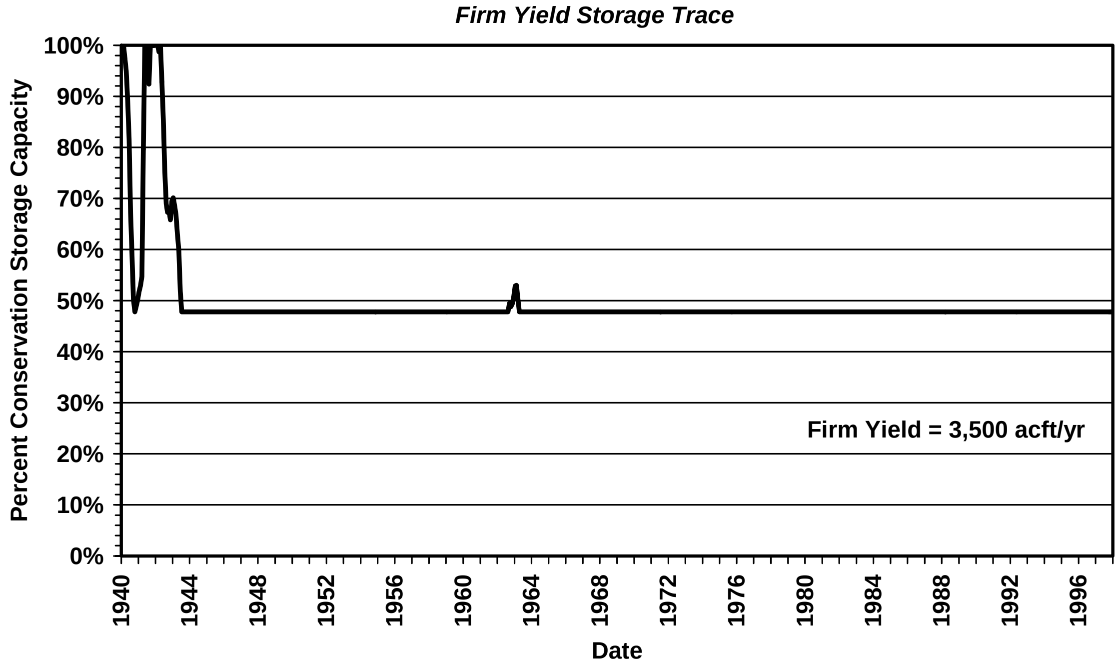
The firm yield of the system was calculated by establishing a firm yield for Lake 7 of 3,500 acft/yr, then operating Lake 8 such that at least 10,000 acft of storage would be maintained in Lake 7. Note that releases from Lake 7 would be passed through Buffalo Springs Lake in order to reach Lake 8. The resulting firm yield of Lake 8 was estimated to be 17,720 acft/yr, for a total combined system yield of 21,200 acft/yr.

Figure 4.4-7 illustrates the simulated Lake 7 and Lake 8 storage levels for the 1940 to 1997 historical period, subject to the firm yield of 17,720 acft/yr for Lake 8 with annual diversions from Lake 7 of 3,500 acft/yr.

Figure 4.4-8 illustrates the changes in streamflows of the North Fork Double Mountain Fork of the Brazos River caused by impounding the unappropriated waters of the Brazos River. There are no significant changes in streamflows at Lake 8. At Lake 7, however, releases of impounded return flows to Lake 8 would increase streamflows between Lake 7 and Lake 8 over natural conditions.

Table 4.4-55.
Daily Natural Streamflow Statistics
Lubbock Jim Bertram Lake System (JBLS) Expansion
Llano Estacado Water Planning Region

Month	Median Flows – Zone 1 Pass-Through Requirements (cfs)	25th Percentile Flows – Zone 2 Pass-Through Requirements (cfs)
Lake 7		
January	0.2	0.0
February	0.2	0.0
March	0.1	0.0
April	0.2	0.0
May	3.4	0.1
June	5.1	0.5
July	1.5	0.0
August	0.6	0.0
September	1.3	0.0
October	0.9	0.0
November	0.6	0.0
December	0.4	0.0
Zone 3 (7Q2) Pass-Through Requirement (cfs):		0
Lake 8		
January	0.3	0.0
February	0.3	0.0
March	0.1	0.0
April	0.3	0.0
May	3.8	0.1
June	5.7	0.5
July	1.7	0.0
August	0.7	0.0
September	1.5	0.0
October	1.0	0.0
November	0.7	0.0
December	0.4	0.0
Zone 3 (7Q2) Pass-Through Requirement (cfs):		0



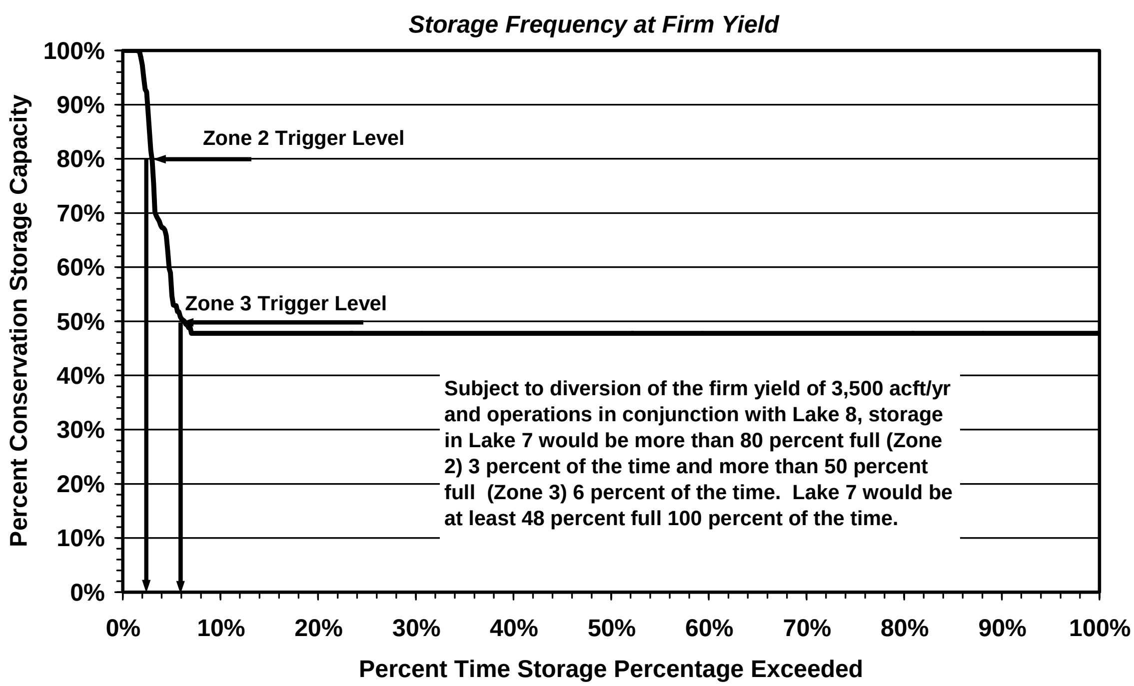
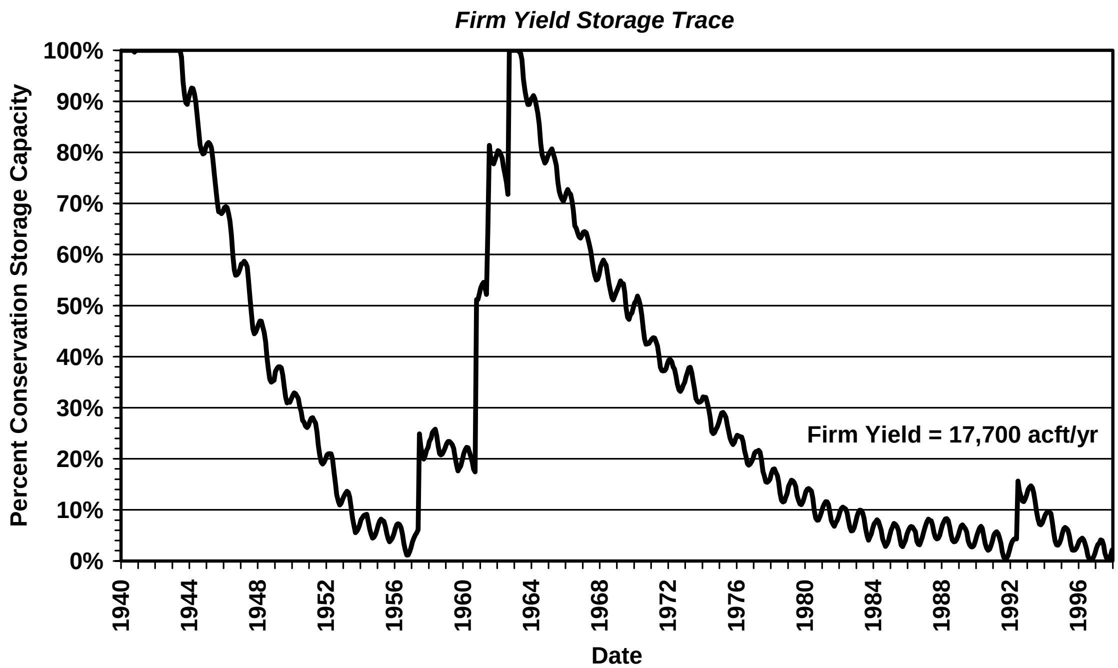


Figure 4.4-7A. Jim Bertram Lake System (JBLS) Expansion Reservoir Storage Considerations – Lake 7



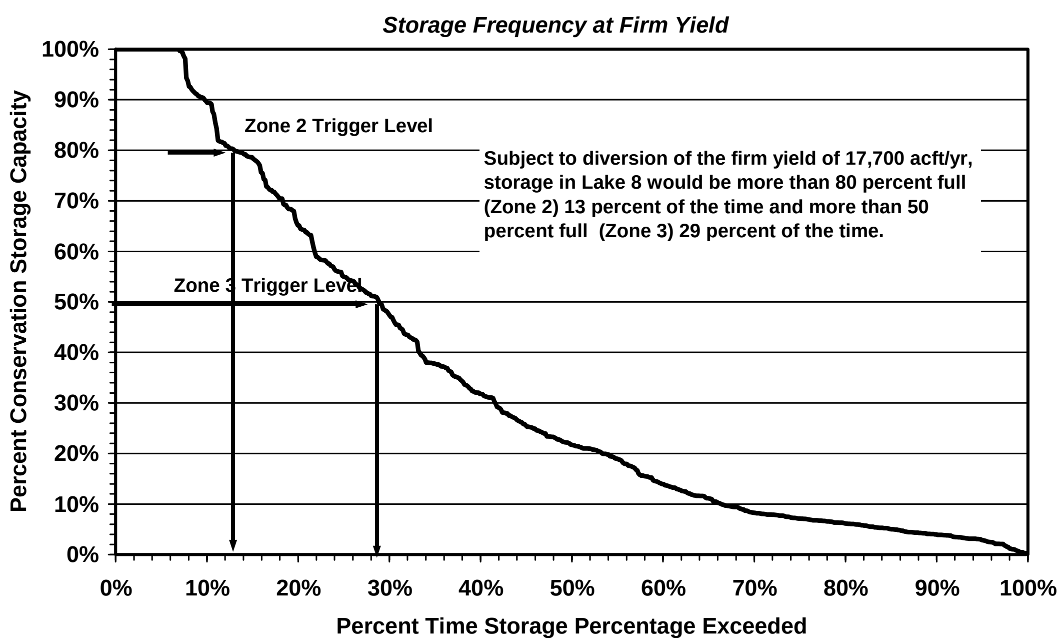
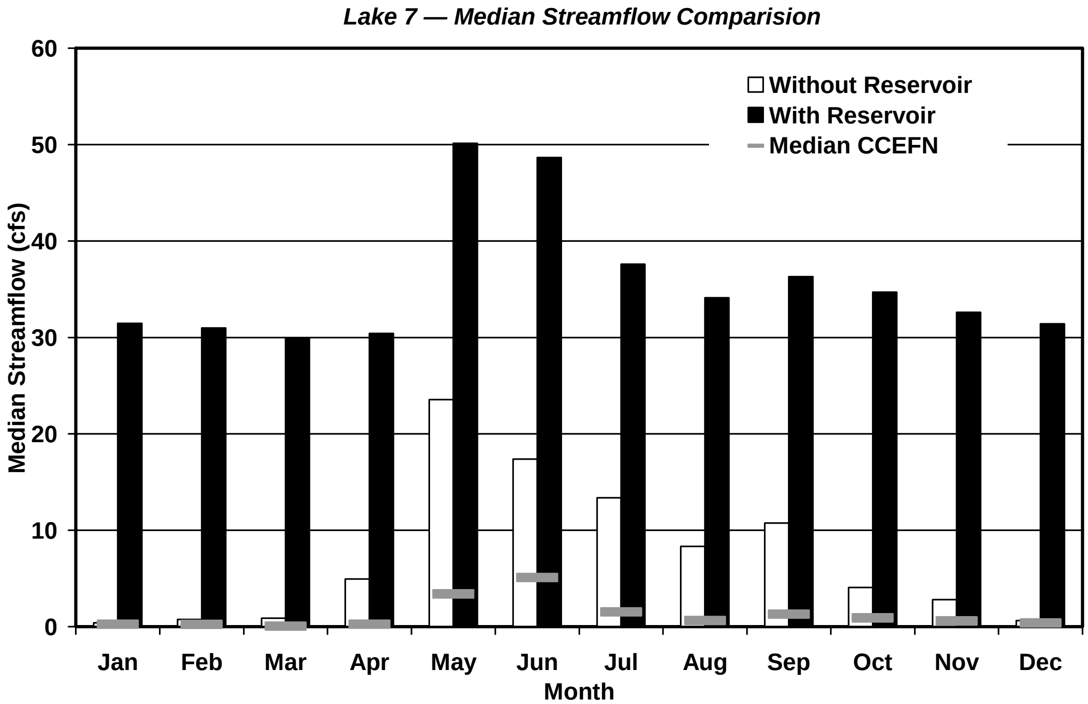


Figure 4.4-7B. Jim Bertram Lake System (JBLS) Expansion Reservoir Storage Considerations – Lake 8



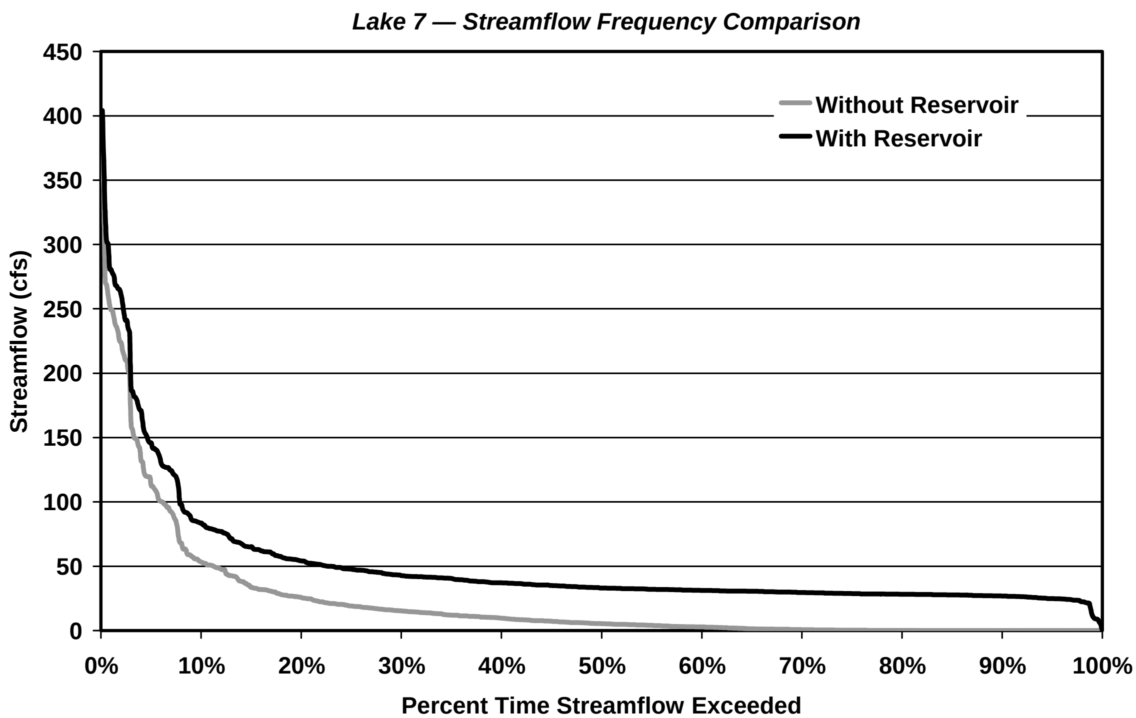
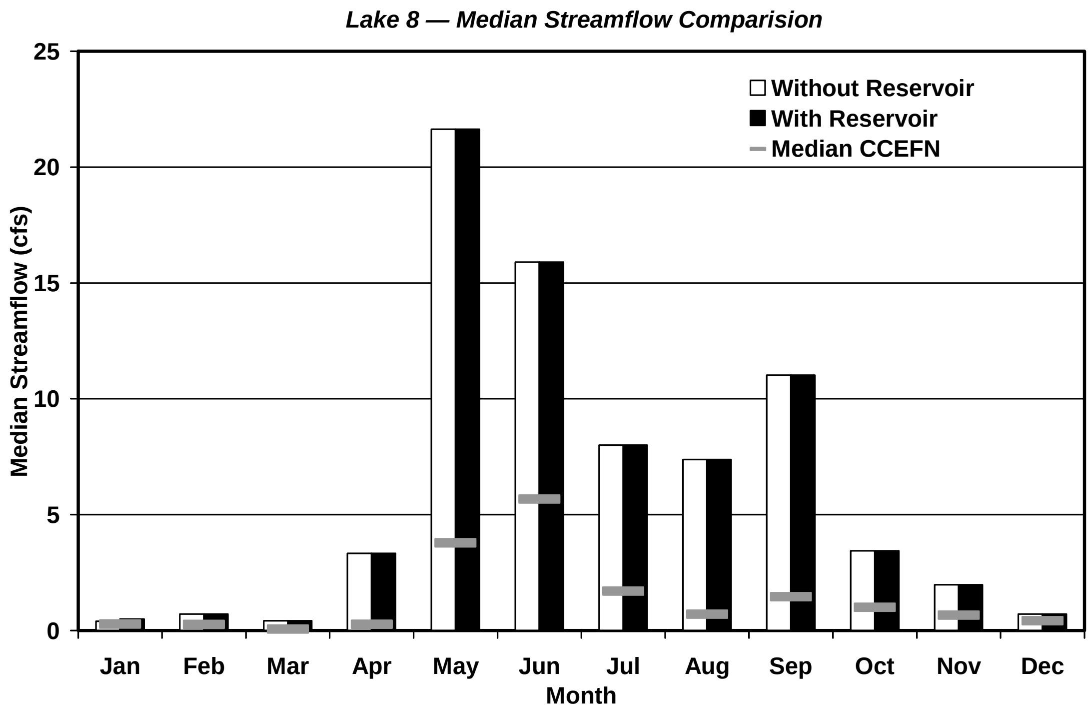


Figure 4.4-8A. Jim Bertram Lake System (JBLS) Expansion Streamflow Comparisons – Below Lake 7



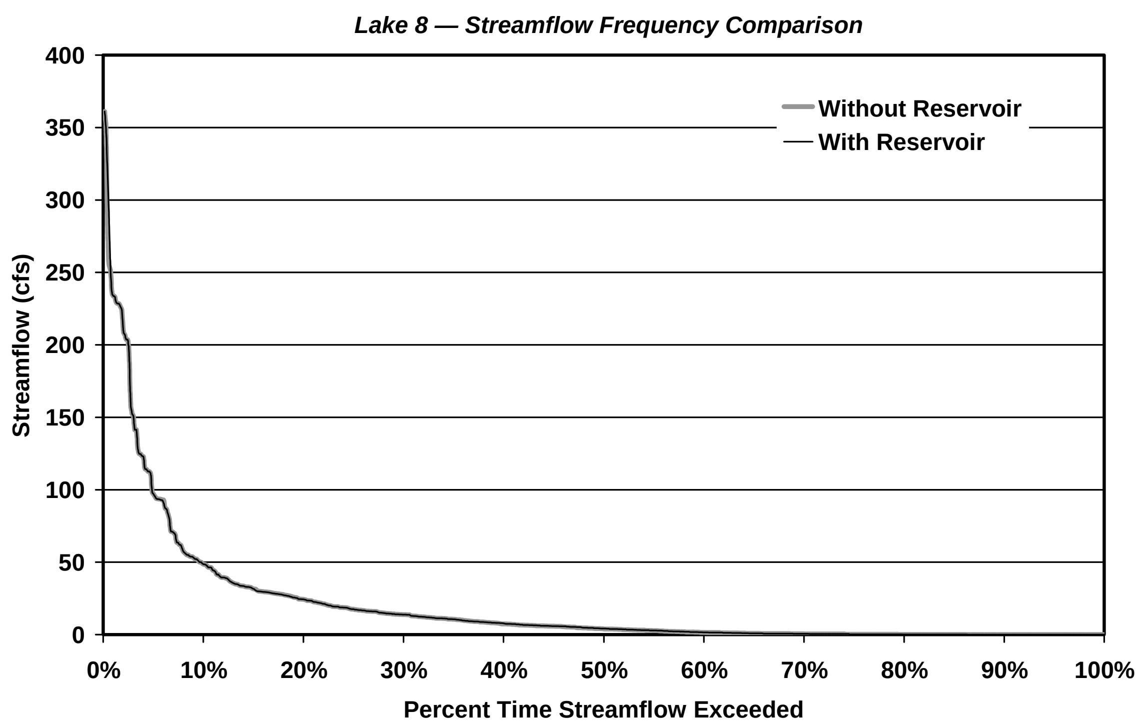


Figure 4.4-8B. Jim Bertram Lake System (JBLS) Expansion Streamflow Comparisons – Below Lake 8

4.4.3.7.3 Environmental and Cultural Resource Issues

The City of Lubbock Storm Water and Reclaimed Water System Project involves the construction of two reservoirs along an approximately 14.5-mile reach of the North Double Mountain Fork of the Brazos River, raw water intake structures and their associated water transmission lines. The proposed lake sites, designated as Lake 7 and Lake 8 are located in Lubbock County southeast of the City of Lubbock within the Western High Plains ecoregion,[13] in the High Plains vegetational area of Texas,[14] and in the Kansan biotic province.[15] The High Plains Region is a nearly level treeless plain with a relatively even surface. It is dominated by native grasses, the major species including buffalo grass (*Buchloe dactyloides)*, blue grama (*Bouteloua gracilis*), and sideoats grama (*Bouteloua curtipendula*). Annual and perennial forbs, legumes and woody species such as beargrass and cholla cactus occasionally invade this grassland region. In zones with loamy soils, honey mesquite (*Prosopis glandulosa)* and yucca have invaded large areas. The prevalent landuse within the proposed Lake 7 project area is mixed rangeland (52%)[16], with additional areas of nonforested wetlands (19%), gravel pits (15%), confined feeding operations (10%), and minor amounts of cropland or pasture. It is unlikely that the area designated as nonforested wetlands has a large amount of wetland areas; however the presence and location of actual wetland areas potentially affected by reservoir construction would have to be determined by a site survey. In addition, a small portion of this proposed lake area is currently an existing reservoir (5%). The Lake 8 project area is divided between nonforested wetland areas (65%), and mixed rangeland (35%). Based upon a review of information available, the dominant vegetation type within the area of both Lake 7 and Lake 8 is considered to be Mesquite-Lotebush-Brush, with the exception of approximately 24% of the southeastern portion of Lake 8 which is identified as juniper.[17]

Within the proposed lake sites, the General Soil Map for Lubbock County shows Potter-Berda-Bippus soils. These soils, found on bottomlands and uplands, and can be very shallow, shallow, or deep, and are located on nearly level to steep slopes. Two of these soil types are

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[13] Omernik, James M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1), pp. 118-125, 1986.
[14] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas, 1962.
[15] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.
[16] U. S. Geological Survey, 1990. Reston, Virginia
[17] The Vegetation Types of Texas. Texas Parks and Wildlife

found on gently sloping to steep slopes, and include Potter soils which are found on uplands and Berda soils which are generally found on foot slopes. Slopes of areas containing these soils are generally found to be 1 to 45 percent. Bippus soils are found on nearly level areas on frequently flooded bottom lands. These soils areas have very little slope, generally less than one percent. The surface layer for all of these soils is composed of a friable, alkaline loam which differs in depth within each soil type from 5 to 30 inches. Rangeland is the most common landuse occurring within areas of Bippus soils. Cultivated crops are not generally grown in this area due to the steep slopes, and the potential for water erosion and flooding.

There are six existing, smaller impoundments along the North Double Mountain Fork of the Brazos River in the upper reaches of the canyon above the proposed Lake 7 location, and two larger lakes, Buffalo Springs Lake and Lake Ransom Canyon above Lake 8 but downstream of Lake 7. The North Double Mountain Fork of the Brazos River (Segment 1241A) is considered perennial from its confluence with the Double Mountain Fork to the dam impounding Lake Ransom Canyon. The water is typically high in dissolved solids, with segment standards for chloride and sulfate of 2500 mg/L and 2400 mg/L, respectively. This segment is on the Draft 2004 303(d) list for excessive bacterial concentrations, and is listed in the Statewide Water Quality Inventory (305b list) for concerns over algal growth and nitrogen concentrations. Although the current data listing on the Brazos River Authority web site indicates that the segment meets the average screening criterion for Fecal Coliforms of 200 MPN/100 ml, 23% of the samples collected exceeded the single grab criterion of 400 MPN/100 ml. Additional study will be required to confirm this result before a TMDL is scheduled. There are no Ecologically Significant River and Stream Segments within the project area.[18]

The major sources for these water bodies include streamflow from natural rainfall, which is generally infrequent and irregular in this area, future return flows, releases of cooling water from a municipal power plant, springs associated with the irrigation of adjoining farm lands by effluent from the main Lubbock Sewer Treatment Plant, and runoff from the city's storm sewer system. The principal function of the proposed Lakes 7 and 8 will be to store and reuse reclaimed water and storm water, and to provide additional recreation opportunities. The upper six small impoundments presently form the core of a municipal park which stretches for approximately 8 miles through the southeast quadrant of the city.

[18] Texas Parks and Wildlife, Water Resources Branch, 2005.

Health concerns for the two proposed lakes include bacteria from discharged water and pollution from storm runoff. Storm runoff, particularly from urban areas, will likely be a source of coliform bacteria, oxygen demanding materials, nutrients and other materials (e.g., oil and grease, metals, household chemicals) potentially affecting water quality. However, this condition is common in streams and their impoundments receiving urban runoff, and has proved a serious problem in limited cases. Water quality and aquatic life conditions in the existing reservoir system are the best predictors of conditions most likely to develop in the proposed Lakes 7 and 8.

Plant and animal species listed by USFWS, and TPWD, as endangered or threatened with potential habitat in Lubbock County are listed in Table 4.4-56. There are two species listed as endangered by the State of Texas found within Lubbock County, the Whooping Crane (*Gus Americana*), and Black-footed Ferret (*Mustela nigripes*). In addition there are three threatened species which are state-listed within the county, the Arctic Peregrine Falcon (*Falco peregrinus tundrius*), Bald Eagle (*Haliaeetus leucocephalus*), and Texas horned lizard (*Phrynosoma cornutum*).

The Whooping Crane, Arctic Peregrine Falcon and Bald Eagle are potential migrants to Lubbock County which may use habitats in the area during migration. A survey of the lake sites may be required to determine whether populations of or potential habitats used by listed species occur in the area to be affected. The Black-footed Ferret is generally found in areas occupied by prairie dogs, usually dry, flat short grasslands including land overgrazed by cattle and the Texas Horned Lizard generally prefers open, arid areas with sparse vegetation. Either of these two species might be found within the mixed rangeland areas of the project.

There are two fish species found in the Brazos River Basin which are candidates for Federal Listing, the sharpnose shiner (*Notropis oxyrhynchus*), and the smalleye shiner (*Notropis buccula*). Both of these species require fairly shallow water in broad, open sandy channels with moderate current. Neither of these shiner species is listed as occurring within Lubbock County.

The primary impacts that would result from construction and operation of the proposed lakes would include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. Figure 4.4-7A (Lake 7 Storage) shows that operation of the proposed Lake 7 near its 50% capacity elevation more than 90% of the time will result in the permanent inundation of

Table 4.4-56.
Potentially Occurring Species that are Rare or Federal-and State-Listed at the Lubbock Jim Bertram Lake System (JBLS) Expansion Llano Estacado Water Planning Region

Birds	***Federal Status***	***State Status***
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Baird's Sparrow (Ammodramus bairdii) – shortgrass prairie with scattered low bushes and matted vegetation.		
Bald Eagle (*Haliaeetus leucocephalus*) - found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds.	LT-PDL	T
Ferruginous Hawk (Buteo regalis) – open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers.		
Lesser Prairie Chicken (Tympanuchus pallidicinctus) – arid grasslands, generally interspersed with shrubs and dwarf trees; nests in a scrape lined with grasses.	C1	
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Snowy Plover (Charadrius alexandrinus) – formerly an uncommon breeder in the Panhandle; potential migrant		
Western Burrowing Owl (*Athene cunicularia hypugaea*) - open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows and man-made structures, such as culvert.		
Whooping Crane *(Grus americana*) - potential migrant; winters in and around Aransas National Wildlife Refuge and migrates to Canada for breeding; only remaining natural breeding population of this species.	LE	E
Mammals		
Black-footed Ferret (Mustela nigripes) – considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area.	LE	E
Black-tailed Prairie Dog (Cynomys ludovicianus) – dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups.		
Cave Myotis Bat (Myotis velifer) – roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonots)* nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore.		
Plains Spotted Skunk (Spilogale putorius interrupta) – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie.		
Swift Fox (Vulpes velox) – restricted to current and historic shortgrass prairie; western and northern portions of Panhandle.		
Reptiles		
Texas Horned Lizard (Phrynosoma cornutum) – open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September.		T
Status Key: DL-De-Listed, PDL-Proposed De-Listed, LE, LT-Federally Listed Endangered/Threatened, PE, PT-Federally Proposed Endangered/Threatened, E/SA, T/SA-Federally Listed Endangered/Threatened by Similarity of Appearance, C1-Federal Candidate for Listing, E,T-State Listed Endangered/Threatened, "blank"-Rare, but with no regulatory listing status.		
June 2005, Annotated County Lists of Rare Species maintained by TPWD, Austin, Texas.		

514 acres of brush – invaded grassland habitat and its conversion to a lacustrine environment in which an aquatic community will develop. Excursions above 50% capacity will be rare and relatively brief, and would be expected to result in little change in the terrestrial habitat now present in the zone between the 50 and 100% capacity elevations. On-site surveys will be required to document existing habitat values and determine the necessity and scope of mitigation for significant losses.

The storage trace for Lake 8 (Figure 4.4-7B) indicates that this larger impoundment will experience water surface elevations exceeding the 50% capacity level more frequently (22%), but diversion of the system yield from this impoundment will result in a more gradual dewatering regime than in Lake 7, and Lake 8 will experience periodic drawdowns to elevations below 10% capacity. The mosaic of grassland and thorny shrublands within the footrprint of Lake 8 will experience decreasing frequencies and durations of inundation at successively higher capacity elevations. At the 8% capacity elevation, about 351 acres will be inundated permanently, while the median water surface elevation for the simulation period, which corresponds to the 30% capacity level, indicates that the lower 889 acres will be under water half or more the time and the upper 829 acres will be inundated half or less of the time. While annual grasses and forbs will rapidly recolonize formerly inundated areas, perennial grass and shrub populations will recover more slowly. With respect to aquatic communities, frequent changes in reservoir surface elevation may be detrimental to shallow-water nesting species, which include the recreationally and economically important sunfish and bass, particularly when these changes occur during the spring and summer seasons when these fish are reproducing.

Operation of the reservoir system will result in an increase in the volume and constancy of streamflow in the North Fork reach between the Lake 7 dam and the Buffalo Springs Lake backwater, and between Buffalo Springs Lake and the Lake 8 backwater, presumably enhancing lotic habitats in those areas (Figure 4.4-8A). These reaches will vary in length depending on the contents of Buffalo Springs Lake and Lake 8. Below Lake 8, the North Fork will experience no change in streamflow at and below existing median monthly flow levels, but reductions in flood flows will occur as the reservoir system captures these infrequent events. Potential changes in channel morphology, and consequent habitat changes below the Lake 8 dam, will reflect the extent that reductions in the frequency of "bankfull" events result from system operation. Although large floods can result in severe scour and extensive redoposition of stream sediments, the events that maintain a stream's typical channel width, characteristic distribution of sediment particles, riffle-pool ratios and nature of streamside vegetation typically recurr at 1 to 2 year intervals.[19] Reduction in the frequency of these events can result in channel narrowing, siltation of large particle substrate areas and encroachment of vegetation into the channel. Reductions in flood flows and stabilization of flow levels in arid areas with water containing high levels of dissolved solids can result in channel encroachment by salt cedar (*Tamarix* spp), which has been a problem significantly affecting both lotic and riparian habitats where it has occurred (e.g., in the Pecos River above Red Bluff Reservoir).

Federal and state laws such as Section 106 of the National Historic Preservation Act and the Antiquities Code of Texas require that impacts to cultural resources be considered. To address impacts these laws outline a consultation process that may involve the State Historic Preservation Officer (SHPO), Native American Tribes, the Advisory Council on Historic Preservation, and other interested parties. The consultation process is usually initiated by gathering information regarding cultural resources located within project area and presenting it to the SHPO for an effect determination. Based on the information available the SHPO makes a determination as to whether the properties affected are eligible for listing on the National Register of Historic Places (NRHP) or for formal designation as a State Archeological Landmark (SAL). If the SHPO feels that more information is needed in order to evaluate eligibility, they may request additional information such as archival research, or archeological field investigations. If the SHPO determines that there is “no effect” to properties eligible for listing on the NRHP or for formal designation as an SAL, the consultation process ends and project activities may proceed. On the other hand, if it is determined that eligible properties will be affected, then mitigation of the effects will likely be required. Mitigation may include additional archeological investigations, archival research, or avoidance and protection.

Available information regarding know cultural resources was gathered from the Texas Archeological Research Laboratory in Austin. Examination of their map files identified 14 recorded archeological sites within the footprint and park boundary of Lake 7 and three within the footprint and park boundary of Lake 8 (see Table 4.4-57).

Sites 41LU9 through 41LU23 have no eligibility recommendations. However sites 41LU132 and 41LU48 were recommended for listing on the NRHP. Site 41LU49 was not recommended for the NRHP.

[19] Allan, J. D. 1995. Stream Ecology. Chapman & Hall, New York.

As there is no evidence of any systematic archeological investigations being conducted for the lake areas, it is likely that the Texas Historical Commission and the U.S. Army Corps of Engineers will require an intensive archeological survey of the dam sites, the maximum flood pool area, and the proposed park areas of both lakes. This information will be required in order to begin the Section 106 and Antiquities Code consultation with these agencies.

Table 4.4-57.
Archeological sites on record for Lake 7 and Lake 8

Lake 7	Site Description	Lake 8	Site Description
41LU9	Prehistoric camp	41LU21	Prehistoric camp
41LU10	Prehistoric camp	41LU22	Prehistoric camp
41LU11	Prehistoric camp	41LU23	Prehistoric camp
41LU12	Prehistoric camp		
41LU13	Prehistoric camp		
41LU14	Prehistoric camp		
41LU15	Prehistoric camp		
41LU16	Prehistoric camp		
41LU17	Prehistoric camp		
41LU18	Prehistoric camp		
41LU19	Prehistoric camp		
41LU132	Prehistoric camp		
41LU48	Stone wall		
41LU49	Prehistoric lithic scatter		

4.4.3.7.4 Engineering and Costing

Costs for this option include the following:

- Land and right-of-way for Lakes 7 and 8, and pipelines and water treatment plant site;
- Construction of dams for Lakes 7 and 8;
- Pump stations and pipelines;
- Environmental impact assessments and archeological studies and recovery, and mitigation, if needed;
- State and federal permit acquisition;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated at $150,759,000 (Table 4.4-58). Annual operation and maintenance costs, including energy, are estimated at $3,808,000, with the total annual cost, including debt service, operation and maintenance, and power cost, totaling $14,575,000 (Table 4.4-58). For an annual quantity of 21,200 acft/yr of treated water ready for delivery to customers, the cost is $696 per acft, or $2.13 per 1,000 gallons (Table 4.4-58). To the extent that interruptible water and other firm developed water are available, the unit costs of water would be lowered.

4.4.3.7.5 Implementation Issues

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-59, and the option meets each criterion.

The implementation of this option to supply additional water to the City of Lubbock depends upon acquisition of the necessary permits, including water rights and those required for construction, as well as other issues as summarized below:

Potential Regulatory Requirements:

- Texas Commission on Environmental Quality Water Right and Storage permits;
- U.S. Army Corps of Engineers Permits will be required for discharges of dredge or fill into wetlands and waters of the U.S. for dam construction, and other activities (Section 404 of the Clean Water Act);
- Texas Commission on Environmental Quality administered Texas Pollutant Discharge Elimination System Storm Water Pollution Prevention Plan;
- General Land Office Easement if State-owned land or water is involved; and
- Texas Parks and Wildlife Department Sand, Shell, Gravel and Marl permit if state-owned streambed is involved.

State and Federal Permits may require the following studies and plans:

- Environmental impact or assessment studies;
- Wildlife habitat mitigation plan that may require acquisition and management of additional land;
- Flow releases downstream to maintain aquatic ecosystems;
- Assessment of impacts on Federal- and State-listed endangered and threatened species; and
- Cultural resources studies to determine resources impacts and appropriate mitigation plan that may include cultural resource recovery and cataloging; requires coordination with the Texas Historical Commission.

Land Acquisition Issues:

- Land acquired for reservoir and/or mitigation plans could include market transactions and/or eminent domain;
- Additional acquisition of rights-of-way and/or easements may be required; and
- Possible relocations or removal of residences, utilities, roads, or other structures.

Table 4.4-58.
Cost Estimate Summary for
Lubbock Jim Bertram Lake System (JBLS) Expansion
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	***Estimated Cost***
Capital Costs	
Construction of Dams and Reservoirs (Lakes 7 and 8)	$15,889,000
Intake and Pump Stations (4.62 MGD and 26.7 MGD)	7,115,000
Transmission Pipelines (21,200 ft , 36 in; 37,000 ft, 90 in, and 79,200 ft, 66 in)	48,407,000
Water Treatment Plant (21 MGD)	22,079,000
Total Capital Cost	**$ 93,490,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies)	30,301,000
Environmental and Archeological Studies and Mitigation	2,768,000
Land Acquisition and Surveying (2,613 acres)	3,405,000
Interest During Construction (7 years, 4 percent)	20,795,000
Total Project Cost	**$ 150,759,000**
Annual Costs	
Debt Service (Pipelines, Pump Stations, & Treatment Plant) (6 percent for 30 years)	$ 8,779,000
Debt Service (Reservoirs) (6 percent for 40 years)	1,988,000
Operation and Maintenance	
Intake, Pipelines, and Pump Stations	662,000
Dams and Reservoirs	238,000
Water Treatment Plant	1,942,000
Pumping Energy Costs (16,096,384 kWh @ $0.06/kWh)	966,000
Total Annual Cost	**$ 14,575,000**
Quantity of Water (acft/yr) Firm Yield	**21,200**
Annual Cost of Water ($ per acft) Firm Yield[1]	**$ 688**
Annual Cost of Water ($ per 1,000 gallons)[1]	**$ 2.11**

[1] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems. To the extent that interruptible water is available, unit cost would be lower.

Table 4.4-59.
Comparison of Lubbock Jim Bertram Lake System (JBLS) Expansion to Plan Development Criteria
Llano Estacado Water Planning Region

Impact Category	*Comment(s)*
A. Water Supply	
1. Quantity	1. Sufficient to meet needs
2. Reliability	2. High reliability
3. Cost	3. Reasonable to High
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low impact
3. Cultural Resources	3. Moderate impact
4. Bays and Estuaries	4. Negligible impact
5. Threatened and Endangered Species	5. Possible Low impact
6. Wetlands	6. Low impact
C. Impact on Other State Water Resources	• No apparent negative impacts on state water resources; no effect on navigation
D. Threats to Agriculture and Natural Resources	• Potential impact on bottomland farms and habitat in reservoir area
E. Equitable Comparison of Strategies Deemed Feasible	• Option is considered to meet municipal and industrial shortages
F. Requirements for Interbasin Transfers	• Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	• None

4.4.3.8 Lubbock North Fork Scalping Operation

4.4.3.8.1 Description of Option

This water supply strategy would involve the diversion of storm water flows (interruptible source) from the North Fork of the Double Mountain Fork of the Brazos River (the North Fork) to Lake Alan Henry to supplement its firm annual yield (Figure 4.4-9). The map shown in Figure 4.4-9 indicates a location of the diversion dam and lake in Garza County, but is only intended to serve as a general conceptual location. When this option is implemented, the specific location will be selected based upon the topography, geology, land availability, permitting, and perhaps other factors. Key components of the proposed system are:

- Diversion dam: Capacity: 1,000 acre-feet;
- Diversion rate: Annual: 30,000 acft/yr;
- Maximum flow: 250 cfs;
- Pump station & pipeline capacity: 250 cfs;
- Pipeline diameter: 96 inches; and
- Pipeline length: 32,000 feet.

Water would be pumped from the diversion lake during storm events and discharged into Gobbler Creek, which would then flow to Lake Alan Henry.

4.4.3.8.2 Quantity of Water Available

Water potentially available for diversion from the North Fork into Lake Alan Henry was estimated using Run 3 of the Brazos River Basin Water Availability Model (Brazos WAM) developed by the Texas Commission on Environmental Quality (TCEQ)[20]. The model utilizes a timeframe from January 1940 through December 1997 hydrologic period of record to estimate water available to existing and potential water rights. The model assumes that existing perpetual water rights are fully utilized, reservoir storage capacity is as originally permitted, and wastewater treatment plant effluent is fully reused (zero return flows).

Available unappropriated streamflows were determined by the Brazos WAM without causing increased shortages to existing downstream rights. The firm yield of Lake Alan Henry was computed subject to the diversion having to pass natural inflows to meet Consensus Criteria for Environmental Flow Needs (CCEFN) instream flow requirements. The streamflow statistics

[20] HDR Engineering, Inc., "Water Availability in the Brazos River Basin and San Jacinto-Brazos Coastal Basin," Texas Natural Resource Conservation Commission (now TCEQ), December 1991.

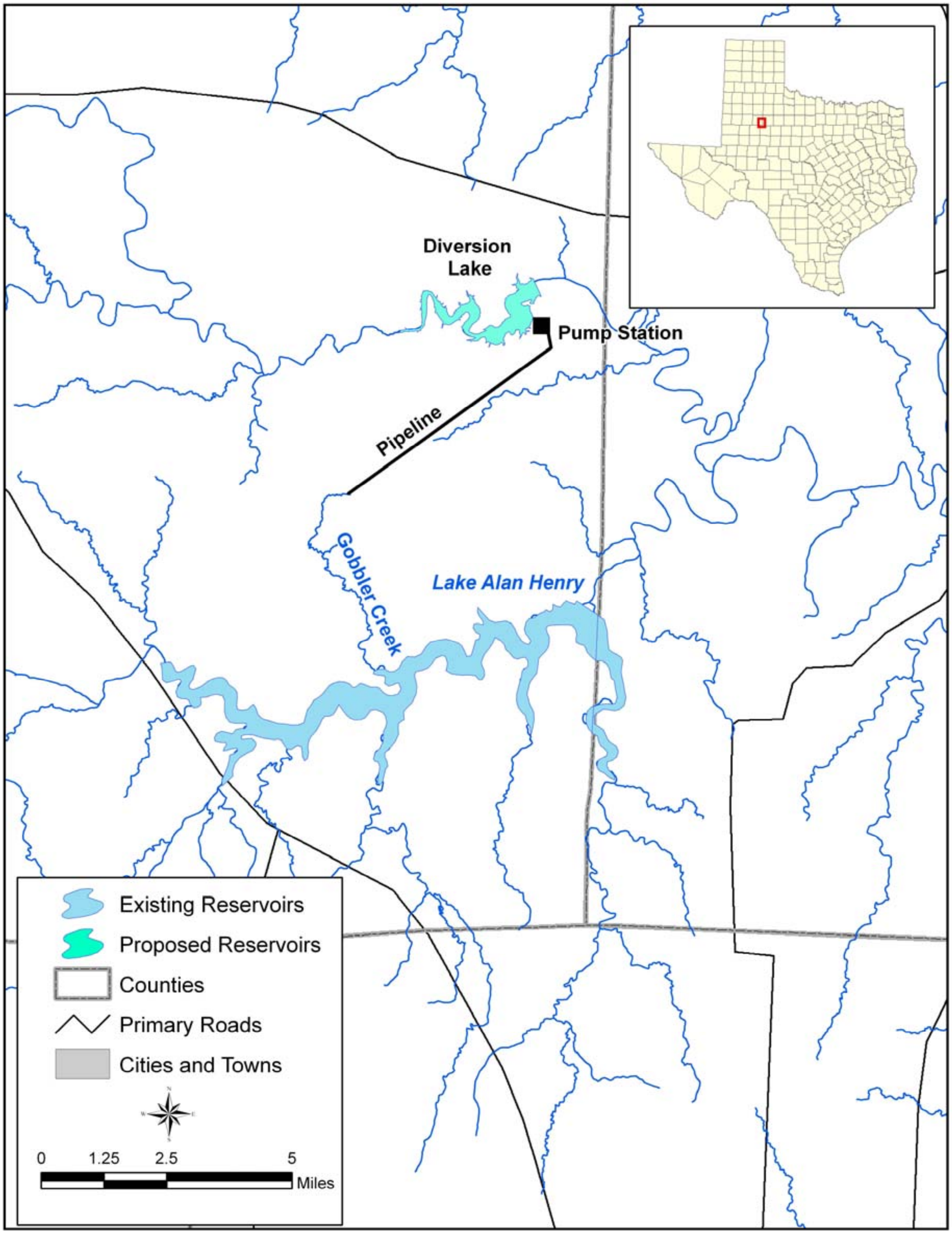


Figure 4.4-9. Lubbock North Fork Scalping Operation

used to determine the CCEFN pass-through requirements for the North Fork diversion are shown in Table 4.4-60.

Table 4.4-60.
Daily Natural Streamflow Statistics
Lubbock North Fork Scalping Operation
Llano Estacado Water Planning Region

Month	***Median Flows – Zone 1 Pass-Through Requirements (cfs)***	***25th Percentile Flows – Zone 2 Pass-Through Requirements (cfs)***
January	2	0
February	3	0
March	1	0
April	1	0
May	8	0
June	13	2
July	4	0
August	2	0
September	5	0
October	4	0
November	3	0
December	3	0
Zone 3 (7Q2) Pass-Through Requirement (cfs):		0.0

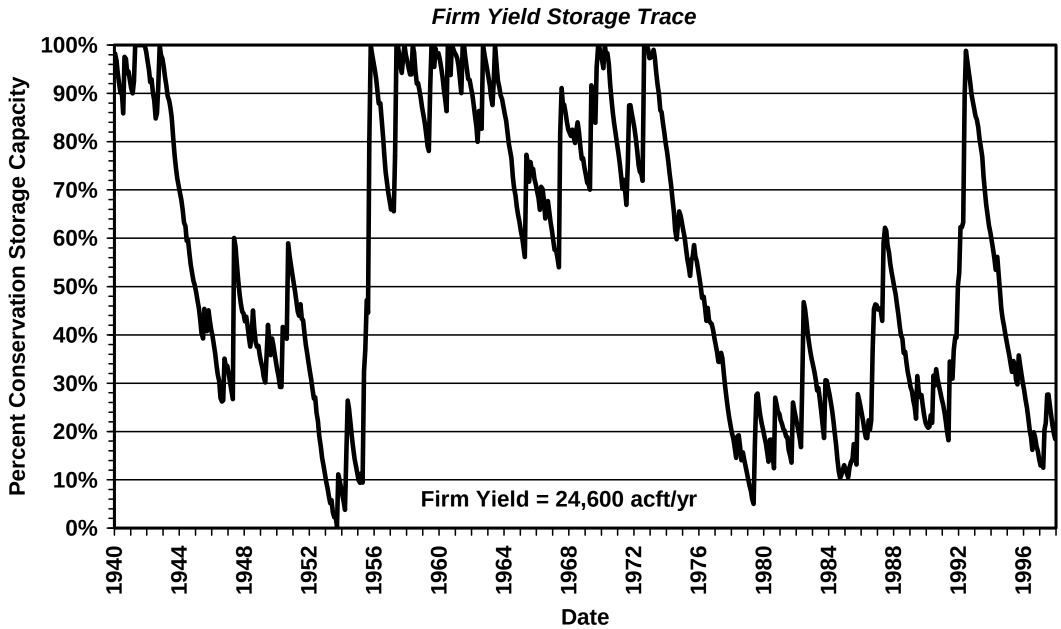
An estimate of the firm yield for Lake Alan Henry of 22,500 acft/yr was provided by the City of Lubbock to the Llano Estacado Regional Water Planning Group. This estimate accounts for a subordination agreement with the Brazos River Authority regarding Possum Kingdom Reservoir. The firm yield of Lake Alan Henry as computed by the Brazos WAM (accounting similarly for the subordination agreement) is 20,600 acft/yr, which is somewhat less than the yield estimate provided by the City of Lubbock. The yield analysis developed for the City of Lubbock is more detailed and in-depth than that computed by the Brazos WAM and is likely somewhat more accurate. With the North Fork diversion into Lake Alan Henry, the yield of the reservoir is increased to 24,600 acft/yr (as computed by the Brazos WAM), indicating that the yield increase due to the North Fork diversion project is approximately 4,000 acft/yr.

Figure 4.4-10 illustrates the simulated Lake Alan Henry storage levels for the 1940 to 1997 historical simulation period, subject to the enhanced firm yield of 24,600 acft/yr. Diversions of storm flows from the North Fork into the reservoir would change North Fork streamflows, as presented in Table 4.4-61 and illustrated in Figure 4.4-11. As shown in the figure and table, monthly median streamflows at the diversion location on the North Fork would decrease, with the largest decline being about 20 cfs in June. However, inspection of the streamflow frequency graph indicates that little change in high or low streamflows would result from the diversion. Streamflows downstream of Lake Alan Henry would be changed minimally by diverting North Fork flows into the reservoir.

Streamflows in Gobbler Creek would increase by an average of about 4,000 acft/yr, with a maximum of 30,000 acft/yr, due to discharge of the North Fork flows. The instantaneous increase in streamflow in Gobbler Creek would be equal to the maximum diversion capacity of 250 cfs.

Table 4.4-61.
Median Monthly Streamflow
Lubbock North Fork Scalping Operation
Llano Estacado Water Planning Region

Month	Monthly Median Streamflow (cfs)			Percent Reduction
	Without Project	With Project	Decrease	
Jan	2.9	2.5	0.4	13%
Feb	3.8	2.7	1.1	28%
Mar	2.8	1.2	1.6	56%
Apr	6.7	2.2	4.5	67%
May	28.3	14.3	14.0	49%
Jun	37.3	16.7	20.6	55%
Jul	13.7	11.0	2.7	20%
Aug	15.0	11.3	3.7	25%
Sep	29.0	16.2	12.8	44%
Oct	8.0	5.0	3.0	37%
Nov	5.2	2.9	2.2	43%
Dec	3.4	3.1	0.4	10%



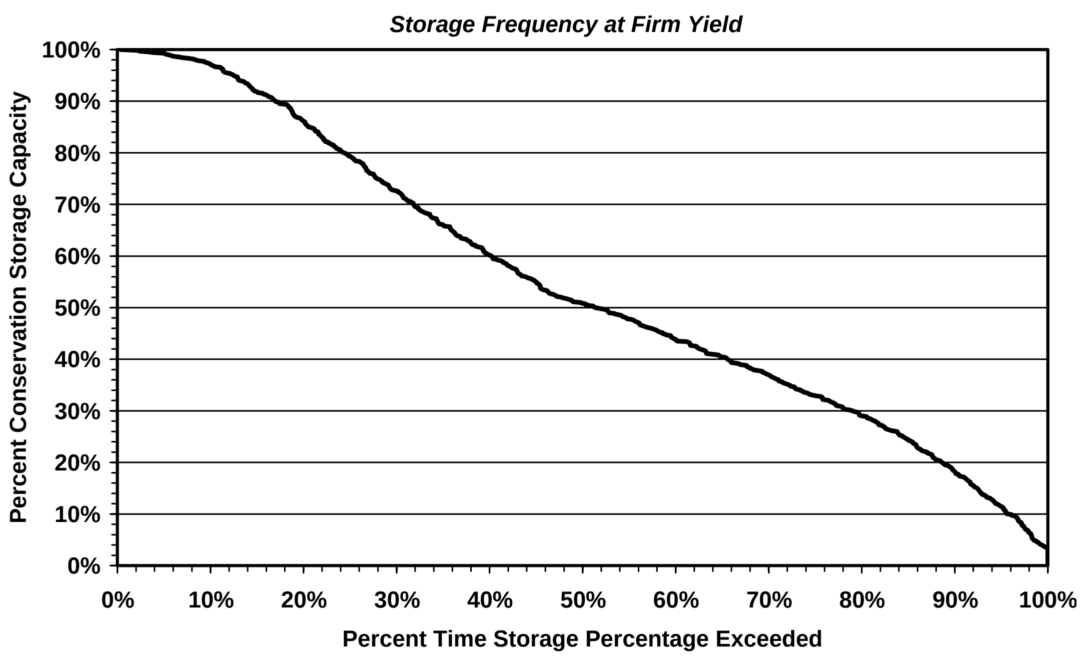
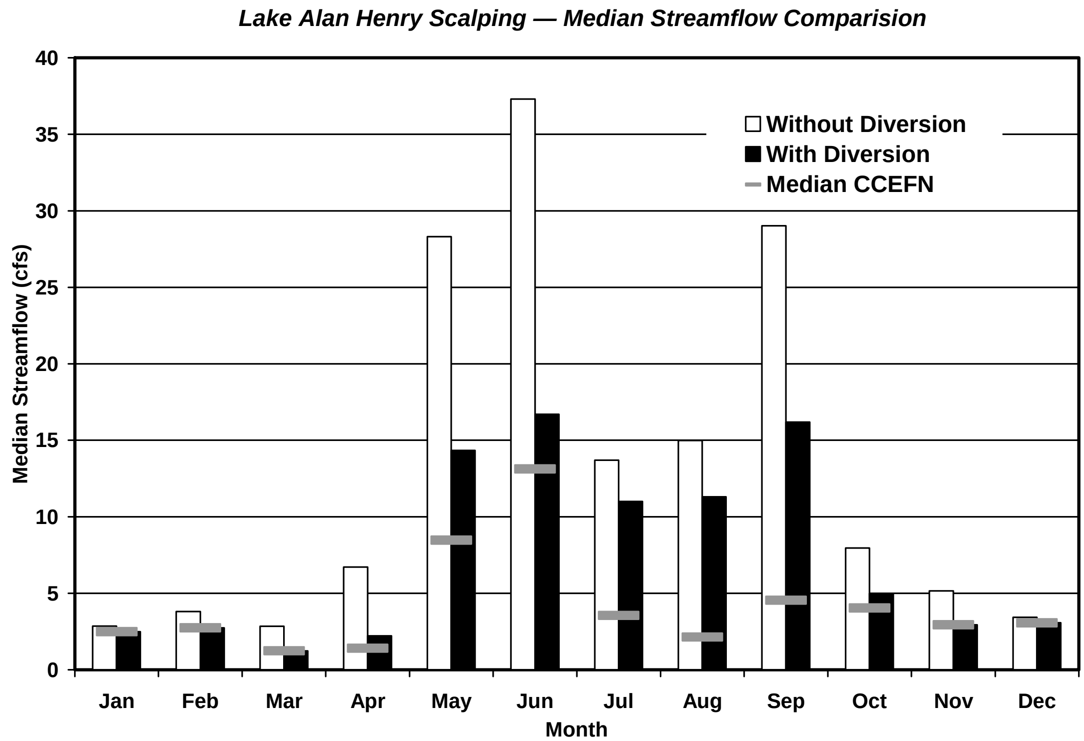


Figure 4.4-10. Lubbock North Fork Scalping Operation Storage Considerations



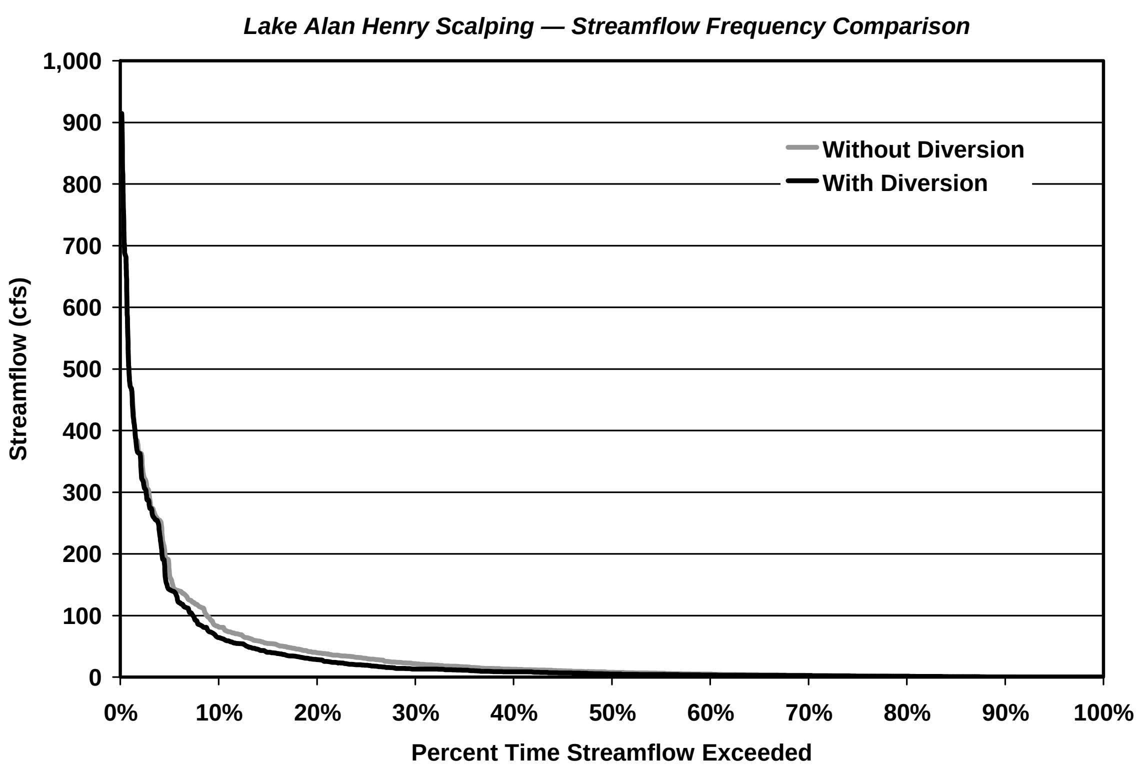


Figure 4.4-11. Lubbock North Fork Scalping Operation Streamflow Comparisons

4.4.3.8.3 Environmental Issues

The North Fork Scalping Operation to supplement the yield of Lake Alan Henry involves the construction of a diversion lake on the North Fork of the Double Mountain Fork of the Brazos River approximately 18 miles southeast of Post, Texas, a raw water intake structure and associated water transmission lines. The approximately six mile pipeline would deliver diverted water to a point on Gobbler Creek, from which it would flow an additional five miles through the existing stream channel to Lake Alan Henry on the Double Mountain Fork Brazos River. The proposed diversion lake site and Lake Alan Henery are both located in Garza County within the Southwestern Tablelands ecoregion,[21] in the Rolling Plains vegetational area of Texas,[22] and in the Kansan biotic province.[23]

The study area is located in the Rolling Plains Ecological Region as designated by the Texas Parks and Wildlife Department (TPWD 2005). This region is characterized gently rolling hills, used primarily as rangeland, that are dissected by streams and rivers that flow from west to east. This area is bordered on the south by the Edwards Plateau Ecological Region and on the west by the High Plains Ecological Region. Vegetation in this area is generally classified as mesquite-buffalo grass. The predominant vegetation form is medium-tall grassland with a sparse shrub cover. Little bluestem (*Schizachyrium scoparium* var. *frequens*), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), Indiangrass (*Sorghastrum nutans*), and sand bluestem (*Andropogon gerardii* var. *paucipilus*) are included in the list of native grasses in this area. Invasion of the rangeland areas in this region by annual and perennial forbs, legumes, and woody species has been facilitated by historic livestock grazing practices and a lack of naturally occurring fire in the area. Dominant woody species include redberry juniper (*Juniperus pinchotii*), yucca, mesquite (*Prosopis glandulosa*), lotebush (*Zizyphus obtusifolia* var. *obtusifolia*), hackberry (*Celtis* sp.), bumelia, pricklypear (*Opuntia* sp.), skunkbush sumac (*Rhus aromatica* var. *flabelliformis*), ephedra, plum (*Prunus* sp.), western soapberry (*Sapindus saponaria*), little leaf sumac (*Rhus microphylla*), shin oak (*Quercus sinuata* var. *breviloba*),

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[21] Omernik, James M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1), pp. 118-125, 1986.
[22] Gould, F.W., "The Grasses of Texas," Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas, 1962.
[23] Blair, W.F., "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117, 1950.

tasajillo (*Opuntia leptocaulis*), agarito (*Berberis trifoliolata*), catclaw acacia (*Acacia* greggii var. *greggii*), lime pricklyash (*Zanthoxylum fagara*), sand sage, and others. Bottomland areas found along larger streams contain American elm (*Ulmus Americana)*, button willow (*Cephalanthus occidentalis)*, pecan (*Carya illinoensis)* and cottonwood (*Populus* sp.). The limestone ridges and steep terrains of this area produce a greater diversity of woody plants and wildlife habitat than would normally be expected from a plains region.

Faunal species include those suited to a semi-arid environment. Riparian zones along the Brazos River and streams and their tributaries contain important wildlife habitat for the region and support populations of white-tailed deer (*Odocoileus virginianus)* and Rio Grande turkeys (*Meleagris gallopavo intermedia)*. Bobwhites (*Colinus virginianus)*, scaled quail (*Callipepla squamata*), mourning dove (*Zenaida macroura*), and a variety of song birds, small mammals, waterfowl, shorebirds, reptiles, and amphibians are found in this region. Large to medium-size mammals include the coyote (*Canis latrans)*, ringtail (*Bassariscus astusus)*, ocelot (*Felis pardalis*), and collared peccary (*Tayassu tajacu)*. Typical smaller herbivores include desert cottontail (*Sylvilagus auduboni*), hispid pocket mouse (*Perognathus hispidis)*, Texas kangaroo rat (*Dipodomys elator)*, Texas mouse (*Peromyscus attwateri*), desert shrew (*Notiosorex crawfordi)*, and rock squirrel (*Spermophilus variegates)*, Bison (*Bos bison)*, and black-footed ferret (*Mustela nigripes)* are historically associated with this area.

Within the proposed diversion lake area, the General Soil Map for Garza County shows Vernon-Rough broken land associations found close to the Brazos River, and Miles associations on the upland areas on either side of the river. Vernon soils are moderately deep clay loams, with slopes ranging from gentle to steep. Rough broken land is found in areas along escarpments and in areas that are generally sloping to steep in grade. The Miles series are generally found on uplands, and are composed of deep, moderately permeable deep fine sandy soils. These soils are well-drained and have a high available water capacity.

Federal and State listed Threatened and Endangered species for Garza County are summarized in Table 4.4-62. The Texas Natural Diversity Database lists two species considered Endangered or Threatened by the US Fish and Wildlife Service in Garza County; the Whooping Crane (*Gus Americana*), Black-footed Ferret (*Mustela nigripes*) and bald eagle (*Haliaeetus leucocephalus*). In addition there are four state-listed species within the county, the Arctic Peregrine Falcon (*Falco peregrinus tundrius*), Palo Duro Mouse (*Peromyscus truei Comanche*), and Texas horned lizard (*Phrynosoma cornutum*).

The Whooping Crane, Arctic Peregrine Falcon and Bald Eagle are potential migrants to Garza County which may use habitats in the area during migration. A survey of the diversion lake site may be required to determine whether populations of or potential habitats used by listed species occur in the area to be affected. The Palo Duro Mouse prefers juniper and mesquite covered slopes of steep-walled canyons of the eastern edge of the Llano Estacado. The Black-footed Ferret is generally found in areas occupied by prairie dogs, usually dry, flat short grasslands including land overgrazed by cattle, and the Texas Horned Lizard generally prefers open, arid areas with sparse vegetation. Either of these two species might be found within the area of the proposed project.

There are two fish species found in the Brazos River Basin which are candidates for Federal Listing, the sharpnose shiner (*Notropis oxyrhynchus*), and the smalleye shiner (*Notropis buccula*). Both of these species require fairly shallow water in broad, open sandy channels with moderate current. Both species are listed as occurring within Garza County. There are no Ecologically Significant River and Stream Segments within the project area.[24]

The primary impacts potentially resulting from construction and operation of the proposed scalping diversion lake and pipeline would include the temporary disturbance during construction of the dam and pipelines. Little difference is anticipated in habitat value between the existing, prevalent grasslands and the permanent pipeline rights-of-way that will be maintained free of woody vegetation. Within the proposed diversion site, the extent of habitat impact will depend on the frequency and duration of inundation events. Although the reach downstream of the diversion dam is intermittent, aquatic life in the North Fork Double Mountain Fork Brazos River may be affected to the extent that flows, or perennial pools, now persist for sufficient annual periods to provide some aquatic habitat. Changes in the size and configuration of the Gobbler Creek channel may result from the increased frequency and magnitude of peak streamflows during diversion events.

The Texas Archeological Research Laboratory does not indicate any recorded sites within the flood pool of the diversion lake, as located herein. Although there are no recorded sites that occur within the floodpool of the lake there is at least one site located approximately 1/4 mile downstream of the proposed dam site. These findings indicate that there has been no systematic effort to record sites in the vicinity of the project.

[24] Texas Parks and Wildlife. Water Resources Branch TPWD 2005.

Table 4.4-62.
Potentially Occurring species that are Rare or Federal-and state-Listed in Garza County near the Lubbock North Fork Scalping Operation Llano Estacado Water Planning Region

Birds	*Federal Status*	*State Status*
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) - potential migrant	DL	T
Baird's Sparrow (Ammodramus bairdii) – shortgrass prairie with scattered low bushes and matted vegetation.		
Bald Eagle (*Haliaeetus leucocephalus*) - found primarily near seacoasts, rivers, and large lakes; nests in tall trees or on cliffs near water; communally roosts, especially in winter; hunts live prey, scavenges, and pirates food from other birds.	LT-PDL	T
Ferruginous Hawk (Buteo regalis) – open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers.		
Mountain Plover (*Charadrius montanus*) – breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; nonbreeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Snowy Plover (Charadrius alexandrinus) – formerly an uncommon breeder in the Panhandle; potential migrant		
Western Burrowing Owl (*Athene cunicularia hypugaea*) - open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows and man-made structures, such as culverts.		
Whooping Crane *(Grus americana*) - potential migrant; winters in and around Aransas National Wildlife Refuge and migrates to Canada for breeding; only remaining natural breeding population of this species.	LE	E
Fishes		
Sharpnose Shiner (Notropis oxyrhynchus) – endemic to Brazos River drainage; also, apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom a combination of sand, gravel, and clay-mud.	C1	
Smalleye Shiner (Notropis buccula) - endemic to upper two-thirds of Brazos River system and its tributaries; apparently introduced into adjacent Colorado River drainage; medium to large prairie streams with sandy substrate and turbid to clear warm water; presumably eats small aquatic invertebrates.	C1	
Mammals		
Black-footed Ferret (Mustela nigripes) – considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area.	LE	E
Black-tailed Prairie Dog (Cynomys ludovicianus) – dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups.		
Cave Myotis Bat (Myotis velifer) – roosts colonially in caves, rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Petrochelidon pyrrhonots)* nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum caves of Panhandle during winter; opportunistic insectivore.		
Palo Duro Mouse (Peromyscus truei Comanche) – rocky, juniper-mesquite-covered slopes of steep-walled canyons of the eastern edge of the Llano Estacado; juniper woodlands in canyon country of the panhandle; primarily nocturnal.		T
Plains Spotted Skunk (Spilogale putorius interrupta) – catholic in habitat; open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie.		
Swift Fox (Vulpes velox) – restricted to current and historic shortgrass prairie; western and northern portions of Panhandle.		
Reptiles		
Texas Horned Lizard (Phrynosoma cornutum) – open, arid and semi-arid regions with sparse vegetation, which could include grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive; breeds March-September.		T
Status Key: DL-De-Listed, PDL-Proposed De-Listed, LE, LT-Federally Listed Endangered/Threatened, PE, PT-Federally Proposed Endangered/Threatened, E/SA, T/SA-Federally Listed Endangered/Threatened by Similarity of Appearance, C1-Federal Candidate for Listing, E,T-State Listed Endangered/Threatened, "blank"-Rare, but with no regulatory listing status		

4.4.3.8.4 Engineering and Costing

Costs for this option include the following:

- Land and right-of-way for diversion dam and pipelines;
- Construction of diversion dam;
- Pump stations and pipelines;
- Environmental impact assessments and archeological studies and recovery, and mitigation, if needed;
- State and federal permit acquisition;
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return.

The total project cost for this option was estimated at $50,055,000 (Table 4.4-63). The total annual cost, including debt service, operation and maintenance, and power cost, is estimated to be $4,296,000. For an annual yield increase of Lake Alan Henry of 4,000 acft/yr, the cost is $1,074 per acft, or $3.30 per 1,000 gallons (Table 4.4-63).

4.4.3.8.5 Implementation Issues

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-64, and the option meets each criterion.

The implementation of this option to supply additional water to the City of Lubbock depends upon acquisition of the necessary permits, including water rights and those required for construction, as well as other issues as summarized below:

Potential Regulatory Requirements:

- Texas Commission on Environmental Quality Water Right and Storage permits;
- U.S. Army Corps of Engineers Permits will be required for discharges of dredge or fill into wetlands and waters of the U.S. for dam construction, and other activities (Section 404 of the Clean Water Act);
- Texas Commission on Environmental Quality administered Texas Pollutant Discharge Elimination System Storm Water Pollution Prevention Plan;
- General Land Office Easement if State-owned land or water is involved; and
- Texas Parks and Wildlife Department Sand, Shell, Gravel and Marl permit if state-owned streambed is involved.

State and Federal Permits may require the following studies and plans:

- Environmental impact or assessment studies;
- Wildlife habitat mitigation plan that may require acquisition and management of additional land;

- Flow releases downstream to maintain aquatic ecosystems;
- Assessment of impacts on Federal- and State-listed endangered and threatened species; and
- Cultural resources studies to determine resources impacts and appropriate mitigation plan that may include cultural resource recovery and cataloging; requires coordination with the Texas Historical Commission.

Land Acquisition Issues:

- Land acquired for reservoir and/or mitigation plans could include market transactions and/or eminent domain;
- Additional acquisition of rights-of-way and/or easements may be required; and
- Possible relocations or removal of residences, utilities, roads, or other structures.

Table 4.4-63.
Cost Estimate Summary for
Lubbock North Fork Scalping Operation
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	*Estimated Cost*
Capital Costs	
Dam and Reservoir (Conservation Pool: 1,000 acft; 650 acres; 2,000 ft. msl)	$1,761,000
Intake and Pump Station (162 MGD)	16,493,000
Transmission Pipeline (6 miles; 96 in. diameter)	14,430,000
Total Capital Cost	**$32,684,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other construction costs; zero for studies)	$10,718,000
Environmental & Archeological Studies and Mitigation	543,000
Land Acquisition and Surveying (681 acres)	705,000
Interest During Construction (3 years @ 4 percent)	5,504,000
Total Project Cost	**$50,055,000**
Annual Costs	
Debt Service (Intake, Pipelines, and Pump Stations) (6 percent for 30 years)	$3,374,000
Reservoir Debt Service (6 percent, 40 years)	241,000
Operation and Maintenance	
Intake, Pipelines, and Pump Stations	557,000
Dam and Reservoir	26,000
Pumping Energy Costs (1,632,043 kWh @ $0.06/kWh) (Diversion of 4,000 acft/yr)	98,000
Total Annual Cost	**$4,296,000**
Quantity of Water (acft/yr)	**4,000**
Annual Cost of Water ($ per acft)[1]	**$1,074**
Annual Cost of Water ($ per 1,000 gallons)[1]	**$3.30**

[1] Annual Cost of Water is for treated water at the treated water storage tanks and does not include costs associated with distribution within municipal systems.

Table 4.4-64.
Comparison of Lubbock North Fork Scalping Operation
to Plan Development Criteria
Llano Estacado Water Planning Region

Impact Category	***Comment(s)***
A. Water Supply	
1. Quantity	1. Sufficient to meet needs
2. Reliability	2. High reliability
3. Cost	3. Reasonable to High
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low impact
3. Cultural Resources	3. Low impact
4. Bays and Estuaries	4. Negligible impact
5. Threatened and Endangered Species	5. Possible Low impact
6. Wetlands	6. Low impact
C. Impact on Other State Water Resources	• No apparent negative impacts on state water resources; no effect on navigation
D. Threats to Agriculture and Natural Resources	• Potential impact on habitat in diversion dam area
E. Equitable Comparison of Strategies Deemed Feasible	• Option is considered to meet municipal and industrial shortages
F. Requirements for Interbasin Transfers	• Not applicable

4.4.3.9 White River Municipal Water District – Reclaimed Water

4.4.3.9.1 Description of Option

This water management strategy would augment the WRMWD's water supply from White River Lake with reclaimed water. For this alternative, a reverse osmosis (RO) water treatment plant (WTP) would be located at the City of Lubbock's wastewater treatment plant (WWTP), and secondary effluent would be obtained from the City of Lubbock WTP and treated with RO on an as-needed basis to remove Total Dissolved Solids (TDS) such that historical levels of TDS are maintained in the reservoir. Following RO treatment, the effluent will be piped approximately 41 miles directly to a proposed constructed wetlands, located on a tributary to the lake. The wetlands would provide treatment for removal of nutrients and constituents, and provide "polishing" prior to discharge into the lake. Following discharge to the wetlands system, the water would flow into the reservoir, mix with the ambient waters, and eventually be withdrawn at the District's intake for treatment at the existing water treatment plant prior to distribution to District customers.[25]

4.4.3.9.2 Quantity of Water Available

Subject to agreement between the City of Lubbock and the WRMWD, the quantity of water available would be 2 MGD, or 2,240 acft/yr.

4.4.3.9.3 Environmental Issues

The environmental issues associated with this water management strategy involve the health implications of utilizing reclaimed water as a supplementary potable water supply, pipeline rights-of-way and sites for pumping plants and storage facilities, the proposed constructed wetlands, and White River Lake, into which the reclaimed water would be placed. Each of these issues is discussed briefly below.

In the case of health implications, a review of available studies indicates,

> "that to date, there are no known documented adverse health impacts associated with use of reclaimed water as a supplementary potable water source. However, there are still many constituents within the wastewater which have not been identified or about which little or no information is available as to the effectiveness of existing treatment technologies in removing them from the

[25] Alan Plummer Associates, Inc., "Water Reuse and Conservation Study, Augmentation of Water Supply Using Reclaimed Water," White River Municipal Water District and Texas Water Development Board, Austin Texas, October 2004.

> potable water supply. In addition, no detailed studies have been performed which address potential long-term health impacts of using reclaimed water to supplement potable water supplies. Consequently, systems using reclaimed water to supplement their potable water supplies assume some level of risk. Most systems have addressed this risk by adopting a conservative "multiple barrier" approach to the treatment and use of reclaimed water. This approach typically includes a combination of providing ample detention time and dilution between the discharge and intake points and providing various degrees of advanced treatment at the wastewater treatment plant and/or the water treatment plant."[26]

In the case of White River Lake, water quality evaluations of reclaimed water alternatives were made, the results of which are summarized below:

- In order to maintain percent blends and detention times within the range recommended as guidance of average percent blend less than 30 percent, and average detention time greater than 1 year, the maximum amount of wastewater that can be diverted to the proposed wetlands/reservoir system is approximately 4 MGD, and
- In order to maintain TDS levels within the range of historically observed values in White River Reservoir, RO treatment must be provided for the wastewater effluent.

It is important to note that the proposed project is sized at 2 MGD, reverse osmosis and constructed wetlands treatments are included.

In the case of rights-of way for pipeline and facilities, since routes and sites can be selected to avoid sensitive wildlife habitat and cultural resources, there would be very little, if any, environmental issues of significant concern.

4.4.3.9.4 Engineering and Costing

Costs for this option include the following:

- Reverse Osmosis Water Treatment Plant
- Conveyance Pump Station and Pumps
- Pipeline and Valves (16-inch)
- Constructed Wetland
- Land and Easements
- Wastewater Effluent
- Engineering, legal, and contingency costs, at 30 percent of the construction costs for pipelines and 35 percent for other facilities; and
- Interest during construction calculated at 6 percent interest rate, and a 4 percent annual rate of return (Table 4.4-65).

[26] Ibid.

Table 4.4-65.
Cost Estimate Summary for
White River Municipal Water District—Reclaimed Water *
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	Estimated Cost
Capital Costs[1]	
Wastewater Effluent	
Reverse Osmosis Water Treatment Plant & Pretreatment Facilities (2 MGD)	$ 5,162,000
Pump Station, Pumps, Electrical & Equipment Setting (2 pumps @ 1400 gpm each)	1,868,000
Pipeline and Valves (16 in, 41 miles) to Wetlands	11,629,700
Wetlands Construction (40 acres @ $13,350/acre)	534,000
Land (40 acres @ $2,000/acre) and Easements (492 acres @ $2,000/acre)	1,064,242
Total Capital Cost[1]	**$20,257,942**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	$ 6,508,795
Interest During Construction (3 years @ 4 percent)	2,979,943
Total Project Cost	**$29,746,680**
Annual Costs	
Debt Service (6 percent for 30 years)	$ 2,159,609
Operation and Maintenance	542,438
Pumping Energy Costs (1,978,551 kWh @ $0.06/kWh)	118,713
Total Annual Cost	**$2,820,760**
Quantity of Water (acft/yr)	**2,240**
Annual Cost of Water ($ per acft)[2]	**$1,259**
Annual Cost of Water ($ per 1,000 gallons)[3]	**$3.86**

[1] Alan Plummer Associates, Inc.," Water District Water Reuse and Conservation Study," White River Municipal Water District and Texas Water Development Board, Austin Texas, October 2004.

[2] Annual Cost of Water is for reclaimed water at White River Lake and does not include costs associated with water treatment and distribution to members' municipal systems.

4.4.3.9.5 Implementation Issues

In order to implement this water management strategy, the White River Municipal Water district will need to enter into an agreement with the City of Lubbock to obtain the necessary wastewater effluent. In addition, it will be necessary to obtain permits from the TCEQ, the USCOE, and other agencies, as follows:

1. Permits and/or Permit Amendments
   a. TCEQ Certificate of Adjudication 12-3693 has been awarded to the White River Municipal Water District to impound not to exceed 44,897 acft per annum of water, and to divert up to 6,000 acft per annum of said water (2,000 acft per annum for mining purposes and 4,000 acft per annum for municipal purposes) at a maximum rate of 4,100 gpm. The District will need to obtain authorization pursuant to Water Code Section 11.042 to convey water through the Lake, and Water Code Section 11.122 to increase the annual amount diverted pursuant to Certificate of Adjudication No. 12-3693. Additionally, the District will need to obtain authorization pursuant to Water Code Section 11.046 to recognize the indirect reuse of groundwater and developed water-based effluent discharged to the headwaters of the reservoir. Each of these authorizations can be pursued through an amendment to Certificate of Adjudication No. 12-3693.
   b. Authorization from TCEQ pursuant to the Clean Water Act and Chapter 26 of the Water Code. This water management strategy contemplates a new outfall from the Lubbock's wastewater treatment facility into the headwaters of White River Lake. As such, TPDES Permit No. 10353-002, granted to the City of Lubbock would need to be amended to authorize this discharge. The transfer of water between the North Fork and the Lake would require a discharge permit pursuant to Chapter 26 of the Water Code, since these are two "distinct sources" of water. In addition the District will need to obtain approval for the design of any water or wastewater treatment facilities contemplated by these options.
   c. USCOE Sections 10 and 404 dredge and fill permits for pipelines impacting wetlands or navigable waters of the U. S.
   d. Texas Parks and Wildlife Department (TPWD) Sand, Gravel, and Marl permit for construction in state owned streambeds.
   e. National Pollution Discharge Elimination System (NPDES) Storm Water Pollution Prevention Plan.
   f. General Land Office (GLO) easement for use of the state-owned streambed; and
   g. Section 404 certification from the TCEQ required by the clean water act.
2. Studies to Support Permit Applications:
   a. Assessment of changes in stream flows.
   b. Habitat mitigation plan.
   c. Environmental surveys.
   d. Cultural resources surveys, studies, and mitigation.
3. Land will have to be acquired either by negotiation or condemnation.

4.4.3.10 White River Municipal Water District – Local Groundwater

4.4.3.10.1 Description of Option

This water management strategy would augment the WRMWD's water supply by drilling up to eight wells within Crosby or Dickens Counties on property owned or leased by the district or one of its member cities, and the connection of the eight wells to WRMWD's existing wholesale supply system via 1,000 linear feet of 6-inch diameter pipeline.

4.4.3.10.2 Quantity of Water Available

The quantity of water available would be 7,742 acft/yr.

4.4.3.10.3 Environmental Issues

There are no known environmental issues associated with this water management strategy.

4.4.3.10.4 Engineering and Costing

Costs of this option include:

- Drilling and equipping eight (8), 600-gpm wells; and
- Construction of 1,000 feet of 6-inch water line (Table 4.4-66).

4.4.3.10.5 Implementation Issues

There are no known implementation issues associated with this water management strategy.

Table 4.4-66.
Cost Estimate Summary for
White River Municipal Water District—Local Groundwater
Llano Estacado Water Planning Region
Second Quarter 2002 Prices

Item	*Estimated Cost*
Capital Costs	
Water Supply Wells (8) (600 gpm)	$ 560,000
Transmission Pipeline (6 in., 1,000 feet)	19,000
Total Capital Cost[1]	**$579,000**
Engineering, Legal Costs and Contingencies (30% for pipelines & 35% for all other)	$ 202,000
Interest During Construction (1 year @ 4 percent)	32,000
Total Project Cost	**$813,000**
Annual Costs	
Debt Service (6 percent for 30 years)	$ 59,000
Operation and Maintenance	6,000
Pumping Energy Costs (4,083,912 kWh @ $0.06/kWh)	245,000
Total Annual Cost	**$310,000**
Quantity of Water (acft/yr)	**7,742**
Annual Cost of Water ($ per acft)[1]	**$40**
Annual Cost of Water ($ per 1,000 gallons)[1]	**$0.12**

[1] Annual Cost of Water is for raw water at the well field and does not include costs associated with water treatment and distribution to members' municipal systems.

4.4.4 Region-Wide Water Management Strategies

There are several water management strategies that have widespread significance and importance to the region, and if pursued could increase regional water supplies and/or improve efficiency of water use. These water management strategies are described and evaluated below.

4.4.4.1 Precipitation Enhancement

4.4.4.1.1 Description of Weather Modification to Enhance Precipitation

Weather modification, as it has been applied in Texas over the past 25 to 30 years, involves cloud seeding to either attempt to create rain when none would have occurred or to attempt to increase rain above what would have naturally occurred. The result of cloud seeding is referred to as precipitation enhancement. The concept of how this is thought to occur is described below.

In natural rainfall, droplets are created from the presence of ice particles (crystals) in the cloud. These crystals are formed when freezing water contacts particles of dust, salt, or sand. The ice crystals form a nucleus around which water droplets attach to make the size of the droplet increase. When the size of a droplet increases sufficiently, it becomes a raindrop and falls from the cloud. Cloud seeding is thought to increase the number of "nuclei" available to take advantage of the moisture in the cloud to form raindrops that would not have otherwise formed. To be effective, seeding must be done at the correct time and in the correct manner.

As a cloud grows taller, the air temperature in the cloud cools and falls below the freezing point of water. This cooling effect means that the cloud droplets, which are much too small to fall as rain, are also cooled to a point where they respond to crystallization when contacted by an ice particle. Consequently, when there are fewer crystals to act as nuclei for raindrops, there will be less rain than would have been if more crystals were present. Although crude experiments to enhance rainfall were attempted in the United States as early as the mid-1800s, modern weather modification was begun in 1946 when it was found that silver iodide (AgI) almost exactly matches the chemical structure of ice crystals.[27] The other seeding chemical used when the cloud temperature is too warm for forming ice is sodium chloride (NaCl).

[27] Jensen, Ric, "Does Weather Modification Really Work?" Texas Water Resources, Summer 1994.

When silver iodide is introduced into a cloud, the number of ice crystals increases and the crystals contact water vapor, causing it to freeze to the crystal. Considerable heat is released to the atmosphere during the freezing and crystal formation phase. The released heat causes the cloud to grow taller and its vertical wind velocity (updraft) to increase. This results in the cloud being able to pull in more moist air and, thus, create more raindrops. However, not all clouds are potential rainmakers. Generally, cloud seeding is performed with a meteorologist working in tandem with pilots utilizing cloud seeding aircraft so that, with direction from the meteorologist, the pilots can target the most promising cloud(s).[28] The criterion used in Texas to find promising clouds is to locate "feeder" cells near developing cloud formations which have temperatures below 23 degrees Fahrenheit. The target cloud must also have sufficient moisture and airflow to be a candidate. About 20 or 30 minutes prior to the desired rainfall event, the candidate cloud is seeded when the airplane releases silver iodide particles in a plume, typically at the base of the cloud so the updraft can draw the particles upward and make more contact with water in the cloud. Seeding is believed to have another effect on large, potentially dangerous thunderstorms capable of causing hail. Seeding tends to mitigate the extreme freezing that results in forming large particles of ice (hail) and makes the moisture more likely to fall as rain.

The criteria for cloud seeding based on experience in Texas since the early 1970s are the following:

- The cloud must be "convective," meaning that it displays instability in the atmosphere;
- Temperature at the top of the cloud must be 23^{o}F or less; and
- The base of the cloud must be lower than 12,000 feet elevation.

Clouds having the characteristics listed above exhibit a warm base, a strong updraft, and sufficient heat to carry water vapor to the cloud top.

A summary of recent cloud seeding experiments in Texas, Florida, Cuba, and Southeast Asia has been presented by the TCEQ in a public information document.[29] The TCEQ concludes the following:

- Cloud seeding with AgI increases rain generated by these clouds by extending the life of the clouds, by allowing the clouds to enlarge laterally so that they cover more area, and by slightly increasing the height of the clouds.
- Rain production of seeded clouds is more efficient than for non-seeded clouds.

[28] Clouds may also be seeded using ground-based silver iodide dispensers. However, in this discussion, only the aircraft method is considered.

[29] Bomar, George, "Some Facts about Cloud Seeding from Recent Research on Rain Enhancement in Texas," Texas Commission on Environmental Quality (TCEQ, formerly TNRCC), 1999.

- The timing of seeding and the selection of clouds are fundamental. These are such critical factors that "…seeding at the wrong time and in the wrong place(s) may actually decrease the rainfall."[30]

In order to engage in weather modification activities, an individual or organization must possess a weather modification license and a weather modification permit issued by the TCEQ (Texas Water Code: Section 18). The purpose of the weather modification license is to demonstrate competence in the field of meteorology necessary to engage in weather modification activities. The weather modification permit specifies the area to which the weather modification activity may be applied and any limitations or conditions to be observed. In the Llano Estacado Water Planning Region, the Southern Ogallala Aquifer Rainfall Enhancement (SOAR) program was in operation in 2005. The SOAR target area includes approximately 2.3 million acres in Gaines, Terry and Yoakum Counties. Each of these counties are within the boundaries of an underground water conservation district, including the Llano Estacado UWCD (Gaines County), South Plains UWCD (Terry and part of Hockley Counties), and Sandy Land UWCD (Yoakum County). The program is administered by the Sandy Land UWCD, with aircraft and radar located at the Plains, TX airport. The Districts maintain a network of 106 rain gauges that are read monthly during the program.

4.4.4.1.2 Summary of Results of Weather Modification Projects of the Past and Potential Quantities of Water Supply from Weather Modification in Llano Estacado Water Planning Region

The reported findings of seven Texas cloud seeding projects are summarized below, in order to gain an indication of the potentials of weather modification to increase water supplies in the Llano Estacado Water Planning Region. The projects are listed in the order in which they were conducted, as follows: Colorado River Municipal Water District Program, Southwest Cooperative Program, Texas Experiment in Augmenting Rainfall through Cloud-Seeding Program, High Plains UWCD Program, Edwards Aquifer Authority Program, North Plains GWCD Program, and Panhandle GWCD Program. Each of these programs is described below, together with the results that are reported for their respective programs.

Colorado River Municipal Water District Program*:* Having been started in 1971, the Colorado River MWD Program is the longest-running operational weather modification program in Texas. The target area is roughly the Upper Colorado River Basin upstream of Spence

[30] Ibid.

Reservoir, comprising some 3,600 square miles. The goals for the program are/were to increase water supplies to Lake J.B. Thomas and Spence Reservoir, and to increase rainfall to agricultural areas. The reported long-term results are that a 34 percent increase (above normal historic precipitation) in the seeded areas and a 13 percent increase in non-seeded areas occurred.[31,32]

Southwest Cooperative Program (SWCP): The Southwest Cooperative Program (SWCP) was begun in 1986 as a cooperative effort between Oklahoma and Texas "…to develop a scientifically sound, environmentally sensitive, and socially acceptable applied weather modification technology for increasing water supplies…in the southern High Plains."[33] The area involved in Texas was 5,000 square miles located between Midland-Odessa and Lubbock. Random cloud seeding experiments were conducted in 1986, 1987, 1989, 1990, and 1994.

During the period 1987 through 1990, 183 experiments were made (93 seeded, 90 non-seeded). The criteria for selection were the following:

- Liquid water content had to be at least 0.5 gm/m^3 and updrafts had to be at least 1,000 ft/min.
- The target had to be a multiple-cell convective unit.
- No cloud or cell height could exceed 10 km (above ground level).
- Some of the tops had to have temperatures -10^{o} C or colder.

The results confirmed increased rainfall. Compared to the non-seeded cells, the seeded cells displayed an increase in maximum height of 7 percent, an increase in the coverage of the rainfall event of 43 percent, an increase in the storm duration of 36 percent, and an increase in rain volumes of 130 percent.[34]

Texas Experiment in Augmenting Rainfall through Cloud Seeding: The State of Texas implemented the Texas Experiment in Augmenting Rainfall through Cloud Seeding (TEXARC) Program in 1994 and 1995 to investigate physical processes within large storms in the Big Spring-San Angelo area. This research was focused on understanding the best ways of seeding clouds to make them more efficient producers of water, rather than quantifying the

[31] Jones, R., "A Summary of the 1988 Rainfall Enhancement Program and a Review of the Area Rainfall and Primary Crop Yield," Report 88-1 of the Colorado River Municipal Water District, 75 pages, 1988.
[32] Jones, R., "A Summary of the 1997 Rainfall Enhancement Program and a Review of the Area Rainfall and Primary Crop Yield," Report 97-1 of the Colorado River Municipal Water District, 54 pages, 1997.
[33] Bomar, George, William L. Woodley, and Dale L. Bates, "The Texas Weather Modification Program: Objectives, Approach, and Progress," Journal of Weather Modification, Volume 31, April 1999.
[34] Rosenfeld, D. and W. L. Woodley, "Effects of Cloud Seeding in West Texas: Additional Results and New Insights," Journal of Applied Meteorology, Volume 32, pp. 1848-1866, 1993.

results. The results showed that seeding must be within the super-cooled updraft region of the cloud to increase rainfall. From this research it was shown that the seeding agent must be carefully placed either directly in the top of the updraft or at the entrance to the updraft at the base of the cloud.

High Plains Underground Water Conservation District No. 1 Program: The High Plains UWCD No. 1 conducted a cloud seeding program between 1997 and 2002. The High Plains Water District's board of directors terminated the program on October 1, 2002, due to negative feedback about the program from constituents.

Edwards Aquifer Authority (EAA) Program: *(Substantial portions of this program description were reproduced from the EAA web page, e-aquifer.com, and are presented here unedited)* "The Edwards Aquifer Authority board of directors voted in the Fall of 1997 to obtain a permit to conduct precipitation enhancement, or cloud seeding, from the TNRCC. The Authority contracted with Weather Modification, Inc. to complete and submit the permit application on the Authority's behalf and work with the TNRCC. The permit was granted by TNRCC in October 1998 and was valid for four years from January 1999 through December 2002. The permit allowed the Authority to conduct precipitation enhancement any time during the year, including the traditional period of April through September. The Authority provided $500,000 for the 1999 program, with half the expenses reimbursed by the TNRCC.

"The target area of the program covered over 6.37 million acres in all or part of Bandera, Bexar, Blanco, Caldwell, Comal, Guadalupe, Hays, Kendall, Kerr, Medina, Real, and Uvalde Counties, at a total cost to the Authority and the State of Texas of 8 to 9 cents an acre.". The Authority use WMI to perform weather modification services in the 12-county area from 1999 through 2001. A TWDB sponsored study of the 1999-2001 EAA precipitation enhancement program reported that the program resulted in approximately 60,000 acft/yr of additional rainfall to the area.

In 2002 and 2003, the EAA contracted with South Texas Weather Modification Association to perform cloud seeding in Bandera, Bexar, and Medina Counties, and at the same time contracted with Southwest Texas Rein Enhancement Association to perform cloud seeding in Uvalde County. An assessment of this effort indicated that in 2003, an additional 85,745 acft of rainfall was created for Bandera, Bexar, and Medina Counties, and 36,733 acft of rainfall was created for Uvalde County.

North Plains Groundwater Conservation District: The North Plains Groundwater Conservation District (GWCD) weather modification program was started in May 2000. The target area included Sherman, Hansford, Ochiltree, Lipscomb, and parts of Dallam, Hartley, Moore, and Hutchinson Counties. The goal for the program is to increase rainfall in the target area by 15 to 20 percent.

Panhandle Groundwater Conservation District: The Panhandle Groundwater Conservation District (GWCD) weather modification program was started in May 2000. The target area included Armstrong, Donley, Carson, Gray, Wheeler, Roberts, Carson, and parts of Potter and Hutchinson Counties. The goals of this program are to increase recharge to the Ogallala Aquifer in selected areas and to reduce irrigation water requirements from the Ogallala Aquifer.

Estimated Potential Quantities of Water Supply Resulting from Weather Modification in the Llano Estacado Regional Water Planning Region: Performance data from cloud seeding programs typically focus on the rainfall event and parameters such as storm duration, cloud height, storm coverage (cloud area), and rainfall amount, rather than water supply parameters like increased stream flows and increased reservoir storage. Where water supply parameters have been measured in cloud seeding programs the results appear to be positive. For example, Colorado River MWD reservoir storage increased from 14,000 acft to 20,000 acft in Lake Spence and from 26,000 acft to 30,000 acft in Lake Thomas since the inception of cloud seeding in the Big Spring and Snyder areas.[35] Also, the Twin Buttes and Fisher Reservoirs increased from a combined 40,000 acft to a combined 230,000 acft during a cloud seeding program sponsored by the City of San Angelo between 1985 and 1989.[36]

Annual precipitation in the area seeded by the High Plains UWCD project was estimated to have been 1.47 and 1.97 inches more in 1997 and 1999, respectively, than the 1945 through 1997 long-term average of 18.29 inches (Figure 4.4-12). Data collected to date indicate that cloud seeding could materially contribute to the Llano Estacado Region's water supplies. For example, for the 20,294 square mile (12,988,160 acres) Llano Estacado Planning Region, an annual increase in precipitation of one and one-half inches would result in an increase of about 1,623,520 acft of water per year to the land surface. At a cost of 7.2 cents per acre, the cost per acft of water is $0.57. Additional precipitation during the growing season, which is the period

[35] Jensen, Ric, Op. Cit., 1994.
[36] Jensen, Ric, Op. Cit., 1994.

during which cloud seeding projects are usually operated, would directly and immediately benefit both dryland and irrigated agriculture. Crop and grazing yields would be increased, irrigation water pumped from the Ogallala Aquifer could be reduced, and lawn irrigation could be reduced. The latter effect would contribute to meeting projected municipal water needs by reducing the quantities used per year from present supplies. Additional water would be available for surface water reservoirs that are used for public water supplies, and runoff into playa basins may be increased, some of which would recharge the aquifer as well as provide water for wildlife. In summary, the benefits resulting from cloud seeding in the Llano Estacado Regional Water Planning Area may include improvements in environmental and economic conditions. Potential improvements include increased crop production, increased livestock grazing, and increased ground and surface water supplies.

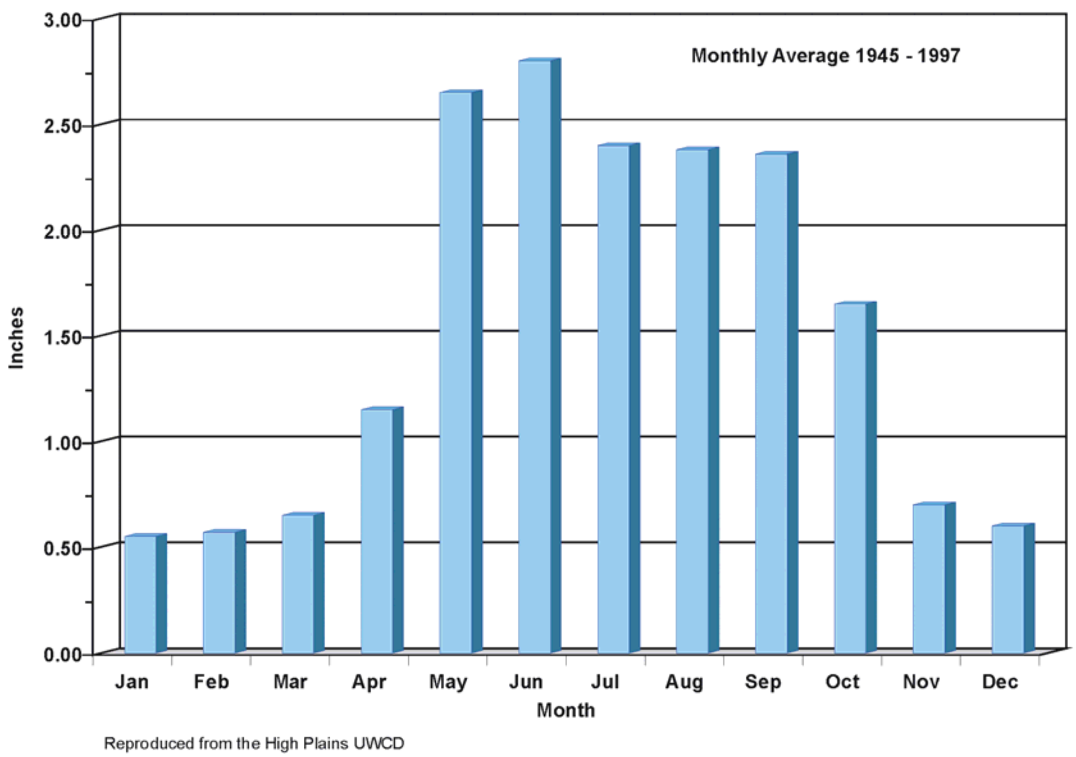

Figure 4.4-12. Rainfall Distribution

4.4.4.1.3 Potential Environmental Effects of Weather Modification

Although cloud seeding for weather modification is not a new technique, the effectiveness of weather modification has not been conclusively documented and efforts to quantify the effects continue. Since Texas established a permit procedure, administered by TCEQ, data have been collected for a scientific evaluation of cloud seeding effectiveness and management. Originally conceived as a means to end droughts, experience shows that cloud seeding may work best during periods of normal rainfall. Weather modification is now considered a long-term water augmentation strategy for freshwater supplies.[37]

The amount of silver iodide and sodium chloride used during a seeding event is believed to be negligible and too widely dispersed to have a measurable effect on the environment. Safe handling and storage of these materials prior to dispersal are a larger concern. Both are normally used in industrial applications and printing. Therefore, procedures for handling and storing silver iodide are well documented. There are no known environmental problems associated with this option.

4.4.4.1.4 Estimated Costs of Weather Modification

The cloud seeding program run by Sandy Land UWCD covers 2,300,000 acres at a total cost of about $109,200 per year, or 4.2 cents per acre per year.

4.4.4.1.5 Weather Modification Implementation Issues

In terms of a measurable and dependable regional water supply option, weather modification in the form of cloud seeding appears to be a beneficial, but somewhat uncertain, source of usable water. Although available data are not adequate to provide estimates of firm yield that can be depended upon during a drought, there are several potential benefits that could perhaps be realized. One important potential benefit of cloud seeding is that a part of the agricultural (irrigated and dryland crops, and rangelands) and municipal water needs could be met. For example, higher rainfall would lower the quantities of irrigation water that has to be withdrawn from the aquifers of the Llano Estacado Regional Water Planning Area for irrigation purposes, dryland production would benefit from increased rainfall, and municipal lawn irrigation could be reduced. Thus, for a relatively low cost, cloud seeding could perhaps meet a part of the agricultural and municipal needs, as well as make significant contributions to aquifer recharge and streamflows of the region, some of which may be collected in surface water reservoirs that are used to meet municipal and industrial water needs. A potential goal of this

[37] Bomar, George, TNRCC Senior Meteorologist, Austin, Texas.

program is to increase rainfall in the target area an average of 2 inches annually over a 10-year period.

4.4.4.2 Brush Control

4.4.4.2.1 Description of Brush Control for Increasing Water Supplies

The interest in brush control as a means to increase water supply has its roots in 1) the belief that Texas rangelands changed after settlement and use by Europeans from predominantly open grasslands to increasing domination of brush and 2) the significantly greater interception of water by brush than grasses. These views suggest the possibility of increasing aquifer recharge and streamflow by controlling and limiting growth of brush and trees in areas where grasslands would have naturally dominated. For this water management option, brush control methods will be described and estimates of cost and potential water supply effects will be presented.

Documentation by early European settlers[38] described Texas rangelands as grasslands. Prior to settlement by Europeans with its associated grazing, significant brush growth was inhibited due to several natural conditions. Tree seeds commonly die following germination in grass cover because they cannot compete with grasses for sunlight and moisture. Also, surviving seedlings are destroyed typically in periodic wildfires that occur in natural grasslands. Heavy grazing lessens the competitiveness of grass relative to brush and removes fuel (grass) for rangeland wildfires. The result of heavy grazing is the increased dominance of trees and brush in grasslands, with a resulting decrease in surface runoff and/or recharge to aquifers.[39]

Of the approximately 12.5 million acres of the Llano Estacado Region, about 30 percent is rangeland (3.8 million acres) (Table 4.4-67). The Natural Resources Conservation Service (NRCS) estimates that nearly 1.9 million acres of rangeland in the region have moderate-to-heavy canopy cover.[40] The most abundant species is mesquite (1.17 million acres), with shinnery oak next most abundant at 487,000 acres. Thus, nearly 87 percent of the moderate-to-heavy brush coverage is mesquite and shinnery oak. Other brush species in the region include sand sage, yucca, snake weed, juniper, and salt cedar.

[38] Smiens, F., S. Fuhlendorf, and C. Tayor, Jr., "Environmental and Land Use Changes: A Long-Term Perspective," Juniper Symposium Proceedings, Texas A & M Agricultural Experiment Station, Sonora, Texas, 1997.
[39] Thurow, T. L., "Assessment of Brush Management as a Strategy for Enhancing Water Yield," Proceedings of the 25th Water for Texas Conference, Texas Water Resources Institute, Texas A & M University, 1998.
[40] Bell, J.R. Natural Resources Conservation Service – Amarillo. December 6, 1999 letter to NRCS Lubbock.

Table 4.4-67.
Approximate Range and Brush-Covered Areas
Llano Estacado Region

County	Range (acres)	Mesquite (acres)	Shinnery Oak (acres)	Sand Sage (acres)	Yucca (acres)	Snake Weed (acres)	Juniper (acres)	Salt Cedar (acres)
Bailey	108,300	42,000	52,000	10,000				
Briscoe	370,000	64,000					64,000	
Castro	106,000				8,700	20,000		
Crosby	221,500	65,000	20,000	2,000	2,000			500
Cochran	190,000	46,000	129,500	9,000				
Dawson	87,000	58,000	5,500					500
Deaf Smith	312,000	37,000				16,000		
Dickens	385,000	238,000	55,000					500
Floyd	117,000	35,000					5,000	
Gaines	162,000	40,000	85,000					
Garza	450,000	150,000	35,000				16,000	400
Hale	30,000	200			2,000	2,000		
Hockley	77,000	45,000	5,000					1,500
Lamb	100,000			18,000	1,500			
Lubbock	17,000	7,500						
Lynn	107,000	58,000	1,700					
Motley	500,000	230,000	25,000	5,000			8,000	500
Parmer	66,000				700	14,000		
Swisher	104,000	3,500			2,000			
Terry	71,000	30,000	20,000	5,000				2,000
Yoakum	197,000	20,000	50,000	5,000				
Totals	**3,787,800**	**1,169,000**	**487,000**	**54,000**	**16,900**	**52,000**	**93,000**	**5,900**

Source: J. R. Bell, Natural Resources Conservation Service Amarillo, December 8, 1999.

Brush is important as food and cover for wildlife in the Llano Estacado Region. Rodents, small mammals, songbirds, and quail use the ripe Mesquite seeds. Deer utilize the leaves and twigs; brush also provides important nesting sites for larger birds such as hawks, ravens, and songbirds. Therefore, for brush control to be implemented while still providing food and cover for wildlife, certain guidelines need to be observed, as follows:

1. Brush Control should achieve the desired plant community of both herbaceous and woody species.

2. Brush Control should apply to target species and protect desired species.
3. Scheduled follow-up treatment is mandatory when desired control is not achieved.
4. Mechanical methods that destroy all ground cover should be followed with revegetation of desired species.
5. An approved plan (patterns, strips, or motts) should be developed to assure that the proper percentage of brush is removed. All essential areas such as draws should be protected.
6. Timing of treatment to minimize harm during wildlife nesting or breeding seasons is important.

Brush control should include protection of present and future land use values. The land value for aesthetics, recreation and wildlife uses is generally greater with some brush than with only herbaceous vegetation.

4.4.4.2.2 Potential Water Yield from Brush Control on Rangelands

In terms of water supply, for purposes of this water planning effort, yield is defined as the quantity of water available in a year for municipal, industrial, agricultural, and other uses, and is expressed as acft per year. Firm yield is the quantity of water available during a critical drought. However, increasing the quantity of water that is not intercepted by brush on rangelands does not necessarily increase yield as defined above for water supply; e.g., there may be other factors that prevent this water from being available. For example, the water could enter the soil as deep percolation, or it could be captured in a rangeland impoundment, each of which would be beneficial to the region.

The water balance stated below can be used to estimate the runoff and/or deep percolation from rangeland.[41]

Runoff + Deep Percolation = Precipitation – Evapotranspiration

and its variables are defined as follows:

Runoff is water that leaves the watershed through surface flow;

Deep Percolation is water that leaves the watershed by percolating through soil absent of roots (or below the rooting zone); and

Evapotranspiration is water vapor entering the atmosphere through both leaf tissue (transpiration) and the drying of wet soil or ponded water (evaporation).

[41] Thurow, T.L., Op. Cit., 1998.

According to the water balance, runoff and/or deep percolation can be increased by decreasing evapotranspiration, which can be accomplished by managing vegetation. There are large differences in interception loss (water in the canopy that can be evaporated) among the common brush (mesquite and juniper) and grasses. Interception losses in Texas range from 14 percent for grass to 73 percent for juniper.[42] Thus, a strategy of limiting brush cover and increasing grass cover would presumably increase runoff and/or deep percolation. There is anecdotal and other information concerning the rangelands of Texas that supports the contention than coverage of brush decreases soil percolation, runoff, and streamflow. For example, historical data on stream flow (USGS Station No. 08134000 at Carlsbad, Texas) and rainfall at the San Angelo weather station for the period from 1925 to 1996 show a reduction in average annual discharge from 38,617 acft to 8,358 acft between the periods 1925 to 1959 and 1960 to 1996, respectively. The declining recorded stream flow coincides with the increasing coverage of mesquite, juniper and other brush that occurred in the North Concho watershed between about 1900 and the 1950s, when coverage was essentially complete.[43]

In the Llano Estacado Region, about 60 percent of the area is cropland. Thus, row-crop cultivation in the region prevented the brush coverage that has occurred on the rangeland of the area. The areas of the region where significant concentrations of brush occur, and where brush management or control has potential to contribute to the region’s water supplies, are in the east “caprock counties” and in the western counties. Information and discussion about the costs and potentials for contributions of brush control to the region’s water supply are presented below.

The seasonal water use differences among trees, brush, and grasses common to the Llano Estacado Region are demonstrated in Table 4.4-68. The average unit water consumption for mesquite and Ashe Juniper is more than twice the average of the common grasses in the region. Thus, a reduction in brush species should result in more water for grass and increased quantities for stream flow and aquifer recharge.

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42 Thurow, T. L. and Hester, J. W., “How an Increase in Juniper Cover Alters Rangeland Hydrology,” Proceedings Juniper Symposium, Texas A & M Agricultural Experiment Station Technical Report 97-1, 1997.

43 Taylor, Charles, A. and Fred E. Smiens, “A History of Land Use of the Edwards Plateau and Its Effect on the Native Vegetation,” 1994 Juniper Symposium, Texas A&M University Research Station at Sonora, 1994.

Table 4.4-68.
Densities and Seasonal Water Use for Common Plant Species
Llano Estacado Region

Species	Density	Seasonal Water Use[1] (acft)
Mesquite[2]	307 plants/acre	0.93
Juniper (no grazing)	309 plants/acre	1.12
Juniper (goat grazing)	114 plants/acre	0.28
Sideoats grama grass[2]	890 pounds/acre	0.20
Kleingrass	1,525 pounds/acre	0.59
Buffalograss	1,340 pounds/acre	0.53

[1] The growing season of April through September.
[2] Common in Llano Estacado Region.

Source: Owens, M.K. and R.W. Knight, "Water Use on Rangelands," Water for South Texas, The Texas Agricultural Experiment Stations, pp. 1-13, October 1992.

4.4.4.2.3 Areas in Llano Estacado Region Where Potential Yield Increase Exists

The areas of the region where significant concentrations of brush occur are in the east "caprock counties" and in the western counties. In addition, in the Llano Estacado Water Planning Region, there are approximately one million acres of land in the U.S. Department of Agriculture's (USDA) Conservation Reserve Program (CRP) on which perennial grass vegetation has been established.44 This program was established to convert cropland to native or adapted vegetation, thereby reducing crop production in an effort to increase crop prices paid for the remaining crops marketed. As the current contracts with the USDA expire on these CRP areas and as the USDA programs change, some of the land may be returned to cultivated row crops; however, some acres are expected to remain in grass. If these grassland acres are not managed to prevent brush infestation, these areas could become brush covered, further contributing to the brush problem of the region.

Soil moisture management is critical to rangeland and pastureland production and is therefore very important to the potentials of brush management to increase water supplies of the region. Research and field trials have shown that as much as 60 percent of the precipitation runs off from poorly managed range and pastures.[45] Maximum opportunity time for infiltration into

[44] USDA Economics and Statistics System. Conservation Reserve File Summary (96004). http\\usda.mannlib.cornell.edu/usda/
[45] Ibid.

the soil cannot be achieved if ranges and pastures are grazed short. One trial in Oldham County, just north of the Llano Estacado Region, showed that with 1,350 pounds of grass cover per acre, runoff from rainfall was 35 percent. With 400 pounds of cover, runoff increased to 72 percent. The Llano Estacado Planning Region has three major soil types, which together with management practices determine the water production potentials of brush management. The soil types are (1) Sandy Soils of the south; (2) Sandy Loams and Loam Textured Soils of the central portion of the region; and (3) Clay Loam and Silty Clay Loam Soils of the north. The vegetation of each soil type is described below.

The sandier textured soils of the southwestern part of the region (Dawson, Gaines, Yoakum, Terry, and Lynn Counties, and parts of Cochran County) support taller grasses such as sand bluestem, little bluestem, sideoats grama, and dropseeds. The main woody plants present are mesquite, shinoak, and sand sagebrush. These brush species are present in moderate amounts on most of the rangeland of the region.[46] Their removal appears to offer significant potential for enhancement of water supplies and grazing.

The sandy loam and loam texture soils generally found in the central portion of the region (Bailey, Lamb, Hockley, Lubbock, and Crosby Counties) supported sideoats grama, blue grama, hairy grama, and sand dropseed and would best be described as a midgrass/shortgrass grassland. As overgrazing occurred, the percentage of these grasses decreased over time and now includes a higher percentage of lower quality grasses and woody species.[47] Mesquite is the most prevalent woody plant and is present on a majority of rangeland of the sandy loam and loam textured soils (Table 4.4-49). This part of the region offers promise for the brush control water management strategy.

The clay loam and silty clay loam texture soils found in the northern part of the region (Hale, Parmer, Castro, and Swisher Counties) supported short grasses, mainly blue grama, and buffalograss, with some occasional western wheatgrass along draws and drainages. As overgrazing occurred, the percentage of these grasses decreased over time and now includes a higher percentage of lower quality grasses and woody species. In this part of the region brush is less of a problem, although there is some presence of cholla, yucca, mesquite, and prickly pear; and brush control could perhaps make a contribution to local water supplies.[48]

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[46] High Plains Underground Water Conservation District No. 1. Background material prepared for the Llano Estacado Regional Water Planning Group. December 10, 1999. Unpublished.
[47] Ibid.
[48] Ibid.

In Crosby County, the watershed that drains into the White River Reservoir has a significant amount of brush. The NRCS performed a study to compare runoff under existing conditions to two hypothetical conditions. The existing condition is light brush coverage over about 70 percent of the 86,000-acre watershed. The hypothetical conditions are for 100 percent brush control in the watershed and no brush control (0 percent) in the watershed. The NRCS study suggested that considerably more runoff could be captured in the reservoir in either the existing condition (light brush on 70 percent of the watershed) or the 100-percent condition (brush control on 100 percent of the watershed), as compared to the condition where no brush control is practiced (Table 4.4-68). For example, for a 2-year frequency, 24-hour rainfall event (relatively often event), under existing brush conditions (70 percent of watershed covered), runoff to the reservoir is estimated at 5,054 acft. With no brush control, runoff is estimated at 2,816 acft, while with 100 percent brush control, runoff is estimated at 6,498 acft, or 2.3 times that for no brush control (Table 4.4-69). For larger, or more intense, but less frequent storms (10-year frequency, 24-hour event), the estimated runoff into the reservoir is 2.6 to 3.4 times that for the 2-year, 24-hour event, depending upon level of brush control (Table 4.4-69).

Table 4.4-69.
Comparison of Water That Could be Collected in White River Reservoir for Varying Degrees of Brush Control
Llano Estacado Region

Rainfall Event	***Runoff Volume Retained in White River Reservoir for Varying Percentages of Watershed with Brush Control***		
	70% existing[1] (acft)	***100% brush control[2] (acft)***	***0% brush control[2] (acft)***
2-year frequency, 24-hour duration	5,054	6,498	2,816
5-year frequency, 24-hour duration	9,098	10,978	5,848
10-year frequency, 24-hour duration	13,935	16,246	9,748

[1] Approximates the existing condition in the watershed.
[2] Hypothetical brush control coverage in watershed, percent of total watershed.

Source: Natural Resources Conservation Service

The methods of brush control are described and costs of the leading methods used in the western parts of Texas are presented below.

4.4.4.2.4 Best Management Practices for Brush Control

The USDA Natural Resources Conservation Service has a conservation practice standard for brush control.[49] The standard includes biological, chemical, mechanical, and burning methods. The biological method describes the use of goats for specific vegetation goats eat. The method involves defoliation of brush systematically. Another standard is for the use of herbicides for brush control. A review of Texas Agricultural Extension Service on-line Expert System for Brush and Weed Control Technology Selection, Version 1.09 (Excel)[50] provided information on chemical agents for control of brush (Table 4.4-70).

Table 4.4-70.
Chemical Agents for Control of Brush

Brush	Chemical Agent	Control Level[1]
Ashe Juniper	Velpar L (hexazinone)	Very high control level
	Tordon 22K (picloram)	Very high control level
Blackjack Oak	Velpar L	Very high control level
	Spike 20P (tebuthiron)	Very high control level
	Crossbow	High control level
Live Oak	None recommended	
Mesquite	Remedy (triclopyr)	Very high control level
	Reclaim (clopyralid)	Very high control level
	Tordon 22K	Very high control level
	Velpar L	High control level
Post Oak	Velpar L	Very high control level
	Spike 20P	Very high control level
	Crossbow	High control level

[1] Very high means 76 to 100 percent of plants killed. High means 56 to 75 percent killed.

The mechanical standard prescribes plowing, grubbing, chaining, and dozing as primary brush control methods. In most cases Natural Resources Conservation Service recommends burning to control sprouts. For control of mesquite and shinoak, the recommended methods include root plowing, power grubbing, and hand grubbing. Control of these types of brush requires uprooting the plants. Because of the higher degree of ground disturbance with these methods, replanting grass is recommended. Replanting grass is done at the next applicable time

[49] Natural Resources Conservation Service, Conservation Practice Standard, Brush Management (Acre) Code 314.
[50] http://cnrit.tamu.edu/rsg/exsel/work/exsel.cgi

following clearing. For example, if planting grass is planned for spring, brush clearing should be performed in early winter.[51]

In 1985, the Texas Legislature authorized a brush control program for the state and placed planning and administration of the program with the Texas State Soil and Water Conservation Board (TSSWCB). The purpose of the program is to provide "selective control, removal, or reduction of noxious brush such as mesquite, salt cedar, or other brush species that consume water to a degree detrimental to water conservation." The Draft State Plan delineates a critical area in Texas for brush control. The counties in the area are those having 16 to 36 inches of precipitation per year. Cost of brush control in the draft plan is shared between landowners and the state. Local soil and water conservation districts determine the maximum and average costs for different control methods and the cost share rates. The methods of brush control that the TSSWCB can approve are those which:

1. Are proven effective and efficient for brush control,
2. Are cost effective,
3. Have beneficial impact on wildlife habitat,
4. Will maintain topsoil to prevent erosion or siltation, and
5. Will allow for revegetation of the area with plants that are beneficial to livestock and wildlife.[52]

Since the Texas brush control program is on a cost-sharing basis with the ranchers, an objective of the program is to equate rancher costs with rancher benefits. The benefit to ranchers would be the increases in income from cattle, sheep, and wildlife that result from brush control. Once the total cost of brush control is determined, then the difference between the total cost and the benefit to the rancher would be the cost that might be attributed to the additional water yield. Presumably, if the rancher receives no benefits, then the rancher would not be interested in engaging in the practices. In this case, brush control costs would have to be borne by the state or the water authority that would benefit from the increased water supply resulting from the practice. In the discussion below, estimates are presented of brush control costs.

[51] NRCS Conservation Practice Standard Code 314 (http://okecs.ok.nrcs.usda.gov/stds/std314.htm)
[52] Texas State Soil and Water Conservation Board, "Draft State Brush Control Plan," April 1, 1999.

4.4.4.2.5 Environmental Issues

Removal of woody species that compete with grasses for water and nutrients have been shown to increase runoff from treated areas. However, there are concerns that the techniques used to remove brush can adversely affect wildlife habitat, and if chemicals are used, concerns extend to their potential effects upon water quality.

A range management plan to protect species should be designed for this strategy. Chaining, cabling, disking, and other mechanical brush removal methods remove some wildlife habitat and expose soil surfaces to wind and water erosion. Therefore, low impact, hand techniques, or well controlled, selective mechanical methods that clear brush in a patchwork or strip fashion, leaving brush berms to control erosion and provide protection for wildlife are preferred.

The chemicals used to remove unwanted vegetation may be detected in surface water sources or may affect air quality, since they are sprayed from the air onto the brush covered areas to be treated. The chemical method of controlling brush can be implemented only after a very thorough evaluation is made, and plans are selected that will avoid chemical runoff into streams or percolation into aquifers.

4.4.4.2.6 Cost of Brush Control

The costs of brush control are estimated using information from brush control studies that have been done to determine brush control costs for rangelands in Texas.[53,54,55] Costs are presented on a present worth, uniform annual basis because brush control requires an initial (year ”1”) investment, plus a periodic future outlay to maintain control (Table 4.4-71). The initial year, or front end, costs per acre for brush control range from $8.10 per acre for chemical applications to light mesquite, to $75.60 per acre to doze and burn heavy cedar (Table 4.4-71). The costs per acre, computed using 30 years as the project horizon, 6 percent interest, and the initial and periodic costs in Table 4.4-71, range from $1.17 per year for light mesquite to $5.27 per year for heavy mesquite, and $5.68 per year for heavy cedar (Table 4.4-72). Costs in

[53] Walker, J.W., F. B. Dugas, F. Baird, S. Bednarz, R. Muttiah, and R. Hicks, “Site Selection for Publicly Funded Brush Control to Enhance Water Yield,” Proceedings, Water for Texas Conference, Austin, Texas, December 1998.
[54] Bach, Joel P. and J. Richard Connor, “Economic Analysis of Brush Control Practices for Increased Water Yield: The North Concho River Example,” Proceedings, Water for Texas Conference, Austin, Texas, December 1998.
[55] Ethridge, D., B. Dahl, and R. Sosebee. Economic Evaluation of Chemical Mesquite Control Using 2,4,5-T. J. Range Management 37:152-156. 1984.

Table 4.4-72 compare to costs reported from $9.61 to $31.90 per acre for chemical control of mesquite using 2,4,5-T in 1984.[56]

Table 4.4-71.
Initial and Interim Costs for Various Brush Control Methods

Brush Condition (method)	One Time Costs		Recurring Costs	
	Year 1 ($/acre)	Year 2 or 3 ($/acre)	Periodic Cost[1] ($/acre)	Frequency of Control (years)
Heavy mesquite (power grubber)	38.90	16.20	9.30	7
Heavy cedar (doze and burn)	75.60	0	9.30	6
Heavy cedar (2-way chain)	16.20	9.30	9.30	7
Moderate mesquite (chemical then prescribed burn)	16.20	0	9.30	6
Moderate cedar (chemical then prescribed burn)	21.60	0	9.30	6
Light mesquite (chemical then prescribed burn)	8.10	0	9.30	6
Light cedar (chemical then prescribed burn)	10.80	0	9.30	6

[1] Costs at intervals shown in column to the right (e.g.; heavy mesquite $9.30 per acre every 7 years).

Source: Bach, Joel P. and J. Richard Connor, "Economic Analysis of Brush Control Practices for Increased Water Yield: The North Concho River Example," Proceedings, Water for Texas Conference, Austin, Texas, December 1998.

Table 4.4-72.
Present Worth and Uniform Annual Costs for
30-Year Brush Control Projects under Varying Brush Conditions

Brush Condition	Present Worth Per Acre (Second Quarter 2002 Costs)	Uniform Annual Cost (per acre)[1]
Heavy mesquite	$78.61	$5.27
Heavy cedar	$84.88	$5.68
Moderate mesquite	$25.49	$1.71
Moderate cedar	$30.89	$2.07
Light mesquite	$17.39	$1.17
Light cedar	$20.08	$1.35

[1] Amortized over 30 years at 6 percent interest.

The following assumptions have been made to simplify the estimation of brush control cost in the Llano Estacado Region:

1. According to the NRCS, about 50 percent of the rangeland in the region has moderate to heavy brush.
2. The two most abundant species are mesquite and shinnery oak.

[56] Ibid.

3. Based upon the conditions stated in No. 1 and 2 above, an estimated unit cost for brush control would be an average of the values in Table 4.4-72 for heavy mesquite and moderate mesquite. These unit values (per acre) would be $52.05 (rounded to $52) and $3.48 (rounded to $3.50) respectively, for present worth and annual cost.
4. All other brush listed in Table 4.4-72 would be assumed to require a cost comparable to light cedar, or $20.08 and $1.35, respectively for present worth and annual cost.
5. Brush control would only be applied to mesquite and shinnery oak in counties of the region having a combined total of 50,000 or more acres of these two species (Table 4.4-67). The reason for setting this acreage condition for the present cost estimation effort is that in counties having fewer than 50,000 acres of these brush species, the brush infested acreages are likely to be too widely dispersed to allow efficient brush control operations. However, this condition is not intended to be a limitation to a brush control effort by anyone who desires to conduct brush control projects.
6. Brush control would or could be applied to only 50 percent of the mesquite and shinnery oak acres of each county that meets the conditions specified in number 5 above. This condition is intended to give adequate latitude for selection of only the most appropriate acreages to which to apply brush control methods from both the wildlife habitat standpoints, and the water producing potentials.

Of the 21 counties of the Llano Estacado Region, 13 counties meet the condition of having 50,000 or more acres of mesquite and shinnery oak combined (Table 4.4-73). The counties located in the southwest corner of the region, and east, below the caprock, have the highest acreages of mesquite and shinnery oak and would be the places to apply brush control practices to increase water supplies for those parts of the region. The existing Alan Henry Reservoir and the proposed Post Reservoir are located in Garza County, which has over 185,000 acres of mesquite and shinnery oak. If brush control works to increase water supplies from reservoirs, then brush control projects on the watersheds of these two reservoirs could result in increased firm yields of both projects and contribute to the region’s water supply.

Based upon the assumptions and costs listed above, the capital outlay to implement brush control upon 50 percent of the mesquite and shinnery oak infested acres in counties having 50,000 acres of these two species of brush is estimated at $40.78 million, with an annual cost of $2.74 million (Table 4.4-73). For example, if brush control on the Alan Henry Reservoir contributing watershed at an annual cost of $323,750 were to increase the yield of the reservoir by 10 percent, or 2,250 acft/yr, the cost per acft of raw water yield at the reservoir would be $144, or $0.44 per 1,000 gallons.

Table 4.4-73.
Estimated Cost of Brush Control
Llano Estacado Region

County	Mesquite (acres)	Shinnery Oak (acres)	Mesquite plus Shinnery Oak (acres)	Estimated Brush Control (acres)[1]	Initial Brush Control Capital Cost (dollars)[2]	Annual Brush Control Cost (dollars)[3]
Bailey	42,000	52,000	94,000	47,000	2,444,000	164,500
Briscoe	64,000		64,000	32,000	1,664,000	112,000
Castro						
Crosby	65,000	20,000	85,000	42,500	2,210,000	148,750
Cochran	46,000	129,000	175,000	87,500	4,550,000	306,250
Dawson	58,000	5,500	63,500	31,750	1,651000	111,125
Deaf Smith	37,000		37,000			
Dickens	238,000	55,000	293,000	146,500	7,618,000	512,750
Floyd	35,000		35,000			
Gaines	40,000	85,000	125,000	62,500	3,250,000	218,750
Garza	150,000	35,000	185,000	92,500	4,810,000	323,750
Hale	200		200			
Hockley	45,000	5,000	50,000	25,000	1,300,000	87,500
Lamb						
Lubbock	7,500		7,500			
Lynn	58,000	1,700	59,700	29,500	1,534,000	103,250
Motley	230,000	25,000	255,000	127,500	6,630,000	446,250
Parmer						
Swisher	3,500		3,500			
Terry	30,000	20,000	50,000	25,000	1,300,000	87,500
Yoakum	20,000	50,000	70,000	35,000	1,820,000	122,500
Totals	1,169,000	487,000	1,656,000	784,250	40,781,000	2,744,875

[1] Estimated at 50 percent of total mesquite and shinnery oak acres.
[2] Calculated at $52 per acre.
[3] Calculated at $3.50 per acre.

4.4.4.2.7 Implementation Issues

Several implementation issues pertain to this potential water supply option. *In situ* brush control studies are only available for catchment-level examples comprising an area 1,000 acres or less. A large-scale brush control program would require the cooperation of many landowners having different interests in their property. In a specific target watershed, there may be property owners who are not dependent on grazing income and therefore have limited interest in brush control. To ensure cooperation of ranch owners, additional incentives or other considerations may be required which could alter the cost estimates for brush control. Another issue is that most of the assumptions and results presented above are based on computer modeling rather than *in situ* examples that have the benefit of several years of performance to demonstrate results. It is recommended that results of current studies at specific sites be evaluated before public funds are invested in major projects in the LERWPA.

One critical implementation issue is how the increase in runoff and/or recharge resulting from brush control would be related to usable water supply. Key questions that need answers are:

- How are the increased runoff and/or recharge verified?
- How much of the increased runoff and/or recharge results in yields of affected aquifers? and
- How is the increased yield of the affected aquifers verified?

See Table 4.4-74 for evaluation of this water management strategy.

4.4.4.3 Desalt Brackish Groundwater

4.4.4.3.1 Description of Option

The purpose of this option is to present estimates of the costs of desalination of brackish groundwater, the potential source of which is the Santa Rosa Aquifer of the Dockum Formation. The Dockum Formation underlies the entire area of the Llano Estacado Region and crops out along the eastern edge of the caprock escarpment (Figure 4.4-13).[57] The primary water-bearing zone in the Dockum is commonly called the "Santa Rosa." The Santa Rosa section consists of up to 700 feet of sand and conglomerate interbedded with layers of silt and shale. Water is under artesian conditions. Recharge is from rainfall on the outcrop, with the long-term average being estimated at less than 50,000 acft/yr (Figure 4.4-13).

[57] Bureau of Economic Geology, The University of Texas at Austin, 1967.

Table 4.4-74.
Evaluations of Brush Control to Enhance Water Supply Yield

Impact Category	Comment(s)
a. Quantity, reliability, and cost of treated water	• Indeterminate to low reliable quantity • Low cost
b. Environmental factors	• Brush control techniques may adversely affect existing wildlife populations, however, for Llano Estacado region, programs would be designed to enhance wildlife habitat • Chemical brush control methods may result in residual chemicals in aquifers and streams
c. State water resources	• No apparent negative impacts on other water resources • Potential benefit to Ogallala Aquifer water resources due to increased water for recharge and increased water for direct use, which would reduce need to withdraw water from aquifer
d. Threats to agriculture and natural resources in region	• Potential threats to habitat due to removal of brush, unless carefully designed to enhance wildlife habitat
e. Recreational	• Potentials to enhance hunting and other outdoor activities
f. Comparison and consistency equities	• Cost model for brush control is based on values reported in the literature; values appear to be comparable to those of other options • No estimate made for cost of water supply yield because data not adequate to estimate yields
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Improvement over current conditions
j. Effect on navigation	• None

Data currently available indicate that the quality of water in the Santa Rosa in the majority of the planning region is unsuitable for most uses without treatment, with the exception of parts of Deaf Smith, Swisher, Briscoe, Floyd, Crosby, Garza, Motley, and Dickens Counties, where the quality of water obtained from the Santa Rosa is adequate for some uses. Concentrations of TDS of this water range from less than 1,000 mg/L in the outcrop and downdip portion, to over 20,000 mg/L in the deeper parts of the formation near the center of the

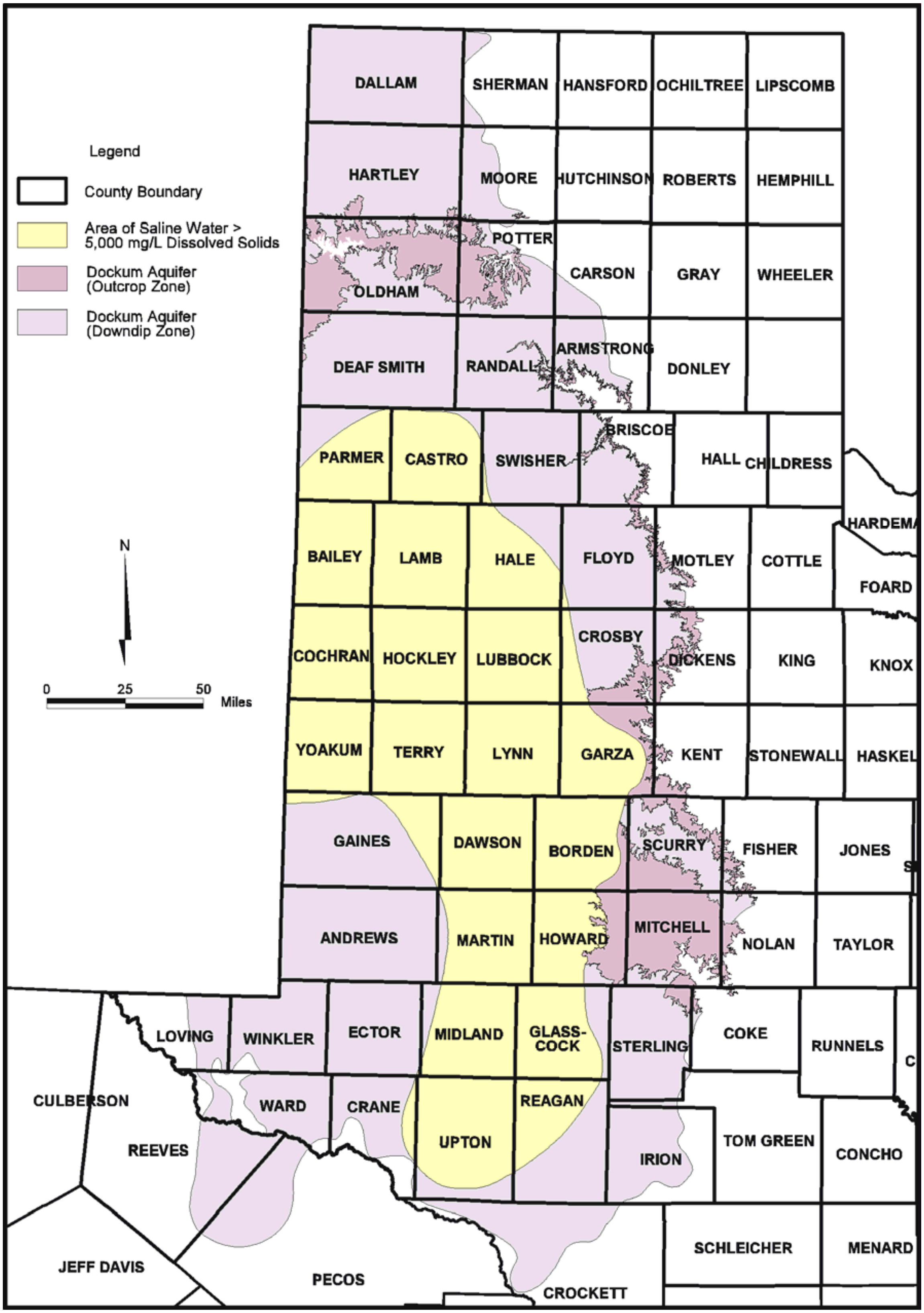

Figure 4.4-13. Santa Rosa Formation of the Dockum Aquifer

planning region (Figure 4.4-13). High sodium levels pose a salinity hazard for irrigation. Mixing Santa Rosa and Ogallala water reduces the salinity concentrations and is being done by some irrigators. Several municipalities are using water from the Santa Rosa, even though the water contains chlorides, sulfate, and dissolved solids that are near or in excess of safe drinking water standards.

In a part of the planning region where oil has been discovered, water from the Santa Rosa is being used for water flooding to recover oil. However, water from the Santa Rosa must be treated to make it compatible for use in water flooding, since the minerals of the Santa Rosa water are reported to cause flocculation to occur when injected into oil bearing formations that have water of a different mineral content.

4.4.4.3.2 General Desalination Background

The commercially available processes that are currently used to desalt seawater and brackish groundwater to produce potable water are:

- Distillation (thermal) Processes; and
- Membrane (non-thermal) Processes.

Each of these processes is described below.

Distillation (Thermal) Processes: Distillation processes produce purified water by vaporizing a portion of the saline feedstock to form steam. Since the salts dissolved in the feedstock are nonvolatile, they remain unvaporized and the steam formed is captured as a pure condensate. Distillation processes are normally very energy-intensive, quite expensive, and are generally used for large-scale desalination of seawater. Heat is usually supplied by steam produced by boilers or from a turbine power cycle used for electric power generation. Distillation plants are commonly dual-purpose facilities that produce purified water and electricity.

In general, for a specific plant capacity the equipment in distillation plants tends to be much larger than membrane desalination equipment. However, distillation plants do not have the stringent feedwater quality requirements of membrane plants. Due to the relatively high temperatures required to evaporate water, distillation plants have high energy requirements, making energy a large factor in the cost of water.

The three main distillation processes in use today are Multistage Flash Evaporation (MSF), Multiple Effect Distillation (MED), and Vapor Compression (VC). All three of these processes utilize an evaporator vessel that vaporizes and condenses the feedstock. The three processes differ in the design of the heat exchangers in the vessels and in the method of heat introduction into the process. Since seawater is not available in the Llano Estacado Region, distillation does not seem appropriate and will not be considered here. However, there are membrane desalination operations in Texas, from which information relevant to the Llano Estacado Region can be obtained. The following discussion and analyses present this information.

Membrane (Non-thermal) Processes: The two types of membrane processes use either pressure, as in reverse osmosis, or electrical charge, as in electrodialysis reversal, to reduce the mineral content of water. Both processes use semi-permeable membranes that allow selected ions to pass through while other ions are blocked. Electrodialysis reversal (EDR) uses direct electrical current applied across a vessel to attract the dissolved salt ions to their opposite electrical charges. EDR can desalt brackish water with TDS up to several thousand mg/L.

Reverse Osmosis (RO) utilizes a semi-permeable membrane that limits the passage of salts from the saltwater side to the freshwater side of the membrane. Electric motor driven pumps or steam turbines (in dual-purpose installations) provide the 800- to 1,200-psi pressure to overcome the osmotic pressure and drive the freshwater through the membrane, leaving a waste stream of brine/concentrate. The basic components of an RO plant include pre-treatment, high-pressure pumps, membrane assemblies, and post-treatment. Pre-treatment is essential because feedwater must pass through very narrow membrane passages during the process and suspended materials, biological growth, and some minerals can foul the membrane. As a result, virtually all suspended solids must be removed and the feedwater must be pre-treated so precipitation of minerals or growth of microorganisms does not occur on the membranes. Various levels of filtration and the addition of various chemical additives and inhibitors normally accomplish this. Post-treatment of product water is usually required prior to distribution to reduce its corrosivity and to improve its aesthetic qualities. Specific treatment is dependent on product water composition.

Depending upon TDS levels of the feedwater, a “single-pass/stage” RO plant can produce water with a TDS of 300 to 500 mg/L, most of which is sodium and chloride. The product water will be corrosive, but this may be acceptable if a source of blending water is available. If not, and if post-treatment is required, the various post-treatment additives may cause the product water to exceed the desired TDS levels. In such cases, or when better water quality is desired, a "two-pass/stage" RO system is used to produce water typically in the 200 mg/L TDS range. In a two-pass RO system, the product water from the first RO pass/stage is further desalted in a second RO pass/stage, and the water from the second pass is blended with water from the first pass.

Recovery rates up to 45 percent are common for a two-pass/stage RO facility. RO plants, which comprise about 31 percent of the world's desalting capacity, range from a few gallons per day (gpd) to 15 million gallons per day (MGD). The largest RO seawater plant in the United States is the 6.7-MGD plant in Santa Barbara, California. The largest RO plant in operation in Texas is a groundwater desalt plant at Kenedy with a capacity of 2.86 MGD (Table 4.4-75). The current domestic and worldwide trend seems to be for the adoption of RO when a single purpose seawater desalting plant is to be constructed. RO membranes have been improved significantly over the past two decades (i.e., the membranes have been improved with respect to efficiency, longer life, and lower prices).

Table 4.4-75.
Municipal Use Desalt Plants in Texas
(>25,000 gpd and as of December 1998)

Location	Source	Total Capacity (MGD)	Desalt Capacity (MGD)	Membrane Type[1]
Bayside, City of	Groundwater	0.15	0.15	RO
Dell City, City of	Groundwater	0.11	0.11	EDR
Ft. Stockton, City of	Groundwater	6.5	3	RO
Granbury, City of	Lake Water	0.35	0.35	EDR
Haciendas del Norte (El Paso)	Groundwater	0.133	0.133	RO
Homestead MUD (El Paso)	Groundwater	0.1	0.1	RO
Kenedy, City of	Groundwater	2.86	0.72	RO
Lake Granbury	Lake Water	3.5	3.5	EDR
Robinson, City of	River	2	2	RO
Seadrift, City of	Groundwater	0.24	0.17	RO
Sherman, City of	Lake Water	6.0	6.0	EDR
Sportsman's Paradise	Lake Water	0.1	0.1	RO
Texas Resort Co.	Lake Water	0.144	0.144	EDR

[1] RO = Reverse Osmosis EDR = Electrodialysis Reversal

Example of Relevant Existing Desalt Projects: In 1996, Seadrift, Texas (population 1,890) was dependent upon the Gulf Coast Aquifer for its water supply. Total dissolved solids and chlorides had reached unacceptable levels of 1,592 mg/L and 844 mg/L, respectively. These values exceeded the primary drinking water standard for TDS (1,000 mg/L) and the secondary drinking water standard for chlorides (300 mg/L). Since the community was not located near an adequate quantity of freshwater or a wholesaler of drinking water, the decision was made to install RO to treat this slightly brackish groundwater. The city installed pressure filters, two RO units, antiscalent chemical feed equipment, and a chlorinator. The capital cost for the system was $1.2 million ($1.39 million in Second Quarter 2002 prices) and the annual O&M cost is $56,000 ($64,848 in Second Quarter 2002 prices), resulting in a total debt service plus O&M cost of about $0.88 ($1.02 in Second Quarter 2002 prices) per 1,000 gallons treated by RO. The capital cost included the cost of facilities in addition to the RO units and their appurtenant equipment. Product water from the RO units is blended with groundwater to meet an acceptable quality level. About 60 percent of the total is from the desalt units.

4.4.4.3.3 Quantity of Supply Available

One way to evaluate the Santa Rosa is to compare it with the Ogallala. The first consideration is the physical location of the respective aquifers. The Ogallala lies near the land surface; the Santa Rosa lies below the Ogallala and is several hundred feet below land surface in most of the planning area. The greater the depth of the formation, the greater the cost to drill, complete, equip, and operate wells to obtain water. A well completed in the Santa Rosa in Deaf Smith County cost approximately $108,000 in 2002, while wells drilled and completed in the Ogallala in the same area, producing comparable yields, cost between $21,600 and $32,400.

The coefficient of storage in the Ogallala is about 0.15, or about 15 percent. The coefficient of storage of the Santa Rosa is about 0.0001. This indicates that at least 100 times more water can be recovered from 100 feet of saturated Ogallala material than could be recovered from 100 feet of decline in the artesian head (water level) of the Santa Rosa. The permeability of the Ogallala is about 400 gallons per day per square foot (gpd/sf), as compared to the 250 gpd/sf for the Santa Rosa.

The decline in feet from the static water level when a well located in the center of a grid of nine wells evenly spaced 440 yards apart, is pumped at a rate of 600 gpm from the Ogallala Aquifer, with a permeability of 400 gpd/sf, a coefficient of storage of 0.15 percent, and a saturated thickness of 100 feet, would be about 31 feet after 15 days of continuous pumping, 41 feet after 30 days of continuous pumping, 58 feet after 60 days of continuous pumping, and 73 feet after 90 days of continuous pumping. This example assumes that all nine wells are being pumped for the time periods stated. An example is given below of the results of comparable pumping for the Santa Rosa Formation. The decline in feet from the static water level when a well is pumped that is located in the center of a grid of nine wells evenly spaced 440 yards apart, pumping 600 gpm from the Santa Rosa Aquifer, with a transmissibility of 22,000 gpd/f, and a coefficient of storage of 0.0001, would be about 215 feet after 15 days of continuous pumping, 234 feet after 30 days of continuous pumping, 254 feet after 60 days of continuous pumping, and 265 feet after 90 days of continuous pumping. This example assumes that all nine wells are being pumped for the time periods stated. Recommended spacing for Santa Rosa wells is one mile.

In summary, the quantity of useable quality water (less than 5,000 mg/L of TDS) in storage in the Santa Rosa Aquifer in the planning region in 2000 is estimated to be about 3.2 million acft. Due to the poor quality of water in the Santa Rosa Aquifer in a large part of the Llano Estacado Planning Region, demineralization would be necessary for municipal and industrial uses. Therefore, estimates of costs of desalination are presented, since such estimates may be useful to local communities that need additional municipal water supply (e.g., may need supply that can be blended with existing sources or supply that can be used directly).

4.4.4.3.4 Environmental Issues

As freshwater is extracted from brackish water, a more concentrated brackish water is produced as a waste product. Concentrated brackish water created from the desalination process is about triple the level of TDS of the brackish aquifer water and must be disposed of properly. For this option, it has been assumed that the brine concentrate will be discharged into the city(s)'s wastewater collection and treatment system.

4.4.4.3.5 Cost Estimates

The cost of desalting brackish groundwater depends upon the concentration levels of minerals in the feedwater to be treated (Table 4.4-76). For purposes of this analysis, cost estimates are presented for two levels of feedwater salinity—3,000 mg/L and 10,000 mg/L, and four water treatment plant sizes—0.1 MGD, 0.5 MGD, 1.0 MGD, and 3.0 MGD (Tables 4.4-77 and 4.4-78).

Table 4.4-76.
Engineering Assumptions for Brackish Groundwater Desalination

Parameter	*Assumption*	*Description*
Raw water salinity	3,000 mg/L & 10,000 mg/L	Range from 1,200 to 1,500 mg/L
Finished water chlorides	Less than 500 mg/L	
RO Feedwater Pressure	300 psi & 400 psi	300 psi for 3,000 mg/L and 400 psi for 10,000 mg/L
Treatment capacity	Varies	
WTP storage	0	Use existing tanks
Booster pumps	0	Use existing tanks
Land for plant	0	Use existing city property
Pipeline friction factor	C = 140	C-900 PVC pipe

The cost per acft for a 0.1 MGD plant to desalt 3,000 mg/L water is estimated at $1,175/acft, or $3.60 per 1,000 gallons. The cost for the same size plant to desalt 10,000 mg/L water is estimated at $1,286/acft, or $3.95 per 1,000 gallons (Tables 4.4-59 and 4.4-60).

At larger sized water treatment plants, the costs are lower. For example, for a 0.5 MGD plant the cost to desalt 3,000 mg/L water is estimated at $503/acft, or $1.54 per 1,000 gallons; the cost to desalt 10,000 mg/L water is estimated at $584/acft, or $1.79 per 1,000 gallons (Tables 4.4-77 and 4.4-78). A 3.0 MGD size plant is estimated to have a desalt cost of $337/acft, or $1.03 per 1,000 gallons for water with 3,000 mg/L of salts, and for water with 10,000 mg/L of salts, the cost is $402/acft, or $1.23 per 1,000 gallons (Tables 4.4-77 and 4.4-78).

4.4.4.3.6 Implementation Issues

Implementation of small community water supply from brackish groundwater sources includes financial and technological issues. For a municipal water demand of about 500,000 gpd, desalination could improve the quality of a backup supply or could perhaps replace a more vulnerable freshwater supply as the primary source. However, the estimated cost, while comparable to conventional treatment, is much higher than communities experience when they do not have to treat their groundwater, except to disinfect. Therefore, the best applications may be for small, remotely located systems where freshwater supplies are readily available nearby. Then desalination may compete economically with projects transporting fresh raw water or treated water over a distance of several miles.

Table 4.4-77.
Cost Estimate Summary for
Brackish Groundwater Desalt (3,000 mg/L TDS)
Second Quarter 2002 Prices

Item	***Estimated Costs (0.1 MGD)***	***Estimated Costs (0.5 MGD)***	***Estimated Costs (1 MGD)***	***Estimated Costs (3 MGD)***
Capital Costs				
Water Treatment Plant	$516,240	$1,163,160	$1,968,840	$4,261,680
Concentrate Disposal	350,000	350,000	350,000	350,000
Total Capital Cost	**$866,240**	**$1,513,160**	**$2,318,840**	**$4,961,680**
Engineering, Legal Costs and Contingencies (35%)	$303,184	$529,606	$811,594	$1,736,588
Interest During Construction (1 year)	51,974	90,790	139,130	297,701
Total Project Cost	**$1,221,398**	**$2,133,556**	**$3,269,600**	**$6,995,969**
Annual Costs				
Debt Service (6 percent for 30 years)	$88,674	$154,896	$237,370	$507,907
Operation and Maintenance:				
Water Treatment Plant	40,548	121,071	226,284	585,187
Concentrate Disposal	2,340	5,850	11,700	39,000
Total Annual Cost	**$131,562**	**$281,817**	**$475,354**	**$1,132,094**
Available Project Yield (acft/yr)	**112**	**560**	**1,120**	**3,360**
Annual Cost of Water ($ per acft)	**$1,175**	**$503**	**$424**	**$337**
Annual Cost of Water ($ per 1,000 gallons)	**$3.60**	**$1.54**	**$1.30**	**$1.03**

Table 4.4-78.
Cost Estimate Summary for
Brackish Groundwater (10,000 mg/L TDS)
Second Quarter 2002 Prices

Item	*Estimated Costs (0.1 MGD)*	*Estimated Costs (0.5 MGD)*	*Estimated Costs (1 MGD)*	*Estimated Costs (3 MGD)*
Capital Costs				
Water Treatment Plant	$576,720	$1,313,280	$2,193,480	$4,761,720
Concentrate Disposal	350,000	350,000	350,000	350,000
Total Capital Cost	**$926,720**	**$1,663,280**	**$2,543,480**	**$5,461,720**
Engineering, Legal Costs and Contingencies (35%)	$324,352	$582,148	$890,218	$1,911,602
Interest During Construction (1 year)	55,603	99,797	152,609	327,703
Total Project Cost	**$1,306,675**	**$2,345,225**	**$3,586,307**	**$7,701,025**
Annual Costs				
Debt Service (6 percent for 30 years)	$94,865	$170,263	$260,366	$559,094
Operation and Maintenance:				
Water Treatment Plant	46,784	150,759	283,101	751,285
Concentrate Disposal	2,340	5,850	11,700	39,000
Total Annual Cost	**$143,989**	**$326,872**	**$555,167**	**$1,349,379**
Available Project Yield (acft/yr)	**112**	**560**	**1,120**	**3,360**
Annual Cost of Water ($ per acft)	**$1,286**	**$584**	**$496**	**$402**
Annual Cost of Water ($ per 1,000 gallons)	**$3.95**	**$1.79**	**$1.52**	**$1.23**

There are two technological issues confronting a small utility that might consider desalination. The first is how to make the more centralized desalt plant compatible with a distribution system that is likely constructed to be compatible with two or more wells. Normally, this would be resolved in the design engineering process.

The second technological issue is the relative complexity of desalination compared to the relative simplicity of a fresh groundwater supply, requiring only extraction from the ground, storage, disinfection and distribution. Desalt plants encounter scaling, corrosion, and chemical challenges that require relatively highly trained and experienced treatment staff. Therefore, the smaller communities might consider contract operations rather than developing in-house expertise to operate desalt plants.

This water supply option has been compared to the plan development criteria, as shown in Table 4.4-79.

Table 4.4-79.
Evaluation of Brackish Groundwater Desalination

Impact Category	*Comment(s)*
a. Quantity, reliability, and cost of treated water	• Unknowns regarding extent and yields of brackish aquifer • Moderately high treatment cost
b. Environmental factors	• Disposal of concentrated brine created from process • Typically in low recharge rate aquifers or confined aquifers; use could lead to the depletion of aquifers • Extracted brackish water possibly replaced by freshwater from a higher strata aquifer, thereby removing and contaminating accessible freshwater
c. State water resources	• In case of brackish aquifer, improves state water resources • For freshwater aquifer having brackish lower zone, potentially contaminates fresh groundwater
d. Threats to agriculture and natural resources in region	• None
e. Recreational	• None
f. Comparison and consistency equities	• Same cost model used to estimate total costs
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Increases
j. Effect on navigation	• Not applicable

4.4.4.4 Post Reservoir—Raw Water at the Reservoir

4.4.4.4.1 Description of Option

The White River Municipal Water District holds TCEQ Certificate of Adjudication Number C3711 for Post Dam and Reservoir, which provides for Authorized Impoundment of 57,420 acre-feet; Authorized Diversion of 5,600 acft/yr for municipal purposes; 1,000 acft/yr for industrial purposes; and 4,000 acft/yr for mining purposes, with the Priority Date of January 20, 1970. The proposed Post Reservoir Project is located on the North Fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas in Garza County (Figure 4.4-14). Preliminary data pertinent to the project were obtained from the September 1968 report entitled “Feasibility Report on Post Reservoir Site.”[58] The proposed project includes a 5,800-ft rolled embankment dam with a 2,000-ft emergency spillway for passing the probable maximum flood (PMF). The project also includes a morning glory type service spillway to pass storm flows up to the 100-year return period.

4.4.4.4.2 Available Supply of Water

The conservation pool would provide approximately 56,000 acft of storage (neglecting sedimentation) and 37,000 acft (including sedimentation) with a surface area of 2,280 acres. The 1968 reservoir analysis indicates that the proposed reservoir will have a firm yield of approximately 9,500 acft/yr in the year 2020 considering runoff, depletion, and sedimentation.

4.4.4.4.3 Environmental Issues

The construction of Post Reservoir would result in the change of an estimated 3,320 acres of land from ranching to that of a reservoir site, inundating about 2,280 acres. It is estimated that the entire 3,320 acres would require wildlife habitat mitigation for which costs have been included in Section 4.4.4.4.4.

4.4.4.4.4 Costing

The following assumptions and conditions were applied in the updating of the costs of this water management strategy:

- Capital costs were updated from 1968 to the Second Quarter of 2002 using the Engineering News Record Construction Cost Index (CCI). The CCI ratio was increased by an additional 15 percent to account for more stringent requirements related to construction activities.
- Engineering, legal costs, and contingencies are calculated as 35 percent of the total capital costs associated with construction of the dam. Environmental studies, mitigation and permitting costs are calculated as 100 percent of the land acquisition cost.
- Land acquisition and survey costs were based on the inundated area during PMF. Land cost was assumed as $1,620/acre for the site.

[58] Freese, Nichols and Endress, 1968, “Feasibility Report on Post Reservoir Site,” prepared for White River Municipal Water District, September. The 1968 cost estimate was $2.2 million.

- Interest during construction is calculated considering a 6 percent interest rate, with a 4 percent return on investments over a 4-year construction period.
- The annual cost for debt service is based on a 6 percent interest rate over a 40-year period.
- O&M costs are calculated as 1.5 percent of the estimated construction costs for the dam and reservoir.

Costs for this option include construction costs and other project costs, which include engineering costs, land acquisition for the reservoir and dam site, and interest during construction. The total project cost for this option was estimated to be $30,456,000 (Table 4.4-80). Financing the project for 40 years at 6 percent annual interest results in an annual expense of $2,023,000 for debt service (Table 4.4-80). Annual operating and maintenance costs total $170,640 (Table 4.4-80). The total annual cost, including debt service and O&M cost, totals $2,194,560 (Table 4.4-80). With an annual firm yield of 9,500 acft/yr, the resulting cost of raw water at the reservoir is $231 per acft, or $0.71 per 1,000 gallons, which dose not include transmission pipeline, water treatment, or distribution system costs.(Table 4.4-80).

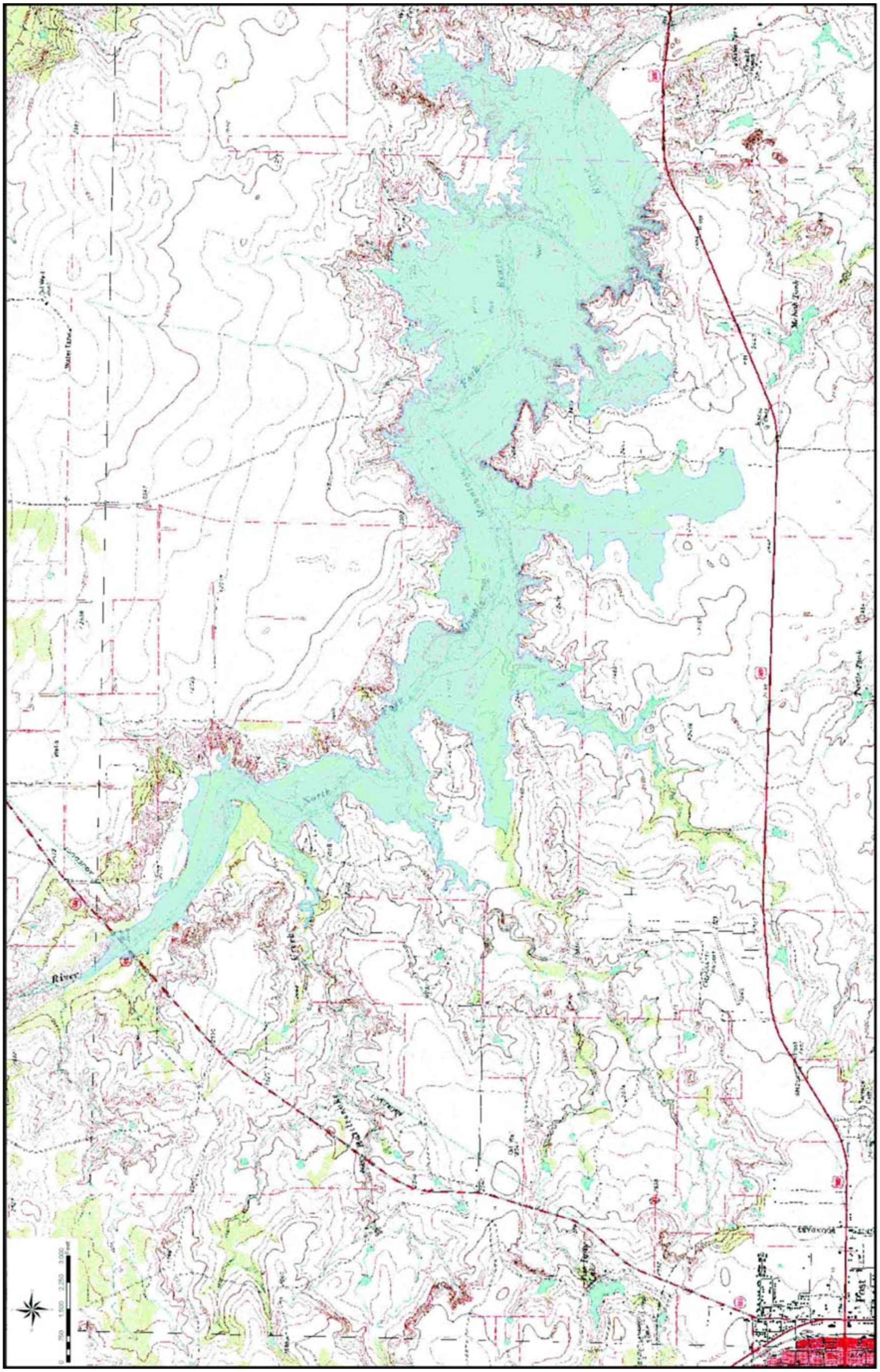

Figure 4.4-14. Post Reservoir

4.4.4.4.5 Implementation Issues

The development of the Post Reservoir will require that the local sponsor, the White River Municipal Water Authority, either proceed with development or make arrangements for another entity to proceed, and customers willing to purchase water at prices adequate to retire the debt and pay operating costs, including water treatment and conveyance to locations of use. Implementation will require the following permits and studies.

1. Permits
   a. USCOE Sections 10 and 404 dredge and fill permits for reservoirs and pipelines impacting wetlands or navigable waters of the U. S.
   b. TPWD Sand, Gravel, and Marl permit for construction in state owned streambeds.
   c. NPDES Storm Water Pollution Prevention Plan.
   d. GLO easement for use of the state-owned streambed; and
   e. Section 404 certification from the TCEQ required by the clean water act.
2. Studies to Support Permit Applications for permits 1.b through 1.f above:
   a. Assessment of changes in stream flows.
   b. Habitat mitigation plan.
   c. Environmental surveys.
   d. Cultural resources surveys, studies, and mitigation.
3. Land will have to be acquired either by negotiation or condemnation.

Table 4.4-80.
Cost Estimate Summary for Post Reservoir
Llano Estacado Region
Second Quarter 2002 Prices

Item	*Estimated Cost for Facilities*
Capital Costs	
Dam and Reservoir (Conservation Pool of 56,000 acft, 2,280 acres, 2,430 ft msl)	
Preparation of Site	$194,400
Core Trench Excavation (74,300 cubic yards)	168,480
Wetted and Rolled Embankment (2,317,400 cubic yards)	5,396,760
Riprap (62,400 cubic yards)	2,422,440
Blanket (25,900 cubic yards)	1,005,480
Service Spillway and Outlet	1,617,840
Mulching (22 acres)	99,360
Irrigation for Downstream Slope	97,200
Relocation[1]	345,600
Total Capital Cost	**$11,347,560**
Engineering, Legal Costs and Contingencies (35% of Total Capital Cost)	$3,971,160
Environmental & Archaeology Studies, Mitigation, and Permitting	5,378,400
Land Acquisition and Surveying (3,320 acres)	5,557,680
Interest During Construction (4 years)	4,201,200
Total Project Cost	**$30,456,000**
Annual Costs	
Debt Service (6 percent for 40 years)	$2,023,920
Operation and Maintenance	170,640
Total Annual Cost	**$ 2,194,560**
Available Project Firm Yield (acft/yr)	**9,500**
Annual Cost of Raw Water at the Reservoir ($ per acft)	**$231**
Annual Cost of Raw Water at the Reservoir ($ per 1,000 gallons)	**$0.71**
[1] The bridge at FM 651 may need to be raised, widened, or relocated.	

4.4.4.5 Research and Development of Drought Tolerant Crops and New Technology

This is a region-wide or regional water management strategy, since it is applicable to individual irrigation and dryland farmers and ranchers. The strategy is described but cannot be evaluated according to TWDB Rules, Section 357.7, because of lack of data.

4.4.4.5.1 Description of Option

Both public and private agricultural research organizations are presently engaged in plant crop breeding, plant nutrition, and cultural practices to improve the productivity, quality, and other characteristics of crops that can be produced in the Llano Estacado and other regions of Texas, the United States, and other countries of the world. In addition, in the Llano Estacado Region, the TWDB has funded a demonstration initiative whose purposes are "… to expedite transfer of available technology to the farms and to develop comprehensive data, utilizing large scale demonstration sites, to assess the cost effectiveness of selected technologies, evaluate and determine the impact of implementation on crop productivity, impacts on reductions of irrigation water use, and impacts on available water supplies."

The LERWPG recommends that funding be continued in adequate levels for research and development of new and improved technology in the fields of drought tolerant strains of crops, new or alternative crops for arid and semiarid regions, plant nutrition, irrigation application methods, brush control, weather modification, aquifer recharge, and development of better information about the aquifers and other water resources of the region.

4.4.4.5.2 Quantity of Water

Not possible to make evaluation.

4.4.4.5.3 Environmental Issues

Not possible to make evaluation.

4.4.4.5.4 Costing

Not possible to make evaluation.

4.4.4.5.5 Implementation

Not possible to make evaluation.

4.4.4.6 Reuse of Municipal Effluent

This is a water management strategy which may have potentials for the industrial, municipal, steam-electric power generation, and irrigation water user groups. The strategy is described, but cannot be evaluated according to TWDB Rules, Section 357.7, because of lack of data.

4.4.4.6.1 Description of Option

Of the total quantities of water used for municipal purposes, approximately 45 percent to 65 percent are returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Water Planning Region, a large percentage of this treated effluent, or reclaimed water, is used for irrigation of open spaces, golf courses, and neighboring farmland. However, the quantity is between 45 and 65 percent of the quantity of municipal use and could perhaps be a significant source of supply for some water users, including perhaps municipal supply in the future if treatment levels can be increased to the extent that the use of such water does not pose a health risk. For example, this water is already at or very near the point of potential municipal use and would not have to be transported to the city, as other sources would have to be. In addition, this water exists, whereas equivalent quantities may not be readily available, if available at all.

4.4.4.6.2 Quantity of Water

Not possible to make evaluation.

4.4.4.6.3 Environmental Issues

Must be studied and treatment technology improved enough to be acceptable by the public and regulatory agencies.

4.4.4.6.4 Costing

Not possible to make evaluation.

4.4.4.6.5 Implementation

Requires further research.

4.4.4.7 Stormwater Capture and Use

This is a water management strategy which may have potentials for the industrial, municipal, steam-electric power generation, and irrigation water user groups. The strategy is described, but cannot be evaluated according to TWDB Rules, Section 357.7, because of lack of data.

4.4.4.7.1 Description of Option

In some cities of the Llano Estacado Region disposal of stormwater has become a serious problem. Lubbock is one of the cities having this problem. Therefore, in this water-short region, it has become desirable to evaluate the possibility to capture, treat, as appropriate and needed, and use this water as a source of supply for non-potable as well as perhaps potable uses. Although it is expected that water treatment technology, such as membranes, can handle the treatment requirements, evaluations are needed of ways to successfully integrate flood protection, storage of this stormwater, and treatment of this water for useful purposes.

4.4.4.7.2 Quantity of Water

Not possible to make evaluation.

4.4.4.7.3 Environmental Issues

Must be studied and treatment technology demonstrated to be acceptable by the public and regulatory agencies.

4.4.4.7.4 Costing

Not possible to make evaluation.

4.4.4.7.5 Implementation

Requires further research.

4.5 Llano Estacado Regional Water Plan

In Section 1, the Llano Estacado Region was described. In Section 2 projections of population and water demand were presented. In Section 3, existing water supplies were tabulated. In Section 4, the projected water demands of Section 2 were compared with the existing water supplies of Section 3 and needs (shortages) for additional supplies were calculated. In Section 4.4, water management strategies were identified, described, and evaluated. The information from Sections 1, 2, 3, and 4 was used in the development of the following water plan for the region.

For purposes of developing the 2006 Llano Estacado Regional Water Plan, the LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs (shortages) and that had per capita water use in year 2000 that was greater than the Llano Estacado Region average per capita water use in 2000 of 172 gallons per person per day (gpcd). The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 Region average municipal water use of 172 gpcd.

Water management strategies included in the plan to meet the needs of specific water user groups include municipal water conservation and local groundwater development for municipalities, and irrigation BMPs and an irrigation water conservation water management strategy for irrigators, while strategies that are not specific to a particular water user group, but instead are region-wide strategies include weather modification and brush management. The plan does not propose any changes to existing water contracts or option agreements. Further, the plan was created in close cooperation with each Wholesale Water Provider in the region, and no strategy contained in the plan would adversely affect any existing water contracts, option agreements, or special water resources.

For each city with a projected need and a per capita water use of 172 gpcd or greater, municipal water conservation is included as a water management strategy until the goal of 172 gpcd is reached. Municipal water conservation beyond that which is estimated to be accomplished through low flow plumbing fixtures and the municipal water conservation strategy is not included, since municipal water conservation is estimated to cost more than the next available source of water; e.g. in the range of $483/acft to $530/acft compared to costs of local groundwater in the range of approximately $75/acft to approximately $29 /acft.

Additional water supply to meet needs above those that can potentially be met through municipal water conservation is the expansion or replacement of existing wells or well fields with new wells. If the new wells or well fields are located on private property, the city will need to purchase that property or purchase water rights.

The proposed plan encourages the continued and expanded use of irrigation BMPs and an irrigation water conservation strategy to meet as much as possible of the projected irrigation needs of the region. Individual irrigators who have not already adopted irrigation BMPs and installed available efficient irrigation application equipment, such as Low Energy Precision Application (LEPA), Low Pressure Sprinkler Systems (LESA), and subsurface or drip irrigation will need to do so as soon as possible to conserve their current water supplies.

Non-specific strategies would contribute to increasing the region's water supplies on a widespread scale for all water user groups, as opposed to being specifically applicable to an individual user group. These include weather modification and brush control. Both weather modification and brush control have been and should continue to be carried out by underground water conservation districts, soil and water conservation districts, and private groups, as desired and supported by the citizens of local areas affected. The local choice is particularly appropriate for precipitation enhancement and brush control strategies.

The water management strategies are intended to assist in meeting the water needs of the region during all types of weather, but are especially directed at meeting needs during drought. In addition, these strategies were selected to contribute to sustainability of present supplies of groundwater. The detailed plans for each of the 21 counties of the Llano Estacado Planning Region are presented in alphabetic order below. In each county plan, each water user group of the county is listed, and if the user group has a projected need (shortage) during the planning horizon, a water management strategy to meet the need is included, except in the case of irrigated agriculture, for which it has been determined that it is not economically feasible to meet all of the projected needs at this time. The strategies selected are those that are estimated to be the lowest cost by virtue of the fact that they are the strategies located nearest to the location of need.

Drought Management is not a recommended water management strategy to meet projected water needs in Region O, in part because it cannot be demonstrated to be an economically feasible strategy. The TWDB socioeconomic impact analysis of unmet water needs in Region O shows non-agricultural business impacts due to unmet water needs (shortages) of approximately $27,000 per acft/yr in 2010 decreasing to approximately $8,000 per acft/yr in 2060 (calculated from data in Table 4-24). Clearly, the cost for water to meet projected water needs is only a fraction of the business losses from not having the quantities of water needed. The Water Conservation water management strategies recommended in the 2006 Regional Water Plan, together with the other water management strategies appear to the LERWPG to be superior to the use of Drought Management strategies that are costly to the economy and the people of the region, and unpredictable as to time of occurrence and duration. The uncertainty and the cost associated therewith is not acceptable to the LERWPG, thus Drought Management is not included as a recommended water management strategy. **However, the LERWPG recognizes the individual cities "Demand Management and Drought Contingency Plans" that are on file with the TCEQ. The surface water supplies of this plan are included only at the firm yield quantities and the groundwater supplies are included at the quantities estimated to be available through existing facilities and aquifer capabilities. Therefore, the LERWPG depends upon water users to follow their respective drought management plans and to implement any additional water conservation needed during droughts that may affect existing and planned water management strategies.**

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4.5.1 Bailey County Water Supply Plan

Table 4.5-1 lists each water user group in Bailey County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-1.
Bailey County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Muleshoe	0	0	No projected surplus/shortage
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-92,835	-93,597	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-1, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.1.1 The City of Muleshoe

4.5.1.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

4.5.1.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Muleshoe.

- Municipal water conservation.

4.5.1.1.3 Costs

Costs of the recommended plan for the City of Muleshoe are:

a. Municipal water conservation:

- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-2 for a cost summary of this option.

Table 4.5-2.
Recommended Plan Costs by Decade for the City of Muleshoe

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	79	81	67	51	44	44
Annual Cost ($/yr)	$44,053	$42,868	$34,469	$25,293	$21,831	$21,430
Unit Cost ($/acft)	$561	$527	$517	$501	$492	$492

4.5.1.2 Irrigation

4.5.1.2.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 176,117 acft/yr in 2000 declining to 70,074 acft/yr in 2060.

4.5.1.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Bailey County has increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Bailey County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.1.2.3 Costs

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $14,850,000

- Annual Cost: $1,160,000; including debt service at 25 yrs useful life of systems (Table 4.5-3).

Table 4.5-3.
Recommended Plan Costs by Decade for Irrigation – Bailey County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	85,285	92,076	92,835	94,094	94,354	93,597
Irrigation Conservation Quantity (acft/yr)	23,295	20,965	18,869	16,982	15,284	13,755
Annual Cost (million dollars/ year)(Table 4.4-11)	1.16	1.16	1.16	1.16	1.16	1.16
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.2 Briscoe County Water Supply Plan

Table 4.5-4 lists each water user group in Briscoe County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-4.
Briscoe County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Silverton	-123	-108	Projected shortage – see plan below
County Other (Quitague)	-92	-86	Projected shortage – see plan below
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected demand
Irrigation	-12,136	-14,581	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-2, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.2.1 The City of Quitaque (Part of Briscoe County Other)

4.5.2.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2014, at which time additional supplies will be needed due to poor water quality

4.5.2.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Dimmitt through 2060.

- Local groundwater development beginning in 2010 needed to supply an additional 86 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala

Aquifer approximately 12 miles from the City of Quitaque into which the city could locate new municipal water supply wells.

4.5.2.1.3 Costs

Costs of the recommended plan for the City of Quitaque to meet projected shortages through 2060 are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-37
   - Date to be Implemented: 2010
   - Total Project Cost: $1,031,448
   - Annual Cost: See Table 4.5-5 for a cost summary of this option.

Table 4.5-5.
Recommended Plan Costs by Decade for the City of Quitaque (Part of Briscoe County Other)

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	107	94	92	93	89	86
Local Groundwater Development						
Quantity Available (acft/yr)	204	183	165	148	134	120
Annual Cost ($/yr)	$94,664	$94,664	$94,664	$19,730	$19,730	$19,730
Unit Cost ($/acft)	$464	$517	$574	$133	$147	$164

4.5.2.2 The City of Silverton

4.5.2.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2010, at which time additional supplies will be needed due to poor water quality

4.5.2.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Silverton through 2060.

- Local groundwater development beginning in 2010 needed to supply an additional 107 acft acft/yr in 2010 and an additional 108 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 12 miles from the City of Silverton into which the city could locate new municipal water supply wells.

4.5.2.2.3 Costs

Costs of the recommended plan for the City of Silverton to meet projected shortages from 2010 to 2060 are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-41
   - Date to be Implemented: 2010
   - Total Project Cost: $1,031,448
   - Annual Cost: See Table 4.5-6 for a cost summary of this option.

Table 4.5-6.
Recommended Plan Costs by Decade for the City of Silverton

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	128	126	123	115	111	108
Local Groundwater Development						
Quantity Available (acft/yr)	204	183	165	148	134	120
Annual Cost ($/yr)	$94,664	$94,664	$94,664	$19,730	$19,730	$19,730
Unit Cost ($/acft)	$464	$517	$574	$133	$147	$164

4.5.2.3 Irrigation

4.5.2.3.1 Description of Supply

- **Source:** Ogallala, Dockum, and Seymour Aquifers
- **Current Supply:** 30,746 acft/yr in 2000 declining to 6,510 acft/yr in 2060.

4.5.2.3.2 Water Supply Plan

The use of irrigation BMPs in the past in Briscoe County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Briscoe

County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.2.3.3 Costs

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $6,420,000
- Annual Cost: $500,000; including debt service at 25 yrs useful life of systems (Table 4.5-7).

Table 4.5-7.
Recommended Plan Costs by Decade for Irrigation – Briscoe County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	0	4,822	12,136	13,651	14,886	14,581
Irrigation Conservation Quantity (acft/yr)	10,070	9,063	8,157	7,341	6,607	5,947
Annual Cost (million dollars/yr) (Table 4.4-11)	6.42	6.42	6.42	6.42	6.42	6.42
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

4.5.3 Castro County Water Supply Plan

Table 4.5-8 lists each water user group in Castro County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-8.
Castro County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Dimmitt	-1,137	-1,130	Projected shortage – see plan below
City of Hart	0	-256	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected demand
Irrigation	-265,683	-351,768	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-3, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.3.1 The City of Dimmitt

4.5.3.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2024, at which time additional supplies will be needed

4.5.3.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Dimmitt through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2017 needed to supply an additional 1,250 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 11 miles from the City of Dimmitt into which the city could locate new municipal water supply wells.

4.5.3.1.3 Costs

Costs of the recommended plan for the City of Dimmitt to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-9 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-20
   - Date to be Implemented: 2017
   - Total Project Cost: $3,405,336
   - Annual Cost: See Table 4.5-9 for a cost summary of this option.

Table 4.5-9.
Recommended Plan Costs by Decade for the City of Dimmitt

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	1,137	1,159	1,150	1,130
Municipal Water Conservation						
Quantity Available (acft/yr)	75	110	97	81	75	74
Annual Cost ($/yr)	$41,337	$53,182	$45,521	$36,599	$33,021	$32,441
Unit Cost ($/acft)	$549	$485	$470	$450	$440	$440
Local Groundwater Development						
Quantity Available (acft/yr)	—	882	1,203	1,083	1,389	1,250
Annual Cost ($/yr)	—	$288,079	$327,317	$327,317	$164,987	$134,434
Unit Cost ($/acft)	—	$327	$272	$302	$119	$108

4.5.3.2 The City of Hart

4.5.3.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2045, at which time additional supplies will be needed

4.5.3.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Hart through 2060.

- Local groundwater development beginning in 2041 needed to supply an additional 352 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Hart into which the city could locate new municipal water supply wells.

4.5.3.2.3 Costs

Costs of the recommended plan for the City of Hart to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-25
   - Date to be Implemented: 2041
   - Total Project Cost: $509,256
   - Annual Cost: See Table 4.5-10 for a cost summary of this option.

Table 4.5-10.
Recommended Plan Costs by Decade for the City of Hart

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	260	256
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	—	—	391	352
Annual Cost ($/yr)	—	—	—	—	$62,333	$62,333
Unit Cost ($/acft)	—	—	—	—	$159	$177

4.5.3.3 Irrigation

4.5.3.3.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 508,153 acft/yr in 2000 declining to 46,905 acft/yr in 2060.

4.5.3.3.2 Water Supply Plan

The use of irrigation BMPs in the past in Castro County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Castro County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.3.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $36,500,000
   - Annual Cost: $2,850,000; including debt service at 25 yrs useful life of systems (Table 4.5-11).

Table 4.5-11.
Recommended Plan Costs by Decade for Irrigation – Castro County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	146,143	192,522	265,683	355,947	357,456	351,768
Irrigation Conservation Quantity (acft/yr)	57,242	51,518	46,366	41,730	37,557	33,801
Annual Cost (million dollars/yr) (Table 4.4-11)	2.85	2.85	2.85	2.85	2.85	2.85
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

4.5.4 Cochran County Water Supply Plan

Table 4.5-12 lists each water user group in Cochran County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-12.
Cochran County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Morton	-565	-496	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-37,006	-72,644	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-4, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.4.1 City of Morton

4.5.4.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.4.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Morton through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2015 needed to supply an additional 561 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala

Aquifer approximately three miles from the City of Morton into which the city could locate new municipal water supply wells.

4.5.4.1.3 Costs

Costs of the recommended plan for the City of Morton to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-13 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-31
   - Date to be Implemented: 2015
   - Total Project Cost: $922,944
   - Annual Cost: See Table 4.5-13 for a cost summary of this option.

Table 4.5-13.
Recommended Plan Costs by Decade for the City of Morton

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	560	565	547	521	496
Municipal Water Conservation						
Quantity Available (acft/yr)	41	56	48	38	34	32
Annual Cost ($/yr)	$22,707	$27,460	$23,105	$17,744	$15,416	$14,666
Unit Cost ($/acft)	$551	$493	$481	$462	$454	$454
Local Groundwater Development						
Quantity Available (acft/yr)	—	855	770	693	623	561
Annual Cost ($/yr)	—	$119,542	$119,542	$119,542	$52,490	$52,490
Unit Cost ($/acft)	—	$140	$155	$172	$84	$94

4.5.4.2 Irrigation

4.5.4.2.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 120,412 acft/yr in 2000 declining to 22,165 acft/yr in 2060.

4.5.4.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Cochran County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Cochran County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.4.3.3 Costs

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $10,390,000
- Annual Cost: $810,000; including debt service at 25 yrs useful life of systems (Table 4.5-14).

Table 4.5-14.
Recommended Plan Costs by Decade for Irrigation – Cochran County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	39,909	38,596	37,006	35,505	76,645	72,644
Irrigation Conservation Quantity (acft/yr)	16,294	14,665	13,198	11,879	10,691	9,622
Annual Cost (million dollars/yr) (Table 4.4-11)	0.81	0.81	0.81	0.81	0.81	0.81
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.5 Crosby County Water Supply Plan

Table 4.5-15 lists each water user group in Crosby County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-15.
Crosby County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Crosbyton	45	-336	Projected shortage – see plan below
City of Lorenzo	-37	-108	Projected shortage – see plan below
City of Ralls	-4	-318	Projected shortage – see plan below
County Other	100	100	Projected surplus
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-10,185	-7,960	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-5, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.5.1 The City of Crosbyton

4.5.5.1.1 Description of Supply

- **Source:** Ogallala Aquifer and White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

4.5.5.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Crosbyton through 2060.

- Local groundwater development in partnership with the White River MWD beginning in 2007 needed to supply an additional 400 acft/yr in 2060.

4.5.5.1.3 Costs

Costs of the recommended plan for the City of Crosbyton to meet 2060 shortages are:

a. Local groundwater development in partnership with the White River MWD:
   - Cost Source: Section 4.4.3.10, Table 4.4-65
   - Date to be Implemented: 2007
   - Annual Cost: See Table 4.5-16 for a cost summary of this option.

Table 4.5-16.
Recommended Plan Costs by Decade for the City of Crosbyton

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	0	336
Local Groundwater Development (with the White River MWD)						
Quantity Available (acft/yr)	400	400	400	400	400	400
Annual Cost ($/yr)	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Unit Cost ($/acft)	$40	$40	$40	$40	$40	$40

4.5.5.2 The City of Lorenzo

4.5.5.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

4.5.5.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Lorenzo through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 150 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Lorenzo into which the city could locate new municipal water supply wells.

4.5.5.2.3 Costs

Costs of the recommended plan for the City of Lorenzo to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-30
   - Date to be Implemented: 2021
   - Total Project Cost: $276,408
   - Annual Cost: See Table 4.5-17 for a cost summary of this option.

Table 4.5-17.
Recommended Plan Costs by Decade for the City of Lorenzo

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	37	69	92	108
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	206	185	167	150
Annual Cost ($/yr)	—	—	$32,947	$32,947	$32,947	$12,866
Unit Cost ($/acft)	—	—	$160	$178	$197	$86

4.5.5.3 The City of Ralls

4.5.5.3.1 Description of Supply

- **Source:** White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

4.5.5.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Ralls through 2060.

- Local groundwater development in partnership with the White River MWD beginning in 2007 needed to supply an additional 400 acft/yr in 2060.

4.5.5.3.3 Costs

Costs of the recommended plan for the City of Ralls to meet 2060 shortages are:

a. Local groundwater development in partnership with the White River MWD:
   - Cost Source: Section 4.4.3.10, Table 4.4-65
   - Date to be Implemented: 2007
   - Annual Cost: See Table 4.5-18 for a cost summary of this option.

Table 4.5-18.
Recommended Plan Costs by Decade for the City of Ralls

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	4	7	323	318
Local Groundwater Development (with the White River MWD)						
Quantity Available (acft/yr)	400	400	400	400	400	400
Annual Cost ($/yr)	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Unit Cost ($/acft)	$40	$40	$40	$40	$40	$40

4.5.5.4 Irrigation

4.5.5.4.1 Description of Supply

- **Source:** Ogallala and Seymour Aquifers, and Reclaimed Water
- **Current Supply:** 113,987 acft/yr in 2000 declining to 81,300 acft/yr in 2060.

4.5.5.4.2 Water Supply Plan

The use of irrigation BMPs in the past in Crosby County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Crosby County irrigation farmers (Section 4.4.1.2).

4.5.5.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $23,060,000
   - Annual Cost: $1,810,000; including debt service at 25 yrs useful life of systems (Table 4.5-19).

Table 4.5-19.
Recommended Plan Costs by Decade for Irrigation – Crosby County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	10,888	10,431	10,185	9,728	8,353	7,960
Irrigation Conservation Quantity (acft/yr)	36,166	32,549	29,294	26,365	23,728	21,355
Annual Cost (million dollars/yr) (Table 4.4-11)	1.81	1.81	1.81	1.81	1.81	1.81
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.6 Dawson County Water Supply Plan

Table 4.5-20 lists each water user group in Dawson County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-20.
Dawson County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Lamesa	383	428	Projected surplus
City of O'Donnell (part)	41	42	Projected surplus
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-90,085	-73,240	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-6, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.6.1 The City of Lamesa

4.5.6.1.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2060.

4.5.6.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Lamesa.

- Municipal water conservation.

4.5.6.1.3 Costs

Costs of the recommended plan for the City of Lamesa are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-21 for a cost summary of this option.

Table 4.5-21.
Recommended Plan Costs by Decade for the City of Lamesa

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	212	400	501	471	448	431
Annual Cost ($/yr)	$112,521	$181,203	$216,082	$198,426	$186,904	$179,828
Unit Cost ($/acft)	$532	$453	$431	$421	$417	$417

4.5.6.2 Irrigation

4.5.6.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** 148,713 acft/yr in 2000 declining to 30,468 acft/yr in 2060.

4.5.6.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Dawson County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Dawson County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.6.3.3 Costs

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $870,000

- Annual Cost: $70,000; including debt service at 25 yrs useful life of systems (Table 4.5-22).

Table 4.5-22.
Recommended Plan Costs by Decade for Irrigation – Dawson County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	95,781	94,812	90,085	86,142	79,397	73,240
Irrigation Conservation Quantity (acft/yr)	1,365	1,228	1,105	995	895	806
Annual Cost (million dollars/yr) (Table 4.4-11)	0.87	0.87	0.87	0.87	0.87	0.87
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.7 Deaf Smith County Water Supply Plan

Table 4.5-23 lists each water user group in Deaf Smith County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-23.
Deaf Smith County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Hereford	3,751	3,789	Projected surplus
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected demand
Irrigation	-222,967	-240,650	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-7, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.7.1 The City of Hereford

4.5.7.1.1 Description of Supply

- **Source:** Ogallala Aquifer and Dockum Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

4.5.7.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Hereford.

- Municipal water conservation.

4.5.7.1.3 Costs

Costs of the recommended plan for the City of Hereford are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-24 for a cost summary of this option.

Table 4.5-24.
Recommended Plan Costs by Decade for the City of Hereford

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	302	572	649	610	596	598
Annual Cost ($/yr)	$161,472	$259,950	$282,905	$258,767	$250,525	$251,263
Unit Cost ($/acft)	$535	$454	$436	$424	$420	$420

4.5.7.2 Irrigation

4.5.7.2.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 379,010 acft/yr in 2000 declining to 66,705 acft/yr in 2060.

4.5.7.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Deaf Smith County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Deaf Smith County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.7.3.3 Costs

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $36,710,000

- Annual Cost: $2,870,000; including debt service at 25 yrs useful life of systems (Table 4.5-25).

Table 4.5-25.
Recommended Plan Costs by Decade for Irrigation – Deaf Smith County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	168,813	193,978	222,967	253,025	245,379	240,650
Irrigation Conservation Quantity (acft/yr)	57,571	51,814	46,633	41,969	37,772	33,995
Annual Cost (million dollars/yr) (Table 4.4-11)	2.87	2.87	2.87	2.87	2.87	2.87
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.8 Dickens County Water Supply Plan

Table 4.5-26 lists each water user group in Dickens County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-26.
Dickens County Surplus/Shortage*

Water User Group	*Surplus/Shortage*[1]		*Comment*
	2030 (acft/yr)	*2060 (acft/yr)*	
City of Spur	0	-257	Projected shortage – see plan below
County Other	80	74	Projected surplus
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-3,133	-2,737	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

1 From Table 4-8, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.8.1 The City of Spur

4.5.8.1.1 Description of Supply

- **Source:** White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

4.5.8.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Spur.

- Municipal water conservation; and
- Local groundwater development in partnership with the White River MWD beginning in 2007 needed to supply an additional 400 acft/yr in 2060.

4.5.8.1.3 Costs

Costs of the recommended plan for the City of Spur are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-27 for a cost summary of this option.

b. Local groundwater development in partnership with the White River MWD:
- Cost Source: Section 4.4.3.10, Table 4.4-65
- Date to be Implemented: 2007
- Annual Cost: See Table 4.5-27 for a cost summary of this option.

Table 4.5-27.
Recommended Plan Costs by Decade for the City of Spur

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	151	257
Municipal Water Conservation						
Quantity Available (acft/yr)	21	42	54	50	48	48
Annual Cost ($/yr)	$11,331	$18,807	$23,019	$20,968	$19,601	$19,601
Unit Cost ($/acft)	$528	$452	$429	$420	$412	$412
Local Groundwater Development (with the White River MWD)						
Quantity Available (acft/yr)	400	400	400	400	400	400
Annual Cost ($/yr)	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Unit Cost ($/acft)	$40	$40	$40	$40	$40	$40

4.5.8.2 Irrigation

4.5.8.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** 10,290 acft/yr in 2000 declining to 5,171 acft/yr in 2060.

4.5.8.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Dickens County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Dickens

County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.8.3.3 Costs

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $1,630,000
- Annual Cost: $130,000; including debt service at 25 yrs useful life of systems (Table 4.5-28).

Table 4.5-28.
Recommended Plan Costs by Decade for Irrigation – Dickens County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	3,407	3,266	3,133	2,999	2,868	2,737
Irrigation Conservation Quantity (acft/yr)	2,561	2,305	2,074	1,867	1,680	1,512
Annual Cost (million dollars/yr) (Table 4.4-11)	0.13	0.13	0.13	0.13	0.13	0.13
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.9 Floyd County Water Supply Plan

Table 4.5-29 lists each water user group in Floyd County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-29.
Floyd County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Floydada	0	0	No projected surplus/shortage
City of Lockney	-240	-212	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected demand
Irrigation	-108,967	-100,072	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-9, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.9.1 The City of Lockney

4.5.9.1.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Mackenzie
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

4.5.9.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Lockney through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 299 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala

Aquifer approximately two miles from the City of Lockney into which the city could locate new municipal water supply wells.

4.5.9.1.3 Costs

Costs of the recommended plan for the City of Lockney to meet 2030 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-29
   - Date to be Implemented: 2021
   - Total Project Cost: $278,280
   - Annual Cost: See Table 4.5-30 for a cost summary of this option.

Table 4.5-30.
Recommended Plan Costs by Decade for the City of Lockney

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	240	234	224	212
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	410	369	332	299
Annual Cost ($/yr)	—	—	$47,072	$47,072	$47,072	$24,833
Unit Cost ($/acft)	—	—	$115	$128	$142	$83

4.5.9.2 Irrigation

4.5.9.2.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 237,922 acft/yr in 2000 declining to 85,742 acft/yr in 2060.

4.5.9.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Floyd County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Floyd County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.9.3.3 Costs

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $43,660,000
- Annual Cost: $3,413,000; including debt service at 25 yrs useful life of systems (Table 4.5-31).

Table 4.5-31.
Recommended Plan Costs by Decade for Irrigation – Floyd County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	90,731	106,390	108,967	108,966	105,148	100,072
Irrigation Conservation Quantity (acft/yr)	68,471	61,624	55,462	49,916	44,924	40,432
Annual Cost (million dollars/yr) (Table 4.4-11)	3.41	3.41	3.41	3.41	3.41	3.41
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.10 Gaines County Water Supply Plan

Table 4.5-32 lists each water user group in Gaines County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-32.
Gaines County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Seagraves	-502	-499	Projected shortage – see plan below
City of Seminole	0	0	No projected surplus/shortage
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-119,738	-140,268	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-10, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.10.1 The City of Seagraves

4.5.10.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

4.5.10.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Seagraves through 2060.

- Local groundwater development beginning in 2006 needed to supply an additional 519 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Seagraves into which the city could locate new municipal water supply wells.

4.5.10.1.3 Costs

Costs of the recommended plan for the City of Seagraves to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-39
   - Date to be Implemented: 2006
   - Total Project Cost: $1,224,828
   - Annual Cost: See Table 4.5-33 for a cost summary of this option.

Table 4.5-33.
Recommended Plan Costs by Decade for the City of Seagraves

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	449	482	502	513	506	499
Local Groundwater Development						
Quantity Available (acft/yr)	645	790	711	640	576	519
Annual Cost ($/yr)	$119,185	$142,875	$142,875	$77,597	$53,891	$53,891
Unit Cost ($/acft)	$185	$181	$201	$121	$94	$104

4.5.10.2 The City of Seminole

4.5.10.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

4.5.10.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Seminole.

- Municipal water conservation.

4.5.10.2.3 Costs

Costs of the recommended plan for the City of Seminole are:

a. Municipal water conservation:

- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-34 for a cost summary of this option.

Table 4.5-34.
Recommended Plan Costs by Decade for the City of Seminole

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	178	384	588	778	938	1,035
Annual Cost ($/yr)	$86,784	$166,714	$244,685	$317,131	$379,477	$418,268
Unit Cost ($/acft)	$487	$434	$416	$407	$405	$404

4.5.10.3 Irrigation

4.5.10.3.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** 415,068 acft/yr in 2000 declining to 160,930 acft/yr in 2060.

4.5.10.3.2 Water Supply Plan

The use of irrigation BMPs in the past in Gaines County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Gaines County irrigation farmers (Section 4.4.1.2), however, the strategy is being applied to practically all of the irrigated acres of the county, and therefore does not have potential except for new irrigated acres in case any are placed into production.

4.5.10.3.3 Costs

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Not applicable

- Total Cost: $ 000
- Annual Cost: $ 000; including debt service at 25 yrs useful life of systems (Table 4.5-35).

Table 4.5-35.
Recommended Plan Costs by Decade for Irrigation – Gaines County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	67,572	105,734	119,738	127,900	134,572	140,268
Irrigation Conservation Quantity (acft/yr)	0	0	0	0	0	0
Annual Cost (million dollars/yr) (Table 4.4-11)	0.00	0.00	0.00	0.00	0.00	0.00
Unit Cost ($/acft) (Table 4.4-12)	0	0	0	0	0	0

4.5.11 Garza County Water Supply Plan

Table 4.5-36 lists each water user group in Garza County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-36.
Garza County Surplus/Shortage*

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Post	183	-206	Projected shortage – see plan below
Lake Alan Henry WSD	-270	-270	New service area – see plan below
County Other	14	14	Projected surplus
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-3,995	-3,212	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-11, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.11.1 The City of Post

4.5.11.1.1 Description of Supply

- **Source:** Lake Mackenzie (via Slaton) and White River Reservoir
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

4.5.11.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Post through 2060.

- Local groundwater development in partnership with the White River MWD beginning in 2007 needed to supply an additional 400 acft/yr in 2060.

4.5.11.1.3 Costs

Costs of the recommended plan for the City of Post to meet 2060 shortages are:

a. Local groundwater development in partnership with the White River MWD:
   - Cost Source: Section 4.4.3.10, Table 4.4-65
   - Date to be Implemented: 2007
   - Annual Cost: See Table 4.5-37 for a cost summary of this option.

Table 4.5-37.
Recommended Plan Costs by Decade for the City of Post

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	261	243	206
Local Groundwater Development (with the White River MWD)						
Quantity Available (acft/yr)	400	400	400	400	400	400
Annual Cost ($/yr)	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Unit Cost ($/acft)	$40	$40	$40	$40	$40	$40

4.5.11.2 Lake Alan Henry WSD

4.5.11.2.1 Description of Supply

- **Source:** Lake Alan Henry via contract with Lubbock.
- **Current Supply:** The new Lake Alan Henry WSD is projected to need supplies prior to 2010.

4.5.11.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the Lake Alan Henry WSD through 2060.

- Supply from Lake Alan Henry beginning prior to 2010.

4.5.11.2.3 Costs

Costs of the recommended plan for the Lake Alan Henry WSD to meet 2060 shortages are:

a. Supply from Lake Alan Henry (See Section 4.4.3.1):
   - Cost Source: Section 4.4.3.1, Table 4.4-49

- Date to be Implemented: 2006
- Total Project Cost: $5,613,000
- Annual Cost: See Table 4.5-38 for a cost summary of this option.

Table 4.5-38.
Recommended Plan Costs by Decade for the Lake Alan Henry WSD

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	270	270	270	270	270	270
Supply from Lake Alan Henry						
Quantity Available (acft/yr)	270	270	270	270	270	270
Annual Cost ($/yr)	$757,000	$757,000	$757,000	$349,000	$349,000	$349,000
Unit Cost ($/acft)	$2,804	$2,804	$2,804	$1,293	$1,293	$1,293

4.5.11.3 Irrigation

4.5.11.3.1 Description of Supply

- **Source:** Ogallala and Dockum Aquifers
- **Current Supply:** 13,243 acft/yr in 2000 declining to 5,259 acft/yr in 2060.

4.5.11.3.2 Water Supply Plan

The use of irrigation BMPs in the past in Garza County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Garza County irrigation farmers (Section 4.4.1.2). The strategy is projected to meet the irrigation water needs of Garza County.

4.5.11.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $3,530,000
   - Annual Cost: $270,000; including debt service at 25 yrs useful life of systems (Table 4.5-39).

Table 4.5-39.
Recommended Plan Costs by Decade for Irrigation – Garza County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	4,712	4,301	3,995	3,721	3,455	3,212
Irrigation Conservation Quantity (acft/yr)	5,535	4,982	4,483	4,035	3,632	3,268
Annual Cost (million dollars/yr) (Table 4.4-11)	0.27	0.27	0.27	0.27	0.27	0.27
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

4.5.12 Hale County Water Supply Plan

Table 4.5-40 lists each water user group in Hale County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-40.
Hale County Surplus/Shortage*

Water User Group	Surplus/Shortage[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Abernathy[2]	-714	-700	Projected shortage – see plan below
City of Hale Center	-509	-498	Projected shortage – see plan below
City of Petersburg	0	-306	Projected shortage – see plan below
City of Plainview	8,445	6,279	Projected surplus – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-139,354	-223,093	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-12, Section 4.1 – Water Needs Projections by Water User Group.
[2] A portion of the City of Abernathy is located in Lubbock County. However, the city's total projected shortage is shown here.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.12.1 The City of Abernathy

4.5.12.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.12.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Abernathy through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2011 needed to supply an additional 863 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 10 miles from the City of Abernathy into which the city could locate new municipal water supply wells.

4.5.12.1.3 Costs

Costs of the recommended plan for the City of Abernathy to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-41 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-15
   - Date to be Implemented: 2011
   - Total Project Cost: $2,974,092
   - Annual Cost: See Table 4.5-41 for a cost summary of this option.

Table 4.5-41.
Recommended Plan Costs by Decade for the City of Abernathy

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	690	714	717	715	700
Municipal Water Conservation						
Quantity Available (acft/yr)	50	48	43	32	28	27
Annual Cost ($/yr)	$27,248	$24,686	$21,580	$15,566	$13,449	$13,182
Unit Cost ($/acft)	$542	$509	$503	$489	$481	$481
Local Groundwater Development						
Quantity Available (acft/yr)	—	823	942	848	959	863
Annual Cost ($/yr)	—	$259,189	$282,878	$282,878	$141,335	$126,058
Unit Cost ($/acft)	—	$315	$300	$334	$147	$146

4.5.12.2 The City of Hale Center

4.5.12.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed.

4.5.12.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Hale Center through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 599 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Hale Center into which the city could locate new municipal water supply wells.

4.5.12.2.3 Costs

Costs of the recommended plan for the City of Hale Center to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-24
   - Date to be Implemented: 2021
   - Total Project Cost: $1,224,828
   - Annual Cost: See Table 4.5-42 for a cost summary of this option.

Table 4.5-42.
Recommended Plan Costs by Decade for the City of Hale Center

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	509	513	507	498
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	607	740	666	599
Annual Cost ($/yr)	—	—	$88,801	$112,490	$112,490	$62,365
Unit Cost ($/acft)	—	—	$146	$152	$169	$104

4.5.12.3 The City of Petersburg

4.5.12.3.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2045, at which time additional supplies will be needed.

4.5.12.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Petersburg through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2041 needed to supply an additional 369 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately one mile from the City of Petersburg into which the city could locate new municipal water supply wells.

4.5.12.3.3 Costs

Costs of the recommended plan for the City of Petersburg to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-43 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-34
   - Date to be Implemented: 2041
   - Total Project Cost: $265,452
   - Annual Cost: See Table 4.5-43 for a cost summary of this option.

Table 4.5-43.
Recommended Plan Costs by Decade for the City of Petersburg

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	0	312	306
Municipal Water Conservation						
Quantity Available (acft/yr)	21	24	20	16	14	14
Annual Cost ($/yr)	$11,503	$12,377	$10,078	$7,411	$6,390	$6,267
Unit Cost ($/acft)	$553	$507	$494	$472	$460	$460
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	—	—	410	369
Annual Cost ($/yr)	—	—	—	—	$43,748	$43,748
Unit Cost ($/acft)	—	—	—	—	$107	$119

4.5.12.4 The City of Plainview

4.5.12.4.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until through the planning period; however, the City is currently planning to drill four additional wells.

4.5.12.4.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Plainview through 2060.

- Local groundwater development beginning in 2010 to supply an additional 1,181 acft/yr in 2060. These wells would be located within the City limits.

4.5.12.4.3 Costs

Costs of the recommended plan for the City of Plainview are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-36
   - Date to be Implemented: 2010
   - Total Project Cost: $528,000
   - Annual Cost: See Table 4.5-44 for a cost summary of this option.

Table 4.5-44.
Recommended Plan Costs by Decade for the City of Plainview

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	0	0	0
Local Groundwater Development						
Quantity Available (acft/yr)	2,000	1,800	1,620	1,458	1,312	1,181
Annual Cost ($/yr)	$145,627	$145,627	$145,627	$107,268	$107,268	$107,268
Unit Cost ($/acft)	$73	$81	$91	$74	$82	$91

4.5.12.5 Irrigation

4.5.12.5.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 365,725 acft/yr in 2000 declining to 77,816 acft/yr in 2060.

4.5.12.5.2 Water Supply Plan

The use of irrigation BMPs in the past in Hale County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Hale County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.12.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $34,630,000
   - Annual Cost: $2,710,000; including debt service at 25 yrs useful life of systems (Table 4.5-45).

Table 4.5-45.
Recommended Plan Costs by Decade for Irrigation – Hale County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	20,936	55,454	139,354	206,865	224,491	223,093
Irrigation Conservation Quantity (acft/yr)	54,306	48,875	43,988	39,589	35,630	32,067
Annual Cost (million dollars/yr) (Table 4.4-11)	2.71	2.71	2.71	2.71	2.71	2.71
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.13 Hockley County Water Supply Plan

Table 4.5-46 lists each water user group in Hockley County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-46.
Hockley County Surplus/Shortage*

Water User Group	*Surplus/Shortage*[1] *2030 (acft/yr)*	*Surplus/Shortage*[1] *2060 (acft/yr)*	*Comment*
City of Anton	-272	-243	Projected shortage – see plan below
City of Levelland	867	1,129	Projected surplus
City of Ropesville	-91	-81	Projected shortage – see plan below
City of Smyer	0	-62	Projected shortage – see plan below
City of Sundown	-353	-316	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-81,841	-80,584	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-13, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.13.1 The City of Anton

4.5.13.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

4.5.13.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Anton through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2006 needed to supply an additional 373 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Anton into which the city could locate new municipal water supply wells.

4.5.13.1.3 Costs

Costs of the recommended plan for the City of Anton to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-47 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-17
   - Date to be Implemented: 2006
   - Total Project Cost: $1,055,736
   - Annual Cost: See Table 4.5-47 for a cost summary of this option.

Table 4.5-47.
Recommended Plan Costs by Decade for the City of Anton

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	263	270	272	268	256	243
Municipal Water Conservation						
Quantity Available (acft/yr)	14	11	6	2	0	0
Annual Cost ($/yr)	$8,113	$5,925	$3,469	$868	—	—
Unit Cost ($/acft)	$561	$561	$561	$561	—	—
Local Groundwater Development						
Quantity Available (acft/yr)	408	569	512	461	415	373
Annual Cost ($/yr)	$93,667	$117,356	$117,356	$64,363	$40,657	$40,657
Unit Cost ($/acft)	$230	$206	$229	$140	$98	$109

4.5.13.2 The City of Ropesville

4.5.13.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

4.5.13.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Ropesville through 2060.

- Local groundwater development beginning in 2021 needed to supply an additional 141 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Ropesville into which the city could locate new municipal water supply wells.

4.5.13.2.3 Costs

Costs of the recommended plan for the City of Ropesville to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-38
   - Date to be Implemented: 2021
   - Total Project Cost: $276,408
   - Annual Cost: See Table 4.5-48 for a cost summary of this option.

Table 4.5-48.
Recommended Plan Costs by Decade for the City of Ropesville

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	91	89	85	81
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	193	174	157	141
Annual Cost ($/yr)	—	—	$32,947	$32,947	$32,947	$12,866
Unit Cost ($/acft)	—	—	$171	$189	$210	$91

4.5.13.3 The City of Smyer

4.5.13.3.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2055, at which time additional supplies will be needed

4.5.13.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Smyer through 2060.

- Local groundwater development beginning in 2051 needed to supply an additional 193 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately one mile from the City of Smyer into which the city could locate new municipal water supply wells.

4.5.13.3.3. Costs

Costs of the recommended plan for the City of Smyer to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-42
   - Date to be Implemented: 2051
   - Total Project Cost: $200,904
   - Annual Cost: See Table 4.5-49 for a cost summary of this option.

Table 4.5-49.
Recommended Plan Costs by Decade for the City of Smyer

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	0	62
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	—	—	—	193
Annual Cost ($/yr)	—	—	—	—	—	$26,775
Unit Cost ($/acft)	—	—	—	—	—	$139

4.5.13.4 The City of Sundown

4.5.13.4.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.13.4.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Sundown through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2016 needed to supply an additional 415 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Sundown into which the city could locate new municipal water supply wells.

4.5.13.4.3 Costs

Costs of the recommended plan for the City of Sundown to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-50 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-44
   - Date to be Implemented: 2016
   - Total Project Cost: $753,720
   - Annual Cost: See Table 4.5-50 for a cost summary of this option.

Table 4.5-50.
Recommended Plan Costs by Decade for the City of Sundown

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	350	353	347	332	316
Municipal Water Conservation						
Quantity Available (acft/yr)	24	25	19	14	11	11
Annual Cost ($/yr)	$13,688	$12,884	$9,935	$6,682	$5,377	$5,112
Unit Cost ($/acft)	$561	$524	$513	$492	$481	$481
Local Groundwater Development						
Quantity Available (acft/yr)	—	412	569	512	461	415
Annual Cost ($/yr)	—	$68,980	$92,669	$92,669	$61,617	$37,911
Unit Cost ($/acft)	—	$167	$163	$181	$134	$91

4.5.13.5 Irrigation

4.5.13.5.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 179,041 acft/yr in 2000 declining to 57,585 acft/yr in 2060.

4.5.13.5.2 Water Supply Plan

The use of irrigation BMPs in the past in Hockley County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Hockley County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.13.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $19,010,000
   - Annual Cost: $1,490,000; including debt service at 25 yrs useful life of systems (Table 4.5-51).

Table 4.5-51.
Recommended Plan Costs by Decade for Irrigation – Hockley County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	62,401	74,555	81,841	86,796	82,789	80,584
Irrigation Conservation Quantity (acft/yr)	29,808	26,827	24,145	21,730	19,557	17,601
Annual Cost (million dollars/yr) (Table 4.4-11)	1.49	1.49	1.49	1.49	1.49	1.49
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.14 Lamb County Water Supply Plan

Table 4.5-52 lists each water user group in Lamb County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-52. Lamb County Surplus/Shortage*

Water User Group	Surplus/(Shortage)[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Amherst	-182	-181	Projected shortage – see plan below
City of Earth	0	-276	Projected shortage – see plan below
City of Littlefield	0	0	Projected shortage – see plan below
City of Olton	0	0	No projected surplus/shortage
City of Sudan	-244	-243	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected surplus/shortage
Mining	0	0	No projected surplus/shortage
Irrigation	-202,325	-253,586	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-14, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.14.1 The City of Amherst

4.5.14.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.14.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Amherst through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2012 needed to supply an additional 275 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately five miles from the City of Amherst into which the city could locate new municipal water supply wells.

4.5.14.1.3 Costs

Costs of the recommended plan for the City of Amherst to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-53 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-16
   - Date to be Implemented: 2012
   - Total Project Cost: $840,312
   - Annual Cost: See Table 4.5-53 for a cost summary of this option.

Table 4.5-53.
Recommended Plan Costs by Decade for the City of Amherst

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	176	182	185	183	181
Municipal Water Conservation						
Quantity Available (acft/yr)	7	5	2	0	0	0
Annual Cost ($/yr)	$4,193	$2,787	$1,173	—	—	—
Unit Cost ($/acft)	$561	$561	$561	—	—	—
Local Groundwater Development						
Quantity Available (acft/yr)	—	196	378	340	306	275
Annual Cost ($/yr)	—	$65,705	$89,394	$89,394	$40,198	$28,345
Unit Cost ($/acft)	—	$335	$236	$263	$131	$103

4.5.14.2 The City of Earth

4.5.14.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2035, at which time additional supplies will be needed

4.5.14.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Earth through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2031 needed to supply an additional 318 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Earth into which the city could locate new municipal water supply wells.

4.5.14.2.3. Costs

Costs of the recommended plan for the City of Earth to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-54 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-21
   - Date to be Implemented: 2031
   - Total Project Cost: $619,608
   - Annual Cost: See Table 4.5-54 for a cost summary of this option.

Table 4.5-54.
Recommended Plan Costs by Decade for the City of Earth

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	283	280	276
Municipal Water Conservation						
Quantity Available (acft/yr)	20	28	25	21	20	19
Annual Cost ($/yr)	$10,882	$13,391	$11,614	$9,491	$8,594	$8,479
Unit Cost ($/acft)	$549	$481	$466	$446	$437	$437
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	—	393	354	318
Annual Cost ($/yr)	—	—	—	$71,353	$71,353	$71,353
Unit Cost ($/acft)	—	—	—	$182	$202	$224

4.5.14.3 The City of Littlefield

4.5.14.3.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Needs new supplies for expanding industrial customer by 2010.

4.5.14.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Littlefield.

- Municipal water conservation, and
- Local groundwater development beginning in 2010. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Littlefield into which the city could locate new municipal water supply wells.

4.5.14.3.3 Costs

Costs of the recommended plan for the City of Littlefield are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-55 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):

- Cost Source: Section 4.4.2, Table 4.4-28
- Date to be Implemented: 2010
- Total Project Cost: $922,944
- Annual Cost: See Table 4.5-55 for a cost summary of this option.

Table 4.5-55.
Recommended Plan Costs by Decade for the City of Littlefield

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	118	196	181	161	151	149
Annual Cost ($/yr)	$64,725	$92,969	$83,321	$71,384	$66,031	$65,173
Unit Cost ($/acft)	$546	$474	$461	$445	$438	$438
Local Groundwater Development						
Quantity Available (acft/yr)	900	810	729	656	590	531
Annual Cost ($/yr)	$119,543	$119,543	$119,543	$52,491	$52,491	$52,491
Unit Cost ($/acft)	$133	$148	$164	$80	$89	$99

4.5.14.4 The City of Olton

4.5.14.4.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet projected demands.

4.5.14.4.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Olton through 2060.

- Municipal water conservation.

4.5.14.4.3 Costs

Costs of the recommended plan for the City of Olton to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7

- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-56 for a cost summary of this option.

Table 4.5-56.
Recommended Plan Costs by Decade for the City of Olton

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	27	17	12	3	0	0
Annual Cost ($/yr)	$15,163	$9,679	$6,787	$1,759	—	—
Unit Cost ($/acft)	$561	$561	$561	$561	—	—

4.5.14.5 The City of Sudan

4.5.14.5.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.14.5.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Sudan through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2016 needed to supply an additional 283 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Sudan into which the city could locate new municipal water supply wells.

4.5.14.5.3. Costs

Costs of the recommended plan for the City of Sudan to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-57 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
- Cost Source: Section 4.4.2, Table 4.4-43
- Date to be Implemented: 2016
- Total Project Cost: $596,508
- Annual Cost: See Table 4.5-57 for a cost summary of this option.

Table 4.5-57.
Recommended Plan Costs by Decade for the City of Sudan

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	236	244	249	246	243
Municipal Water Conservation						
Quantity Available (acft/yr)	15	12	12	4	3	3
Annual Cost ($/yr)	$8,265	$6,594	$3,959	$2,396	$1,817	$1,568
Unit Cost ($/acft)	$561	$561	$561	$561	$561	$561
Local Groundwater Development						
Quantity Available (acft/yr)	—	432	389	350	315	283
Annual Cost ($/yr)	—	$70,809	$70,809	$70,809	$27,473	$27,473
Unit Cost ($/acft)	—	$164	$182	$202	$87	$97

4.5.14.6 Irrigation

4.5.14.6.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 385,564 acft/yr in 2000 declining to 45,547 acft/yr in 2060.

4.5.14.6.2 Water Supply Plan

The use of irrigation BMPs in the past in Lamb County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Lamb County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.14.3.3 Costs

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-11

- Date to be Implemented: Prior to 2010
- Total Cost: $10,410,000
- Annual Cost: $810,000; including debt service at 25 yrs useful life of systems (Table 4.5-58).

Table 4.5-58.
Recommended Plan Costs by Decade for Irrigation – Lamb County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	114,256	158,591	202,325	240,170	250,798	253,586
Irrigation Conservation Quantity (acft/yr)	16,324	14,691	13,222	11,900	10,710	9,639
Annual Cost (million dollars/yr) (Table 4.4-11)	0.81	0.81	0.81	0.81	0.81	0.81
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

4.5.15 Lubbock County Water Supply Plan

Table 4.5-59 lists each water user group in Lubbock County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-59.
Lubbock County Surplus/Shortage

Water User Group	Surplus/Shortage[1]		Comment
	2030 (acft/yr)	2060 (acft/yr)	
City of Abernathy			See Hale County
City of Idalou	0	-272	Projected shortage – see plan below
City of Lubbock	2,062	-1,223	Projected surplus – see plan below
City of New Deal	-20	-20	Projected shortage – see plan below
City of Ransom Canyon	0	0	Projected surplus
City of Shallowater	-190	-184	Projected shortage – see plan below
City of Slaton	499	533	Projected surplus
City of Wolfforth	-1,522	-1,787	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected surplus/shortage
Mining	0	0	No projected surplus/shortage
Irrigation	-95,320	-96,308	Projected shortage –see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-15, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.15.1 The City of Abernathy (See Hale County)

4.5.15.2 The City of Idalou

4.5.15.2.1 Description of Supply

- **Source:** Ogallala Aquifer

- **Current Supply:** Adequate to meet demands until approximately 2035, at which time additional supplies will be needed

4.5.15.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Idalou through 2060.

- Local groundwater development beginning in 2031 needed to supply an additional 332 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Idalou into which the city could locate new municipal water supply wells.

4.5.15.2.3 Costs

Costs of the recommended plan for the City of Idalou to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-26
   - Date to be Implemented: 2031
   - Total Project Cost: $596,508
   - Annual Cost: See Table 4.5-60 for a cost summary of this option.

Table 4.5-60.
Recommended Plan Costs by Decade for the City of Idalou

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	274	273	272
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	—	410	369	332
Annual Cost ($/yr)	—	—	—	$70,809	$70,809	$70,809
Unit Cost ($/acft)	—	—	—	$173	$192	$213

4.5.15.3 The City of Lubbock

4.5.15.3.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2060.

4.5.15.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Lubbock.

- Municipal water conservation, and
- Lake Alan Henry Pipeline
- City of Lubbock Well Field
- Lubbock Expand Bailey County Well Field
- CRMWA Expand Capacity of Groundwater Supply
- Lubbock Brackish Groundwater Desalination
- Jim Bertram Lake System Expansion, and
- Lubbock North Fork Scalping Operation.

4.5.15.3.3 Costs

Costs of the recommended plan for the City of Lubbock are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

b. Lake Alan Henry Pipeline:
   - Cost Source: Section 4.4.3.2, Table 4.4-50
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $174,909,000
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

c. City of Lubbock Well Field:
   - Cost Source: Section 4.4.3.3, Table 4.4-51
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $7,718,000
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

d. Lubbock Expand Capacity of Bailey County Well Field
   - Cost Source: Section 4.4.3.4, Table 4.4-52
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $2,541,000
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

e. CRMWA Expand Capacity of Groundwater Supply
   - Cost Source: Section 4.4.3.5, Table 4.4-53

- Date to be Implemented: Prior to 2010
- Total Project Cost: ($79,398,000 to expand 31,659 acft/yr and add 15,000 acft/yr to replace lost capacity, annual cost is $10,255,800; Lubbock share of expansion is 37.058 percent of cost and quantity.)
- Annual Cost: See Table 4.5-61 for a cost summary of this option.

f. Lubbock Brackish Groundwater Desalination
   - Cost Source: Section 4.4.3.6, Table 4.4-54
   - Date to be Implemented: 2020
   - Total Project Cost: $10,051,230
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

g. Lubbock Jim Bertram Lake System Expansion
   - Cost Source: Section 4.4.3.7. Table 4.4-57
   - Date to be Implemented: 2020
   - Total Project Cost: $150,759,000
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

h. Lubbock North Fork Scalping Operation
   - Cost Source: Section 4.4.3.8. Table 4.4-63
   - Date to be Implemented: 2045
   - Total Project Cost: $50,055,000
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

Table 4.5-61.
Recommended Plan Costs by Decade for the City of Lubbock

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	0	1,519	1,223
Municipal Water Conservation (Strategy is included until the regional goal of 172 gpcd is reached)						
Quantity Available (acft/yr)	1,180	489	0	0	0	0
Annual Cost ($/yr)	$613,515	$254,508	—	—	—	—
Unit Cost ($/acft)	$520	$520	—	—	—	—
Lake Alan Henry Pipeline						
Quantity Available (acft/yr)	0	22,230	22,230	22,230	22,230	22,230
Annual Cost ($/yr) (millions)	—	$26.584	$26.584	$26.584	$26.584	$26.584
Unit Cost ($/acft)	—	$1,196	$1,196	$1,196	$1,196	$1,196
City of Lubbock Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr) (millions)	$1.644	$1.644	$1.644	$1.644	$1.644	$1.644
Unit Cost ($/acft)	$294	$294	$294	$294	$294	$294
Expand Bailey County Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr)	$213,000	$213,000	$213,000	$213,000	$213,000	$213,000
Unit Cost ($/acft)	$38	$38	$38	$38	$38	$38
CRMWA Expand Groundwater Supply (See 4.5.15.3.3e above)						
Quantity Available (acft/yr)	14,911	14,911	14,911	14,911	14,911	14,911
Annual Cost ($/yr) (millions)	$3.340	$3.340	$4.175	$2.222	$1.983	$1.431
Unit Cost ($/acft)*	$224	$224	$280	$149	$133	$96
Lubbock Brackish Groundwater Desalination						
Quantity Available (acft/yr)	3,360	3,360	3,360	3,360	3,360	3,360
Annual Cost ($/yr) (millions)	$1.700	$1.700	$1.700	$1.700	$1.700	$1.700
Unit Cost ($/acft)	$506	$506	$506	$506	$506	$506
Lubbock Jim Bertram Lake System Expansion						
Quantity Available (acft/yr)	0	21,200	21,200	21,200	21,200	21,200
Annual Cost ($/yr) (millions)	—	$14.575	$14.575	$14.575	$14.575	$14.575
Unit Cost ($/acft)	—	$688	$688	$688	$688	$688
Lubbock North Fork Scalping Operation						
Quantity Available (acft/yr)	0	0	0	0	4,000	4,000
Annual Cost ($/yr) (millions)	—	—	—	—	4.296	4.296
Unit Cost ($/acft)	—	—	—	—	$1,074	$1,074

4.5.15.4 The City of New Deal

4.5.15.4.1 Description of Supply

- **Source:** City of Slaton (CRMWA)
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.15.4.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of New Deal through 2060.

- Local groundwater development beginning in 2011 needed to supply an additional 127 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of New Deal into which the city could locate new municipal water supply wells.

4.5.15.4.3 Costs

Costs of the recommended plan for the City of New Deal to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-32
   - Date to be Implemented: 2011
   - Total Project Cost: $427,416
   - Annual Cost: See Table 4.5-62 for a cost summary of this option.

Table 4.5-62.
Recommended Plan Costs by Decade for the City of New Deal

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	12	20	20	25	20
Local Groundwater Development						
Quantity Available (acft/yr)	—	193	174	157	141	127
Annual Cost ($/yr)	—	$45,290	$45,290	$45,290	$14,239	$14,239
Unit Cost ($/acft)	—	$235	$260	$288	$101	$112

4.5.15.5 The City of Ransom Canyon

4.5.15.5.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

4.5.15.5.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Ransom Canyon.

- Municipal water conservation.

4.5.15.5.3 Costs

Costs of the recommended plan for the City of Ransom Canyon are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-63 for a cost summary of this option.

Table 4.5-63.
Recommended Plan Costs by Decade for the City of Ransom Canyon

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	35	90	162	248	325	342
Annual Cost ($/yr)	$16,898	$38,910	$67,875	$101,807	$132,633	$139,628
Unit Cost ($/acft)	$487	$434	$419	$411	$408	$408

4.5.15.6 The City of Shallowater

4.5.15.6.1 Description of Supply

- **Source:** Ogallala Aquifer and City of Lubbock (Lake Meredith)
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

4.5.15.6.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Shallowater through 2060.

- Local groundwater development beginning in 2006 needed to supply an additional 255 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Shallowater into which the city could locate new municipal water supply wells.

4.5.15.6.3 Costs

Costs of the recommended plan for the City of Shallowater to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-40
   - Date to be Implemented: 2006
   - Total Project Cost: $375,804
   - Annual Cost: See Table 4.5-64 for a cost summary of this option.

Table 4.5-64.
Recommended Plan Costs by Decade for the City of Shallowater

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	157	180	190	184	192	184
Local Groundwater Development						
Quantity Available (acft/yr)	432	389	350	315	283	255
Annual Cost ($/yr)	$52,769	$52,769	$52,769	$25,466	$25,466	$25,466
Unit Cost ($/acft)	$122	$136	$151	$81	$90	$100

4.5.15.7 The City of Wolfforth

4.5.15.7.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed

4.5.15.7.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Wolfforth through 2060.

- Local groundwater development beginning in 2007 needed to supply an additional 1,792 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Wolfforth into which the city could locate new municipal water supply wells.

4.5.15.7.3 Costs

Costs of the recommended plan for the City of Wolfforth to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-47
   - Date to be Implemented: 2007
   - Total Project Cost: $3,957,513
   - Annual Cost: See Table 4.5-65 for a cost summary of this option.

Table 4.5-65.
Recommended Plan Costs by Decade for the City of Wolfforth

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	1,097	1,424	1,522	1,614	1,719	1,787
Local Groundwater Development						
Quantity Available (acft/yr)	1,164	2,132	1,919	1,727	1,991	1,792
Annual Cost ($/yr)	$96,626	$396,581	$396,581	$357,740	$163,582	$163,582
Unit Cost ($/acft)	$83	$186	$207	$207	$82	$91

4.5.15.8 Irrigation

4.5.15 8.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 302,880 acft/yr in 2000 declining to 81,005 acft/yr in 2060.

4.5.15 8.2 Water Supply Plan

The use of irrigation BMPs in the past in Lubbock County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Lubbock County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.15.3.3 Costs

a. Irrigation water conservation:
- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $33,810,000
- Annual Cost: $2,640,000; including debt service at 25 yrs useful life of systems (Table 4.5-66).

Table 4.5-66.
Recommended Plan Costs by Decade for Irrigation – Lubbock County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	66,665	85,695	95,320	106,660	100,194	96,308
Irrigation Conservation Quantity (acft/yr)	53,014	47,713	42,942	38,648	34,783	31,305
Annual Cost (million dollars/yr) (Table 4.4-11)	2.64	2.64	2.64	2.64	2.64	2.64
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

4.5.16 Lynn County Water Supply Plan

Table 4.5-67 lists each water user group in Lynn County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-67.
Lynn County Surplus/Shortage

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of O'Donnell (part)	122	143	Projected surplus
City of Tahoka	44	113	Projected surplus
City of Wilson	-65	-55	Projected shortage – see plan below
County Other	100	100	Projected surplus
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	28,082	42,915	Projected surplus – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-16, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.16.1 The City of Wilson

4.5.16.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.16.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Wilson through 2060.

- Local groundwater development beginning in 2011 needed to supply an additional 127 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately two miles from the City of Wilson into which the city could locate new municipal water supply wells, and
- Purchase water from the City of Lubbock.

4.5.16.1.3 Costs

Costs of the recommended plan for the City of Wilson to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-46
   - Date to be Implemented: 2011
   - Total Project Cost: $276,408
   - Annual Cost: See Table 4.5-68 for a cost summary of this option.

b. Purchase from Lubbock
   - Cost Source: Estimated by City of Wilson
   - Date to be Implemented: 2007
   - Total Cost:
   - Annual Cost: See Table 4.5-68 for a cost summary of this option.

Table 4.5-68.
Recommended Plan Costs by Decade for the City of Wilson

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	68	65	63	60	55
Local Groundwater Development						
Quantity Available (acft/yr)	—	193	174	157	141	127
Annual Cost ($/yr)	—	$32,947	$32,947	$32,947	$12,866	$12,866
Unit Cost ($/acft)	—	$171	$189	$210	$91	$101
Purchase from Lubbock						
Quantity Available (acft/yr)	61	61	16	61	61	61
Annual Cost ($/yr)	43,250	43,250	43,250	17,750	17,750	17,750
Unit Cost ($/acft)	$709	$709	$709	$291	$291	$291

4.5.16.2 Irrigation

4.5.16.2.1 Description of Supply

- **Source:** Ogallala and Edwards-Trinity Aquifers, and Reclaimed Water
- **Current Supply:** 132,810 acft/yr in 2000 declining to 129,302 acft/yr in 2060.

4.5.16.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Lynn County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Lynn County irrigation farmers (Section 4.4.1.2) even though there is no projected need (shortage) during the planning period. Irrigation water conservation will contribute to extending the future life of the aquifer in the county.

4.5.16.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $12,000,000
   - Annual Cost: $940,000; including debt service at 25 yrs useful life of systems (Table 4.5-69).

Table 4.5-69.
Recommended Plan Costs by Decade for Irrigation – Lynn County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	0	0	0	0	0	0
Irrigation Conservation Quantity (acft/yr)	18,814	16,933	15,240	13,716	12,344	11,110
Annual Cost (million dollars/yr) (Table 4.4-11)	0.94	0.94	.094	0.94	0.94	0.94
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.17 Motley County Water Supply Plan

Table 4.5-70 lists each water user group in Motley County and their corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-70.
Motley County Surplus/Shortage

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Matador	0	0	No projected surplus/shortage
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-1,208	-1,025	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-17, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.17.1 The City of Matador

4.5.17.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands through 2060.

4.5.17.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Matador.

- Municipal water conservation.

4.5.17.1.3 Costs

Costs of the recommended plan for the City of Matador are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-71 for a cost summary of this option.

Table 4.5-71.
Recommended Plan Costs by Decade for the City of Matador

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation						
Quantity Available (acft/yr)	20	37	49	57	63	62
Annual Cost ($/yr)	$10,028	$16,265	$20,641	$23,283	$25,752	$25,161
Unit Cost ($/acft)	$498	$442	$422	$412	$406	$406

4.5.17.2 Irrigation

4.5.17.2.1 Description of Supply

- **Source:** Ogallala and Seymour Aquifers
- **Current Supply:** 12,097 acft/yr in 2000 declining to 6,616 acft/yr in 2060.

4.5.17.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Motley County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Motley County irrigation farmers (Section 4.4.1.2). however, information available indicates that practically all of the presently irrigated acreages are equipped with efficient application systems. Irrigation water conservation will contribute to extending the future life of the aquifer in the county.

4.5.17.3.3 Costs

a. Irrigation water conservation:

- Cost Source: Section 4.4.1.2, Table 4.4-11
- Date to be Implemented: Prior to 2010
- Total Cost: $000,000
- Annual Cost: $000,000; including debt service at 25 yrs useful life of systems (Table 4.5-72).

Table 4.5-72.
Recommended Plan Costs by Decade for Irrigation – Motley County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	1,332	1,266	1,208	1,154	1,092	1,025
Irrigation Conservation Quantity (acft/yr)	0	0	0	0	0	0
Annual Cost (million dollars/yr) (Table 4.4-11)	0.00	0.00	0.00	0.00	0.00	0.00
Unit Cost ($/acft) (Table 4.4-12)	0	0	0	0	0	0

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4.5.18 Parmer County Water Supply Plan

Table 4.5-73 lists each water user group in Parmer County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-73.
Parmer County Surplus/Shortage

Water User Group	*Surplus/Shortage*[1] *2030 (acft/yr)*	*Surplus/Shortage*[1] *2060 (acft/yr)*	*Comment*
City of Bovina	0	0	No projected surplus/shortage
City of Farwell	-410	-371	Projected shortage – see plan below
City of Friona	-879	-791	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected demand
Irrigation	-361,917	-350,632	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-18, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.18.1 The City of Farwell

4.5.18.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.18.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Farwell through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2015 needed to supply an additional 265 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Farwell into which the city could locate new municipal water supply wells.

4.5.18.1.3 Costs

Costs of the recommended plan for the City of Farwell to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-74 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-22
   - Date to be Implemented: 2015
   - Total Project Cost: $619,608
   - Annual Cost: See Table 4.5-74 for a cost summary of this option.

Table 4.5-74.
Recommended Plan Costs by Decade for the City of Farwell

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	405	410	408	393	371
Municipal Water Conservation						
Quantity Available (acft/yr)	33	64	94	101	97	91
Annual Cost ($/yr)	$16,995	$28,613	$39,744	$42,015	$39,726	$37,532
Unit Cost ($/acft)	$520	$448	$424	$414	$412	$412
Local Groundwater Development						
Quantity Available (acft/yr)	—	404	363	327	294	265
Annual Cost ($/yr)	—	$71,353	$71,353	$71,353	$26,339	$26,339
Unit Cost ($/acft)	—	$177	$197	$218	$90	$99

4.5.18.2 The City of Friona

4.5.18.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

4.5.18.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Friona through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2010 needed to supply an additional 971 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 4 miles from the City of Friona into which the city could locate new municipal water supply wells.

4.5.18.2.3 Costs

Costs of the recommended plan for the City of Friona to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-75 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-23
   - Date to be Implemented: 2010
   - Total Project Cost: $1,615,812
   - Annual Cost: See Table 4.5-75 for a cost summary of this option.

Table 4.5-75.
Recommended Plan Costs by Decade for the City of Friona

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	0	879	870	838	791
Municipal Water Conservation						
Quantity Available (acft/yr)	46	34	20	5	0	0
Annual Cost ($/yr)	$25,727	$19,130	$11,206	$2,821	-	-
Unit Cost ($/acft)	$561	$561	$561	$561	-	-
Local Groundwater Development						
Quantity Available (acft/yr)	121	549	1,332	1,198	1,079	971
Annual Cost ($/yr)	$86,462	$125,701	$204,177	$132,618	$117,341	$86,788
Unit Cost ($/acft)	$715	$229	$153	$111	$109	$89

4.5.18.3 Irrigation

4.5.18.4.1 Description of Supply

- **Source:** Ogallala Aquifer and Reclaimed Water
- **Current Supply:** 419,139 acft/yr in 2000 declining to 39,225 acft/yr in 2060.

4.5.18.4.2 Water Supply Plan

The use of irrigation BMPs in the past in Parmer County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Parmer County irrigation farmers (Section 4.4.1.2). However, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.18.3.3 Costs

a. Irrigation water conservation:
    - Cost Source: Section 4.4.1.2, Table 4.4-11
    - Date to be Implemented: Prior to 2010
    - Total Cost: $15,240,000
    - Annual Cost: $1,190,000; including debt service at 25 yrs useful life of systems (Table 4.5-76).

Table 4.5-76.
Recommended Plan Costs by Decade for Irrigation – Parmer County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	160,682	331,096	361,917	358,080	354,283	350,632
Irrigation Conservation Quantity (acft/yr)	23,900	21,510	19,359	17,423	15,681	14,113
Annual Cost (million dollars/yr) (Table 4.4-11)	1.19	1.19	1.19	1.19	1.19	1.19
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.19 Swisher County Water Supply Plan

Table 4.5-77 lists each water user group in Swisher County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-77.
Swisher County Surplus/Shortage

Water User Group	*Surplus/Shortage*[1]		*Comment*
	2030 (acft/yr)	*2060 (acft/yr)*	
City of Happy	0	0	No projected surplus/shortage
City of Kress	-105	-96	Projected shortage – see plan below
City of Tulia	-416	-417	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected demand
Mining	0	0	No projected demand
Irrigation	-95,896	-107,552	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-19, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.19.1 The City of Kress

4.5.19.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

4.5.19.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Kress through 2060.

- Local groundwater development beginning in 2006 needed to supply an additional 120 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately six miles from the City of Kress into which the city could locate new municipal water supply wells.

4.5.19.1.3 Costs

Costs of the recommended plan for the City of Kress to meet 2060 shortages are:

a. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-27
   - Date to be Implemented: 2006
   - Total Project Cost: $578,424
   - Annual Cost: See Table 4.5-78 for a cost summary of this option.

Table 4.5-78.
Recommended Plan Costs by Decade for the City of Kress

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	104	104	105	103	100	96
Local Groundwater Development						
Quantity Available (acft/yr)	204	184	165	149	134	120
Annual Cost ($/yr)	$57,634	$57,634	$57,634	$15,611	$15,611	$15,611
Unit Cost ($/acft)	$283	$313	$349	$105	$117	$130

4.5.19.2 The City of Tulia

4.5.19.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2005, at which time additional supplies will be needed.

4.5.19.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Tulia through 2060.

- Municipal water conservation; and
- Local groundwater development beginning in 2006 needed to supply an additional 510 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately four miles from the City of Tulia into which the city could locate new municipal water supply wells.

4.5.19.2.3 Costs

Costs of the recommended plan for the City of Tulia are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-79 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-45
   - Date to be Implemented: 2006
   - Total Project Cost: $992,160
   - Annual Cost: See Table 4.5-79 for a cost summary of this option.

Table 4.5-79.
Recommended Plan Costs by Decade for the City of Tulia

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	417	417	416	416	416	417
Municipal Water Conservation						
Quantity Available (acft/yr)	18	0	0	0	0	0
Annual Cost ($/yr)	$10,101	—	—	—	—	—
Unit Cost ($/acft)	$561	—	—	—	—	—
Local Groundwater Development						
Quantity Available (acft/yr)	864	778	700	630	567	510
Annual Cost ($/yr)	$133,310	$133,310	$133,310	$54,022	$54,022	$54,022
Unit Cost ($/acft)	$154	$171	$190	$86	$95	$106

4.5.19.3 Irrigation

4.5.19.3.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** 173,007 acft/yr in 2000 declining to 58,866 acft/yr in 2060.

4.5.19.3.2 Water Supply Plan

The use of irrigation BMPs in the past in Swisher County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Swisher County irrigation farmers (Section 4.4.1.2), which is projected to meet the irrigation needs through 2020. However, it is not economically feasible to meet all of the irrigation needs (shortages) beyond 2020, at this time.

4.5.19.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $48,750,000
   - Annual Cost: $3,810,000; including debt service at 25 yrs useful life of systems (Table 4.5-80).

Table 4.5-80.
Recommended Plan Costs by Decade for Irrigation – Swisher County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	22,755	60,445	95,896	104,407	107,622	107,552
Irrigation Conservation Quantity (acft/yr)	76,453	68.808	61,927	55,734	50,161	45,145
Annual Cost (million dollars/yr) (Table 4.4-11)	3.81	3.81	3.81	.3.81	3.81	3.81
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

4.5.20 Terry County Water Supply Plan

Table 4.5-81 lists each water user group in Terry County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-81.
Terry County Surplus/Shortage

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Brownfield	-280	-457	Projected shortage – see plan below
City of Meadow	0	0	No projected surplus/shortage
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected demand
Mining	0	0	No projected surplus/shortage
Irrigation	-101,339	-90,149	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-20, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.20.1 The City of Brownfield

4.5.20.1.1 Description of Supply

- **Source:** Ogallala Aquifer and Canadian River Municipal Water Authority
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.20.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Brownfield through 2060.

- Municipal water conservation,
- Expand supplies from CRMWA.

4.5.20.1.3 Costs

Costs of the recommended plan for the City of Brownfield to meet 2060 shortages are:

a. Municipal water conservation:
- Cost Source: Section 4.4.1, Table 4.4-7
- Date to be Implemented: Prior to 2010
- Annual Cost: See Table 4.5-82 for a cost summary of this option.

b. Expand Supplies from CRMWA:
- Cost Source: Section 4.4.3.5, Table 4.4-53
- Date to be Implemented: Prior to 2010
- Total Project Cost: Purchase at per acre-foot cost from CRMWA (Based on calculation of Brownfield share of CRMWA supply at 1.56 percent, or 494 acft/yr)
- Annual Cost: See Table 4.5-82 for a cost summary of this option.

Table 4.5-82.
Recommended Plan Costs by Decade for the City of Brownfield

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	115	280	435	458	457
Municipal Water Conservation						
Quantity Available (acft/yr)	211	448	687	802	793	788
Annual Cost ($/yr)	$108,354	$199,174	$289,463	$329,799	$323,839	$322,040
Unit Cost ($/acft)	$514	$444	$421	$411	$408	$408
Expand Supplies from CRMWA *						
Quantity Available (acft/yr)*	494	494	494	494	494	494
Annual Cost ($/yr)*	% of total	%	%	%	%	% of total
Unit Cost ($/acft)*	$216	$216	$216	$216	$216	$216
* See 4.5.20.1.3 c, above.						

4.5.20.2 Irrigation

4.5.20.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** 184,848 acft/yr in 2000 declining to 57,984 acft/yr in 2060.

4.5.20.2.2 Water Supply Plan

The use of irrigation BMPs in the past in Terry County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Terry County irrigation farmers (Section 4.4.1.2), however, information available indicates that nearly all of presently irrigated acres are equipped with efficient application systems, thus, there is very little potential for additional irrigation conservation through use of this water management strategy. As is the case elsewhere in Region O, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.20.3.3 Costs

a. Irrigation water conservation:
   - Cost Source: Section 4.4.1.2, Table 4.4-11
   - Date to be Implemented: Prior to 2010
   - Total Cost: $1,360,000
   - Annual Cost: $100,000; including debt service at 25 yrs useful life of systems (Table 4.5-83).

Table 4.5-83.
Recommended Plan Costs by Decade for Irrigation – Terry County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	74,855	92,101	101,339	106,651	98,164	90,149
Irrigation Conservation Quantity (acft/yr)	2,135	1,922	1,729	1,556	1,401	1,261
Annual Cost (million dollars/yr) (Table 4.4-11)	0.10	0.10	0.10	0.10	0.10	0.10
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.21 Yoakum County Water Supply Plan

Table 4.5-84 lists each water user group in Yoakum County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-84.
Yoakum County Surplus/Shortage

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Denver City	-1,172	-1,141	Projected shortage – see plan below
City of Plains	-468	-457	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected demand
Steam Electric	0	0	No projected surplus/shortage
Mining	0	0	No projected surplus/shortage
Irrigation	-21,868	-18,485	Projected shortage – see plan below
Beef Feedlot Livestock	0	0	No projected demand
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-21, Section 4.1 – Water Needs Projections by Water User Group.
* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.21.1 The City of Denver City

4.5.21.1.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2025, at which time additional supplies will be needed

4.5.21.1.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Denver City through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2021 needed to supply an additional 1,076 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately 14 miles from the City of Denver City into which the city could locate new municipal water supply wells.

4.5.21.1.3 Costs

Costs of the recommended plan for the City of Denver City to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-85 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-19
   - Date to be Implemented: 2021
   - Total Project Cost: $3,764,772
   - Annual Cost: See Table 4.5-85 for a cost summary of this option.

Table 4.5-85.
Recommended Plan Costs by Decade for the City of Denver City

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	1,172	1,220	1,181	1,141
Municipal Water Conservation						
Quantity Available (acft/yr)	77	169	179	171	160	155
Annual Cost ($/yr)	$41,299	$76,513	$78,094	$72,252	$66,984	$64,710
Unit Cost ($/acft)	$535	$452	$436	$423	$418	$418
Local Groundwater Development						
Quantity Available (acft/yr)	—	—	1,476	1,328	1,195	1,076
Annual Cost ($/yr)	—	—	$384,239	$384,239	$384,239	$110,728
Unit Cost ($/acft)	—	—	$260	$289	$322	$103

4.5.21.2 The City of Plains

4.5.21.2.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** Adequate to meet demands until approximately 2015, at which time additional supplies will be needed

4.5.21.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended to meet the projected shortages of the City of Plains through 2060.

- Municipal water conservation, and
- Local groundwater development beginning in 2012 needed to supply an additional 405 acft/yr in 2060. There appears to be adequate saturated thickness of the Ogallala Aquifer approximately three miles from the City of Plains into which the city could locate new municipal water supply wells.

4.5.21.2.3 Costs

Costs of the recommended plan for the City of Plains to meet 2060 shortages are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-86 for a cost summary of this option.

b. Local groundwater development (See Section 4.4.2 for scheduling and a cost summary of this option):
   - Cost Source: Section 4.4.2, Table 4.4-35
   - Date to be Implemented: 2012
   - Total Project Cost: $771,276
   - Annual Cost: See Table 4.5-86 for a cost summary of this option.

Table 4.5-86.
Recommended Plan Costs by Decade for the City of Plains

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	0	448	468	488	473	457
Municipal Water Conservation						
Quantity Available (acft/yr)	33	68	106	107	102	98
Annual Cost ($/yr)	$17,369	$30,599	$45,256	$44,414	$41,992	$40,576
Unit Cost ($/acft)	$523	$447	$425	$417	$414	$414
Local Groundwater Development						
Quantity Available (acft/yr)	—	618	556	501	451	405
Annual Cost ($/yr)	—	$95,448	$95,448	$95,448	$39,415	$39,415
Unit Cost ($/acft)	—	$154	$172	$191	$87	$97

4.5.21.3 Irrigation

4.5.21.3.1 Description of Supply

- **Source:** Ogallala Aquifer
- **Current Supply:** 127,273 acft/yr in 2000 declining to 76,183 acft/yr in 2060.

4.5.21.3.2 Water Supply Plan

The use of irrigation BMPs in the past in Yoakum County have increased water use efficiency and thereby contributed to maintaining levels of irrigation production in the region. The Irrigation Water Conservation Water Management Strategy is recommended for Yoakum County irrigation farmers (Section 4.4.1.2), however, information available indicates that nearly all of presently irrigated acres are equipped with efficient application systems, thus, there is very little potential for additional irrigation conservation through use of this water management strategy. As is the case elsewhere in Region O, it is not economically feasible to meet all of the irrigation needs (shortages) at this time.

4.5.21.3.3 Costs

a. Irrigation water conservation:
  - Cost Source: Section 4.4.1.2, Table 4.4-11
  - Date to be Implemented: Prior to 2010
  - Total Cost: $680,000

- Annual Cost: $50,000; including debt service at 25 yrs useful life of systems (Table 4.5-87).

Table 4.5-87.
Recommended Plan Costs by Decade for Irrigation – Yoakum County

Plan Element	2010	2020	2030	2040	2050	2060
Projected Irrigation Need (Shortage) (acft/yr)	23,779	22,744	21,868	20,553	19,434	18,485
Irrigation Conservation Quantity (acft/yr)	1,074	966	870	783	704	634
Annual Cost (million dollars/yr) (Table 4.4-11)	0.05	0.05	0.05	0.05	0.05	0.05
Unit Cost ($/acft) (Table 4.4-12)	50	55	62	68	76	84

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4.5.22 Water Supply Plans for Wholesale Water Providers

Table 4.5-88 lists each Wholesale Water Provider identified by the Llano Estacado RWPG and their corresponding surplus or shortage in years 2030 and 2060. Water supply plans have been developed for CRMWA, City of Lubbock, and WRMWD are described below. Mackenzie Municipal Water Authority is also projected have a shortage during the planning period; however no plan has been developed for this entity. Instead, a plan to develop locally available groundwater has been developed for each of the MMWA customers with a projected need.

Table 4.5-88.
Wholesale Water Provider Surplus/Shortage

Water User Group	*Surplus/Shortage[1]*		*Comment*
	2030 (acft/yr)	*2060 (acft/yr)*	
Canadian River Municipal Water Authority (CRMWA)	-7,028	-15,257	Projected shortage – see plan below
City of Lubbock	6,509	6,799	Projected surplus
Mackenzie Municipal Water Authority (MMWA)	-2,128	-1,936	Projected shortage – see comment above
White River Municipal Water District (WRMWD)	-686	-1,489	Projected shortage – see plan below

[1] From Table 4-23, Section 4.2 – Water Needs Projections by Major Water Provider.

4.5.22.1 Canadian River Municipal Water Authority (CRMWA)(See Section 4.4.3.5)

4.5.22.1.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Meredith System
- **Current Supply:** Adequate to meet demands through 2060.

4.5.22.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the CRMWA System.

- Expand Capacity of Groundwater Supply to meet needs of CRMWA customers in Regions O and A.

4.5.22.2.3 Costs

Costs of the recommended plan for CRMWA are:

- Cost Source: Section 4.4.3.5, Table 4.4-53
- Date to be Implemented: Prior to 2010
- Total Project Cost: $79,398,000
- Annual Cost: See Table 4.5-89 for a cost summary of this option.

Table 4.5-89.
Recommended Plan Costs by Decade for the Canadian River Municipal Water Authority

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	1,207	1,734	1,028	12,112	16,742	16,257
CRMWA Expand Groundwater Supply						
Quantity Available (acft/yr)	31,659	31,659	36,659	41,659	46,659	46,659
Annual Cost ($/yr) (millions)	$7.087	$7.087	$10.256	$6.189	$6.189	$4.487
Unit Cost ($/acft)	$224	$224	$280	$149	$133	$96

4.5.22.2 The City of Lubbock (See Sections 4.4.3 and 4.5.15.3)

4.5.22.2.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2060.

4.5.22.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Lubbock.

- Municipal water conservation, and
- Lake Alan Henry Pipeline
- City of Lubbock Well Field
- Lubbock Expand Bailey County Well Field
- CRMWA Expand Capacity of Groundwater Supply
- Lubbock Brackish Groundwater Desalination
- Jim Bertram Lake System Expansion, and
- Lubbock North Fork Scalping Operation.

4.5.22.2.3 Costs

Costs of the recommended plan for the City of Lubbock are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-90 for a cost summary of this option.

b. Lake Alan Henry Pipeline:
   - Cost Source: Section 4.4.3.2, Table 4.4-50
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $174,909,000
   - Annual Cost: See Table 4.5-90 for a cost summary of this option.

c. City of Lubbock Well Field:
   - Cost Source: Section 4.4.3.3, Table 4.4-51
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $7,718,000
   - Annual Cost: See Table 4.5-90 for a cost summary of this option.

d. Lubbock Expand Capacity of Bailey County Well Field
   - Cost Source: Section 4.4.3.4, Table 4.4-52
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $2,541,000
   - Annual Cost: See Table 4.5-90 for a cost summary of this option.

e. CRMWA Expand Capacity of Groundwater Supply
   - Cost Source: Section 4.4.3.5, table 4.4-53
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: ($79,398,000 to expand 31,659 acft/yr and add 15,000 acft/yr to replace lost capacity, annual cost is $10,255,800; Lubbock share of expansion is 37.058 percent of cost and quantity.)
   - Annual Cost: See Table 4.5-90 for a cost summary of this option.

f. Lubbock Brackish Groundwater Desalination
   - Cost Source: Section 4.4.3.6 table 4.4-54
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $10,051,230
   - Annual Cost: See Table 4.5-90 for a cost summary of this option.

g. Jim Bertram Lake System Expansion
   - Cost Source: Section 4.4.3.7, table 4.4-57
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $150,759,000

- Annual Cost: See Table 4.5-90 for a cost summary of this option.

h. Lubbock North Fork Scalping Operation
- Cost Source: Section 4.4.3.8, table 4.4-62
- Date to be Implemented: Prior to 2045
- Total Project Cost: $50,055,000
- Annual Cost: See Table 4.5-90 for a cost summary of this option.

Table 4.5-90.
Recommended Plan Costs by Decade for the City of Lubbock

Plan Element	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Projected Shortage (acft/yr)	0	0	0	0	1,519	1,223
Municipal Water Conservation (Strategy is included until the regional goal of 172 gpcd is reached)						
Quantity Available (acft/yr)	1,180	489	0	0	0	0
Annual Cost ($/yr)	$613,515	$254,508	—	—	—	—
Unit Cost ($/acft)	$520	$520	—	—	—	—
Lake Alan Henry Pipeline						
Quantity Available (acft/yr)	0	22,230	22,230	22,230	22,230	22,230
Annual Cost ($/yr) (millions)	—	$26.584	$26.584	$26.584	$26.584	$26.584
Unit Cost ($/acft)	—	$1,196	$1,196	$1,196	$1,196	$1,196
City of Lubbock Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr) (millions)	$1.644	$1.644	$1.644	$1.644	$1.644	$1.644
Unit Cost ($/acft)	$294	$294	$294	$294	$294	$294
Expand Bailey County Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr)	$213,000	$213,000	$213,000	$213,000	$213,000	$213,000
Unit Cost ($/acft)	$38	$38	$38	$38	$38	$38
CRMWA Expand Groundwater Supply (See 4.5.15.3.3e above)						
Quantity Available (acft/yr)	14,911	14,911	14,911	14,911	14,911	14,911
Annual Cost ($/yr) (millions)	$3.340	$3.340	$4.175	$2.222	$1.983	$1.431
Unit Cost ($/acft)*	$224	$224	$280	$149	$133	$96
Lubbock Brackish Groundwater Desalination						
Quantity Available (acft/yr)**	3,360	3,360	3,360	3,360	3,360	3,360
Annual Cost ($/yr) (millions)*	1.700	1.700	1.700	1.700	1.700	1.700
Unit Cost ($/acft)*	$506	$506	$506	$506	$506	$506

Lubbock Jim Bertram Lake System Expansion						
Quantity Available (acft/yr)**	—	21,200	21,200	21,200	21,200	21,200
Annual Cost ($/yr) (millions)*	—	$14.575	$14.575	$14.575	$14.575	$14.575
Unit Cost ($/acft)*	—	$688	$688	$688	$688	$688
Lubbock North Fork Scalping Operation						
Quantity Available (acft/yr)**	0	0	0	0	4,000	4,000
Annual Cost ($/yr) (millions)*	—	—	—	—	$4.296	$4.296
Unit Cost ($/acft)*	—	—	—	—	$1,074	$1,074

4.5.22.3 White River Municipal Water District (See Section 4.4.3.6)

4.5.22.3.1 Description of Supply

- **Source:** Reclaimed Water from Lubbock
- **Current Supply:** Adequate to meet demands through 2010.

4.5.22.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the White River Municipal Water District.

- Municipal water conservation, and
- Reclaimed Water, and
- Local groundwater development by 2010 on land owned by the District in Crosby County.

4.5.22.3.3 Costs

Costs of the recommended plan for the White River Municipal Water District are:

a. Reclaimed Water:
   - Cost Source: Section 4.4.3.9, table 4.4-64
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $29,746,680
   - Annual Cost: See Table 4.5-91 for a cost summary of this option.

b. Local groundwater development (see Section 4.4.3.7 for a cost summary of this option).

- Cost Source: Section 4.4.3.10, Table 4.4-65
- Date to be Implemented: 2010
- Total Project Cost: $813,000
- Annual Cost: See Table 4.5-91 for a cost summary of this option.

Table 4.5-91.
Recommended Plan Costs by Decade for the White River Municipal Water District*

Plan Element	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Projected Shortage (acft/yr)	0	0	0	0	0	0
Municipal Water Conservation (By Member Cities)						
Quantity Available (acft/yr)	21	42	54	50	48	48
Annual Cost ($/yr)	$11,331	$18,807	$23,019	$20,968	$19,601	$19,601
Unit Cost ($/acft)	$528	$452	$429	$420	$412	$412
Reclaimed Water*						
Quantity Available (acft/yr)	—	2,240	2,240	2,240	2,240	2,240
Annual Cost ($/yr) (millions)	—	$2.821	$2.821	$2.821	$2.821	$2.821
Unit Cost ($/acft)	—	$1,259	$1,259	$1,259	$1,259	$1,259
Local Groundwater Development						
Quantity Available (acft/yr)	—	7,742	7,742	7,742	7,742	7,742
Annual Cost ($/yr)	—	$310,000	$310,000	$310,000	$310,000	$310,000
Unit Cost ($/acft)	—	$40	$40	$40	$40	$40

* This water management strategy augments the quantity of water that can be obtained from White River Lake for diversion to the District's existing water treatment plant located at the lake. The purpose of the WMS is to maintain the District's capability to supply water to its member cities.

4.5.23 Region-Wide Water Management Strategies Included in the Llano Estacado Water Plan

4.5.23.1 Precipitation Enhancement (See Section 4.4.4.1 for a description of this option)

Weather modification is included in the Llano Estacado Regional Water Plan. Weather modification, or precipitation enhancement, has the potential to increase the quantity of water that would be available to all water user groups in the Llano Estacado Region, as well as reduce pumpage requirements from the Ogallala Aquifer. Several cloud seeding operations are being carried out in Texas, including the Southern Ogallala Rainfall Enhancement (SOAR) program, which includes 2.3 million acres in Gaines, Terry, and Yoakum Counties at an annual cost of $109,200, or 4.7 cents per acre per year.

Although available data and cloud seeding experience are not adequate to give reliable estimates of long-term increases in precipitation, the present information indicates that precipitation can be increased by cloud seeding. For the 3,593 square mile (2,300,000-acre) SOAR area, an increase in precipitation of one and one-half inches would result in an increase of about 287,500 acft of water per year to the land surface. At a cost of 4.7 cents per acre, the cost per acft of water is $0.38.

Additional precipitation during the growing season, which is the period during which present cloud seeding projects are operated, would directly and immediately benefit dryland and irrigated agriculture. Crop and grazing yields will be increased, irrigation water pumped from the Ogallala Aquifer can be reduced, and lawn irrigation can be reduced. The latter effect will contribute to meeting projected municipal water needs by reducing the quantities used per year from present supplies. Additionally, increased runoff could increase the water supply in public water supply reservoirs. An increase of water supply in playa lakes would increase natural recharge and provide water for wildlife.

4.5.23.2 Brush Control (See Section 4.4.4.2 for a description of this option)

Brush control is included in the Llano Estacado Regional Water Plan. Brush control could increase water supply in the Llano Estacado Region by increasing the runoff into lakes and reservoirs. The areas of the region where significant concentrations of brush occur are in the east “caprock counties” and in the western counties. In addition, there are approximately one million acres in the U.S. Department of Agriculture’s (USDA) Conservation Reserve Program (CRP) located within the region. As the current contracts with USDA expire on these CRP areas and as the USDA programs change, some of the land may be returned to cultivated row crops; however, some of the land is expected to remain in grass. If these grassland acres are not managed to prevent brush infestation, these areas could become brush covered and thereby further contribute to the brush problem of the region.

Of the 21 counties in the region, 13 counties meet the condition of having 50,000 or more acres of mesquite and shinnery oak combined. The counties located in the southwest corner of the region and along the caprock have the highest acreages of mesquite and shinnery oak and would primarily be the locations where brush control can be applied to increase water supplies. As has been demonstrated in Crosby County on the White River Reservoir watershed, brush control can contribute to increased inflows to a reservoir. The existing Alan Henry Reservoir and the proposed Post Reservoir are located in Garza County, which has over 185,000 acres of mesquite and shinnery oak. Brush control projects on the watersheds of these two reservoirs could result in increased firm yields and thereby contribute to the region's water supply.

The capital outlay to implement brush control upon 50 percent of the mesquite and shinnery oak infested acres in counties having more than 50,000 acres of these two species of brush is estimated at $40.78 million, with an annual cost of $2.74 million (see Section 4.4.4.2 for a discussion of costing assumptions and procedures). For example, if brush control were to be implemented on the Alan Henry Reservoir contributing watershed, the annual cost would be approximately $324,675. If the yield of the reservoir were increased by 10 percent, or 2,250 acft/yr, the cost per acft of raw water yield at the reservoir would be $144, or $0.44 per thousand gallons. The owners of the Alan Henry Reservoir and the proposed Post Reservoir should cooperate with the landowners of the watersheds and the Texas State Soil and Water Conservation Board to implement brush control on these watersheds.

4.5.23.3 Desalt Brackish Groundwater (See Section 4.4.4.3 for a description of this option)

Desalting brackish groundwater is included in the Llano Estacado Regional Water Plan. The potential source of water for this option is the Santa Rosa Aquifer of the Dockum Formation, which underlies the entire area of the Llano Estacado Water Planning Region. Data currently available indicate that the quality of water in the Santa Rosa in the majority of the planning region is unsuitable for most uses without treatment, including most municipal and irrigation uses. Water treatment costs are estimated at $303 to $369 per acft, depending upon brine concentration of the feedwater. Individual cities that need water could consider this source.

4.5.23.4 Post Reservoir (See Section 4.4.4.4 for a description of this option)

Post Reservoir is included in the Llano Estacado Regional Water Plan. The proposed Post Reservoir Project is located on the North Fork of the Double Mountain Fork of the Brazos River northeast of Post, Texas in Garza County. Post Reservoir could serve as a future water supply source for cities and industries in the eastern part of the planning area. The firm yield of Post Reservoir is 9,500 acft/yr. The cost of raw water at the reservoir is $231 per acft.

4.5.23.5 Research and Development of Drought Tolerant Crops and New Technology (See Section 4.4.4.5 for a description of this option)

Research and development of drought tolerant crops, new technology, and demonstration initiatives to expedite transfer of available technology to are included in the Llano Estacado Regional Water Plan. In addition, the Llano Estacado Regional Water Planning Group recommends that funding be continued at adequate levels to accomplish these objectives.

4.5.23.6 Reuse of Municipal Effluent (See Section 4.4.4.6 for a description of this option)

Of the total quantities of water used for municipal purposes, approximately 45 percent to 65 percent is returned to the respective municipal wastewater treatment plants for treatment and disposal. In the Llano Estacado Water Planning Region a large percentage of this treated effluent or reclaimed water is used for irrigation of open spaces, golf courses, and neighboring farmland. The quantity is between 45 percent and 65 percent of the quantity of municipal use and could be a significant source of water in the future for a number of uses, including perhaps municipal use, if treatment levels can be increased to the extent that the use of such water does not pose a health risk. The Llano Estacado Regional Water Planning Group recommends that funding be made available to universities, water districts, and the cities to further study the quantity of water available from this option and to study treatment technologies to make this option feasible for a larger number of uses.

4.5.23.7 Stormwater Capture and Use (See Section 4.4.4.7 for a description of this option)

In some cities of the Llano Estacado Water Planning Region disposal of stormwater has become a serious problem. Lubbock is one of the cities having this problem. Therefore, in this water-short region, it has become desirable to evaluate the possibility to capture, treat, as appropriate and needed, and use this water as a source of supply for non-potable as well as potable uses. The Llano Estacado Regional Water Planning Group recommends that funding be made available to the cities and water districts to further study the quantity of water available from this option and to study ways to successfully integrate flood protection, storage, and treatment, as needed, of this stormwater for useful purposes.

4.5.23.8 Agricultural Water Conservation Practices on Farms (See Section 4.4.1.2 for a description of this option)

Agricultural water conservation practices on farms are included in the Llano Estacado Regional Water Plan in order to sustain the present water supplies, enhance agricultural profitability, and enhance playa basins for wildlife habitat and aquifer recharge. In the Llano Estacado Region, both irrigation and non-irrigated, or dryland farming is projected. For the most part, the irrigated acreages are those acres lying above saturated sections of the Ogallala Formation that have sufficient quantities of water to justify drilling, equipping, and pumping irrigation wells. Such wells supply water that is used to supplement precipitation for crop production.

Irrigated and dryland farming attempt to maximize the efficiency of use of irrigation water and precipitation in the area. This is done through the use of Low Energy Precision Application (LEPA) and Low Pressure Sprinkler (LESA) irrigation systems, furrow diking, plant residue management, bench leveling, and terracing.

4.5.24 Public Education

Underground water conservation districts, cities, universities, the Texas Agricultural Extension Service and other water agencies will continue existing education and information dissemination programs. In addition, Llano Estacado Region water suppliers and agencies will build a strong cooperative relationship with formal and informal educators including the region's Educational Service Centers and Independent School Districts.

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4.5.25 Drought and Drought Response

Water supplies are included in Section 3 of the Llano Estacado Regional Water Plan as firm yields during drought of record for surface water sources, and dependable supplies during drought of record for groundwater sources, i.e., drought of record conditions underlie the calculations of water supply available from each source, included in Section 3 for each water user group. Therefore, each source of supply is for drought conditions. In addition, in accordance with requirements of SB 1, TCEQ has required retail water suppliers to prepare drought contingency plans. However, Texas Water Code Section 16.053(e)(3)(A) and 31 TAC 357.5(e)(7) require that for each source of water supply in the regional water planning area designated in accordance with 31 TAC 357.7(a)(1), the regional water plan shall identify: (A) factors specific to each source of water supply to be considered in determining whether to initiate a drought response, and (B) actions to be taken as part of the response.

Given that the major source of water for all uses in the Llano Estacado Region is the Ogallala Aquifer, with surface water from the Canadian River Municipal Water Authority, White River Municipal Water District, and Mackenzie Municipal Water Authority, for some municipal and industrial uses, the effects of drought are through increased demands upon the water supply facilities to provide larger quantities of water from each water supply source. For example, in the region, demands increase during droughts, placing ever-greater demands upon wells, pumps, motors, storage facilities, and the aquifer and surface water reservoirs. Therefore, the primary factor specific to each water supply is atmosphere conditions affecting precipitation, evaporation, and evapotranspiration. Thus, when atmospheric conditions result in: (1) reduced precipitation and (2) increased evaporation and evapotranspiration, the Llano Estacado Regional Water Plan recommendation is that drought response be initiated as described below.

Drought Trigger Conditions will be based on local atmospheric conditions using the currently available PET stations. For the purposes of this planning cycle, it is recommended that local precipitation be factored into the consideration of implementing a drought trigger. Recommended drought triggers are presented as follows.

4.5.25.1 Drought Triggers

Alert Stage of Drought: Precipitation at less than 50 percent of the 30 year average for the month and 55 percent of the 30 year average of the preceding twelve months.

Warning Stage of Drought: Precipitation at less than 25 percent of the 30 year average for the month and 45 percent of the 30 year average of the preceding twelve months.

The Llano Estacado Water Planning Area will be divided into geographical areas based on location of existing PET stations for drought trigger and response purposes. The current locations of a PET stations within Region O are Dimmitt, Earth, Farwell, Halfway, Lamesa, Lubbock, and Seminole.

The drought trigger and response zones in the Llano Estacado Water Planning Area are shown in Table 4.5-92.

Table 4.5-92.
Drought Trigger and Response Zones
in the Llano Estacado Water Planning Area

PET Stations	*Counties*
Dimmitt	Castro, Deaf Smith, and Swisher
Earth	Cochran and Lamb
Farwell	Bailey and Parmer
Halfway	Briscoe, Floyd, Hale, and Motley
Lamesa	Dawson, Garza, and Lynn
Lubbock	Crosby, Dickens, Hockley, and Lubbock
Seminole	Gaines, Terry, and Yoakum

4.5.25.2 Drought Response

As the LERWPG is a planning body only, with no implementation authority, it is emphasized that these drought triggers and responses are recommendations only. Since local public water suppliers and water districts are all required to have adopted a Drought Contingency Plan that contains drought responses unique to each specific entity, these entities are the only ones who have the authority to manage their particular water supply or area of authority. Therefore, the LERWPG recommends that these entities carry out their respective plans based upon the triggers listed above.

For example:

1. When the Alert Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the

relevant geographical area. Those entities exercise their authority to implement their own Drought Contingency Plans, as they deem necessary.

2. When the Warning Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the relevant geographical area. These entities exercise their authority to implement their own Drought Contingency Plans, as they deem necessary.

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Section 5
Impacts of Water Management Strategies on Key Parameters of Water Quality [31 TAC §357.7(a)(12)] and Impacts of Moving Water from Rural and Agricultural Areas [31 TAC §357.7(a)(8)(G)]

5.1 Impacts of Water Management Strategies on Key Parameters of Water Quality

In accordance with Regional Water Planning Guidelines 357.7(a)(12), at its November 20, 2003, meeting, the LERWPG identified the following list of key parameters of water quality as important to the use of the water resource:

- Chlorides;
- Sulfates;
- Nitrates;
- Flouride;
- Arsenic;
- Total Dissolved Solids (TDS);
- Dissolved Oxygen (DO);
- pH Range;
- Indicator Bacteria; and
- Temperature.

The uses of the water resources in the Llano Estacado Region were identified as follows:

- Recreation;
- Aquatic Life;
- Domestic Water Supply;
- Agriculture – Crop Irrigation ;
- Agriculture – Livestock Water; and
- Agribusiness.

The water management strategies included in the Regional Water Plan are:

- Municipal Water Conservation;
- Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Supply;
- Water Supply from Lake Alan Henry and Groundwater Sources;
- Precipitation Enhancement;

- Brush Control;
- Desalt Brackish Groundwater;
- Recovery of Capillary Water;
- Cistern Well Construction;
- Post Reservoir-Raw Water at the Reservoir;
- Research and Development of Drought Tolerant Crops and New Technology;
- Reuse of Municipal Effluent for Potable Water Supply; and
- Stormwater Capture, Treatment, and Use.

Municipal Water Conservation: The municipal water conservation water management strategy is projected to have the potential to meet approximately 3,163 acft/yr of municipal water demand in 2010, 6,435 acft/yr in 2030, and 7,672 acft/yr in 2060 (Table 4.4-6). This water management strategy would not affect the key water quality parameters listed above.

Water Supply from Nearby Groundwater Sources for Cities Projected to Need Additional Municipal Supply: This water management strategy involves the addition of water wells and/or well fields by 29 municipalities of the region. In most cases, this strategy is the expansion of municipal supplies from existing sources available to each respective city (Section 4.4.2). However, in some cases it will be necessary for the individual municipality to obtain locations for additional well fields in nearby locations. As was determined in the analyses, in all but three cases adequate saturated formation exists within a 2- to 5-mile radius of each city, respectively, to locate new well fields. For the other three, the distances are between 6 and 14 miles. In effect, this water management strategy is a continuation of existing practices which have shown no indication of affecting the water quality parameters listed above. In addition, the quality of the water available is suitable for the intended municipal use.

Water Supply from Lake Alan Henry and Groundwater Sources: The use of Lake Alan Henry water may have the potential to result in slight increases in chlorides, sulfates, and TDS in the downstream reaches of the stream on which it is located. The expansion of groundwater uses from wells in Lubbock, Lubbock's Bailey County well field, and other groundwater sources being sought by CRMWA would not be expected to affect the water quality parameters identified above.

Precipitation Enhancement: This strategy is an attempt to increase precipitation within parts of the Llano Estacado Region, and as such is not be expected to affect the water quality parameters identified above.

Brush Control: This strategy is an attempt to reduce the undesirable use of both ground and surface water by a range of woody species, and thereby increase the quantities of water available for all other uses. This strategy is not expected to affect the water quality parameters identified above.

Desalt Brackish Groundwater: This strategy relies upon the use of source water for municipal uses which is lower in quality than other source waters now being used and/or included in other water management strategies. The return flows of municipal effluent from the use of this water management strategy may be higher in chlorides, sulfates, and TDS, than return flows from other source waters now being used and/or included in other water management strategies, depending upon the level of demineralization of the brackish groundwater.

Post Reservoir–Raw Water at the Reservoir: This strategy would result in a new source of surface water, which is not expected to affect the water quality parameters listed above.

Research and Development of Drought-Tolerant Crops and New Technology: This strategy involves the invention of new water using or water using related technology and as such cannot be evaluated as to potential effects upon the water quality parameters listed above until the specified techniques are known.

Reuse of Municipal Effluent for Potable Water Supply: This strategy proposes to reuse municipal effluent whose quality is lower than the original source water. Therefore, the water will have to be demineralized before it can be used for potable purposes, and depending upon the degree of demineralization, would be expected to have higher concentrations of water quality constituents than presently used sources. The resulting return flows would also be higher in many of the water quality parameters listed above, including chlorides, sulfates, nitrates, and TDS.

Stormwater Capture, Treatment, and Use: As is the case with municipal effluent, this strategy proposes to capture, treat and make available for use stormwater for municipal uses within the region. The quality of stormwater depends upon the drainage areas from which it is captured. In the case of reservoirs such as Alan Henry and Post, the quality is usually high and is the type of water for which there is extensive, successful experience with treatment and use. In the case of stormwater runoff from urban areas, the quality may be poor due to transport of urban pollutants such as oil, grease, pesticides, insecticides, and bacteria. Treatment of such water will be required, and the quality of the resulting water and its return flows depends directly upon the degree of treatment given.

5.2 Impacts of Moving Water from Rural and Agricultural Areas

Total water use in the Llano Estacado Region in year 2000 was reported at 4.530 million acft, with projected demands of 3.704 million acft in 2060. Of the total projected demands, irrigated agriculture and livestock uses are more than 95 percent; with municipal use in the 2 to 2.5 percent range over the planning period. Supplies available are projected to decline from 4.66 million acft in 2000 to 1.478 million acft in 2060. Recommended water management strategies for municipal uses would result in the development of approximately16,204 acft/yr, or 0.768 percent of total supply available on an annual basis. Of this total, about 50 percent (8,102 acft/yr) would be from existing well fields that were obtained many years ago by municipalities for municipal uses, and about 50 percent (8,102 acft/yr) would be transferred from rural and agricultural areas to municipal areas through the acquisition of additional sites for well fields in approximately 12 to 15 widely dispersed locations near to the municipalities that acquire them. The impacts of these transfers are not considered to be significant to the local areas.

Section 6
Consolidated Water Conservation and Drought Management Recommendations for the Regional Water Plan
[31 TAC §357.7(a)(11)]

6.1 Municipal Water Conservation (See Section 4.4.1.1)

Municipal water conservation is included in the Llano Estacado Regional Water Plan. The objective of the municipal water conservation option is to reduce per capita water use at a rate of 1 percent per year for those municipalities with projected needs (shortages) until the municipality's per capita water use is at year 2000 region-wide average per capita water use of 172 gpcd. The potentials for municipal water conservation in addition to that expected from the continued use of low flow plumbing fixtures in the Llano Estacado Region are about 7,672 acft/yr, or 8.2 percent of the projected 2060 municipal demand. Although the potential is modest, it is very important that municipal water conservation continue to be emphasized through active public information and education programs in the public schools, through the media, and at the individual water utility levels. With respect to the latter, it is suggested that each water utility of the region measure its water distribution system leaks and unaccounted for water and set goals to bring this parameter into the 12 to 15 percent range. In addition, during droughts municipalities are expected to follow their respective Demand Management and Drought Contingency Plans and to practice additional water conservation, if needed.

6.2 Irrigation Water Conservation (See Section 4.4.1.2)

The use of agricultural water conservation BMPs on farms, and an irrigation water conservation water management strategy are included in the Llano Estacado Regional Water Plan in order to sustain the present water supplies, enhance agricultural profitability, and enhance playa basins for wildlife habitat and aquifer recharge. In the Llano Estacado Region, both irrigation and non-irrigated (dryland farming) is projected. For the most part, the irrigated acreages are those acres lying above saturated sections of the Ogallala aquifer that have sufficient quantities of water to justify drilling, equipping, and pumping irrigation wells. Such wells supply water that is used to supplement precipitation for crop production.

Irrigated and dryland farming attempts to maximize the efficiency of use of irrigation water and precipitation in the area. This is done through the use of Irrigation BMPs, including

LEPA and LESA irrigation systems, in conjunction with furrow diking and plant residue management.

6.3 Drought and Drought Response

Water supplies are included in Section 3 of the Llano Estacado Regional Water Plan as firm yields during drought of record for surface water sources, and dependable supplies during drought of record for groundwater sources (i.e., drought of record conditions underlie the calculations of water supply available from each source, included in Section 3 for each water user group). Therefore, each source of supply is for drought conditions. In addition, in accordance with requirements of Senate Bill 2, TCEQ has required retail water suppliers to prepare drought contingency plans.

Given that the major source of water for all uses in the Llano Estacado Region is the Ogallala Aquifer, with surface water from the Canadian River Municipal Water Authority, White River Municipal Water District, and Mackenzie Municipal Water Authority for some municipal and industrial uses, the effects of drought are through increased demands upon the water supply facilities to provide larger quantities of water from each water supply source. For example, in the region, demands increase during droughts, placing ever-greater demands upon wells, pumps, motors, storage facilities, and the aquifer and surface water reservoirs. Therefore, the primary factor specific to each water supply is atmosphere conditions affecting precipitation, evaporation, and evapotranspiration. Thus, when atmospheric conditions result in: (1) reduced precipitation and (2) increased evaporation and evapotranspiration, the Llano Estacado Regional Water Plan recommendation is that drought response be initiated as described below.

Drought Trigger Conditions will be based on local atmospheric conditions using the currently available PET stations. For the purposes of this planning cycle, it is recommended that local precipitation be factored into the consideration of implementing a drought trigger. Recommended drought triggers are presented as follows.

- **Alert Stage of Drought**: Precipitation at less than 50 percent of the 30-year average for the month and 55 percent of the 30-year average of the preceding 12 months.
- **Warning Stage of Drought**: Precipitation at less than 25 percent of the 30-year average for the month and 45 percent of the 30-year average of the preceding 12 months.

The Llano Estacado Water Planning Area is divided into geographical areas based upon location of existing PET stations for drought trigger and response purposes. The current locations of PET stations within Region O are Dimmitt, Earth, Farwell, Halfway, Lamesa, Lubbock, and Seminole. The drought trigger and response zones in the Llano Estacado Water Planning Area are shown in Table 6-1.

Table 6-1.
Drought Trigger and Response Zones
in the Llano Estacado Water Planning Area

PET Stations	***Counties***
Dimmitt	Castro, Deaf Smith, and Swisher
Earth	Cochran and Lamb
Farwell	Bailey and Parmer
Halfway	Briscoe, Floyd, Hale, and Motley
Lamesa	Dawson, Garza, and Lynn
Lubbock	Crosby, Dickens, Hockley, and Lubbock
Seminole	Gaines, Terry, and Yoakum

6.4 Drought Response

As the LERWPG is a planning body only, with no implementation authority, it is emphasized that these drought triggers and responses are recommendations only. Since local public water suppliers and water districts are all required to have adopted a Drought Contingency Plan that contains drought responses unique to each specific entity, these entities are the only ones who have the authority to manage their particular water supply or area of authority. Therefore, the LERWPG recommends that these entities carry out their respective plans based upon the triggers listed above. For Example:

When the Alert Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the relevant geographical area. Those entities exercise their authority to implement their own Drought Contingency Plans, as they deem necessary.

When the Warning Stage Drought Conditions have been triggered as described above, the (RELEVANT BODY, COMMITTEE, ETC.) will notify all affected entities in the relevant geographical area. It is recommended that these entities exercise their respective authority(ies) to implement their own Drought Contingency Plans, as they deem necessary.

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Section 7
Consistency with Long-Term Protection of the State's Water Resources, Agricultural Resources, and Natural Resources [31 TAC §357.7(a)(13) and §357.14(2)(C)]

The 2006 Llano Estacado Regional Water Plan (2006 Plan) is consistent with long-term protection of the state's water resources, agricultural resources, and natural resources and is developed based on guidance principles outlined in the Texas Administrative Code Chapter 358-State Water Planning Guidelines. The 2006 Plan was produced with an understanding of the importance of orderly development, management, and conservation of water resources and is consistent with laws applicable to water use for the state and regional water planning areas. In the case of groundwater, the 2006 Plan recognizes principles for groundwater use in Texas and the programs of groundwater conservation districts within the Llano Estacado Region. The rules of groundwater conservation districts in the region and the programs of water conservation districts were followed when determining groundwater availability.

The 2006 Plan identifies actions and policies necessary to meet the Region's projected municipal, industrial, steam-electric power, mining, and livestock needs, by developing and recommending water management strategies to meet their needs with reasonable cost, and good water quality. However, even with an irrigation water conservation water management strategy, it was not possible to meet all of the projected needs of irrigated agriculture. A socioeconomic impact analysis was performed to estimate the economic loss associated with not meeting these needs (Appendix C).

The 2006 Plan considered environmental information resulting from site-specific studies and ongoing water development projects when evaluating water management strategies. A list of endangered and threatened species in the Llano Estacado Region for each county was obtained from the U.S. Fish and Wildlife Service and these possible habitats were considered for each water management strategy (Appendix A).

The 2006 Plan consists of water conservation initiatives, and initiatives to respond to drought conditions by the municipal water user group, and the use of water conservation best BMPs in the irrigation water use group was described in terms of how these BMPs have resulted in high water use efficiency by this WUG.

The LERWPG conducted numerous meetings during the 2006 planning cycle, with meetings open to the public, and the LERWPG's decisions were based upon the best available information. The Region coordinated water planning and management activities with local, regional, state, and federal agencies and cooperated with Region A (Panhandle Region) to identify common needs. The LERWPG considered recommendations of stream segments with unique ecological value by Texas Parks and Wildlife. At this time, the LERWPG recommends that no stream segments or reservoir sites with unique ecological value be designated. The Planning Group developed policy recommendations for the 2006 Plan including improved water demand and water supply data, continued support for the Rule of Capture as modified by the Rules and Regulations of existing underground water conservation districts, continued funding for regional water planning, and especially that the Legislature provide adequate funding for the implementation of water management strategies of the plan.

Section 8
Unique Stream Segments/Reservoir Sites/ Legislative Recommendations
[31 TAC §357.7(a)(8-9); 31 TAC §357.8; and 31 TAC §357.9]

8.1 Identification of Unique Ecological Stream Segments and Reservoir Sites

The Texas Parks and Wildlife Department identified three stream segments in the Llano Estacado Region that it has classified as ecologically significant. Two pass through Caprock Canyons State Park in Briscoe County. They are: (1) North Prong Little Red River, and (2) South Prong Little Red River. The third is Prairie Dog Town Fork Red River from SH 70 crossing at the Briscoe/Hall County line upstream to the Briscoe/Armstrong County line.

The Llano Estacado Regional Water Planning Group did not elect to identify any unique ecological stream segments or reservoir sites in the region.

8.2 Legislative and Administrative Recommendations

1. The Llano Estacado Regional Water Planning Group urges the Legislature to continue the regional water planning effort with adequate funding to continue to:
   a. Pay the administrative costs associated with the regional water planning effort;
   b. Pay for the collection, assimilation, and analysis of basic data needed to assess the ground and surface water resources of each planning region of the state to a 90 percent accuracy level;
   c. Pay for the development and maintenance of a basic data network adequate to maintain a current inventory of the ground and surface water resources of the state;
   d. Pay for development and maintenance of computer models that will utilize the data described in "b" and "c" above to quantify the groundwater resources in each aquifer in the state and project future availability based on historical net changes in storage (i.e., the average annual net change in storage that occurred during the past 10 years, plus any known increases in water use or decrease in water use that may be achieved through conservation efforts). This should provide a reasonably accurate estimate of future water availability when used in the model projections. Using net depletion eliminates the need to use estimates of pumpage and natural recharge, neither of which are well documented and can easily be over- or underestimated; and
   e. Pay for costs associated with ongoing efforts to educate the public about the regional water planning process, water management strategies, and conservation needed within the 16 respective water planning regions.

2. The Llano Estacado Regional Water Planning Group urges the Legislature to authorize and provide funding for the following water conservation programs and activities:

    a. Implementation of a statewide public awareness program for water conservation;

    b. Implementation of a tiered local/regional/statewide public recognition program for water conservation achievements;

    c. Establishment by the Texas Water Development Board of a Water Conservation Advisory Council and a water conservation resource library; and

    d. Provision of funding for water conservation incentives for all water user groups – agriculture, municipal and industrial.

3. The Llano Estacado Regional Water Planning Group urges the Texas Water Development Board to develop standardized methodologies, definitions, and data for characterizing and computing per capita daily water use (gpcd) that will ultimately allow municipalities and other public water suppliers to set realistic, meaningful, and achievable local water conservation targets and goals. To be of any value it is imperative that the methodologies be able to recognize demographics, climate, hydrology, geology, and other local and regional factors.

4. The Llano Estacado Regional Water Planning Group urges the Texas Water Development Board to make major improvements in the accuracy of irrigation and livestock water use/demand information needed for regional water planning purposes.

5. The Llano Estacado Regional Water Planning Group concurs with the Legislature that underground water conservation districts are the preferred method of managing groundwater in the State of Texas.

6. The Llano Estacado Regional Water Planning Group urges the Legislature not to empower the regional planning groups with any water management, regulatory or legislative authority.

7. The Llano Estacado Regional Water Planning Group supports the creation and operation of underground water conservation districts that are organized and function under Chapter 36 of the Texas Water Code.

8. The Llano Estacado Regional Water Planning Group supports the Rule of Capture as modified by the Rules and Regulations of existing underground water conservation districts.

9. The Llano Estacado Regional Water Planning Group does not support a transport fee for surface or groundwater transported within the State of Texas.

10. The Llano Estacado Regional Water Planning Group recommends a modification of the SB1 restrictions on TWDB financing and TCEQ permitting to include "alternative water management strategies," provided that the alternatives are

developed under the same evaluation criteria as selected strategies and the alternatives are included in the RWPG's adopted regional water plan.

11. The Llano Estacado Regional Water Planning Group recommends funding research programs and studies to achieve a better understanding of the recharge mechanisms of the Ogallala Aquifer, including the role(s) of playas, as follows:
    a. Identification and quantification of the recharge mechanisms for the Ogallala; and
    b. Identification and description of the impact of playa basin siltation on recharge.
12. The Llano Estacado Regional Water Planning Group urges the Texas Parks & Wildlife Department, federal and state agencies, the Playa Lakes Joint Venture and other habitat and wildlife organizations to pursue rehabilitation of playa basins in the Southern High Plains of Texas through silt removal and habitat management on the property of willing, cooperating landowners.
13. The Llano Estacado Regional Water Planning Group supports and encourages the development and voluntary use of Best Management Practices to improve recharge and to protect playa basins from siltation, including creation and preservation of native grass buffers on land surrounding playas to maintain their water holding capacity.
14. The Llano Estacado Regional Water Planning Group supports the practice of controlling aquatic vegetation as a water conservation practice, and particularly supports and encourages the Canadian River Municipal Water Authority's efforts of controlling salt cedar along the Canadian River drainage above Lake Meredith as a means to increase water flow to the reservoir for water supply and environmental purposes. Further, the Planning Group encourages similar controls be applied to other watersheds of the Region, including those of Lakes Mackenzie, White River, and Alan Henry.
15. The Llano Estacado Regional Water Planning Group supports voluntary protection of springs and seeps as they exist and encourages landowners to use best management practices to maintain remnant springs and seeps in the region.
16. The Llano Estacado Regional Water Planning Group supports and encourages the continued use of working groups of ranching and farming organizations, environmental groups, state and federal biologists and private landowners to arrive at best management practices to conserve and manage species proposed for listing as threatened or endangered.
17. The Llano Estacado Regional Water Planning Group recommends that the Legislature provide adequate funding for the implementation of water management strategies in the plan, including loans for public water supplies, precipitation enhancement, brush management, water conservation, and research and development of drought tolerant species and more efficient irrigation technology.

18. The Llano Estacado Regional Water Planning Group recommends that the Panhandle Regional Water Planning Group (Region A) join with Region O in a cooperative effort to develop a “groundwater supply water management strategy” in both Region O and Region A, such effort to be planned and performed during the first year of the next planning cycle. The LERWPG further recommends that the completed “groundwater supply water management strategy” be considered as an amendment to each respective Regional Water Plan.

Section 9
Report to the Legislature on Water Infrastructure Funding Recommendations [31 TAC §357.7(a)(14)]

9.1 Introduction

Senate Bill 2 (77th Texas Legislature) requires that an Infrastructure Financing Report (IFR) be incorporated into the regional water planning process. In order to meet this requirement, each regional water planning group (RWPG) is required to examine the funding needed to implement the water management strategies and projects identified and recommended in the region's January 2006 regional water plan.

9.2 Objectives of the Infrastructure Financing Report

The primary objectives of the Infrastructure Financing Report are as follows:

- To determine the financing options proposed by political subdivisions to meet future water infrastructure needs (including the identification of any State funding sources considered); and
- To determine what role(s) the RWPGs propose for the State in financing the recommended water supply projects.

9.3 Methods and Procedures

For the Llano Estacado Water Planning Area, all municipal water user groups having water needs and recommended water management strategies in the regional plan with an associated capital cost were surveyed using the questionnaire provided by the TWDB (Appendix H). For individual cities the survey was mailed to either the mayor or the city manager.

The surveys were mailed via first class U.S. Mail, along with supporting documentation that summarized the water management strategies included in the regional plan for that entity. One follow-up telephone contact was made with each political subdivision surveyed that did not respond by the due date.

9.4 Survey Responses

The Llano Estacado RWPG mailed survey packages to 34 municipal water user groups and received 18 responses, a 53 percent response rate. Copies of the completed surveys and related documentation are included in Appendix I. As shown in Table 9-1, the 18 responses represent about 91 percent of the estimated capital costs of water management strategies included in the Regional Water Plan. Of those responding, for which total capital costs are $471,981,397, the survey shows that $624,442 (0.1 percent of the total capital costs) would be paid from local cash reserves. Approximately $456.3 million (88 percent of the total capital costs) would be financed through bonds, $8.1 million (1.6 percent of the total capital costs) would be paid with Federal Government programs, $6.4 million (1.2 percent of the total capital costs) would be financed through State Government programs, and $484,775 (0.1 percent of the total capital costs) would be financed through other means. Some entities did not provide quantifiable responses to the survey due to concerns about data accuracy and the potential for the amounts given to be taken out of context. It is also important to note that it is unclear how the remaining nine percent of the capital costs ($46,157,153) (for those entities not responding) would be financed. Table 9-2 provides a brief summary of responses from all utilities that provided written comments.

With respect to the role of the State in financing the recommended water supply projects, the Llano Estacado Regional Water Planning Group recommends that the Legislature provide adequate funding for the implementation of water management strategies in the plan, including loans for public water supplies (see Section 8, Number 17).

Table 9-1.
Summary of Survey Responses

Name of Political Subdivision	Recommended Project/Strategy	Implementation Date	Capital Cost to be paid by Political Subdivision)	Planning on Implementing the recommended Strategy? (Y/N)	% Cash Reserves	% Bonds	% Bank Loans	% Government Programs - Federal	% Government Programs - State	% Other
Canadian River MWA	CRMWA Expand Groundwater Suppl	2007	$ 59,052,000	Y	$0	$59,052,000	$0	$0	$0	$0
City of Dimmitt	Local Groundwater Development	2015	$ 3,405,336	Y	$0	$0	$0	$3,405,336	$0	$0
City of Farwell	Local Groundwater Development	2015	$ 619,608	Y	$61,961	$185,882	$0	$117,726	$0	$254,039
City of Friona	Local Groundwater Development	2007	$ 1,615,812	Y	$0	$1,373,440	$0	$242,372	$0	$0
City of Idalou	Local Groundwater Development	2035	$ 596,508	Y	$0	$149,127	$0	$0	$447,381	$0
City of Kress	Local Groundwater Development	2007	$ 578,424	Y	$0	$491,660	$0	$86,764	$0	$0
City of Lorenzo	Local Groundwater Development	2025	$ 276,408	Y	$0	$0	$0	$138,204	$138,204	$0
City of Lubbock	Lake Alan Henry Pipeline	2045	$174,909,000	Y	$0	$174,909,000	$0	$0	$0	$0
City of Lubbock	City of Lubbock Wellfield	2007	$ 7,718,000	Y	$0	$7,718,000	$0	$0	$0	$0
City of Lubbock	Lubbock Expand Capacity of Baily County Well Field	2007	$ 2,541,000	Y	$0	$2,541,000	$0	$0	$0	$0
City of Lubbock	Brackish Groundwater Desalination	2010	$ 6,894,600	Y	$0	$6,894,600	$0	$0	$0	$0
City of Lubbock	Jim Bertram Lake System Expansion	2020	$150,759,000	Y	$0	$150,759,000	$0	$0	$0	$0
City of Lubbock	North Fork Scalping Operation	2020	$ 50,055,000	Y	$0	$50,055,000	$0	$0	$0	$0
City of Morton	Local Groundwater Development	2015	$ 922,944	Y	$230,736	$0	$0	$230,736	$230,736	$230,736
City of Olton	Local Groundwater Development	2025	$ 922,944	Y	$184,589	$0	$0	$369,178	$369,178	$0
City of Petersburg	Local Groundwater Development	2045	$ 265,452	Y	$26,545	$0	$0	$26,545	$212,362	$0
City of Ropesville	Local Groundwater Development	2025	$ 276,408	Y	$27,641	$0	$0	$248,767	$0	$0
City of Shallowater	Local Groundwater Development	2007	$ 375,804	N	$0	$0	$0	$0	$0	$0
City of Sudan	Local Groundwater Development	2015	$ 596,508	N	$0	$0	$0	$0	$0	$0
City of Sundown	Local Groundwater Development	2015	$ 753,720	Y	$0	$256,265	$0	$248,728	$248,728	$0
City of Wilson	Local Groundwater Development	2015	$ 276,408	Y	$13,820	$0	$0	$262,588	$0	$0
City of Wolfforth	Local Groundwater Development	2007	$ 3,957,513	Y	$79,150	$1,978,757	$0	$0	$1,899,606	$0
Lake Alan Henry WSD	Supply from Lake Alan Henry	2007	$ 5,613,000	Y	$0	$0	$0	$2,806,500	$2,806,500	$0
		Totals	**$472,981,397**		**$624,442**	**$456,363,731**	**$0**	**$8,183,442**	**$6,352,694**	**$484,775**
DID NOT RESPOND										
City of Abernathy	Local Groundwater Development	2015	$ 2,974,092							
City of Amherst	Local Groundwater Development	2015	$ 840,213							
City of Anton	Local Groundwater Development	2007	$ 1,055,736							
City of Bovina	Local Groundwater Development	2015	$ 904,728							
City of Denver City	Local Groundwater Development	2025	$ 3,764,772							
City of Earth	Local Groundwater Development	2035	$ 619,608							
City of Hale Center	Local Groundwater Development	2025	$ 1,224,828							
City of Hart	Local Groundwater Development	2045	$ 509,256							
City of Lockney	Local Groundwater Development	2025	$ 276,408							
City of New Deal	Local Groundwater Development	2015	$ 427,416							
City of Plains	Local Groundwater Development	2015	$ 771,276							
City of Plainview	Local Groundwater Development	2015	$ 528,000							
City of Ralls	Local Groundwater Development	2025	$ 275,408							
City of Seagraves	Local Groundwater Development	2007	$ 1,224,828							
City of Smyer	Local Groundwater Development	2055	$ 200,904							
White River MWD	Reclaimed Water	2015	$ 29,746,680							
White River MWD	Local Groundwater Development	2015	$ 813,000							
		Total	**$ 46,157,153**							

Table 9-2.
Survey Responses — Comments and Proposed Options
Llano Estacado Regional Water Planning Area

FRIONA	The TWDB will be consulted for possible funding for water supply development.
IDALOU	Possibly use the State Revolving Fund to fund 100% of the projects. The City could also use general obligation bonds if the interest rate was lower.
KRESS	The City of Kress is currently working on two water well projects. If completed, this will add two wells for a total of 5 wells. Additional wells on one well site may be possible.
OLTON	A TCDP grant will require a 10% minimum match.
PETERSBURG	Possibly use the Office of Rural Community Affairs to

	provide financing.
ROPESVILLE	Will use a government grant with match.
SHALLOWATER	The City of Shallowater is pursing an agreement with the City of Lubbock to purchase water.

Section 10
Adoption of Plan
[31 TAC §357.11-12]

10.1 Public Involvement Program

Public involvement was begun at the start of the Llano Estacado regional water planning process to allow ample opportunity for public input into the process of developing the regional water plan, as well as opportunity to review and comment upon the Initially Prepared Plan.

Since the adoption of the 2001 Plan, the High Plains Underground Water Conservation District No. 1 continues to provide public information about the regional water planning process during the current 5-year planning cycle (2001 to 2006). The public information activities are described and listed below.

The LERWPG's website (www.llanoplan.org) is and continues to be the primary method of distributing information to the public. The site contains the LERWPG mission statement; a list and map of the counties within the region; agendas for all meetings in 2002-2005; minutes of all meetings in 2002-2005; a list of the planning group members, their respective e-mail addresses, and the water user groups they represent; a list of LERWPG committees; the 2001 approved regional water management plan; 2001 suggested water management strategies; other related information, such as websites for other regional water planning groups in Texas; a request form for publications, such as *Soils of the Llano Estacado Region* and *Conservation Tillage Within The LERWPG*; and an online form to provide feedback to the webmaster. This regularly updated site has received more than 1,400 visits since it received a major makeover on October 7, 2004.

The High Plains Underground Water Conservation District No. 1 website (www.hpwd.com) is another online source for information relating to the LERWPG. Meeting notices and news releases about the LERWPG are also posted to the HPWD site. This regularly updated site has received more than 210,000 visits since 1997.

In addition, High Plains Underground Water Conservation District staff have written and distributed news releases to regional media about the revisions planned to the 2001 LERWPG water management plan.

LERWPG representatives and High Plains Water District staff have given numerous presentations to civic clubs and professional groups about the regional water planning process and the updated plan. District staff members have also spent many hours answering public inquiries about the plan since the first 5-year planning cycle.

The public involvement program has included duly noticed public meetings, news releases, articles in *The* Cross *Section* (High Plains Water District monthly newsletter), and presentations at public meetings. In addition, a public hearing on the scope of work was held February 22, 2002 at the USDA-ARS Cropping Systems Laboratory, 3810 4th Street, in Lubbock, Texas.

The following news releases about the Llano Estacado Regional Water Management Plan were distributed to media organizations within the 21-county region:

2002	
January 2002	Advance for February 1, 2002 LERWPG meeting.
February 2002	Advance for February 22, 2002 public hearing on scope of work.
March 2002	Advance for March 18, 2002 LERWPG meeting.
April 2002	Advance for April 18, 2002 LERWPG meeting.
May 2002	Advance for May 16, 2002 LERWPG meeting.
August 2002	Advance for August 29, 2002 LERWPG meeting.
2003	
January 2003	Advance for February 4, 2003 LERWPG meeting.
July 2003	Advance for July 23, 2003 LERWPG meeting.
November 2003	Advance for November 20, 2003 LERWPG meeting.
2004	
March 2004	Advance for March 25, 2004 LERWPG meeting.
October 2004	Advance for October 28, 2004 LERWPG meeting.
2005	
January 2005	Advance for January 20, 2005 LERWPG meeting.
March 2005	(No advance release issued due to time constraints.)
June 2005	Draft IPP ready for on-line viewing at LERWPG web site.
July 2005	LERWPG sets August 11 public hearing to receive comments on draft IPP.
December 2005	Advance for December 15, 2005 meeting.

A reporter from the *Lubbock Avalanche-Journal* was assigned to cover the regional water planning group during the past year, which has resulted in several news stories appearing in the newspaper.

The following articles about the Llano Estacado Regional Water Management Plan were published in *The Cross Section*, a monthly publication of the High Plains Underground Water Conservation District No. 1, from 2002 to 2005:

2002	
February 2002	Water planning group sets Feb. 22 public hearing.
June 2002	Second phase of water planning now underway.
September 2002	Who does what in the wide world of High Plains water?
December 2002	Water Resources Committee outlines key water challenges.
2003	
November 2003	Select committee to review all facets of water mgmt in state.
2004	
January 2004	Senate Committee On Water Policy conducts first hearing.
August 2004	Senate Committee On Water Policy conducts Lubbock hearing.
August 2004	2004 proving to be busy year for High Plains Water District.
November 2004	Task force reports filed.
December 2004	Districts to face several issues during upcoming legislative session.
2005	
January 2005	"Conservation Currents:" Wrap up of Ogallala symposium.
March 2005	LERWPG nears deadline for completion of draft IPP.
June 2005	Draft LERWPG plan submitted for TWDB review.
July 2005	Public to offer comments on draft initially prepared plan.
September 2005	Public offers comments on draft initially prepared plan.
November 2005	Feature photo of members reviewing revisions to draft IPP.

Either LERWPG members or High Plains Underground Water Conservation District No. 1 employees gave the following interviews and presentations about the Llano Estacado Regional Water Management Plan from 2002 to 2005:

Date	Location	Association or media organization
2002		
01/14/02	Lubbock	Golden K Kiwanis Club.
01/22/02	Hereford	Hereford Rotary Club.
01/28/02	Lubbock	Interview with Clear Channel Radio Network.
01/31/02	Lubbock	Southwest Kiwanis Club.
02/06/02	Lubbock	Fox News Radio Interview (TTO Show).
02/19/02	Lubbock	"Ag Ed" program on KRFE-AM 580.

02/20/02	Lubbock	South Plains Association of Governments.
03/11/02	Lubbock	Lubbock Chamber of Commerce Ag Committee.
03/28/02	Silverton	Briscoe County TCE meeting.
04/16/02	Plainview	Plainview Optimist Club.
04/23/02	Abernathy	Abernathy Lions Club.
04/25/02	Amarillo	Southwest Kiwanis Club.
05/21/02	Levelland	Levelland Rotary Club.
06/27/02	Lubbock	Meeting with Councilman Tom Martin.
07/02/02	Wolfforth	Wolfforth Lions Club.
07/11/02	Ruidoso, NM	TACC Co-op Managers.
08/07/02	Amarillo	Amarillo North Lions Club.
09/05/02	Plainview	GMA meeting.
09/18/02	Lubbock	Inside Lubbock meeting.
09/20/02	Lubbock	Meeting with regional water leaders & Sen. Duncan
10/16/02	Lubbock	Texas Agricultural Lifetime Leadership Tour.
10/18/02	Lubbock	Lubbock AMBUCS club.
11/14/02	Amarillo	Texas Grain and Feed Association meeting.
12/11/02	Lubbock	Westminster Presbyterian Church Men's' group.
2003		
01/20/03	Lubbock	Regional Chairs conference call.
02/12/03	Lubbock	TAMU Grain Sorghum advisory committee.
03/04/03	Hereford	Precincts 3 & 4 County Committee meeting.
03/05/03	Lubbock	Precincts 1 & 2 County Committee meeting.
03/06/03	Plainview	Precinct 5 County Committee meeting.
06/13/03	Lubbock	Interview with Avalanche-Journal.
06/16/03	Lubbock	"Ag Ed" Show on KRFE-AM 580.
06/19/03	Lubbock	Association of Hispanic Municipal Officials.
06/30/03	Hereford	Hereford Rotary Club.
07/01/03	Lubbock	Fox Radio News.
07/14-15/02	Portales, NM	Ogallala aquifer conference.
08/19/03	Lubbock	Leadership Texas.
08/21/03	Hale Center	Caprock Water Association.
10/15/03	Lubbock	Interview with KOHN Radio.
10/21/03	Amarillo	Presentation to Caprock Feeders.
11/03/03	Lubbock	Ag Lead Group.
11/14/03	Long Beach	NWRA Irrigation Caucus.
11/20/03	Lubbock	Bioscience Breakfast.

2004

01/07/04	Lubbock	Texas Farm Bureau radio interview.
01/14/04	Lubbock	Plains Cotton Growers board meeting.
01/16/04	Lubbock	"Ag Ed" Show on KRFE-AM 580.
02/24/04	Post	Post Rotary Club.
02/26/04	Canyon	Precinct 4 meeting.
03/04/04	Lubbock	St. Johns' Methodist Men's Group.
03/08/04	Plainview	Region A & O meeting.
03/09/04	Muleshoe	Precinct 3 meeting.
04/02/04	Lockney	Leadership Lockney meeting.
04/08/04	Tahoka	Tahoka Rotary Club.
04/12/04	Hereford	Hereford Retired Teachers Association.
04/15/04	Lubbock	KOHN Radio interview.
04/27/04	O'Donnell	O'Donnell Rotary Club.
05/04/04	Muleshoe	Muleshoe Rotary Club.
07/01/04	Lubbock	Lubbock Commercial Realtors.
07/05/04	Lubbock	Plains Cotton Growers Board meeting.
07/09/04	Lubbock	Industrial Lions Club.
07/20/04	Levelland	Levelland Rotary Club.
08/09/04	Lockney	Lockney Producers meeting.
08/12/04	Lubbock	Senate Select Committee on Water Policy hearing.
09/07/04	Lubbock	West Texas Ag Chemical Conference.
09/08/04	Lubbock	Texas Ag Industries.
09/27/04	Lubbock	"Ag Ed" on KRFE-AM 580.
09/29/04	Lubbock	Dr. Don Ethridge' s Ag economics class at TTU.
10/06/04	Lubbock	Presentation to TALL tour group.
10/12/04	Levelland	Hockley County Farm Bureau meeting.
10/16/04	Lubbock	Presentation to Lubbock Forum.
10/20/04	Farwell	Texico Rotary Club.
10/27/04	Lubbock	Interview with Lubbock Avalanche-Journal.
10/27/04	O'Donnell	O'Donnell Women's Study Group.
11/05/04	Lubbock	Colloquium on future of West Texas water.
11/10/04	Crosbyton	Crosbyton Lions Club.
11/18-19/04	Austin	Texas Ground Water 2004 conference.
12/8-9/04	Lubbock	Ogallala symposium presentations
12/10/04	Lubbock	Interview with KLLL Radio.
12/13/04	Olton	Olton Agronomy meeting.

2005

01/06/05	Amarillo	Regional Desalination meeting.
01/21/05	Lubbock	SB 1053 demonstration project press conference.
01/21/05	Lubbock	SORGA managers meeting.
01/26/05	Austin	Desalination meeting.
01/31/05	Lubbock	"Ag Ed" program on KRFE-AM 580.
02/09/05	Lockney	Leadership Lockney.
02/14/05	Lubbock	Dr. Ethridge' s Ag economics class.
02/16/05	Lubbock	South Plains SWCD meeting.
03/08/05	Lubbock	KTXT-TV interview during water documentary.
03/21/05	Austin	T-CARET meeting.
04/13/05	WashingtonDC	Texas Water Day
04/18/05	Lubbock	Westminster Presbyterian Church Prime-Timers group.
04/19/05	Lubbock	Westmark Commercial Realtors.
06/24/05	Lubbock	Interview on KRFE Radio.
07/13/05	Hereford	Hereford Lions Club.
07/14/05	Lubbock	Presentation To Commercial Realtors Group.
07/27/05	Lubbock	Interview on FOX Radio 950.
07/29/05	Lubbock	Interview on "Perspectives" Program on KLLL Radio.
08/05/05	Lubbock	Interview on KRFE Radio.
08/16/05	Lubbock	Presentation To TX Society of Professional Engineers.
08/20/05	Lubbock	Floyd County Ag Tour at Demonstration Site.
09/28/05	Lubbock	Media Interview with Darcy Tucker of KCBD-TV.
10/14/05	Abernathy	1st State Bank Board of Directors Meeting.
11/01/05	Lubbock	West Texas Water Utilities School.
11/14/05	Lubbock	Texas Farm Bureau Ag Lead Class.
11/18/05	Lubbock	Texas Tech College of Agriculture and Natural Resources Advisory Board Meeting.

10.2 Data Gathering and Coordination with Water Supply and Water Conservation Entities

During June and July of 2003, the High Plains Underground Water Conservation District No. 1, Mesa Underground Water Conservation District, Sandy Land Underground Water Conservation District, South Plains Underground Water Conservation District, Garza County Underground and Fresh Water Conservation District, Llano Estacado Underground Water Conservation District, White River Municipal Water District, Canadian River Municipal Water Authority, Brazos River Authority, and Red River Authority were contacted and requested to provide up-to-date information about their respective programs and plans. The information provided by each entity was used to update the respective entity's information in Sections 1, 3, and 4 of the Regional Water Plan.

10.3 Informational Mailouts to Water User Groups and Supply Entities

During the course of the revision and update of the Llano Estacado Regional Water Plan, the population, water demand, and water needs (shortages) projections were transmitted to county judges, mayors, and city managers of the region for review and comment. The population projections were forwarded on August 1, 2002, with a deadline for review comments of September 16, 2002. No comments were received.

The water demand projections were forwarded to county judges, mayors, and city managers on February 19, 2003 with a deadline of March 14, 2003 for comments. Comments were received from Ransom Canyon, Wolfforth, Levelland and Smyer, with requests for revisions. In response to the water demand projections review comments, by letter dated July 28, 2003, the LERWPG requested the TWDB to make revisions as follows:

(a) Increase population and water demand projections for Ransom Canyon and Wolfforth;

(b) Check and revise per capita water use for Levelland from 138 gpcd to 153 to 155 gpcd;

(c) That projections be made and included for Smyer;

(d) That mining and livestock water demand projections provided by the LERWPG be substituted for projections by TWDB; and

(e) That average irrigation water use for the period 1985 through 2000, as calculated from water use data found in TWDB irrigation water use files, be used in the GAM models in making projections of quantities of groundwater available for use in each of the counties of Region O.

Following the actions and responses to the population and water demand projections reviews, as described above, including tabulations of surface water and groundwater supplies available to each Water User Group (WUG) of the region, calculations were made of water needs (shortages) of each WUG. The water needs (shortages) were then forwarded to mayors and city managers of the Llano Estacado Region on February 7, 2005 for review and comment, and a public meeting was scheduled and held on February 17, 2005 at the offices of the High Plains Underground Water Conservation District No. 1 with representatives (20 individuals attended the

February 17, 2005 public meeting) of the cities to explain the projections of municipal needs (shortages), obtain information about current water supplies available to the cities and plans to meet future need, and suggested water management strategies to be considered by the LERWPG to meet the needs of individual municipalities.

10.4 Llano Estacado Regional Water Planning Group Meetings

The Llano Estacado Regional Water Planning Group conducted regular meetings on the dates listed below. Notices of all public meetings were duly posted at the Lubbock County Courthouse, the administrative office of the High Plains Underground Water Conservation District No. 1, and on the LERWPG and HPWD websites.

2002

February 1, 2002

February 22, 2002 public hearing on scope of work

March 18, 2002

April 18, 2002

May 16, 2002

August 29, 2002

2003

February 4, 2003

July 23, 2003

November 20, 2003

2004

March 25, 2004

October 28, 2004

2005

January 20, 2005

March 17, 2005

April 21, 2005

May 19, 2005

August 11, 2005 -- Public hearing regarding draft initially prepared plan.

November 10, 2005.

December 15, 2005.

10.5 Coordination with Other Regions and Counties of Region O

Notices of all public meetings were sent to the chairs of the regional water planning groups in the state and all who requested them. In addition, Region O cooperated with Region A in the development and filing of an application to the TWDB for supplemental funding to identify and evaluate water management strategies to increase quantities and reliability of supplies from CRMWA during periods of drought. Region A revised yields of Lake Meredith and has provided revised information to Region O, which has been used in water supply analyses for CRMWA member cities of Region O.

10.6 Texas Water Development Board Comments for Llano Estacado Region (Region O) Regional Water Planning Group Initially Prepared Plan, Contract No. 2002-483-458 and LERWPG Responses

Attachment
Llano Estacado Regional Water Plan – Region O

LEVEL 1—Comments and questions must be satisfactorily addressed in order to meet statutory, agency rule, and/or contract requirements.

Executive Summary

1. Page ES-11, paragraph 6 (last): Correct water demands to reflect TWDB approved water demand as follows. *[Title 31, Texas Administrative Code (TAC) §357.5(d)(1)& (2)]*:
    a. The TWDB approved water demand for 2060 in is 354 acre-feet.
    b. The TWDB approved water demand for 2060 in the Red River Basin is 817,354 acre-feet.
    c. The TWDB approved water demand for 2060 in the Colorado River Basin is 710,676 acre-feet.

    Response: The demand values stated above are the "Total Demand" values before the effects of plumbing fixtures water conservation instead of the "Net Demand" values tabulated in the regional plan. The values contained in the Region O Plan are the "Net Demand" values and are the TWDB approved demand projections.

2. Page ES-14, Table ES-1 and Chapter 4, page 4-90, second paragraph: Reconcile Table ES-14 which lists 51 WUGs with needs with the text on page 4-90 which states there are 49 WUGs with needs. *[Title 31, TAC §357.7(a)(4)(A)]*

    Response: The numbers have been revised in response to reviews of the Initially Prepared Plan (IPP), and have been reconciled between Section 4 and the ES.

Chapter 2: Population and Water Demand Projections

3. Population and demand figures for river basins are slightly different than the amounts in the planning database (DB07). These differences may be due to rounding or reallocation between river basins. Please revise or coordinate with TWDB staff to ensure that data in the plan is consistent with DB07. *[Title 31, TAC §357.5(d)(1)& (2)]*

   Response: The population and water demands values in the report have been checked and are consistent with the TWDB approved population and demand values.

<u>Chapter 3: Water Supply Analysis</u>

4. Chapter 3: Ensure that groundwater district management plans were considered in the planning process. *[Title 31, TAC §357.5(k)(1)(D)]*

   Response: The Underground Water Conservation District management plans were considered during the planning process, and are summarized and referenced in the plan (see Section 1.9.2.1).

5. Page 3-6, Table 3-1: Include information on water supplies by type of use. *[Title 31, TAC §357.7(a)(3)(A)(iv)]*

   Response: Table 3-1 on Page 3-6 presents water supplies available by source on a county/river basin level. The values in this table are shown by type of use in the needs tables (Tables 4-1 through 4-22).

6. Determine surface water supplies using WAM Run 3 or a TWDB approved alternate method and not from estimated water use data. *[Title 31, TAC §357.7(a)(3)]*

   Response: Changes were made and WAM results for White River Lake and Lake Mackenzie were used. For White River Lake the WAM results show 2,431 acft/yr in 2010, and 8 acft/yr in 2060. In the case of Lake Mackenzie, the WAM results indicate zero water available. For White River Lake, water management strategies provide enough water to meet projected needs of customers. For Lake Mackenzie, alternative local groundwater strategies were added for customers.

7. Chapter 3: Include information on water right permits in the plan. *[Contract Exhibit "B," Section 2.2]*

   Response: A brief discussion was added concerning water right permits in Section 3.2. A list of all water right permits in the region is included in Appendix F.

8. Provide groundwater availability for all counties and aquifers in the regional water planning area. *[Contract Exhibit "B," Section 2.2]*

   Response: An explanation was included in Section 3.3 that both groundwater and surface water availability is presented in Table 3-1 and Tables 4-1 through 4-22 for

each county-basin area (county and part of county for counties having area in more that one river basin) of the planning region.

9. Page 3-3: Please verify the firm yield of Lake Alan Henry. *[Title 31, TAC §357.7(a)(3)]*

   Response: The Firm Yield of Lake Alan Henry of 22,500 acft/yr was calculated using hydrologic data for the period of 1940 through 2002. The calculations are reported in a "Draft Memorandum to File," by Thomas C. Gooch, P.E., and Andres A. Salazar, Ph.D., Freese and Nichols, March 19, 2003, and are cited in the plan in Section 3.2.4.

Chapter 4: Identification, Evaluation and Selection of Water Management Strategies Based on Needs

10. Pages 4-3 to 4-83, Table 4-1 to Table 4-22: All of the livestock-county-basin discrepancies listed under Chapter 2 comments carry through to the County-specific tables in Chapter 4. These tables list the demand, supply, and the resulting surplus/shortage. Please revise or coordinate with TWDB staff to ensure the plan is consistent with the DB07. [*Title 31, TAC §357*.5(d)(1) - (2)]

    Response: The livestock demand values have been checked and are consistent with the approved TWDB demand values.

11. Pages 153-161, and Chapter 4.4.4.4, Pages 207-211: Strategies need to be adjusted to provide appropriate environmental water needs. [*Title 31, TAC §357.5(e)(1)*] Evaluations should use environmental information resulting from existing site-specific studies or state environmental planning criteria adopted by the board for inclusion in the state water plan. [*Contract Exhibit "B", Section 4.2.8*] Provide the required environmental analysis for the Post Reservoir water management strategy.

    Response: Adjustments to provide for environmental needs are not appropriate since the strategies referenced involve Lake Alan Henry and Post Dam and Reservoir. TCEQ Permit 4146 for Lake Alan Henry authorizes impoundment of 115,937 acre-feet and the diversion of up to 35,000 acft/yr of water for municipal purposes, with a Priority Date of October 5, 1981. Permit 4146 does not provide for other purposes. TCEQ Certificate of Adjudication Number C3711 for Post Dam and Reservoir, Authorizes Impoundment of 57,420 acre-feet; Diversion of 5,600 acft/yr for municipal purposes; 1,000 acft/yr for industrial purposes; and 4,000 acft/yr for mining purposes, with the Priority Date of January 20, 1970. Certificate of Adjudication Number C3711 does not provide for other purposes.

12. Describe how the plan protects water contracts, option agreements, or special water resources. *[Title 31, TAC §357.5(e)(3) and §357.5(h)]*

    Response: The following was added to the third paragraph of Section 4.5. "The plan does not propose any changes to existing water contracts or option agreements. Further, the plan was created in close cooperation with each Wholesale Water

Provider in the region, and no strategy contained in the plan would adversely affect any existing water contracts, option agreements, or special water resources."

13. Page 4-216: Drought contingency must be recommended as a water management strategy for certain water user groups with a need and must be considered for all water user groups with a need. If not recommended, please provide reasons for not adopting drought management strategies for each water user group with a need. *[Title 31, TAC §357.7(a)(7)(B) and Texas Water §Code 11.1272]*

    Response: Drought Management is not a recommended water management strategy to meet projected water needs in Region O, in part because it cannot be demonstrated to be an economically feasible strategy. The TWDB socioeconomic impact analysis of unmet water needs in Region O shows non-agricultural business impacts due to unmet water needs (shortages) of approximately $27,000 per acft/yr in 2010 decreasing to approximately $8,000 per acft/yr in 2060 (calculated from data in Table 4-24). Clearly, the cost for water to meet projected water needs is only a fraction of the business losses from not having the quantities of water needed. However, the LERWPG recognizes the individual cities "Demand Management and Drought Contingency Plans" that are on file with the TCEQ.

14. Section 4.4.1.2; Section 4.5: In the 2001 Llano Estacado Regional Water Plan, the Llano Estacado Regional Water Planning Group recommended water management strategies to meet needs for irrigated agriculture that were based on a variety of water conservation best management practices. In the 2001 Llano Estacado Regional Water Plan it was estimated that by the year 2050, the region would be realizing an annual water savings of 155,856 acre-feet per year as a result of these conservation best management practices. This savings represents 18 percent of the statewide total in 2050 for water conservation in the 2002 State Water Plan. The capital cost for implementation of these water conservation best management practices was estimated to be approximately $148 million.

    As a result, local and regional entities (groundwater conservation districts and soil and water conservation districts) and the State have made significant financial and programmatic commitments to strengthening and enhancing agricultural water conservation on the Southern High Plains of Texas. In particular, the Texas Water Development Board, in 2004, committed $6.225 million over an eight year period to fund an Agricultural Demonstration Initiative, proposed by Texas Tech University and the High Plains Groundwater Conservation District No. 1. There are also two other active research grants for approximately $100,000 for the enhancement and evaluation of agricultural water conservation water best management practices and other management strategies and projects for districts in the Llano Estacado Regional Water Planning Area.

    Texas Water Code 16.053(j)(2)(B) states that the TWDB can provide financial assistance to political subdivisions only if the TWDB determines that the needs to be addressed by the project will be addressed in a manner that is consistent with the regional water plan. A review of the 2006 Initially Prepared Plan for the Llano Estacado Region, however, documents that the Planning Group has no future plans to pursue any additional agricultural water conservation in the region. In fact, the 2006 Initially Prepared Plan does not contain any water savings from agricultural water conservation (or the cost to implement any of the potential water conservation best management practices).

While the Planning Group is only required to consider water conservation to meet water supply needs, it should be duly noted that state financing for both current and future water supply projects for irrigated agriculture may be negatively impacted if the project to be funded is determined to no longer be consistent with the 2006 Llano Estacado Regional Water Plan. If the 2006 Llano Estacado Regional Water Plan is adopted in the current form, then agricultural water conservation projects including the ongoing Agricultural Demonstration Initiative and future TWDB loans to groundwater conservation districts for water conservation projects and equipment such as center pivots and drip irrigation systems will have to be reviewed and potentially have future funding terminated. *[Title 31, TAC §357.5(e)(6)and §357.7(a)(7)(A)]*

Response: The Regional Water Planning Group has revised Section 4.4.1.2, Irrigation Water Conservation, to include an Irrigation Water Conservation Strategy in addition to the Irrigation Best Management Strategies referenced above.

15. Page 4-85, Table 4-23. Report water supplies and availability, water demands, and needs for each wholesale water provider by category of water use (municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock) for each county or portion of a county in the regional water planning area. If a county or portion of a county is in more than one river basin, data shall be reported for each river basin. The wholesale water provider's current contractual obligations to supply water must be reported in addition to any demands projected for the wholesale water provider. *[Title 31, TAC §357.7(a)(3)(B)]*

    Response: Printout from DB07 for each WWP in the region has been included as Appendix G.

16. Pages 4-223, 4-230, 4-249, 4-255, 4-260, 4-264, 4-271, 4-273, 4-285: The reason why conservation was not adopted for some municipal WUGs with needs must be more clearly documented. Region O should be commended for recommending that every municipal WUG above the target goal of 172 gpcd adopt municipal water conservation strategies regardless of whether they have a need or not until they meet that goal. However, if the WUG has a need municipal conservation strategies have been dropped from its plan either entirely or after a certain decade because it has reached the 172 gpcd goal. The reason the conservation strategy was dropped should be documented. (i.e. why conservation is not cost effective, etc.) For example, the cities of Hart, Lorenzo, Hale Center, Ropesville, Amherst, Olton, New Deal, Shallowater, Wolfforth, and Friona all have needs and some have conservation strategies for a few decades, but some don't have any conservation strategies because they will reach the goal through natural replacement of plumbing fixtures. *[Title 31, TAC §357.7(a)(7)(A)]*

    Response: For purposes of developing the 2006 Llano Estacado Regional Water Plan, the LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs

(shortages) and that had per capita water use in year 2000 that was greater than the Llano Estacado Region average per capita water use in 2000. The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 Region average municipal water use of 172 gpcd. For each city with a projected need and a per capita water use of 172 gpcd or greater, municipal water conservation is included as a water management strategy until the goal of 172 gpcd is reached. Municipal water conservation beyond that which is estimated to be accomplished through plumbing fixtures and the municipal water conservation strategy is not included, since municipal water conservation is estimated to cost more than the next available source of water; e.g. in the range of $483/acft to $530/acft compared to costs of local groundwater in the range of approximately $75/acft to approximately $290/acft.

17. Provide a quantitative reporting of environmental factors is included in the evaluation of water management strategies. *[Title 31, TAC §357.7(a)(8)(A)(ii)]*

    Response: To the extent that environmental information is available, it has been included in the environmental issues subsection of each water management strategy.

18. Pages 4-124 through 4-152, Tables 4.4-12 through 4.4-40: Include interest during construction (IDC) and construction periods, as applicable. *[Contract Exhibit "B," Section 4.2.9]*

    Response: In the tables referenced, since the construction period for wells and pipelines of these water management strategies are expected to be of only a few months, interest during construction is not calculated separately, and would be covered in the allowance for contingencies, if needed. The date of "Year Needed" is the approximate date at which construction is expected to occur.

19. Pages 4-204 and 4-205, Tables 4.4-59 and 4.4-60: Provide costs for brine concentrate disposal associated with brackish groundwater desalination *[Contract Exhibit "B," Section 4.2.9]*

    Response: The referenced tables and associated text have been revised to include brine concentrate disposal costs.

20. Pages 4-124 through 4-152, Tables 4.4-12 through 4.4-40. Provide O&M costs, as applicable. *[Contract Exhibit "B," Section 4.2.9]*

    Response: The referenced tables have been updated to include O&M costs.

21. Provide costs of each water management strategy considered according to guidelines contained in *Contract Exhibit "B," Section 4.2.9]*.

    Response: This comment has been addressed in Comments 18, 19, and 20 above.

<u>General Comments</u>

LEVEL 2—Comments and suggestions that might be considered to clarify or help enhance the plan.

<u>Chapter 2: Population and Water Demand Projections</u>

22. Pages 2-20, Table 2-9: Consider revising tables to ensure consistency in the data presented. The smaller summary table for Beef Cattle Feedlot demands at the bottom of the page, the 2060 demand amount, 78,845 acre-feet, differs from the 2060 total amount in the larger table, 45,512 acre-feet.

    Response: Table 2-9 was corrected from 78,845 to 45,512.

<u>Chapter 4: Identification, Evaluation and Selection of Water Management Strategies Based on Needs</u>

23. Pages 4-98 & 4-99, Table 4.4-4: Consider including Smyer, Terry County Other, and Deaf Smith County Other, Wolfforth, and Shallowater in this table.

    Response: Table 4.4-4 was corrected to add lines on which the cities are listed.

24. Revise Table 4-23 and text for consistency in the number of wholesale water providers.

    Response: The change was made.

25. Page 270: Municipal water conservation is recommended as a strategy from 2010 to 2020 for the city of Lubbock, but not for other decades. Consider providing an explanation of why conservation strategies are not recommended for Lubbock past 2020.

    Response: Explanation is included in the text. Water Conservation Strategy is included until the regional goal of 172 gpcd is reached.

26. Page 308, last paragraph: Change reference from TNRCC to TCEQ.

    Response: The change was made.

27. Page 4-307: Revise descriptions to reflect the correct section title. Post Reservoir should be 4.4.4.4, drought tolerant crops should be 4.4.4.6, Reuse should be 4.4.4.7 and Stormwater is 4.4.4.8.

    Response: The changes were made.

10.7 Public Comments and LERWPG Responses

The Llano Estacado Regional Water Planning Group (LERWPG) received comments on the Initially Prepared Plan from the following entities, groups, and individuals:

1. City of Silverton;
2. City of Lubbock;
3. National Wildlife Federation, Environmental Defense, and Sierra Club;
4. Mr. J. Collier Adams, Jr. and
5. Texas Parks and Wildlife Department (State Agency).

The comments of the Cities of Silverton and Lubbock are listed below, together with responses to each.

Comment: The City of Silverton explained that the IPP had not included water management strategies adequate to deal with Silverton and neighboring areas of Briscoe County water supply and water quality problems.

Response: A Local Groundwater Water Management Strategy was added for Silverton and Briscoe County, County Other (Quitaque) to meet projected needs, as corrected following the IPP review.

Comment: The City of Lubbock explained that population and water demand projections in the IPP are too low. In addition, Lubbock requested that 4 additional water management strategies be included in the plan. The 4 additional strategies are as follows: (1) Lubbock Brackish Groundwater Desalination; (2) Lubbock Jim Bertram Lake System (JBLS) Expansion; (3) Lubbock North fork Scalping Operation; and (4) CRMWA II (Well Field and Transmission System – Amarillo, Plainview, and Lubbock).

Response: At its meeting on December 15, the LERWPG considered and approved Lubbock's request to increase Lubbock's population, per capita water use, and municipal water demand projections, and included an Addendum to the 2006 Plan in which the increased projections are presented. The water management strategies numbers 1, 2, and 3 were added, and number 4 was included for further study in cooperation with Region A.

The comments of organizations and individuals are summarized below, and a response is given for each summarized comment.

Comment: Concerns remain regarding the Post Reservoir and it potential impacts to downstream instream uses including aquatic and riparian habitats and water quality.

Response: The White River Municipal Water District holds TCEQ Certificate of Adjudication Number C3711 for Post Dam and Reservoir, which Authorizes Impoundment

of 57,420 acre-feet; Diversion of 5,600 acft/yr for municipal purposes; 1,000 acft/yr for industrial purposes; and 4,000 acft/yr for mining purposes, with the Priority Date of January 20, 1970. Certificate of Adjudication Number C3711 does not provide for other purposes.

Comment: Potential impacts to spring flows and spring ecosystems should be identified where additional groundwater development was identified as a water management strategy.

Response: There is no known methodology available with which to make such estimates. In addition, quantities of additional groundwater development associated with the proposed Local Groundwater Water Management Strategies for municipal purposes are so widely dispersed and in such small quantities, that reliable estimates cannot be made of the potential, if any, effects upon spring flows within the planning area from this source of pumping.

Comment: Disappointment was expressed that the Plan does not recommend nomination of any stream segments as ecologically unique.

Response: The LERWPG did not view such action as being appropriate for the Regional Water Plan at this time.

Comment: Questions are raised about the goals of the Municipal Water Conservation Water Management Strategy and that Drought Management is not considered as a water management strategy.

Response: The LERWPG adopted a municipal water conservation goal of reducing per capita water use by 1 percent per year for those WUGs that have projected needs (shortages) and that had per capita water use in year 2000 that exceeded the Llano Estacado Region average per capita water use in 2000 of 172 gpcd. The goal is to continue the municipal water conservation water management strategy of reducing per capita water use by 1 percent per year until per capita water use is reduced to the year 2000 region average. In accordance with the goal, municipal water conservation is included in the plan for each municipal WUG that had a projected need (shortage). Drought Management is not a recommended water management strategy to meet projected water needs in Region O, in part because it cannot be demonstrated to be an economically feasible strategy (See Response to TWDB comment No. 13), and in part because it would be duplicative of existing "Demand Management and Drought Contingency Plans" of cities of the region. The LERWPG recognizes the individual cities' "Demand Management and Drought Contingency Plans" that are on file with the TCEQ, and encourages their use as appropriate.

Comment: Questions were raised about the lack of a specific Irrigation Water Management Strategy.

Response: The Regional Water Planning Group has revised Section 4.4.1.2, Irrigation Water Conservation, to include an Irrigation Water Conservation Strategy in addition to the Irrigation Best Management Strategies referenced above.

Comment: Questions are raised about the inclusion of water management strategies for Lubbock, and the Post Reservoir, since there are no specific customers shown for either water management strategy.

Response: Lubbock owns Lake Alan Henry and would use the water when needed. Post Reservoir would be used to supply water to members of the White River Municipal Water District, owner of TCEQ Certificate of Adjudication Number C3711.

Comment: Questions were raised about the potentials of Precipitation Enhancement and Brush Management to produce quantities of water usable by identified water user groups.

Response: It is important to note that both of these strategies are very general and are included without estimates of quantities or associated costs. As the text shows, precipitation enhancement is being applied to about 2.3 million acres at a cost of $109,200 per year (4.2 cents per acre) in the southern part of the region by the Sandy Land Underground Water Conservation District.

Comment: Regarding the White River Municipal Water District-Reclaimed Water Management Strategy, the point was made that if the effluent currently is discharged to a stream or wetland, the effect of reduced flows should be evaluated.

Response: The effluent considered is currently being discharged via land disposal to farmland. At present, the quantity of acres available for disposal is not adequate. Thus, this strategy would assist in reducing the levels of effluent application to acreage available.

Comment: A request was made that more information be provided about Recovery of Capillary Water and Cistern Wells.

Response: These 2 water management strategies were removed from the IPP. However, reference to them had not been removed from Section 5 of the IPP. In the Plan, these references were removed.

Comment: The discussion does not address potential water quality issues expected as water levels decline with continued mining of aquifer supplies.

Response: There are no readily available data pertaining to water quality as water levels in the aquifer decline, thus it was not addressed.

Comment: The discussion of Drought and Drought Response highlights the discrepancy associated with the Water Planning Process whereby water supplies are based on firm yields during drought of record, but water demands are based on fully meeting water needs during the drought of record, even though drought plans implemented by municipalities will result in lower water demands during drought.

Response: Texas Water Development Board (TWDB) Rules direct that water management strategies be included to meet projected water needs, using the projected water demands approved by the TWDB. Rules further direct that water conservation and drought

management be considered for WUGs with projected needs, and if water conservation and drought management are not adopted the reason must be documented. In the case of municipalities, the LERWPG has included Municipal Water Conservation for municipalities with projected needs, and has documented why it did not include Drought Management as a water management strategy. For irrigated agriculture, an Irrigation Water Conservation Strategy was included after the IPP review. Drought management as a water management strategy for irrigated agriculture is not addressed since there is no practical manner in which to give it consideration.

Comment: The discussion in Section 5 of Impacts of Moving Water from Rural and Agricultural Areas only refers to the Nearby Groundwater Sources strategy. Other strategies, especially the CRMWA Groundwater Expansion need to be addressed.

Response: Generally speaking, similar comments apply to the CRMWA Groundwater Expansion; e.g.; the water being considered for this strategy is not now being used for any purpose, and is not projected to be needed to meet needs in the future. It is located beneath rangeland in Region A and would be available from willing sellers.

Comment: Wherever possible, groundwater resources should be managed on a sustainable basis.

Response: The Regional Water Planning Group recognizes that the High Plains Ogallala formation with any appreciable pumping is not sustainable; however with the implementation of water conservation strategies, the longevity of the Ogallala can be appreciably extended.

Comment: Senate Bill 1 directs consideration of voluntary and emergency transfers of water as a key mechanism for meeting water demands. Water Code Section 16.051 (d) directs that rules governing the development of the state water plan shall give specific consideration to "principles that result in the voluntary redistribution of water resources." Similarly, Section 16.053 (e)(5)(H) directs that regional water plans must include consideration of "voluntary transfers of water within the region using, but not limited to, regional water banks, sales, leases, options, subordination agreements, and financing arrangements…."

Response: Since there are no interconnections among the municipal and irrigation water users, except those of the Canadian River Municipal Water Authority, the Regional Water Planning Group could not give these types of transfers consideration.

Comment: One reviewer provided comments concerning the protection and use of fresh water by the oil and gas industry in the region to wit:

1. Companies are permitted by the Railroad Commission of Texas to dispose of brackish produced water into the Santa Rosa,
2. Companies prefer to use cheap clean water from the Ogallala for secondary recovery operations,
3. Oil companies do not use Santa Rosa water for makeup to supplement secondary recovery fluid because it is chemically incompatible, and

4. Companies do not monitor injection systems for line leaks and leaks that go undetected can contaminate the shallow aquifers.

Response: The LERWPG understands the practices related to these comments as follows:

1. **Both the Railroad Commission of Texas (RRC) and the Texas Commission of Environmental Quality (TCEQ) review every injection permit application in the state and define for that well where the useable quality water zones are located. The RRC has very strict regulations for how those zones are to be protected from contamination. Currently, permits are not issued for disposal of brackish produced water into any protected zone including the Santa Rosa. Any specific instance of injection into the Santa Rosa should be immediately brought to the attention of the RRC and TCEQ.**
2. **The RRC and TCEQ review every injection permit application and the use of fresh water is always the fluid of last choice. Before fresh water use is allowed the operator must show that no chemically compatible and economically available alternative exists. The proposed water use in the IPP clearly shows that the mining industry (which consists mainly of oil and gas in Region O) accounts for less than 0.5% of the total fresh water use in the region while contributing over 10% to the economy of the region.**
3. **The oil industry does in fact use some Dockum water for makeup but that use is indeed limited because of a chemical incompatibility with the produced water from many secondary recovery projects. The precipitation of dissolved solids in the water has the effect of plugging the oil producing formation with solids almost immediately with very serious declines in oil production. In fact, over 90% of the water used by the oil and gas industry in the region is satisfied with recycle water.**
4. **Injection systems operate at high pressures necessary to maintain the pressure in the oil producing reservoir to maximize the recovery of the oil. It is highly unlikely that injection line leaks would go undetected and contaminate the shallow aquifers because leaks in high pressure lines worsen very quickly and the leaks are easily identified and quickly fixed. It is more likely that low pressure production lines could explain undetected leaks.**

Comment: The Plan does not address the use of water resources under the City of Lubbock to meet Lubbock's needs.

Response: The Plan includes a water management strategy to develop 5,600 acft/yr from this source (4.4.3.3 City of Lubbock Well Field).

10.8 Final Plan Adoption

At its meeting on December 15, 2005, the motion to approve the LERWPG plan was made by Robert Josserand and seconded by Member Bill Harbin. All 15 members in attendance voted "aye," and the plan was approved.

Appendix A

Threatened, Endangered, and Rare Species of the Llano Estacado Region

Table 1. Threatened, Endangered, and Rare Species of the Llano Estacado Region

Common Name	*Scientific Name*	*Habitat Preference*	*Listing USFWS*	*Listing TPWD*
American Peregrine Falcon	*Falco peregrinus anatum*	Potential migrant; nests in west Texas	DL	E
Artic Peregrine Falcon	*Falco peregrinus tundrius*	Potential migrant	DL	T
Baird's Sparrow	*Ammodramus bairdii*	Shortgrass prairie with scattered low bushes and matted vegetation		
Ferruginous Hawk	*Buteo regalis*	Open country, primarily prairies, plains, and badlands; nests in tall trees along streams or on steep slopes, cliff ledges, river-cut banks, hillsides, power line towers		
Interior Least Tern	*Sterna antillarum athalassos*	Nests along sand and gravel bars within braided streams and rivers; known to nest on man-made structures as well	LE	E
Lesser Prairie Chicken	*Tympanuchus pallidicinctus*	Arid grasslands, generally interspersed with shrubs and dwarf trees; nests in a scrape lined with grasses	C1	
Mountain Plover	*Charadrius montanus*	Breeding: nests on high plains or shortgrass prairie, on ground in shallow depression; non-breeding: shortgrass plains and bare, dirt (plowed) fields; primarily insectivorous		
Snowy Plover	*Charadrius alexandrinus*	Formerly an uncommon breeder in the Panhandle; potential migrant		
Western Burrowing Owl	*Athene cunicularia hypugaea*	Open grasslands, especially prairie, plains, and savanna, sometimes in open areas such as vacant lots near human habitation or airports; nests and roosts in abandoned burrows		
Whooping Crane	*Grus americana*	Potential migrant	LE	E
Sharpnose Shiner	*Notropis oxyrhynchus*	Endemic to Brazos River drainage; also apparently introduced into adjacent Colorado River drainage; large turbid river, with bottom combination of sand, gravel, and clay-mud.	C1	
Smalleye Shiner	*Notropis buccula*	Endemic to upper Brazos River system and its tributaries; apparently introduced into adjacent Colorado River drainage; medium to large prairie streams with sandy substrate and turbid to clear warm water; presumable eats small aquatic invertebrates.	C1	
Black Bear	*Ursus americanus*	Within historical range of Louisiana Black Bear in eastern Texas, Black Bear is federally listed threatened and inhabits bottomland hardwoods and large tracts of undeveloped forested areas; in remainder of Texas, Black Bear is not federally listed and inhabits desert lowlands and high elevation forests and woodlands; dens in tree hollows, rock piles, cliff overhangs, caves or brush piles.	T/SA; NL	T
Black-footed Ferret	*Mustela nigripes*	Considered extirpated in Texas; potential inhabitant of any prairie dog towns in the general area	LE	E
Black-tailed Prairie Dog	*Cynomys ludovicianus*	Dry, flat, short grasslands with low, relatively sparse vegetation, including areas overgrazed by cattle; live in large family groups		

Table 1 continued

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Listing TPWD
Cave Myotis Bat	*Myotis velifer*	Colonial and cave-dwelling; also roosts in rock crevices, old buildings, carports, under bridges, and even in abandoned Cliff Swallow (*Hirundo pyrrhonota*) nests; roosts in clusters of up to thousands of individuals; hibernates in limestone caves of Edwards Plateau and gypsum cave of Panhandle during winter; opportunistic insectivore		
Jones' Pocket Gopher	*Geomys knoxjonesi*	Southwestern plains of Texas; deep sandy soils of aeolian origin; small isolated population vulnerable to land use changes		
Palo Duro Mouse	*Peromyscus truei comanche*	Rocky, juniper-mesquite-covered slopes of steep-walled canyons of the eastern edge of the Llano Estacado; juniper woodlands in canyon country of the panhandle; primarily nocturnal		T
Plains Spotted Skunk	*Spilogale putorius interrupta*	Open fields, prairies, croplands, fence rows, farmyards, forest edges, and woodlands; prefers wooded, brushy areas and tallgrass prairie		
Swift Fox	*Vulpes velox*	Restricted to current and historical shortgrass prairie; western and northern portions of Panhandle		
Texas Garter Snake	*Thamnophis sirtalis annectens*	Wet or moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March-August		
Texas Horned Lizard	*Phrynosoma cornutum*	Open, arid and semi-arid regions with sparse vegetation, including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sand to rocky; burrows in soil, enters rodent burrows, or hides under rocks when inactive; breeds March-September		T
Texas Kangaroo Rat	*Dipodomys elator*	Mesquite not required, but mostly in association with scattered mesquite shrubs and sparse, short grasses in areas underlain by firm clay soils; along fencerows adjacent to cultivated fields/roads; burrowing into soil with openings usually at base of mesquite or shrub; dirt pushed into openings to give burrow a closed appearance; active throughout year; nocturnal; feeds on grass, seeds, insects, and annual and perennial forbs; metabolizes water from foods, but will drink water when available; young born in underground nest chamber		T
Mexican mud-plantain	*Heteramthera mexicana*	Aquatic; ditches and ponds; flowering June-August		

LE, LT - Federally Listed Endangered/Threatened
PE, PT - Federally Proposed Endangered/Threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
C1 - Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
DL, PDL - Federally Delisted/Proposed for Delisting
E, T - State Endangered/Threatened
"blank" - Rare, but with no regulatory listing status

Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.

Source: Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' Special Species. 8/24/04.

Appendix B

Springs and Seeps of the Llano Estacado Water Planning Region

Appendix B

Springs and Seeps of the Llano Estacado Region

By
Jim Steiert, Member
Llano Estacado Regional Water Planning Group

The Environmental Committee of the Llano Estacado Regional Water Planning Group is aware that springs and seeps historically existed in the region. They never emitted water in quantities comparable to the high-volume springs noted elsewhere in Texas. Most of the region's springs and seeps disappeared as native grassland was cultivated and irrigated agriculture evolved. Ogallala aquifer pumpage that drew down the water table is usually blamed for the demise of springs. In his 1981 work "Springs of Texas," Gunnar Brune maintains that siltation that began when the native grass cover was removed from the land was also a factor. Topsoil that washed into creeks and draws choked many springs. Landscape lost capacity to absorb recharge water. Brune notes invasive brush species including salt cedar and juniper adjacent to many now-defunct spring sites. Interception of recharge flow by brush species cannot be discounted as a factor in the loss of spring flow.

Springs and seeps still occur in the Llano Estacado Region. Their flow is minimal in comparison to historic times. While some springs pour water from the Ogallala aquifer, others flow only after prolonged, substantial rainfall. Water that soaks into surrounding lands still gradually feeds the springs. Many springs and seeps are located on private land and their presence can only be confirmed through frequent and close observation. Landowners may be reluctant to allow public access to these sites due to concern over liability, the wish to avoid damage to the landscape, etc. The flow from most of these springs is local and does not contribute to river flow. Spring water may travel a short distance and generally evaporates or runs back into the ground. Seeps are generally little more than small pools sustained by minimal flow from underground. Where springs and seeps still exist they are important to local wildlife and may be a source of livestock or recreational water.

The Llano Estacado region experienced unusually heavy rainfall during 2004 that renewed spring and seep flows in some locations. Where normal annual rainfall is roughly 18 inches, 42 inches of more of precipitation fell on parts of the region. Renewed spring flows noted in 2004-2005 are out-of-the-ordinary, localized, and a direct result of abundant rainfall.

According to "Major and Historical Springs of Texas" published by the TWDB, and from information garnered by area residents, several active springs and seeps are located within the Llano Estacado Planning Region. Their flows can fluctuate substantially. Included here is a list of historic springs in the Llano Estacado Region, as well as information on any spring and seep sites still active. Material in this report is taken primary from "Springs of Texas" Volume 1 by Gunnar Brune, and is supplemented with anecdotal information.[1] **BOLD TYPE IN THE DESCRIPTIVE TEXT INDICATES CURRENTLY ACTIVE SPRINGS AND SEEPS.**

BAILEY COUNTY: At the time of his 1978 documentation, Brune found that the springs of Bailey County had nearly all ceased flowing. Through history, several springs issued from Tertiary Ogallala sand and more recent sand and caliche, and from Cretaceous limestone. Springs were located primarily along Blackwater Draw and its larger tributaries, and adjacent to the larger lakes. Cultivation of grassland diminished the soil's ability to absorb recharge water and the springs along Blackwater Draw were largely gone by the 1930s. Among historic springs mentioned by Brune, and their location are Alkali Springs, 1.5 miles south of Baileyboro; Barnett Springs, 6.8 miles southeast of Coyote Lake and just over a half-mile northeast of Baileyboro; Blackwater Lake and Springs, 6.2 miles west of Muleshoe; Jumbo and Turnbo Springs, 1.8 miles northeast of Muleshoe; Butler Springs, in the northeast corner of the county on the Parmer County line and just over a half-mile west of Lamb County line; and White Springs, in the Muleshoe National Wildlife Refuge 6.2 miles south of Needmore. **In a telephone interview on March 24, 2005, Mr. Jim Young of Muleshoe reported that springs have consistently maintained seeps on property he owns south of Baileyboro Lake just south of the Baileyboro community for the 10 years he has owned the land. These are not large flows but do maintain standing water. Mr. Harold Beierman, manager of the Muleshoe National Wildlife Refuge near Needmore said that abundant rainfall during 2004 has caused seeps to moisten the ground at several sites on the refuge. Beierman said that spring flow also occurred at Paul's Lake on private property north of the refuge, and that water was present in the lake throughout the fall and winter of 2004-2005.**

BRISCOE COUNTY: Most of the historic springs in Briscoe County issued from Tertiary Ogallala sand and Quaternary sands and gravels such as the Tule, in the western part of the county. From 15,000 years ago, when Clovis man frequented the springs, until over a century ago, nearly all of the springs ran continuously. Remains of mammoths hunted by the Clovis people have been found in Briscoe County, Hearths, projectile points, knives and scrapers and paintings on rock cliffs indicated that from Clovis to historic times, man and animal have associated with spring sites here. Irrigation caused a severe decline in the water table, a major cause of the failure of most springs, but extensive erosion also resulted in creeks being choked with sand and silt, and many springs were buried. Evidence indicates that Coronado followed the waters of Tule Creek in 1541 and stopped at **HULSEY SPRINGS,** located just below the caprock in Palo Duro Canyon, approximately nine miles north of Vigo Park. This name evidently represented several small springs at that location. Brune documented springs still running on **Deer**, **Turkey**, and **Cedar** springs with flow rates of 20.5, 39.6 and 15.8 gallons per minute respectively on September 4, 1978. **According to NRCS records, Dick Cogdell is the current landowner of the site. A telephone interview with Mrs. Dick Cogdell on February 2, 2005 revealed that Turkey Springs remains the primary active spring at that location. The spring does not flow during hot, dry summers. Any spring flow is dependent on abundant rainfall soaking into the surrounding**

[1] Brune, Gunnar, Springs of Texas, Vol I, Texas A&M University Press, College Station, Texas, 2002.

landscape and feeding the spring, and water does not flow a large distance from the site when the spring is running.

A number of other spring sites were also documented by Brune in Briscoe County. Some of these go by other localized names. **In favorable seasons such as 2004, when abundant rainfall provides a recharge source, some of these springs revive, but run only a small distance before going back underground or evaporating. Mr. Rank Cogdell of the Vigo Park area reported in a phone interview on February 2, 2005, that he observed many active springs along Tule Canyon during a helicopter flight over the area in January of 2005. He reported that the Tule has numerous springs along its length, and that in the winter Tule Creek and Deer Creek are the only locations with spring flow sufficient to provide dependable livestock water, with flow from Deer Creek estimated at roughly 20 gallons per minute. The best of the small localized springs on the Tule was located within two miles of Highway 207 that runs between Claude and Silverton. Mr. Cogdell commented that a favorable fall and winter of rainfall had created spring flows in Briscoe County that likely would not be maintained once dryer weather set in. Water from these springs does not travel large distances or contribute to river flows.**

Among other historic springs mentioned by Brune are Marting Springs, roughly 5 miles southwest of Brice; Burson Springs, 9.3 miles northwest of Turkey; Bell Springs, 6.2 miles northwest of Turkey; Gyp Springs, 5.5 miles northwest of Quitaque; Haynes Springs, 2.4 miles upstream from Gyp Springs on the South Prong of the Little Red River; Cottonwood and Red Rock Springs, 4.3 miles west-northwest of Quitaque on Little Cottonwood Creek; Las Lenguas Springs, 8.6 miles west-southwest of Quitaque; Rock Springs, 7.4 miles west-northwest of Silverton; and Mayfield Spring, 1.8 miles north-northeast of Rock Springs.

CASTRO COUNTY: As late as 1978 Brune indicated that no springs flow in Castro County, although in historic times many issued from Ogallala sand, gravel, silt and caliche. Springs once maintained a flowing stream in Running Water Draw, but this has not been the case in modern times. Decline of the water table due to pumping from the Ogallala and siltation contributed to the failure of springs. Among historic spring sites and their locations was Flagg Springs, 3.1 miles south of the Flagg community and 6.8 miles upstream from Sunnyside on Running Water Draw. Jumbo Lake, 6.2 miles northeast of Easter, was once kept full by seeps from Ogallala silt and sand. Middle Tule Draw northeast of Nazareth held some pools of live water, as did the North Fork of the Running Water Draw. Running Water Draw was fed by springs near Sunnyside.

COCHRAN COUNTY: Brune documented in1978 that hardly any springs still flowed in Cochran County, although they issued in abundance from the Ogallala when the water table was at or near the surface. Springs were especially numerous around Silver Lake and along the major draws. Historic spring sites include Morton Springs, 3.1 miles west of Morton, that dried up in 1907, and Silver Springs, on the northwest side of Silver Lake. Discharge of springs around the lake was impacted by irrigation pumping, and the presence of salt cedars could also account for some water loss. South-southeast of Lehman about 6.2 miles springs or seeps may have flowed in former times. In the southeast corner of the county just over a half-mile from north of the Yoakum County line and 8.6 miles west of the Hockley County line springs formerly kept a draw running with water year-round.

CROSBY COUNTY: Historically, Crosby County was abundantly endowed with springs, mostly in the canyon breaks below the caprock, with water flowing from Ogallala and Triassic Dockum sands. Over the past 75 years the springs declined markedly as the Ogallala water table dropped. Brune noted in 1978 that Crawfish Creek was dry except in times of heavy rainstorms. Among historic creeks and their location, as listed by Brune were Rock House Springs, near the junction of Highway 651 and 193 in northern Crosby County; Ericson Springs, 1.2 miles west-southwest of Mount Blanco, issuing in a ravine with vertical caliche cliffs, the site offered only a seep in 1978; Dewey Springs, a group of springs on the north side of Dewey Lake located 4.3 miles east-northeast of Crosbyton, now dry; Silver Falls, below the Highway 82 crossing of the White River, was once a source of water for White River Reservoir, but the spring flow diminished; Couch, or English Springs, 8 miles east of Crosbyton in Blanco Canyon, dry now; Davidson Springs, 4.9 miles southeast of Crosbyton; Cold Springs, 8 miles southeast of Crosbyton; L7 Springs,9.3 miles south-southeast of Crosbyton; Wilson Springs, 2.4 miles east-southeast of Cap Rock; Cottonwood Springs, 9.9 miles east-northeast of Slaton on Plum Creek; C Bar Springs, 8.6 miles east-southeast of Slaton; and Gholson Springs, 6.2 miles east-northeast of Slaton.

DAWSON COUNTY: The larger springs of Dawson County were in the breaks and canyons below the caprock such as TJF Draw, Tobacco Creek and Gold Creek Canyons. Small springs on the plains such as those along Sulphur Springs Draw were the first to fail as the water table began declining. Many creeks also were filled with drifting sand during dust storms. Brune's field studies during 1975 showed the springs issuing from Pleistocene sand, Tertiary Ogallala sand and lower Cretaceous limestone. Among spring sites documented by Brune and their location are Sulphur Springs Draw, 3.1 south of Welch, where several small springs or seeps are speculated to have flowed during historic times; Rock Crusher or turner Springs, 6.8 miles south of O'Donnell, where Brune metered a flow rate of 30.1 gallons per minute in October of 1978, with the water flow increasing greatly over that metered in June of 1938; Earl Springs, 1.2 miles north of Rock Crusher Springs; Tobacco Springs, at the head of Tobacco Creek, 8.6 miles south-southeast of O'Donnell; Indian Springs, 5.5 miles east-northeast of Tobacco Springs, where an historic people lived in caves and left pictographs on the walls; West Tobacco Springs, 4.9 miles south-southwest of Tobacco Springs; and Mullins Springs, 14.2 miles east of Lamesa and 3.7 miles northeast of the Midway community in a canyon. Mullins Springs flowed until 1969.

DEAF SMITH COUNTY: Springs flowed along Tierra Blanca and Palo Duro creeks below the caprock in the northwest corner, and at Garcia Lake and other large lakes or deep depressions. In nearly all cases historic springs flowed from Ogallala sand and caliche, with a few issuing from Dockum sandstone. Tierra Blanca Creek once flowed constantly and large blue holes of spring water flowed to the surface at the community of Blue Water, later named Hereford. While irrigation's drawdown of the Ogallala aquifer was a factor in the decline of spring flow, Brune's studies indicated the plowing of native grasslands loosened fragile topsoil that washed into Tierra Blanca Creek and smothered many springs. Ability of the soil to recharge water to the aquifer was also damaged. During studies in May of 1977, Brune documented historic spring sites and their locations. Based on his studies at that time, Brune concluded that Big Springs on the Gault Ranch along Tierra Blanca Creek, about 4.3 miles west of the Randall County line, was the only flowing spring in Deaf Smith County, with a flow of about 5 gallons per minute. **Southeast of the Big Springs site about 3.1 miles, Parker Springs flowed from the base of caliche caprock Most of the springs at this location had disappeared by April of 2002, but one small spring has continued to seep, maintaining a small pool of water. Heavy rains in the area revitalized Devil's Canyon, south of Parker Springs. Seepage continues to maintain water in a cattle watering tank at that site. Sulphur Springs in Sulphur Park on the old L.R. Bradly farm, just upstream from the junction of Tierra Blanca Creek and Frio Draw was once the site of a lake popular for recreation. The Sulphur Springs area is today part of the City of Hereford's farm, some 4.9 miles northeast of Hereford, and two or three springs run intermittently here. Brune believed that Sulphur Springs failed by the 1940s. Recharge from rainfall or some other factor served to rejuvenate at least light flow, and several seeps can be found along Tierra Blanca Creek on the City of Hereford property. Spring flow in this area travels only a small distance before evaporating or going below ground. Just east of the Sulphur Springs area, several live springs are present on ranch property along the Tierra Blanca Creek. From 1972 through 1994 the flow of some 20 springs on the site did not stop, although it was often minimal. Most springs at this location flow intermittently, declining during the heavy irrigation season. During the fall and winter months water may flow for a mile or more in the channel of Tierra Blanca Creek. One spring at the site has flowed at a rate as high as 30 gallons per minute, but the flow falls off to approximately 15 gallons per minute during irrigation season. There is some question as to whether this water originates from the Ogallala, or a local perched aquifer.**

Bridwell Springs, on the Bridwell Ranch in the northwestern corner of the county have gone dry. Fowler Springs was found 1.8 miles west of the Randall County line on Palo Duro Creek, and Hodges Spring, 2.4 miles west of the Randall County line, are among springs that formerly flowed along Palo Duro Creek. Ojo Frio or Cold Spring was located in the Frio Draw upstream from its junction with Tierra Blanca Creek. Punta De Agua or Source of Water was 5.5 miles west of Hereford in Tierra Blanca Creek. Below this point Tierra Blanca Creek flowed constantly, but began to falter in 1925, well before massive development of irrigation, and after about 1940 there was no flow except from surface runoff. In western Deaf Smith County, 2.4 miles east of the New Mexico state line, the XIT Ranch used Escarbada Springs in historic times, but they are now dry. At least one small seep is still active in this area of western Deaf Smith County, adjacent to the New Mexico border. Ojo de Garcia or Little Garcia Springs formerly flowed from Dockum sandstone 1.2 miles west-northwest of Garcia Lake in western Deaf Smith County. Spring flow eventually decline to seeps, and water is only present in Garcia Lake now when large localized rainstorms cause runoff to flow to the lake.

DICKENS COUNTY: The northwest corner of Dickens County lies on the High Plains, underlain by Tertiary Ogallala sand, gravel and caliche. Abundant springs once flowed from this formation all along the caprock escarpment, but most have disappeared due to heavy pumping for the Ogallala aquifer. The remainder of the county lies in the Rolling Plains, where springs trickle from Permian gypsum and sandstone. Some historic springs were choked by erosion and buried as early as 1914. Most springs declined permanently by 1979. Historic springs and their locations include Browning Springs, 3.1 miles northwest of Dickens in Hobble Scobble Canyon; another spring is 4.9 miles northwest of Dickens. Pecan Grove Spring was 5.5 miles southeast of McAdoo. On Grapevine Creek were White House Springs, 4.3 miles northeast of McAdoo. Cottonwood Springs were just over a half-mile west of Afton, which can still flow in the event of heavy local rainfall. Erosion choked the creek bed in this area. A half-mile north of Afton are Patton Springs, which was eventually covered by a lake; Jackson Springs, 6.2 miles north of Dickens went dry and the creek channel filled with sand; **Sanders Springs, east-northeast of Afton, is also subject to rainfall recharge, with Brune documenting a flow of 158.4 gallons per minute in August, 1979 after a heavy local rainstorm; Shinnery Springs 6.2 miles southwest of Dumont on the Pitchfork Ranch still run year around according to Wyman Meinzer of Benjamin, TX. Brune documented a flow of less than 5 gallons per minute in August, 1979. Meinzer reports the flow is not large but is consistent. The water does not flow a long distance.** Dripping Springs are 5.5 miles southwest of Dumont, and were termed similar to Shinnery Springs. Law Springs are 2.4 miles northeast of Dickens. Dickens or Crow Springs are less than a mile northeast of Dickens. Brune noted a flow of 38 gallons per minute in August, 1979 following heavy rain. Mitchell Springs are 1.8 miles east-southeast of Dickens.

FLOYD COUNTY: Brune pronounced the story of springs in Floyd County as largely one of water sources that were once important, but are no more due to decline of the water table. Springs formerly issued from sands and gravels of the Ogallala formation. Blue Hole Springs was on Quitaque Creek 6.2 miles east of South Plains. It had no water flow in July of 1978 and had been partially filled with cobbles and gravel. Likewise, Bain Springs 8.6 miles southwest of Flomot, just below the caprock, was dry. Montgomery Springs, in Blanco Canyon, just north of the Crosby County line, ceased flowing in 1948. Massie Springs, 6.2 miles southwest of Floydada, ceased flowing about 1945.

GAINES COUNTY: Most of the springs here flowed from Ogallala and more recent sands. Decline of the Ogallala aquifer is cited as a cause for most springs drying up. Boar's Nest Springs in northwest Gaines County were dry by 1955. Cedar Lake or Laguna Sabinas in northeastern Gaines County was once surrounded and fed by numerous fresh and saline springs. Buffalo Springs on the north side of the lake and Johnson Springs on the south side of the lake had only small flows by 1963, but none of the Cedar Lake springs were flowing by 1977, although a few seeps were still evident. Balch Springs on McKensie Draw south of Cedar Lake was still yielding 39.6 gallons of water a minute when Brune measured in March, 1977, but **Bobby Tabor, soil conservationist with the Seminole Field office of NRCS, in a telephone interview on**

February 3, 2005, reported there is no flow in that area today. A number of seeps were cited by Brune as existing along McKenzie Draw. Mr. Tabor related that a local landowner reported to him early in 2005 that at McKenzie Lake 19.2 miles east of Seminole and south of Cedar Lake two springs located on private property still run into McKenzie Lake. The flow rate isn't known, but probably isn't large. South of Seminole 5.5 miles, Indian Wells was the site of as many as 20 seeps issuing from Ogallala sand. Downstream on Seminole Draw, six springs formerly flowed. Brune projects there were probably also seeps along Monument Draw in the southwestern corner of the county. Ward's Well at Hackberry Grove 2.4 miles south of Seminole was a former area of shallow water that could be hand-dipped, but the water table declined at this site.

GARZA COUNTY: The western edge of the county lies on the High Plains and on the edge of these plains springs flowed from Tertiary sand, gravel and caliche. Much of the county lies on the Red Bed or Gypsum Plains where some springs issued from Quaternary sand, gravel and caliche and from Triassic Dockum sandstone. Many springs weakened or failed as groundwater declined and severe erosion filled many stream channels and buried springs. **Mr. Glen Killough, district conservationist with the Post field office of the NRCS, says many seeps still exist off the caprock. They are local and their waters do not contribute to in-stream flows. Seeps and any small spring flows remaining are highly dependent on rainfall.** In the way of historic references: Post Springs, 3.1 miles west of Post, once a source of part of the water for that city, are now dry. Golf Course Springs 3.1 miles northwest of Post once discharged water over a mile downstream and were strong in the 1930s, declined to only a seep in 1975. Tipton Springs, 4.3 miles northwest of Post, have been dry since about 1945. Barnum Springs were 7.4 miles north-northwest of Post. Live water existed in holes until about 1975. Double U Springs were noted 3.7 miles southeast of Eastland. Brune measured a flow of 3.1 gallons per minute in June, 1979. Whiskey Springs, 3.1 miles northeast of Southland were a tiny trickle of 0.79 gallons per minute in June of 1979 and a similar spring in Red Creek 1.2 miles south-southwest flowed even less. Llano Springs 8 miles north of Post on the northeast side of the Brazos River flowed until the 1940s, and seeps could still occur in the event of wet weather. Lane Springs 6.2 miles southwest of Kalgary had declined to seep status by the time of Brune's survey and Indian Springs 5.5 miles south-southeast of Kalgary trickled at 1.9 gallons per minute when Brune measured in August of 1979, and might be subject to some seepage in the event of favorable rainfall. Chimney Springs were noted less than a half-mile upstream. K Springs were located 3.7 miles east-southeast of Indian Springs. Southeast of Lane Springs some seeps were noted and 2.4 miles farther south Slick Nasty Springs were once an important watering site on the Spur Ranch, but reduced to seeps. OS Springs was cited 9.3 miles east of Post, south of the North Fork of the Double Mountain Fork of the Brazos River, characterized even in 1979 as only wet weather seeps. Reed Springs, 4.9 miles east of Justiceburg was a seep from Dockum sandstone. Rocky Springs, 5.5 miles east-southeast of Justiceburg fed Rocky Creek with slightly saline water from Dockum sandstone bluffs. Spring Creek Springs were 4.3 miles southeast of Grassland, and were about seven groups of springs that flowed 34.8 gallons per minute in the winter, but less in summer. Spring water flowed as much as two miles. Cooper Springs in Cooper's Canyon 4.3 miles south of

Post were once strong but flowed only about 11 gallons per minute in 1979. Boy Scout Springs, 2.4 miles southwest of Post stopped flowing about 1946 but there were still wet weather seeps in 1979. Box Canyon Springs, 2.4 miles west-southwest of Post flowed at 13.1 gallons per minute in June of 1979.

HALE COUNTY: Brune noted no flowing springs in Hale County, although historically, springs and spring-fed creeks were abundant. Decline of the water table is a factor in the demise of the springs. Norfleet Springs were in the northwest corner of the county 1.2 miles from the Lamb County line on Running Water Draw and bubbled up in 12 or 13 springs in the 1930s, but failed by 1945. Downstream on Running Water Draw 6.2 miles west of Edmonson was Ojo de Agua Springs. These and other springs maintained a running stream in Running Water Draw. These springs dried up in the 1950s with some seepage until the 1960s. Jones Springs were 3.1 miles west of Edmonson. Running Water Springs were roughly 2.4 miles south of Edmonson, on the north side of the draw. Up to 12 feet of silt from erosion had filled the draw by the late 1970s. On Crawfish Draw were once Crawfish Springs 7.4 miles south of Hale Center. They dried up by 1920. Eagle Springs were 7.4 miles west-northwest of Abernathy on Blackwater Draw. It dried up in the 1930s and seeped intermittently until the 1940s.

HOCKLEY COUNTY: The springs of Hockley County issued from Tertiary Ogallala sand and gravel. Decline of the water table impacted local springs. Silver Springs was located at Silver Lake or Laguna Plata, in the northwest corner of the county, where springs issued at various points around the lake. The flow was less than a gallon per minute in October of 1978. The Devil's Ink Well was a pool of water in Sucker Rod Draw 3.7 miles east-southeast of Pep. Yellow House Springs were two small springs 4.3 miles east of Pep. Small springs once flowed 4.3 miles northeast of Pettit. Some seeps existed in Yellow House Draw until about 1920.

LAMB COUNTY: The channel from Water Draw 6.2 miles east-southeast of Sunnyside, has been choked with sand washed in by erosion. King Springs was 6.8 miles north of Olton. It fed into Running Water Draw, but failed in the 1950s, however there was some seepage into the 1960s. Many springs once flowed on Blackwater Draw. Alamosa Springs was 4.3 miles east of the Bailey County line on Blackwater Draw. Soda Lake and Springs were two miles farther south. Spring Lake was located on Blackwater Draw 4.9 miles west of Earth. Springs here lasted until 1942, with seeps persisting until the early 1960s. In the sandhills, many lakes were once fed by springs and seeps. Sod House Spring 6.2 miles north of Amherst on Blackwater Draw flowed until the 1950s. Rocky Ford Springs were just upstream from the Highway. Brune noted only a few springs still flowing here in the late 1970s. Springs formerly ran on County Road 385 crossing of Blackwater Draw 6.8 miles northeast of Amherst, but faltered in the 1940s and were gone in the 1950s. Fieldton Springs south of Fieldton were gone around 1949. Hart Springs were a little over a half mile southeast of Hart Camp, but the springs, draw and lake that dried up in the 1930s. Bull Springs, at Bull Lake 8 miles west of Littlefield, were already only a seep by 1978. Rains could cause some seepage. Roland Springs formed a chain of pools in Bull Draw, and they were only seeps in October of 1978, although the springs ran a bit in the winter. Glumpler Springs were 3.1 miles north-

northeast of Pep and flowed about 8 gallons per minute in October, 1978. Just south of Glumpler Creek on Goat Creek Green Springs flowed 11.8 gallons per minute of slightly saline water in October, 1978. Illusion Springs on the north end of Illusion Lake flowed 25.3 gallons per minute of moderately saline water in October, 1978. At the end of Yellow Lake Yellow Springs was part of a series of freshwater springs once present along the eastern shore of Yellow Lake, and flowed an intermittent 2.2 gallons per minute in October, 1978. Some saline springs were 1.8 miles west of Yellow Lake, near the Hockley County line, with one flowing 11.2 gallons per minute in 1978 and several others dry.

LUBBOCK COUNTY: Springs once flowed abundantly along Yellowhouse and Blackwater Draws, emerging chiefly from Ogallala sand and gravel. Lubbock Springs were at the Lubbock Lake archaeological site near the intersection of Highway 84 and Loop 289. These springs had failed to flow by the early 1950s. **Buffalo Springs, in Yellow House Canyon 9.9 miles southeast of Lubbock, were immersed by a lake at the site. Brune reported that measurement of the flow of Buffalo Springs could be made only by comparing discharge above and below Buffalo Lake and allowing for evaporation. Discharge including all springs in the Buffalo Lake area was 1,246.9 gallons per minute as measured by Brune in 1976, and the historic high discharge was 1,521.2 gallons in 1969, when all spring flow combined was measured. Currently, effluent from Lubbock of 1 to 2 million gallons per day flows into Buffalo Lake. Johnson Springs are at Lake Ransom Canyon just downstream from Buffalo Lake and may receive some recharge from Buffalo Lake. Brune measured 15.8 gallons per minute in December, 1975, but the flow had declined to less than a gallon per minute by August, 1978.** Tinsley Springs, 3.7 miles downstream in Yellow House Canyon, flowed 11.5 gallons per minute in August, 1978.

LYNN COUNTY: In Lynn County, spring water flowed mainly from Ogallala sand and gravel, with some from Triassic Dockum sandstone, but spring output has been reduced due to the decline of the aquifer. Double Lakes Springs, 8.6 miles northwest of Tahoka on the north side of Double Lakes, issued 15.8 gallons per minute in December 1975. Spring sites were partially buried by sediment. **Tahoka Springs on the west side of Tahoka Lake 6.21 miles north of Tahoka included a large spring near the north end of the lake that flowed 53.8 gallons per minute in December, 1974, and several other springs farther south combined for a flow of 95 gallons per minute at that time.** Moore Springs, 2.4 miles southeast of Grassland in Moore's Draw produced 25.3 gallons per minute in 1975. Guthrie Springs were in Chimney Draw northwest of Guthrie Lake, 3.7 miles southwest of Tahoka, but last flowed some 75 years ago. Saleh Lake and Seeps were noted 3.7 miles southeast of New Moore. Gooch Springs about 1.2 miles farther west at Gooch Lake, and the largest spring flowed 12.3 gallons per minute in October 1978. **Frost Lake, 4.3 miles south-southwest of New Moore was fed by water from Frost Springs, which discharge 66.5 gallons per minute in October, 1978. New Moore Springs, 1.8 miles west-northwest of New Moore were reported by Brune as being suddenly rejuvenated in 1968 by a combination of high rainfall and potential injection of water brought in from Rich Lake at the upstream Ozark-Mahoning mine. Brune measured a flow of 90.3 gallons per minute of moderately saline water**

in October of 1978. Historically, the flow at this location has been greater in the winter months. Mr. Pat Childress of O'Donnell reported in a telephone interview on February 6, 2005, that a lake had formed at the New Moore Springs site as the spring flow had been greatly enhanced by the heavy rainfall of 2004. The springs were at that time covered by the lake water and Mr. Childress estimated that the flow was probably comparable to past measurements, although spring flow had declined severely and the springs had about dried up prior to the high rainfall year of 2004. The lake at the location is filled with what Mr. Childress called "gyppy" water, not suitable for human consumption, but used by wildlife. Frost Springs was also reported by Mr. Childress to have regained strength thanks to the high rainfall. Brune noted in 1975 that water flowed into the swampy area at New Moore Springs from Ogallala sand and that salt cedars were numerous around the site, with flow increasing in the winter when salt cedars and other vegetation were dormant. Spring and seep-fed lakes and pools in this area have historically been important to large numbers of sandhill cranes as well as to wintering ducks.

MOTLEY COUNTY: Nearly all springs in the county flow from Ogallala sand and Triassic Dockum sandstone. Pumping from the Ogallala aquifer has caused a decline in the aquifer and lessened spring flow. Quitaque Creek, estimated in the 1940s to be capable of furnishing 3 million gallons per day, had greatly reduced flows by the mid1970s. **Roaring Springs, 3.1 miles south of the town of that name, remains one of the crown jewels of spring flow in the Llano Estacado Region, although its flow is greatly diminished from historic levels. The area around the springs has been developed with a golf course, camp ground and RV parking. Spring waters fall with namesake sound over a sandstone ledge. The recharge area for Roaring Springs is 12 miles or more to the west, where rainfall runoff slowly seeps into Ogallala sands. Today, irrigation of pasture land just upstream from the spring site can greatly diminish the flow when wells begin operating in the summer. Brune noted, when measuring spring flow in 1978 at 633 gallons per minute, that very little decline in spring slow had occurred in the previous 40 years; i.e.; the flow was 664 gallons per minute in 1962, and the all-time high flow since records began in 1937 was 1,125 gallons per minute in 1946. However, heavy irrigation pumping wasn't occurring adjacent to the springs at that time. While anecdotal information was obtained via phone calls in February 2005, current flow measurements were not available. Anecdotes from local residents indicate that spring flow has declined appreciably over the past two decades. One local resident related that filling a recreational swimming pool with flow from the springs could once be accomplished overnight, but now the process takes days. Water from Roaring Springs feeds into a swimming pool and runs only a short distance before entering the South Pease or Tongue River, where it quickly goes underground. The South Pease merges with the Middle and North Pease to form the Pease River that eventually flows into the Red River.** Scab Springs, 13.6 miles east of Matador on Highway 70, have been dry since 1945. Wolf Spring, 7.4 miles southwest of Roaring Springs were the source of Wolf Creek, where the combined flow of several springs at the site amounted to 112.5 gallons per minute when Brune noted them in June of 1975. Anecdotal information taken in February 2005 indicated they do not flow now. **Dutchman Springs on Dutchman**

Creek 6.21 miles west-northwest of Roaring Springs was measured by Brune at 36.4 gallons per minute in July, 1979. Anecdotal information gathered in February 2005 indicated that some seasonal seepage still occurs at the site, though it is little more than a trickle. The presence of several earthen dams along the headwaters of the spring drainage may be one of the reasons for the decline of this spring. Ballard Springs, 1.2 miles south of Matador, were measured at 13.4 gallons per minute in July, 1978, and fed an earthen stock tank. Priest Springs, 2.4 miles southwest of Matador, measured 20.5 gallons per minute in August 1978. Willow Springs, 3.7 miles southwest of Matador, flowed 15 gallons per minute in August 1978. Dripping Springs, now dry, were 6.21 miles west-southwest of Matador. Lost Canyon springs were 5.5 miles west of Matador in Lost Canyon. Mott Camp Springs were 10.5 miles west of Matador. Chimney Springs were 1.2 miles northwest of Mott Camp Springs and were only wet weather seeps in 1978. Burleson Springs, 8.6 miles west-southwest of Whiteflat, had ceased flowing by 1978. Chimney Springs, 1.2 miles northwest of Mott Camp Springs were cited as wet weather seeps in 1978. Miller Springs, 7.4 miles west of Whiteflat flowed only 1.5 gallons per minute in 1979.

PARMER COUNTY: Springs were once numerous along the county's major draws, but they began to disappear by 1900. On Frio Draw, about a half-mile east of the Texas-New Mexico state line, on the north side, a spring flowed intermittently from a cave in 1927. At Mustang Lake, 2.4 miles north-northwest of Bovina, springs flowed until the 1930s. A spring also once flowed intermittently 3.7 miles east of Bovina on Running Water Draw.

SWISHER COUNTY: In Swisher County, springs once flowed along Tule Creek, and historically, spring water flowed in North, Middle, and South Tule Creeks. As the aquifer level declined, spring flow diminished. Some springs were also buried by silt from severe erosion. Rogers Springs in western Mackenzie Lake Park offered only seeps from Triassic sandstone when measured by Brune in September 1978. Prairie Dog Springs were at the Highway 2301 crossing of Tule Creek, but are now only a seep. About a half-mile northwest of the bridge JA or Anderson Springs once flowed, but they were dry when Brune noted them. Hackberry Springs were some 1,600 feet farther upstream. They dried up in 1974. Dawson Springs were 3.1 miles downstream from the Highway 1318 crossing of Tule Creek. They ran until the 1930s when some were buried by silt. Just over a half-mile downstream from the Highway 1318 crossing were Elkins Springs, now, long dry. Edwards Springs were 1.2 miles upstream from the Highway 1318 crossing. They flowed in winter until drying up in 1956. Poff Springs were 0.62 miles downstream from the Highway 146 crossing and 3.1 miles north-northeast of Tulia. They ceased flowing about 1940. Faulkner Springs were in Mackenzie Park in southeast Tulia, and flowed until the 1930s. Maupin Springs, 1.8 miles upstream from Highway 87 flowed until the 1920s. Hardy Springs, 3.1 miles past the Highway 87 crossing, are dry.

TERRY COUNTY: Springs in Terry County issue primarily from Ogallala sand and caliche, and in modern times, are highly wet-weather dependent. **Mr. Jason Coleman of the South Plains Underground Water Conservation District reported in February 2005 that abundant summer, fall, and early winter rainfall in 2004**

contributed to a renewal of some springs and seeps that generally flow from Ogallala sands. Some on the perimeter of saline lakes are not Ogallala, but flow from a Cretaceous outcrop exposed at the surface. Mr. Coleman reports that many of his observations are of pools only, without measurable flow, probably supported by slow seeps. One member of the South Plains UWCD board has several such seeps on his dryland farm on the Terry-Lynn County line. Another board member reported several seeps/springs near his house north of Wellman along Sulphur Springs Draw. This gentleman had not seen water standing in that draw for nearly 60 years prior to the 2004 wet-weather-related events. Mr. Coleman found one section of Lost Draw running from southeast Terry County into Lynn County that contained a small lake lying in Terry County, probably spring or seep-fed. Decline of the groundwater level has been a factor in the demise of most springs and seeps in this county. At Rich Springs at Rich Lake, 4.3 miles south-southeast of Meadow, water issued from Tahoka Sand on Duck Creek shale. Brune measured flow from springs at the north end of the lake totaling 19 gallons per minute in October 1978, and noted the presence of many other very small springs flowing around the lake. Rich Lake has historically been important to sandhill cranes as a roost site. Local anecdotal information indicated that in previous times, the lake rose before rains, indicating that springs and the lake were impacted by barometric pressure. Mound Springs at Mound Lake, 10.5 miles east-northeast of Brownfield was documented by Brune as flowing 63.3 gallons per minute of highly saline water in December of 1975. This water fed into Mound Lake. On South Lost Draw, 10.5 miles southeast of Brownfield, Seven Lakes was fed by numerous springs and seeps, with the springs increasing flow before a rain when barometric pressure changed. Brune documented the historic presence of many small springs along Sulphur Springs Draw 6.21 miles east-southeast of Wellman. Many of these seep-fed lakes and pools have historically been important to wildlife including sandhill cranes and waterfowl.

YOAKUM COUNTY: Brune noted following studies in March 1977 that springs and seeps formerly existed along all of the major draws in Yoakum County, flowing mainly from Ogallala and more recent sands, but decline of the water table resulted in all of the springs of the county drying up. Oho Springs were in New Mexico, 3.1 miles west of Bronco, Texas. Ulou was downstream on Sulphur Springs Draw, about halfway between Bronco and Plains, where springs once likely existed. Other springs also likely existed farther downstream on Sulphur Springs Draw. Southwest of Plains 9.9 miles, INK Basin was once a seep-fed freshwater basin, has been dry since 1949. Evidence of springs was also found present in Lost Draw in the northeast part of the county.

Appendix C

Socioeconomic Impacts of Unmet Water Needs in the Llano Estacado Water Planning Area

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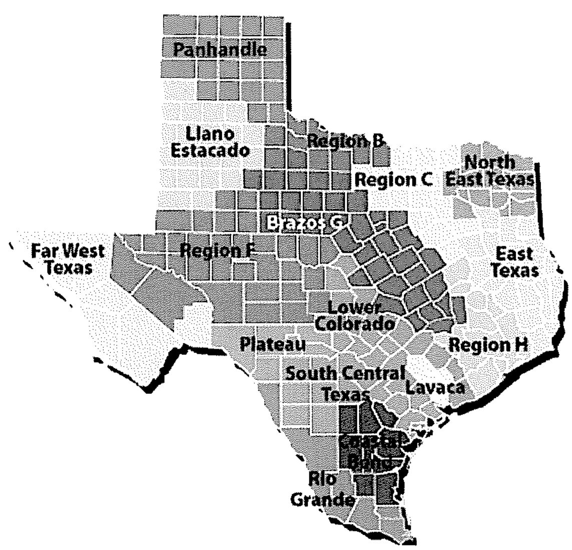
Prepared by:

Stuart Norvell and Kevin Kluge of The Texas Water Development Board's Office of Water Resources Planning

Prepared in support of the:

Llano Estacado Water Planning Group and the 2006 Texas State Water Plan

March 2005



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Executive Summary

Background

Water shortages due to severe drought combined with infrastructure limitations would likely curtail or eliminate economic activity in business and industries heavily reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on business and industry, but they might also bias corporate decision makers against plant expansion or plant location in Texas. From a societal perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Section 357.7(4) of the rules for implementing Texas Senate Bill 1 requires regional water planning groups to evaluate the social and economic impacts of projected water shortages (i.e., "unmet water needs") as part of the planning process. The rules contain provisions that direct the Texas Water Development Board (TWDB) to provide technical assistance to complete socioeconomic impact assessments. In response to requests from regional planning groups, staff of the TWDB's Office of Water Resources Planning designed and conducted analyses to evaluate socioeconomic impacts of unmet water needs.

Overview of Methodology

Two components make up the overall approach to this study: 1) an economic impact module and 2) a social impact module. Economic analysis addresses potential impacts of unmet water needs including effects on residential water consumers and losses to regional economies stemming from reductions in economic output for agricultural, industrial and commercial water uses. Impacts to agriculture, industry and commercial enterprises were estimated using regional "input-output" models commonly used by researchers to estimate how reductions in business activity might affect a given economy. Details regarding the methodology and assumptions for individual water use categories (i.e., municipal consumers including residential and commercial water users, manufacturing, steam-electric, mining, and agriculture) are in the main body of the report (see Section 2).

The social component focuses on demographic effects including changes in population and school enrollment. Methods are based on population projection models developed by the TWDB for regional and state water planning. With the assistance of the Texas State Data Center, TWDB staff modified these models and applied them for use here. Basically, the social impact module incorporates results from the economic impact module and assesses how changes in a region's economy due to water shortages could affect patterns of migration in a region.

Summary of Results

Table and Figure E-1 summarize estimated economic impacts. Variables shown include:[1]

[1] Total sales are not a good measure of economic prosperity because they include sales to other industries for further processing. For example, a farmer sells rice to a rice mill, which the rice mill processes and sells it to another consumer. Both transactions are counted in an input-output model. Thus, total sales "double count." Regional income plus business taxes are more suitable because they are a better measure of net economic returns.

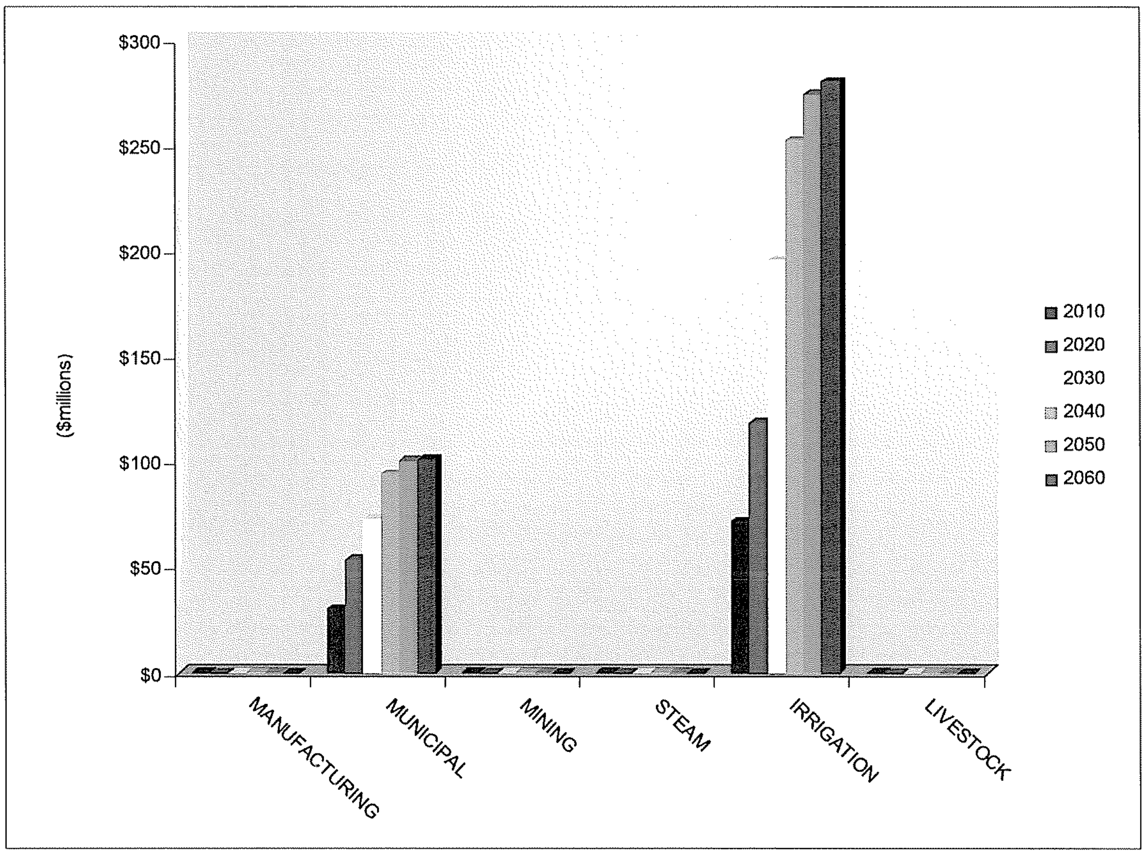
- **sales** - economic output measured by sales revenue;
- **jobs** - number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income** - total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments for the region; and
- **business taxes** - sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include any type of income tax).

If drought of records conditions return and water supplies are not developed, study results indicate that the Llano Estacado Water Planning Area would suffer significant losses with the majority of impacts coming from losses associated with irrigated farming. If such conditions occurred 2010 lost income to residents in the region could total $103 million with associated job losses approaching 4,370. State and local governments could lose almost $10 million in tax receipts. If such conditions occurred in 2060, income losses could amount to $382 million, and job losses could be as high 13,440. Nearly $32 million worth of state and local taxes would be lost. Reported figures and are probably conservative because they are based on estimated costs for a single year; but in much of Texas, the drought of record lasted several years. For example, in 2050 models indicate that shortages would cost residents and businesses in the region about $380 million in lost income. Thus, if shortages lasted for three years total income losses related to needs could easily reach $1,140 million.

Table E-1: Annual Economic Impacts of Unmet Water Needs (years, 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)				
Year	Sales ($millions)	Income ($millions)	Jobs	State and Local Taxes ($millions)
2010	$263.36	$103.00	4,414	$9.83
2020	$412.61	$175.22	7,032	$15.64
2030	$643.79	$272.58	13,553	$23.86
2040	$805.76	$351.06	12,553	$29.13
2050	$868.76	$379.88	13,509	$32.03
2060	$884.49	$386.50	13,679	$32.41

Source: Based on economic impact models developed by the Texas Water Development Board, Office of Water Resources Planning

Figure E-1: Distribution of Lost Income by Water Use Category due to Unmet Water Needs
(years: 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)



Source: Analysis of the Texas Water Development Boards, Office of Water Resource Planning

Table E-2 shows potential losses in population and school enrollment. Changes in population stem directly from the number of lost jobs estimated as part of the economic impact module. In other words, many - but not all - people would likely relocate due to a job loss and some have families with school age children. Section 1.3 in the main body of the report discusses methodology in detail.

Table E-2: Regional Social Impacts of Unmet Water Needs (years 2010, 2020, 2030, 2040, 2050 and 2060)

Year	Population Loss	Declines in School Enrollment
2010	5,310	1,245
2020	8,470	1,995
2030	14,830	3,590
2040	10,720	2,320
2050	11,540	2,495
2060	11,700	2,530

Source: Based on models developed by the Texas Water Development Board, Office of Water Resources Planning and the Texas State Data Center.

Introduction

Texas is one the nation's fastest growing states. From 1950 to 2000, population in the state grew from about 8 million to nearly 21 million. By the year 2050, the total number of people living in Texas is expected to reach 40 million. Rapid growth combined with Texas' susceptibility to severe drought makes water supply a crucial issue. If water infrastructure and water management strategies are not improved, Texas could face serious social, economic and environmental consequences - not only in our large metropolitan cities, but also on our farms and rural areas.

Water shortages due to severe drought combined with infrastructure limitations would likely curtail or eliminate economic activity in business and industries heavily reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on business and industry, but they might also bias corporate decision makers against plant expansion or plant location in Texas. From a societal perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Section 357.7(4) of the rules for implementing Texas Senate Bill 1 requires regional water planning groups to evaluate the social and economic impacts of unmet water needs as part of the planning process. The rules contain provisions that direct the Texas Water Development Board (TWDB) to provide technical assistance to complete socioeconomic impact analyses. In response to requests from regional planning groups, TWDB staff designed and conducted required studies. The following document prepared by the TWDB's Office of Water Resources Planning summarizes analysis and results for the South Central Texas Water Planning Area (Region L). Section 1 provides an overview of concepts and methodologies used in the study. Sections 2 and 3 provide detailed information and analyses for each water use category employed in the planning process (i.e., irrigation, livestock, municipal, manufacturing, mining and steam-electric).

1. Overview of Terms and Methodology

Section 1 provides a general overview of how economic and social impacts were measured. In addition, it summarizes important clarifications, assumptions and limitations of the study.

1.2 Measuring Economic Impacts

Economic analysis as it relates to water resources planning generally falls into two broad areas. Supply side analysis focuses on the costs and alternatives of developing new water supplies or implementing programs that provide additional water from current supplies. Demand side analysis concentrates on impacts and benefits of providing water to people, businesses and the environment. Analysis in this report focuses strictly on demand side impacts. Specifically, it addresses the potential economic impacts of unmet water needs including: 1) losses to the regional economy stemming from reductions in economic output, and 2) costs to residential water consumers associated with implementing emergency water procurement and conservation programs.

1.2.1 Impacts to Agriculture, Business and Industry

As mentioned earlier, severe water shortages would likely affect the ability of business and industry to operate resulting in lost output, which would adversely affect the regional economy. A variety tools are available to estimate such impacts, but by far, the most widely used today are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools formed the basis for estimating economic impacts for agriculture (irrigation and livestock water uses) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water uses).

Basically, an IO/SAM model is an accounting framework that traces spending and consumption between different economic sectors including businesses, households, government and "foreign" economies in the form of exports and imports. As an example, Table 1 shows a highly aggregated segment of an IO/SAM model that focuses on key agricultural sectors in a local economy. The table contains transactions data for three agricultural sectors (cattle ranchers, dairies and alfalfa farms). Rows in Table 1 reflect sales from each sector to other local industries and institutions including households, government and consumers outside of the region in the form of exports. Columns in the table show purchases by each sector in the same fashion. For instance, the dairy industry buys $11.62 million worth of goods and services needed to produce milk. Local alfalfa farmers provide $2.11 million worth of hay and local households provide about $1.03 million worth of labor. Dairies import $4.17 million worth of inputs and pay $2.37 million in taxes and profits. Total economic activity in the region amounts to about $807.45 million. The entire table is like an accounting balance sheet where total sales equal total purchases.

Table 1: Example of a County-level Transaction and Social Accounting Matrix for Agricultural Sectors ($millions)

Sectors	Cattle	Dairy	Alfalfa	All other Industries	Taxes, govt. & profits	Households	Exports	Total
Cattle	$3.10	$0.01	$0.00	$0.03	$0.02	$0.06	$10.76	$13.98
Dairy	$0.07	$0.13	$0.00	$0.25	$0.01	$0.00	$11.14	$11.60
Alfalfa	$0.00	$2.11	$0.00	$0.01	$0.02	$0.01	$10.38	$12.53
Other industries	$2.20	$1.56	$2.90	$50.02	$70.64	$66.03	$48.48	$241.83
Taxes, govt. & profits	$2.37	$2.61	$5.10	$77.42	$0.23	$49.43	$83.29	$220.45
Households	$0.82	$1.03	$1.38	$50.94	$45.36	$7.13	$14.64	$121.30
Imports	$5.41	$4.17	$3.16	$63.32	$104.17	$5.53	$0.00	$185.76
Total	$13.97	$11.62	$12.54	$241.99	$220.45	$128.19	$178.69	$807.45

* Columns contain purchases and rows represent sales. Source: Adapted from Harris, T.R., Narayanan, R., Englin, J.E., MacDiarmid, T.R., Stoddard, S.W. and Reid, M.E. "*Economic Linkages of Churchill County.*" University of Nevada Reno. May 1993.

To understand how an IO/SAM model works, first visualize that $1 of additional sales of milk is injected into the dairy industry in Table 1. For every $1 the dairies receive in revenue, they spend 18 cents on alfalfa to feed their cows; nine cents is paid to households who provide farm labor, and another 13 cents goes to the category "other industries" to buy items such as machinery, fuel, transportation, accounting services etc. Nearly 22 cents is paid out in the form of profits (i.e., returns to dairy owners) and taxes/fees to local, state and federal government. The value of the initial $1 of revenue in the dairy sector is referred to as a first-round or **direct effect.**

As the name implies, first-round or direct effects are only part of the story. In the example above, alfalfa farmers must make 18 cents worth of hay to supply the increased demand for their product. To do so, they purchase their own inputs, and thus, they spend part of the original 18 cents that they received from the dairies on firms that support their own operations. For example, 12 cents is spent on fertilizers and other chemicals needed to grow alfalfa. The fertilizer industry in turn would take these 12 cents and spend them on inputs in its production process and so on. The sum of all re-spending is referred to as the **indirect effect** of an initial increase in output in the dairy sector.

While direct and indirect impacts capture how industries respond to a change, **induced impacts** measure the behavior of the labor force. As demand for production increases, employees in base industries and supporting industries will have to work more; or alternatively, businesses will have to hire more people. As employment increases, household spending rises. Thus, seemingly unrelated businesses such as video stores, supermarkets and car dealers also feel the effects of an initial change.

Collectively, indirect and induced effects are referred to as **secondary impacts**. In their entirety, all of the above changes (direct and secondary) are referred to as **total economic impacts**. By nature, total impacts are greater than initial changes because of secondary effects. The magnitude of the increase is what is popularly termed a multiplier effect. Input-output models generate numerical multipliers that estimate indirect and induced effects.

In an IO/SAM model impacts stem from changes in output measured by sales revenue that in turn come from changes in consumer demand. In the case of water shortages, one is not assuming a change in demand, but rather a supply shock - in this case severe drought. Demand for a product such as corn has not necessarily changed during a drought. However, farmers in question lack a crucial input (i.e., irrigation water) for which there is no *short-term* substitute. Without irrigation, she cannot grow irrigated crops. As a result, her cash flows decline or cease all together depending upon the severity of the situation. As cash flows dwindle, the farmer's income falls, and she has to reduce expenditures on farm inputs such as labor. Lower revenues not only affect her operation and her employees directly, but they also indirectly affect businesses who sell her inputs such as fuel, chemicals, seeds, consultant services, fertilizer etc.

The methodology used to estimate regional economic impacts consists of three steps: 1) develop IO/SAM models for each county in the region and for the region as whole, 2) estimate direct impacts to economic sectors resulting from water shortages, and 3) calculate total economic impacts (i.e., direct plus secondary effects).

Step 1: *Generate IO/SAM Models and Develop Economic Baseline*

IO/SAM models were estimated using propriety software known as IMPLAN PRO™ (Impact for Planning Analysis). IMPLAN is a modeling system originally developed by the U.S. Forestry Service in the late 1970s. Today, the Minnesota IMPLAN Group (MIG Inc.) owns the copyright and distributes data and software. It is probably the most widely used economic impact model in existence. IMPLAN comes with databases containing the most recently available economic data from a variety of sources.[2] Using IMPLAN software and data, transaction tables

[2]The basic IMPLAN database consists of national level technology matrices based on the Benchmark Input-Output Accounts generated the U.S. Bureau of Economic Analysis and estimates of final demand, final payments, industry output and employment for various economic sectors. IMPLAN's regional data (i.e. states, a counties or groups of counties within a state) are divided into two basic categories: 1) data on an industry basis including value-added, output and employment and 2) data on a commodity basis including final demands and institutional sales. State-level data are balanced to the national totals using a matrix ratio allocation system and county data are balanced to state totals. In other words, much of the data in IMPLAN is based on a national average for all industries.

conceptually similar to the one discussed previously (see Table 1 on page 8) were estimated for each county in the region and for the region as a whole. Each transaction table contains 528 economic sectors and allows one to estimate a variety of economic statistics including:

- **total sales** - total production measured by sales revenues;
- **intermediate sales** - sales to other businesses and industry within a given region;
- **final sales** - sales to end users in a region and exports out of a region;
- **employment** - number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income** - total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes** - sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include income taxes).

TWDB analysts developed an economic baseline containing each of the above variables using year 2000 data. Since the planning horizon extends through 2060, economic variables in the baseline were allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Projections for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category. Monetary impacts in future years are reported in year 2000 dollars.

It is important to stress that employment, income and business taxes are the most useful variables when comparing the relative contribution of an economic sector to a regional economy. Total sales as reported in IO/SAM models are less desirable and can be misleading because they include sales to other industries in the region for use in the production of other goods. For example, if a mill buys grain from local farmers and uses it to produce feed, sales of both the processed feed and raw corn are counted as "output" in an IO model. Thus, total sales double-count or overstate the true economic value of goods and services produced in an economy. They are not consistent with commonly used measures of output such as Gross National Product (GNP), which counts only final sales.

Another important distinction relates to terminology. Throughout this report, the term *sector* refers to economic subdivisions used in the IMPLAN database and resultant input-output models (528 individual sectors based on Standard Industrial Classification Codes). In contrast, the phrase *water use category* refers to water user groups employed in state and regional water planning including irrigation, livestock, mining, municipal, manufacturing and steam electric. All sectors in the IMPLAN database were assigned to a specific water use category (see Attachment A of this report).

Step 2: *Estimate Direct Economic Impacts of Water Shortages*

As mentioned above, direct impacts accrue to immediate businesses and industries that rely on water. Without water industrial processes could suffer. However, output responses would likely vary depending upon the severity of a shortage. A small shortage relative to total water use may have a nominal effect, but as shortages became more critical, effects on productive capacity would increase.

For example, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. In the case of manufacturing, a good example occurred in the summer of 1999 when Toyota Motor Manufacturing experienced water shortages at a facility near Georgetown, Kentucky. As water levels in the Kentucky River fell to historic lows due to drought, plant managers sought ways to curtail water use such as reducing rinse operations to a bare minimum and recycling water by funneling it from paint shops to boilers. They even considered trucking in water at a cost of 10 times what they were paying. Fortunately, rains at the end of the summer restored river levels, and Toyota managed to implement cutbacks without affecting production. But it was a close call. If rains had not replenished the river, shortages could have severely reduced output.[3]

Note that the efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

To account for uncertainty regarding the relative magnitude of impacts to farm and business operations, the following analysis employs the concept of elasticity. Elasticity is a number that shows how a change in one variable will affect another. In this case, it measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities used in this study are:[4]

- if unmet water needs are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;
- if water shortages are 5 to 30 percent of total water demand, for every 1.0 one percent of unmet need, there is a corresponding 0.25 percent reduction in output;
- if water shortages are 30 to 50 percent of total water demand, for every 1.0 one percent of unmet need, there is a corresponding 0.50 percent reduction in output; and
- if water shortages are greater than 50 percent of total water demand, for every 1.0 one percent of unmet need, there is a corresponding 1.0 percent (i.e., a proportional reduction).

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. When calculating direct effects for the municipal, steam electric, manufacturing and livestock water use categories, sales to final demand were applied to avoid double counting impacts. The formula for a given IMPLAN sector is:

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[3] See, Royal, W. "*High And Dry - Industrial Centers Face Water Shortages.*" in Industry Week, Sept, 2000.

[4] Elasticities are based on one of the few empirical studies that analyze potential relationships between economic output and water shortages in the United States. The study, conducted in California, showed that a significant number of industries would suffer reduced output during water shortages. Using a survey based approach researchers posed two scenarios to different industries. In the first scenario, they asked how a 15 percent cutback in water supply lasting one year would affect operations. In the second scenario, they asked how a 30 percent reduction lasting one year would affect plant operations. In the case of a 15 percent shortage, reported output elasticities ranged from 0.00 to 0.76 with an average value of 0.25. For a 30 percent shortage, elasticities ranged from 0.00 to 1.39 with average of 0.47. For further information, see, California Urban Water Agencies, "*Cost of Industrial Water Shortages.*" Prepared by Spectrum Economics, Inc. November, 1991.

$D_{i,t} = Q_{i,t} *, S_{i,t} * E_Q * RFD_i * DM_{i(Q, L, I, T)}$

where:

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

E_Q = elasticity of output and water use

$DM_{i(L, I, T)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Direct impacts to irrigation and mining are based upon the same formula; however, total sales as opposed to final sales were used. To avoid double counting, secondary impacts in sectors other than irrigation and mining (e.g., manufacturing) were reduced by an amount equal to or less than direct losses to irrigation and mining. In addition, in some instances closely linked sectors were moved from one water use category to another. For example, although meat packers and rice mills are technically manufacturers, in some regions they were reclassified as either livestock or irrigation. All direct effects were estimated at the county level and then summed to arrive at a regional figure. See Section 2 of this report for additional discussion regarding methodology and caveats used when estimating direct impacts for each water use category.

Step 3: *Estimate Secondary and Total Economic Impacts of Water Shortages*

As noted earlier, the effects of reduced output would extend well beyond sectors directly affected. Secondary impacts were derived using the same formula used to estimate direct impacts; however, regional level *indirect* and *induced* multiplier coefficients were applied and only final sales were multiplied.

1.2.2 Impacts Associated with Domestic Water Uses

IO/SAM models are not well suited for measuring impacts of shortages for domestic uses, which make up the majority of the municipal category.[5] To estimate impacts associated with domestic uses, municipal water demand and thus needs were subdivided into two categories - residential and commercial. Residential water is considered "domestic" and includes water that people use in their homes for things such as cooking, bathing, drinking and removing household waste and for outdoor purposes including lawn watering, car-washing and swimming pools. Shortages to residential uses were valued using a tiered approach. In other words, the more severe the shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic costs would be much higher in this case because people could probably not live with such a reduction,

[5] A notable exception is the potential impacts to the nursery and landscaping industry that could arise due to reductions in outdoor residential uses and impacts to "water intensive" commercial businesses (see Section 2.3.3).

and would be forced to find emergency alternatives. The alternative assumed in this study is a very uneconomical and worst-case scenario (i.e., hauling water in from other communities by truck or rail). Section 2.3.3 of this report discusses methodology for municipal uses in greater detail.

1.3 Measuring Social Impacts

As the name implies, the effects of water shortages can be social or economic. Distinctions between the two are both semantic and analytical in nature - more so analytic in the sense that social impacts are much harder to measure in quantitative terms. Nevertheless, social effects associated with drought and water shortages usually have close ties to economic impacts. For example, they might include:

- demographic effects such as changes in population,
- disruptions in institutional settings including activity in schools and government,
- conflicts between water users such as farmers and urban consumers,
- health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations),
- mental and physical stress (e.g., anxiety, depression, domestic violence),
- public safety issues from forest and range fires and reduced fire fighting capability,
- increased disease caused by wildlife concentrations,
- loss of aesthetic and property values, and
- reduced recreational opportunities. [6]

Social impacts measured in this study focus strictly on demographic effects including changes in population and school enrollment. Methods are based on models used by the TWDB for state water planning and by the U.S. Census Bureau for national level population projections. With the assistance of the Texas State Data Center (TSDC), TWDB staff modified population projection models used for state water planning and applied them here. Basically, the social impact model incorporates results from the economic component of the study and assesses how changes in labor demand due to unmet water needs could affect migration patterns in a region. Before discussing particulars of the approach model, some background information regarding population projection models is useful in understanding the overall approach.

1.3.1 Overview of Demographic Projection Models

More often than not, population projections are reported as a single number that represents the size of an overall population. While useful in many cases, a single number says nothing about the composition of projected populations, which is critical to public officials who must make decisions regarding future spending on public services. For example, will a population in the future have more elderly people relative to today, or will it have more children? More children might mean that more schools are needed. Conversely, a population with a greater percentage of elderly people may need additional healthcare facilities. When projecting future populations, cohort-survival models break down a population into groups (i.e., cohorts) based on

[6] Based on information from the website of the National Drought Mitigation Center at the University of Nebraska Lincoln. Available online at: http://www.drought.unl.edu/risk/impacts.htm. See also, Vanclay, F. "*Social Impact Assessment*." in Petts, J. (ed) International Handbook of Environmental Impact Assessment. 1999.

factors such as age, sex and race. Once a population is separated into cohorts, one can estimate the magnitude and composition of future population changes.

Changes in a population's size and makeup in survival cohort models are driven by three factors:

1. *Births:* Obviously, more babies mean more people. However, only certain groups in a population are physically capable of bearing children- typically women between the ages of 13 and 49. The U.S. Census Bureau and the TSDC continually updates fertility rates for different cohorts. For each race/ethnicity category, birth rates decline and then stabilize in the future.

2. *Deaths:* When people die, populations shrink. Unlike giving birth, however, everyone is capable of dying and mortality rates are applied to all cohorts in a given population. Hence their name, cohort-survival models use survival rates as opposed to mortality rates. A survival rate is simply the probability that a given person with certain attributes (i.e., race, age and sex) will survive over a given period of time.

3. *Migration:* Migration is the movement of people in or out of a region. Migration rates used to project future changes in a region are usually based on historic population data. When analyzing historic data, losses or increases that are not attributed to births or deaths are assumed to be the result of migration. Migration can be further broken down into changes resulting from economic and non-economic factors. Economic migrants include workers and their families that relocate because of job losses (or gains), while non-economic migrants move due to lifestyles choices (e.g., retirees fleeing winter cold in the nation's heartland and moving to Texas).

In summary, knowledge of a population's composition in terms of age, sex and race combined with information regarding birth and survival rates, and migratory patterns, allows a great deal of flexibility and realism when estimating future populations. For example, an analyst can isolate population changes due to deaths and births from changes due to people moving in and out of a region. Or perhaps, one could analyze how potential changes in medical technology would affect population by reducing death rates among certain cohorts. Lastly, one could assess how changes in *economic conditions* might affect a regional population.

1.3.2 Methodology for Social Impacts

Two components make up the model. The first component projects populations for a given year based on the following six steps:

1) *Separate "special" populations from the "general" population of a region:* The general population of a region includes the portion subject to rates of survival, fertility, economic migration and non-economic migration. In other words, they live, die, have children and can move in and out of a region freely. "Special populations," on the other hand, include college students, prisoners and military personnel. Special populations are treated differently than the general population. For example, fertility rates are not applied to prisoners because in general inmates at correctional facilities do not have children, and they are incapable of freely migrating or out of a region. Projections for special populations were compiled by the TSDC using data from the Higher Education Coordinating Board, the Texas Department of Criminal Justice and the U.S. Department of Defense. Starting from the 2000 Census, general and special populations were broken down into the following cohorts:

- age cohorts ranging from age zero to 75 and older,
- race/ethnicity cohorts, including Anglo, Black, Hispanic and "other," and
- gender cohorts (male and female).

2) *Apply survival and fertility rates to the general population*: Survival and fertility rates were compiled by the TSDC with data from the Texas Department of Health (TDH). Natural decreases (i.e., deaths) are estimated by applying survival rates to each cohort and then subtracting estimated deaths from the total population. Birth rates were then applied to females in each age and race cohort in general and special populations (college and military only) to arrive at a total figure for new births.

3) *Estimate economic migration based on labor supply and demand*: TSDC year 2000 labor supply estimates include all non-disabled and non-incarcerated civilians between the ages of 16 and 65. Thus, prisoners are not included. Labor supply for years beyond 2001 was calculated by converting year 2000 data to rates according to cohort and applying these rates to future years. Projected labor demand was estimated based on historical employment rates. Differences between total labor supply and labor demand determines the amount of in or out migration in a region. If supply is greater than demand, there is an out-migration of labor. Conversely, if demand is greater than supply, there is an in-migration of labor. The number of migrants does not necessarily reflect total population changes because some migrants have families. To estimate how many people might accompany workers, a migrant worker profile was developed based on the U.S. Census Bureau's Public Use Microdata Samples (PUMs) data. Migrant profiles estimate the number of additional family members, by age and gender that accompany migrating workers. Together, workers and their families constitute economic migration for a given year.

4) *Estimate non-economic migration*: As noted previously, migration patterns of individuals age 65 and older are generally independent of economic conditions. Retirees usually do not work, and when they relocate, it is primarily because of lifestyle preferences. Migratory patterns for people age 65 or older are based on historical PUMs data from the U.S. Census.

5) *Calculate ending population for a given year*: The total year-ending population is estimated by adding together: 1) surviving population from the previous year, 2) new births, 3) net economic migration, 4) net non-economic migration and 5) special populations. This figure serves as the baseline population for the next year and the process repeats itself.

The second component of the social impact model is identical to the first and includes the five steps listed above for each year where water shortages are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060). The only difference is that labor demand changes in years with shortages. Shifts in labor demand stem from employment impacts estimated as part of the economic analysis component of this study with some slight modifications. IMPLAN employment data is based on the number of full and part-time jobs as opposed to the number of people working. To remedy discrepancies, employment impacts from IMPLAN were adjusted to reflect the number of people employed by using simple ratios (i.e., labor supply divided by number of jobs) at the county level. Declines in labor demand as measured using adjusted IMPLAN data are assumed to affect net economic migration in a given regional water planning area. Employment losses are adjusted to reflect the notion that some people would not relocate but would seek employment in the region and/or public assistance and wait for conditions to improve. Changes in school enrollment are simply the proportion of lost population between the ages of 5 and 17.

1.4 Clarifications, Assumptions and Limitations of Analysis

As with any attempt to measure and quantify human activities at a societal level, assumptions are necessary and every model has limitations. Assumptions are needed to maintain a level of generality and simplicity such that models can be applied on several geographic levels and across different economic sectors. In terms of the general approach used here several clarifications and cautions are warranted:

1) While useful for planning purposes, this study is not a benefit-cost analysis (BCA). BCA is a tool widely used to evaluate the economic feasibility of specific policies or projects as opposed to estimating economic impacts of unmet water needs. Nevertheless, one could include some impacts measured in this study as part of a BCA if done so properly.

2) Since this is not a BCA, future impacts are not weighted differently. In other words, estimates are not "discounted." If used as a measure of benefits in a BCA, one must consider the uncertainty of estimated monetary impacts.

3) All monetary figures are reported in constant year 2000 dollars.

4) Shortages reported by regional planning groups are the starting point for socioeconomic analyses. No adjustments or assumptions regarding the magnitude or distributions of unmet needs among different water use categories are incorporated in the analysis.

5) Estimated impacts are point estimates for years in which needs are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060).They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from severe drought conditions combined with infrastructure limitations. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals and resultant impacts are measured. Given, that reported figures are not cumulative in nature, it is inappropriate to sum impacts over the entire planning horizon. Doing so, would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case. Similarly, authors of this report recognize that in many communities needs are driven by population growth, and in the future total population will exceed the amount of water available due to infrastructure limitations, *regardless of whether or not there is a drought*. This implies that infrastructure limitations would constrain economic growth. However, since needs as defined by planning rules are based upon water supply and demand under the assumption of drought of record conditions, it improper to conduct economic analysis that focuses on growth related impacts over the planning horizon. Figures generated from such an analysis would presume a 50-year drought of record, which is unrealistic. Estimating lost economic activity related to constraints on population and commercial growth due to lack of water would require developing water supply and demand forecasts under "normal" or "most likely" future climatic conditions.

6) IO multipliers measure the strength of backward linkages to supporting industries (i.e., those who sell inputs to an affected sector). However, multipliers say nothing about forward linkages consisting of businesses that purchase goods from an affected sector for further processing. For example, ranchers in many areas sell most of their animals to local meat packers who process animals into a form that consumers ultimately see in grocery stores and restaurants. Multipliers do not capture forward linkages to meat packers, and since meat packers sell livestock purchased from ranchers as "final sales," multipliers for the ranching sector do fully account for all losses to a region's economy. Thus, in some cases throughout this study forward processors were included when estimating economic impacts.

7) Cautions regarding interpretations of direct and secondary impacts are warranted. IO/SAM multipliers are based on "fixed-proportion production functions," which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, employers may not lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly

people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an *upper bound*. Similarly, since population projections are based on reduced employment in the region, they should be considered an upper bound as well.

8) IO models are static in nature. Models and resultant multipliers are based upon the structure of the U.S. and regional economies in the year 2000. In contrast, unmet water needs are projected to occur well into the future (i.e., 2010 through 2060). Thus, the analysis assumes that the general structure of the economy remains the same over the planning horizon.

9) With respect to municipal needs, an important assumption is that people would eliminate all outdoor water use before indoor water uses were affected, and people would implement emergency indoor water conservation measures before commercial businesses had to curtail operations, and households had to seek alternative sources of water. Section 2.3.3 discusses this in greater detail.

10) Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, figures should be adjusted to reflect the extended duration. The drought of record in Texas for many communities lasted several years.

2. Results of Economic Impact Analysis

Part 2 of this report summarizes economic analysis for each water use category. Section 2.1 presents the year 2000 economic baseline for Region O. Section 2.2 presents results for agricultural water uses including livestock and irrigated crop production, while Section 2.3 reviews impacts to municipal and industrial water uses including manufacturing, mining, steam-electric and municipal demands.[7]

2.1 Economic Baseline

Table 2 summarizes baseline economic variables for the region. In year 2000, business and industry produced $24,499 million in output that generated nearly $11,266 million in income for residents in the area. Economic activity supported an estimated 262,455 full and part-time jobs. Business and industry also generated $1,016 million in state and local taxes. Sections 2.2.and 2.3 discuss contributions of individual water use categories in greater detail.

Table 2: Year 2000 Economic Baseline for Region O (monetary figures reported in $millions)

	Sales Activity			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Irrigation	$802.57	$179.55	$621.77	9,968	$167.51	$14.81
% of Total	3%	2%	4%	4%	1%	1%
Livestock*	$3,836.05	$1,133.95	$2,702.10	12,707	$497.33	$38.07
% of Total	16%	15%	16%	5%	4%	4%
Manufacturing	$2,480.17	$346.57	$2,133.60	11,722	$673.44	$18.92
% of Total	10%	5%	13%	4%	6%	2%
Mining	$1,524.43	$386.77	$1,137.66	3,339	$696.91	$80.72
% of Total	6%	5%	7%	1%	6%	8%
Steam Electric	$312.53	$81.44	$231.08	623	$223.50	$40.03
% of Total	1%	72%	1%	0%	2%	4%
Municipal	$15,543.31	$5,408.65	$10,134.65	224,097	$9,007.85	$824.43
% of Total	63%	1%	60%	85%	80%	81%
Total	$24,499.05	$7,979.16	$16,960.87	262,455	$11,266.54	$1,016.99
% of Total	100%	100%	100%	100%	100%	100%

* Livestock includes regional meat-packing sector. Source: Generated by the Texas Water Development Board, Office of Water Resources Planning using IMPLAN models and data from MIG, Inc.

[7] Attachment B of this report contains tables showing the distribution of impacts at the county level and city level (municipal uses only).

2.2 Agriculture

Of all the water planning areas in the state, agriculture makes up the largest share of economic activity in Region O. In 2000, farmers using irrigation produced about $802 million dollars worth of crops that generated a total of almost $167 million in income - about one percent of total income in the region. Although seemingly small relative to other water use categories, one should note that a significant portion of output from irrigated farms feeds the region's livestock industry, which in turn had sales totaling $3,836 million in 2000 that generated $497 million worth of income and provided 12,707 jobs to the region. Collectively, irrigated farming and livestock account for about five percent of income and nine percent of jobs in the region.

2.2.1 Irrigation

Since, default IMPLAN data do not distinguish irrigated production from dry-land production, the first step in estimating impacts to irrigation required calculating gross sales for IMPLAN crop sectors. Once gross sales were known other statistics such as employment and income were derived using IMPLAN direct multiplier coefficients. Gross sales for a given crop are based on two data sources:

1) county-level statistics collected and maintained by the TWDB and the USDA Natural Resources Conservation Service (NRCS) including the number of irrigated acres by crop type and water application per acre, and

2) regional-level data published by the Texas Agricultural Statistics Service (TASS) including prices received for crops (marketing year averages), crop yields and crop acreages.

Crop categories used by the TWDB differ from those used in IMPLAN datasets. To maintain consistency, sales and other statistics are reported using IMPLAN crop classifications. Table 3 shows the TWDB crops included in corresponding IMPLAN sectors. Table 4 summarizes acreage and estimated annual water use for each crop type (year 2000).

Table 3: Crop Classifications Used in TWDB Water Use Survey and Corresponding IMPLAN Crop Sectors Applied in Socioeconomic Impact Analysis

IMPLAN Sector	TWDB Sector
Cotton	Cotton
Feed Grains	Corn, sorghum and "forage crops"
Food Grains	Rice, wheat and "other grains"
Fruits	Citrus
Hay and Pasture	Alfalfa and "other hay and pasture"
Oil Crops	Peanuts, soybeans and "other oil crops"
Sugar Crops	Sugar-beets and sugarcane
Tree Nuts	Pecans
Vegetables *	Deep-rooted vegetables, shallow-rooted vegetables and potatoes
Other Crops	"All other crops" "other orchards" and vineyards

* includes melons

Table 4. Summary of Irrigated Crop Acreage and Water Demand for Region O (Year 2000)				
Sector	Acres (1000s)	Distribution of Acres	Water Use (1000s of AF)	Distribution of Water Use
Cotton	2,023	61.4%	2,368	54.5%
Feed Grains	554	16.8%	1,007	23.2%
Food Grains	365	11.1%	423	9.7%
Oil Crops	211	6.4%	351	8.1%
Hay and Pasture	69	2.1%	106	2.4%
Vegetables	47	1.4%	67	1.5%
Other	20	0.6%	22	0.5%
Tree Nuts	3	0.1%	5	0.1%
Total	3,292	100%	4,349	100%

Source: Water demand figures are taken from the Texas Water Development Board 2006 Water Plan Projections data for year 2000. Statistics for irrigated crop acreage are based upon annual survey data collected by the TWDB and the National Resources Conservation Service (USDA).

Table 5 shows year 2000 economic data for irrigated crop production in the region.[8] Generating $421 million in sales and providing jobs for 2,430 people in the region, cotton is the largest sector. As mentioned previously, distinguishing between intermediate and final sales is important when discussing economic impacts. For example, the majority of output from the cotton sector moves out of the region as exports (i.e., final sales). In contrast, more one-half of feed grain output stays in the region as intermediate sales. Almost all feed grain sold to local businesses (roughly 99 percent) goes to feedlots and cattle ranchers. Thus, if water shortages occurred at projected levels, reductions in feed grain production could affect ranchers in the region. However, data that would allow the TWDB to measure such impacts are not readily available, and these effects are not considered in this study.

[8] The TWDB category entitled "other crops" is not included in economic analyses given that data regarding types of crops and activities included in the grouping are not available, and thus it difficult if not impossible to generate economic indicators for the group.

Table 5: Year 2000 Direct Economic Activity for Irrigated Crop Production in Region O (monetary figures reported in $millions)						
	Sales Activity			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Cotton	$420.86	$33.80	$387.06	3,974	$99.76	$8.64
Feed Grains	$159.42	$85.33	$74.09	1,938	$26.00	$2.91
Oil Bearing Crops	$104.54	$40.06	$64.48	2,438	$23.99	$2.33
Vegetables	$72.88	$6.82	$66.07	603	$13.09	$0.49
Food Grains	$24.05	$3.29	$20.76	376	$2.65	$0.26
Hay and Pasture	$19.16	$10.26	$8.91	607	$1.71	$0.17
Tree Nuts	$1.65	$1.25	$0.41	32	$0.32	$0.01
Total	$802.57	$621.77	$621.77	9,968	$167.51	$14.81

* Does not include dry-land crop production. Source: Generated by the Texas Water Development Board, Office of Water Planning using IMPLAN Pro™ software and data.

An important consideration when estimating impacts to irrigation was determining which crops are affected by water shortages. One approach is the so-called rationing model, which assumes that farmers respond to water supply cutbacks by fallowing the lowest value crops in the region first and the highest valued crops last until the amount of water saved equals the shortage.[9] For example, if farmer A grows vegetables (higher value) and farmer B grows wheat (lower value) and they both face a proportionate cutback in irrigation water, then farmer B will sell water to farmer A. Farmer B will fallow her irrigated acreage before farmer A fallows anything. Of course, this assumes that farmers can and do transfer enough water to allow this to happen. A different approach involves constructing farm-level profit maximization models that conform to widely-accepted economic theory that farmers make decisions based on marginal net returns. Such models have good predictive capability, but data requirements and complexity are high. Given that a detailed analysis for each region would require a *substantial* amount of farm-level data and analysis, the following investigation assumes that projected shortages are distributed equally across predominant crops in the region. "Predominant" in this case are crops that comprise at least one percent of total acreage in the region (see Table 4).

The following steps outline the overall method used to estimate direct impacts to irrigated agriculture:

1. *Distribute shortages across predominant crop types in the region.* Again, unmet water needs were distributed equally across crop sectors that constitute one percent or more of irrigated acreage in 2000.

2. *Estimate associated reductions in output for affected crop sectors.* Output reductions are based on elasticities discussed in Section 1.2.1 and on estimated values per acre for different crops. Values per acre stem from the same data used to estimate output for the year 2000 baseline. Given that 2000 may have been an unusually poor or productive year

[9] The rationing model was initially proposed by researchers at the University of California at Berkeley, and was then modified for use in a study conducted by the U.S. Environmental Protection Agency that evaluated how proposed water supply cutbacks recommended to protect water quality in the Bay/Delta complex in California would affect farmers in the Central Valley. See, Zilberman, D., Howitt, R. and Sunding, D. "*Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delta*." Western Consortium for Public Health. May 1993.

for some crops and not necessarily representative of normal conditions, statistics regarding yield, price and acreage for crop sectors were averaged over a five-year period (1995-2000) if sufficient data were available.

3. *Offset reductions in output by revenues from dry-land production.* If TASS acreage data indicate that farmers grow a dry-land version of a given crop in the region (e.g., cotton or corn), estimated losses from irrigated acreage are offset by assumed revenues from dry-land harvests. Basically, the analysis assumes that farmers who use irrigation would try and grow something even if irrigation water were not available. Given that water shortages are expected to occur under drought conditions, values per acre for dry-land crops are based on 1998 and/or 1996 yields and prices. Both 1996 and 1998 were particularly bad drought years for most of West Texas. Table 6 summarizes data used to estimate the value of lost output.

Table 6: Data Used to Estimate Impacts to Irrigated Crop Production in Region O

IMPLAN Crop sector	Gross sales revenue per irrigated acre	Gross sales revenue per dry-land acre (drought conditions)	Data Sources for yield, prices and planted acreage used to estimate gross sales per acre
Cotton	$340	$50	Based on data from TASS for Irrigated Cotton Southern High Plains region. Average values (1995-2000). Dry-land value based on same regional data using 1998 yields and prices for dry-land cotton.
Feed Grains	$215	$25	Five-year (1995-2000) average weighted by corn, grain sorghum and other forage crop acreage based on TASS for Southern High Plains Region. Dry-land value based on same regional data and crops using 1998 yields and prices for dry-land acreage.
Food Grains	$120	$20	Based on data from TASS for irrigated wheat in the Northern High Plains District. Average values (1995-2000). Dry-land value based on same regional data using 1998 yields and prices for dry-land wheat.
Oil Crops	$715	$0	Average values (1995-2000) weighted by acreage for TASS peanuts, sunflowers and soybeans for the Southern High Plains. Dry-land value assumed nominal since 85 % of oil crop acreage consists of peanuts.
Hay and Pasture	$315	$45	Average values (1995-2000) weighted by acreage for TASS alfalfa data, and TAMU crop enterprise budgets for sprinkler irrigated permanent pasture in the Panhandle and Southern Plains Districts. Dry-land value is for sprinkler irrigated pasture and assumes a 50 % reduction in harvest. No dry-land value for alfalfa.
Vegetables	$1900	$0	Average values (1995-2000) weighted by acreage for statewide TASS data for deep and shallow rooted vegetables including potatoes. No dry-land value assumed.

* Includes melons. All values are rounded. TASS = Texas Agricultural Statistics Service. TAMU = Texas A&M University.

The Llano Estacado 2006 Water Plan indicates that under drought of record conditions, shortages to irrigation would occur in most counties in the region. Table 7 summarizes estimated impacts. Attachment B of this report shows impacts by county, and Attachment C shows impacts by major river basin.

Table 7: Annual Economic Impacts of Unmet Water Needs for Irrigation in Region L
(years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$194.24	$71.81	2,910	$6.32
2020	$310.39	$119.01	4,800	$10.69
2030	$522.60	$195.66	10,980	$17.64
2040	$680.36	$252.41	9,900	$22.75
2050	$740.90	$274.65	10,750	$24.74
2060	$757.34	$280.53	10,980	$25.28

* Estimates are based on *projected* economic activity in the region. Source: Based on economic impact models developed by the Texas Water Development Board, Office of Water Planning.

2.2.2 Livestock

No water shortages for livestock were reported for Region O.

2.3 Municipal and Industrial

Municipal and industrial (M&I) water uses make up the majority of economic activity in the region. In 2000, M&I users generated $19.9 billion in sales and $10.6 billion worth of income. M&I added nearly $1.0 billion to state and local tax revenues and provided 206,840 jobs.

2.3.3 Municipal

Table 8 summarizes economic activity for municipal uses. In 2000, businesses and institutions that make up the municipal category produced $15.5 billion worth of goods and services. In return, they received $5.4 billion in wages, salaries and profits. Municipal uses generate the bulk of business taxes in the region $0.4 billion nearly (81 percent). Top commercial sectors in terms of income and output include wholesale trade, real estate, communications, banking, medical and transportation, and eating and drinking establishments.

Table 8: Year 2000 Direct Economic Activity for Municipal Water Uses in Region O (monetary figures reported in $millions)						
Sector	Sales Activity			Jobs	Regional Income	Business Taxes
	Total	Intermediate	Final			
Wholesale Trade	$1,161.52	$648.53	$512.99	12,458	$636.54	$165.58
Banking	$914.52	$223.32	$691.20	4,609	$590.83	$14.78
Communications	$783.26	$208.26	$575.00	3,131	$392.86	$41.82
Real Estate	$780.12	$419.44	$360.68	4,329	$462.62	$92.30
Doctors and Dentists	$599.85	$0.00	$599.85	4,957	$415.34	$7.97
Freight Transport	$552.29	$327.96	$224.33	5,528	$211.98	$6.66
Eating & Drinking	$541.45	$25.37	$516.07	15,868	$243.31	$33.95
All Other Municipal Sectors	$10,210.31	$3,555.78	$6,654.53	173,217	$6,054.38	$461.37
Total	$15,543.31	$5,408.65	$10,134.65	224,097	$9,007.85	$824.43
Source: Generated using data from MIG, Inc., and models developed by the TWDB using IMPLAN software.						

Estimating direct economics impacts for the municipal category is complicated for a number of reasons. For one, municipal uses comprise a range of different consumers including commercial businesses, institutions (e.g., schools and government) and households. However, reported shortages do not specify how needs are distributed among different consumers. In other words, how much of a municipal need is commercial and how much is residential? The amount of commercial water use as a percentage of total municipal demand was estimated based on "GED" coefficients (gallons per employee per day) published in secondary sources (see Attachment A). For example, if year 2000 baseline data for a given economic sector (e.g., amusement and recreation services) shows employment at 30 jobs and the GED coefficient is 200, then average daily water use by that sector is (30 x 200 = 6,000 gallons) and thus annual use is 6.7 acre-feet. Water not attributed to commercial use is considered domestic, which includes single and multi-family residential consumption, institutional uses and all use designated as "county-other." The estimated proportion of water used for commercial purposes ranges from about 5 to 35 percent of total municipal demand at the county level. Less populated rural counties occupy the lower end of the spectrum, while larger metropolitan counties are at the higher end.

As mentioned earlier, a key study assumption is that people would eliminate outdoor water use before indoor water consumption was affected; and they would implement *voluntary* emergency indoor water conservation measures before people had to curtail business operations or seek emergency sources of water. This is logical because most water utilities have drought contingency plans. Plans usually specify curtailment or elimination of outdoor water use during periods of drought. In Texas, state law requires retail and wholesale water providers to prepare and submit plans to the Texas Commission on Environmental Quality (TCEQ). Plans must specify demand management measures for use during drought including curtailment of "non-essential water uses."[10] Thus, when assessing municipal needs there are several important considerations: 1) how much of a need would people reduce via eliminating outdoor uses and implementing

[10] Non-essential uses as defined by the State of Texas include, but are not limited to, landscape irrigation and water for swimming pools or fountains. For further information see the Texas Environmental Quality Code §288.20.

emergency indoor conservation measures; and 2) what are the economic implications of such measures?

Determining how much water is used for outdoor purposes is key to answering these questions. The proportion used here is based on several secondary sources. The first is a major study sponsored by the American Water Works Association, which surveyed cities in states including Colorado, Oregon, Washington, California, Florida and Arizona. On average across all cities surveyed 58 percent of residential water use was for outdoor activities. In cities with climates comparable to large metropolitan areas of Texas, the average was 40 percent.[11]Earlier findings of the U.S. Water Resources Council showed a national average of 33 percent. Similarly, the United States Environmental Protection Agency (USEPA) estimated that landscape watering accounts for 32 percent of total residential and commercial water use on annual basis.[12] A study conducted for the California Urban Water Agencies (CUWA) calculated values ranging from 25 to 35 percent.[13] Unfortunately, there does not appear to be any comprehensive research that has estimated non-agricultural outdoor water use in Texas. As an approximation, an average annual value of 30 percent based on the above references was selected to serve as a rough estimate in this study. With respect to emergency indoor conservation measures, this analysis assumes that citizens in affected communities would reduce needs by an additional 20 percent. Thus, 50 percent of total needs could be eliminated before households and businesses had to implement emergency water procurement activities.

Eliminating outdoor watering would have a range of economic implications. For one, such a restriction would likely have adverse impacts on the landscaping and horticultural industry. If people are unable to water their lawns, they will likely purchase less lawn and garden materials such as plants and fertilizers. On the other hand, during a bad drought people may decide to invest in drought tolerant landscaping, or they might install more efficient landscape plumbing and other water saving devices. But in general, the horticultural industry would probably suffer considerable losses if outdoor water uses were restricted or eliminated. For example, many communities in Colorado, which is in the midst of a prolonged drought, have severely restricted lawn irrigation. In response, the turf industry in Colorado has laid off at least 50 percent of its 2,000 employees.[14] To capture impacts to the horticultural industry, regional sales net of exports for the greenhouse and nursery sectors and the landscaping services sector were reduced by proportion equal to reductions in outdoor water use. Note that these losses would not necessarily appear as losses to the regional or state economies because people would likely spend the money that they would have spent on landscaping on other goods in the economy. Thus, the net effect to state or regional accounts could be neutral.

Other considerations include the "welfare" losses to consumers who had to forgo outdoor and indoor water uses to reduce needs. In other words, the water that people would have to give up has an economic value. Estimating the economic value of this forgone water for each planning area would be a very time consuming and costly task, and thus secondary sources served as a proxy. Previous research funded by the TWDB, explored consumer "willingness to pay" for avoiding restrictions on water use.[15] Surveys revealed that residential water consumers in Texas

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[11] See, Mayer, P.W., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W., Dziegielewski, D., Nelson, J.O. "*Residential End Uses of Water*." Research sponsored by the American Water Works Association and completed by Aquacraft, Inc. and Planning and Management Consultants, Ltd. (PMCL@CDM).

[12] U.S. Environmental Protection Agency. *"Cleaner Water through Conservation*." USEPA Report no. 841-B-95-002. April, 1995.

[13] Planning and Management Consultants, Ltd. "*Evaluating Urban Water Conservation Programs: A Procedures Manual*." Prepared for the California Urban Water Agencies. February 1992.

[14] Based on assessments of the Rocky Mountain Sod Growers. See, "*Drought Drying Up Business for Landscapers*." Associated Press. September, 17 2002.

[15] See, Griffin, R.C., and Mjelde, W.M. " *Valuing and Managing Water Supply Reliability*. Final Research Report for the Texas Water Development Board: Contract no. 95-483-140." December 1997.

would be willing to pay - on average across all income levels - $36 to avoid a 30 percent reduction in water availability lasting for at least 28 days. Assuming the average person in Texas uses 140 gallons per day and the typical household in the state has 2.7 persons (based on U.S. Census data), total monthly water use is 13,205 gallons per household. Therefore, the value of restoring 30 percent of average monthly water use during shortages to residential consumers is roughly one cent per gallon or $2,930 per acre-foot. This figure serves as a proxy to measure consumer welfare losses that would result from restricted outdoor uses and emergency indoor restrictions.

The above data help address the impacts of incurring water needs that are 50 percent or less of projected use. Any amount greater than 50 percent would result in municipal water consumers having to seek alternative sources. Costs to residential and non-water intensive commercial operations (i.e., those that use water only for sanitary purposes) are based on the most likely alternative source of water in the absence of water management strategies. In this case, the most likely alternative is assumed to be "hauled-in" water from other communities at annual cost of $6,530 per acre-foot for small rural communities and approximately and $10,995 per acre-foot for metropolitan areas.[16]

This is not an unreasonable assumption. It happened during the 1950s drought and more recently. For example, in 2000 at the heels of three consecutive drought years Electra - a small town in North Texas - was down to its last 45 days worth of reservoir water when rain replenished the lake, and the city was able to refurbish old wells to provide supplemental groundwater. At the time, residents were forced to limit water use to 1,000 gallons per person per month - less than half of what most people use - and many were having water hauled delivered to their homes by private contractors.[17] In 2003 citizens of Ballinger, Texas, were also faced with a dwindling water supply due to prolonged drought. After three years of drought, Lake Ballinger, which supplies water to more than 4,300 residents in Ballinger and to 600 residents in nearby Rowena, was almost dry. Each day, people lined up to get water from a well in nearby City Park. Trucks hauling trailers outfitted with large plastic and metal tanks hauled water to and from City Park to Ballinger.[18] In Australia, four cities have run out of water as a result of drought, and residents have been trucking in water since November 2002. One town has five trucks carting about one acre-foot eight times daily from a source 20 miles away. They had to build new roads and infrastructure to accommodate the trucks. Residents are currently restricted to indoor water use only.[19]

Direct impacts to "water intensive" commercial sectors were estimated in a fashion similar to other business sectors. Output was reduced according to the severity of projected shortages. Water intensive is defined as non-medical related sectors that are heavily dependent upon water to provide services. These generally include:

- car-washes,
- laundry and cleaning facilities,
- sports and recreation clubs and facilities including race tracks,
- amusement and recreation services,
- hotels and lodging places, and
- eating and drinking establishments.

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[16] For rural communities, figure assumes an average truck hauling distance of 50 miles at a cost of 8.4 cents per ton-mile (an acre foot of water weighs about 1,350 tons) with no rail shipment. For communities in metropolitan areas, figure assumes a 50 mile truck haul, and a rail haul of 300 miles at a cost of 1.2 cents per ton-mile. Cents per ton-mile are based on figures in: Forkenbrock, D.J., "*Comparison of External Costs of Rail and Truck Freight Transportation.*" Transportation Research. Vol. 35 (2001).

[17] Zewe, C. "*Tap Threatens to Run Dry in Texas Town.*" July 11, 2000. CNN Cable News Network.

[18] Associated Press, "*Ballinger Scrambles to Finish Pipeline before Lake Dries Up.*" May 19, 2003.

[19] Healey, N. (2003) *Water on Wheels*, Water: Journal of the Australian Water Association, June 2003.

For “non-water intensive” sectors, the study assumes that businesses would haul water by truck.

An example will illustrate the breakdown of municipal water needs and the overall approach to estimating impacts of municipal needs. Assume City B has an unmet need of 50 acre feet in 2020 and projected demands of 200 acre-feet. In this case, residents of City B could eliminate needs via restricting all outdoor water use. City A, on the other hand, has an unmet need of 150 acre-feet in 2020 with a projected demand of 200 acre-feet. Thus, total shortages are 75 percent of total demand. Emergency outdoor and indoor conservation measures would eliminate 50 acre-feet of projected needs; however, 50 acre-feet would still remain. This remaining portion would result in costs to residential and commercial water users. Water intensive businesses such as car washes, restaurants, motels, race tracks would have to curtail or eliminate operations (i.e., sales revenues would decline), and residents and non-water intensive businesses would have to pay to have water trucked-in assuming it was available.

The last element of municipal water shortages considered focused on lost water utility revenues. Estimating these was straightforward. Analyst used annual data from the “*Water and Wastewater Rate Survey*” published annually by the Texas Municipal League to calculate an average value per acre-foot for water and sewer. For water revenues, averages rates multiplied by total water needs served as a proxy. For lost wastewater, total unmet needs were adjusted for return flow factor of 0.60 and multiplied by average sewer rates for the region. Needs reported as “county-other” were excluded under the presumption that these consist primarily of self-supplied water uses. In addition, 15 percent of water demand and needs are considered non-billed or “unaccountable” water that comprises things such leakages and water for municipal government functions (e.g., fire departments). Lost tax receipts are based on current rates for the “miscellaneous gross receipts tax, “which the state collects from utilities located in most incorporated cities or towns in Texas.

The Llano Estacado 2006 Water Plan indicates that under drought of record conditions, shortages to municipal water uses would occur in Castro, Gaines, Hale, Hockley, Lamb, Lubbock, Parmer and Yoakum counties. Tables 9 through 12 summarize estimated impacts to residents, commercial businesses (water intensive and non-water intensive), water utilities and the horticultural industry. Attachment B of this report shows impacts by county, and Attachment C shows impacts by major river basin.

Table 9: Annual Economic Impacts of Unmet Water Needs for Water Intensive Commercial Businesses (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)

Year	Total Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$63.08	$29.35	1,420	$3.41
2020	$88.89	$41.90	2,025	$4.72
2030	$95.84	$45.15	2,180	$5.76
2040	$97.65	$46.02	2,225	$5.88
2050	$99.65	$47.72	2,310	$6.77
2060	$99.17	$46.68	2,260	$6.63

* Estimates are based on projected economic activity in the region. Source: Source: Generated by the Texas Water Development Board, Office of Water Planning.

Table 10: Annual Economic Impacts of Unmet Water Needs for Horticultural Industry (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)				
Year	Sales ($millions)	Regional Income ($millions)	Jobs	Business Taxes ($millions)
2010	$3.25	$1.71	90	$0.06
2020	$7.23	$3.81	205	$0.13
2030	$13.85	$7.30	390	$0.26
2040	$15.28	$8.06	430	$0.28
2050	$15.84	$8.35	450	$0.29
2060	$15.44	$8.14	440	$0.28
Source: Generated by the Texas Water Development Board, Office of Water Planning.				

Table 11: Annual Costs to Residential Water Users and Non-Water Intensive Commercial Businesses (years 2000, 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)	
Year	$millions
2010	$0.13
2020	$10.50
2030	$24.47
2040	$44.57
2050	$49.17
2060	$51.15
Source: Generated by the Texas Water Development Board, Office of Water Planning.	

Table 12: Annual Losses of Water Utility Revenues and Taxes due to Unmet Water Needs (years 2010, 2020, 2030, 2040, 2050 and 2060, constant year 2000 dollars)		
Year	$millions	Utility Taxes
2010	$2.79	$0.05
2020	$6.10	$0.11
2030	$11.49	$0.20
2040	$12.46	$0.22
2050	$12.85	$0.23
2060	$12.55	$0.22
Figures do not include potential losses related to water shortages for manufacturing sectors that purchase utility water. Source: Generated by the Texas Water Development Board, Office of Water Planning.		

2.3.2 Manufacturing

No water shortages for manufacturing were reported for Region O.

2.3.3 Mining

No water shortages for mining were reported for Region O.

2.3.4 Steam-Electric

No water shortages for steam-electric livestock were reported for Region O.

3. Regional Social Impacts

As discussed previously in Section 1.3, social impacts focus on changes in population loss and resulting declines in school enrollment in counties that make up Region O. As shown in Table 19, water shortages in 2010 could result in a population loss of 5,310 people with a corresponding reduction is school enrollment of 1,245. Models suggest that shortages in 2060 could cause population in the region to fall by 11,700 people and school enrollment by 2,530 students.

Table 13: Estimated Regional Social Impacts of Unmet Water Needs in Region O
(years, 2010, 2020, 2030, 2040, 2050 and 2060)

Year	Population Losses	Declines in School Enrollment
2010	5,310	1,245
2020	8,470	1,995
2030	14,830	3,590
2040	10,720	2,320
2050	11,540	2,495
2060	11,700	2,530

Source: Generated by the Texas Water Development Board, Office of Water Planning.

Attachment A: Baseline Regional Economic Data

Tables A-1 through A-6 contain data from several sources that form a basis of analyses in this report. Economic statistics were extracted and processed via databases purchased from MIG, Inc. using IMPLAN Pro™ software. Values for gallons per employee (i.e. GED coefficients) for the municipal water use category are based on several secondary sources.[20] County-level data sets along with multipliers are not included given their large sizes (i.e., 528 sectors per county each with 12 different multiplier coefficients). Fields in Tables A-1 through A-6 contain the following variables:

- *GED* - gallons of water use per employee per day (municipal use only);
- *total sales* - total industry production measured in millions of dollars (equal to shipments plus net additions to inventories);
- *intermediate sales* - sales to other industries in the region measured in millions of dollars;
- *final sales* - all sales to end-users including sales to households in the region and exports out of the region;
- *jobs* - number of full and part-time jobs (annual average) required by a given industry;
- *regional income* - total payroll costs (wages and salaries plus benefits), proprietor income, corporate income, rental income and interest payments;
- *business taxes* - sales taxes, excise taxes, fees, licenses and other taxes paid during normal business operations (includes all payments to federal, state and local government except income taxes).

[20] Sources for GED coefficients include: Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G. Cushing, K.K., and Mann, A. "*Waste Not, Want Not: The Potential for Urban Water Conservation in California.*" Pacific Institute. November 2003. U.S. Bureau of the Census. 1982 Census of Manufacturers: Water Use in Manufacturing. USGPO, Washington D.C. See also: "*U.S. Army Engineer Institute for Water Resources, IWR Report 88-R-6.*," Fort Belvoir, VA. See also, Joseph, E. S., 1982, "*Municipal and Industrial Water Demands of the Western United States.*" Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, v. 108, no. WR2, p. 204-216. See also, Baumann, D. D., Boland, J. J., and Sims, J. H., 1981, "*Evaluation of Water Conservation for Municipal and Industrial Water Supply.*" U.S. Army Corps of Engineers, Institute for Water Resources, Contract no. 82-C1.

Table A-1: Baseline Economic Data for Predominant Irrigated Crops in Region O (Year 2000, monetary figures reported in $millions)

Sector	Total Sales	Intermediate Sales	Final Sales	Jobs	Regional Income	Business Taxes
Cotton	$420.86	$33.80	$387.06	3974	$99.76	$8.64
Feed Grains	$159.42	$85.33	$74.09	1938	$26.00	$2.91
Food Grains	$24.05	$3.29	$20.76	376	$2.65	$0.26
Fruits	$72.88	$6.82	$66.07	603	$13.09	$0.49
Grass Seeds	$1.65	$1.25	$0.41	32	$0.32	$0.01
Hay and Pasture	$19.16	$10.26	$8.91	607	$1.71	$0.17
Tree Nuts	$104.54	$40.06	$64.48	2438	$23.99	$2.33
Total	$802.57	$180.79	$621.77	9,968	$167.51	$14.81

Table A-2: Baseline Economic Data for Livestock Sectors, Region O (Year 2000, monetary figures reported in $millions)

Sector	Total Sales	Intermediate Sales	Final Sales	Jobs	Regional Income	Business Taxes
Cattle Feedlots	$1,965.01	$719.44	$1,245.57	4519	$325.38	$25.93
Dairy Farm Products	$11.03	$1.77	$9.25	57	$1.59	$0.01
Hogs, Pigs and Swine	$32.71	$32.21	$0.51	242	$1.60	$0.18
Miscellaneous Livestock	$3.41	$1.30	$2.11	167	$0.48	$0.01
Other Meat Animal Products	$0.05	$0.05	$0.00	2	$0.00	$0.00
Poultry and Eggs	$8.82	$4.47	$4.35	54	$0.93	$0.02
Ranch Fed Cattle	$229.88	$225.13	$4.75	2378	$15.37	$1.10
Range Fed Cattle	$113.92	$111.78	$2.14	1412	$10.35	$0.67
Sheep, Lambs and Goats	$0.70	$0.65	$0.05	53	$0.06	$0.00
Meat Packing Plants	$1,470.51	$37.14	$1,433.37	3824	$141.57	$10.14
Total	$3,836.05	$1,133.95	$2,702.10	12,707	$497.33	$38.07

Table A-3: Baseline Economic Data for Municipal Sectors, Region O (Year 2000, monetary figures reported in $millions)

Sector	GED	Total Sales	Intermediate Sales	Final Sales	Jobs	Regional Income	Business Taxes
Accounting, Auditing and Bookkeeping	120	$150.29	$115.16	$35.14	2617	$118.44	$1.35
Advertising	117	$20.66	$18.19	$2.47	237	$9.14	$0.17
Agricultural, Forestry, Fishery Services	-	$180.49	$178.74	$1.75	7620	$105.60	$4.67
Air Transportation	171	$38.64	$10.84	$27.80	467	$18.19	$2.60
Amusement and Recreation Services,	427	$24.49	$0.38	$24.11	1093	$13.61	$1.32
Apparel & Accessory Stores	68	$61.12	$2.99	$58.14	1654	$33.78	$9.75
Arrangement Of Passenger	130	$34.63	$4.26	$30.36	236	$23.91	$1.03
Automobile Parking and Car Wash	681	$22.76	$2.61	$20.14	620	$15.37	$1.05
Automobile Rental and Leasing	147	$25.54	$19.10	$6.44	346	$14.91	$2.02
Automobile Repair and Services	55	$174.45	$36.84	$137.61	2187	$88.11	$7.98
Automotive Dealers & Service Stations	49	$379.86	$45.42	$334.45	4793	$226.54	$58.75
Banking	59	$914.52	$223.32	$691.20	4609	$590.83	$14.78
Beauty and Barber Shops	216	$28.83	$2.61	$26.21	1042	$17.60	$0.35
Bowling Alleys and Pool Halls	86	$3.38	$0.01	$3.38	136	$1.86	$0.30
Building Materials & Gardening	35	$75.63	$7.81	$67.82	1549	$53.96	$12.44
Business Associations	160	$35.89	$11.00	$24.89	756	$26.49	$0.02
Child Day Care Services	120	$45.69	$0.00	$45.69	1146	$14.80	$0.43
Colleges, Universities, Schools	75	$32.44	$0.23	$32.21	1287	$20.45	$0.00
Commercial Sports Except Racing	391	$3.86	$2.36	$1.50	136	$2.50	$0.20
Commodity Credit Corporation	-	$0.00	$0.00	$0.00	0	$0.00	$0.00
Communications, Except Radio and TV	47	$783.26	$208.26	$575.00	3131	$392.86	$41.82
Computer and Data Processing Services	40	$34.15	$27.33	$6.82	510	$27.63	$0.52
Credit Agencies	156	$212.12	$123.79	$88.33	5518	$114.65	$7.41
Detective and Protective Services	84	$17.04	$10.79	$6.26	592	$12.86	$0.23
Doctors and Dentists	203	$599.85	$0.00	$599.85	4957	$415.34	$7.97
Domestic Services	-	$29.27	$29.27	$0.00	3695	$29.37	$0.00
Eating & Drinking	157	$541.45	$25.37	$516.07	15868	$243.31	$33.95
Electrical Repair Service	37	$29.71	$10.21	$19.51	377	$12.12	$1.05
Elementary and Secondary Schools	169	$5.20	$0.00	$5.20	268	$2.77	$0.00
Engineering, Architectural Services	87	$116.80	$97.78	$19.03	1286	$50.60	$0.75
Equipment Rental and Leasing	29	$75.99	$40.87	$35.11	623	$33.59	$2.33

Table A-3: Baseline Economic Data for Municipal Sectors, Region O (Year 2000, monetary figures reported in $millions)

Federal Government - Military	-	$39.56	$39.56	$0.00	1221	$39.56	$0.00
Federal Government - Non-Military	-	$96.39	$96.39	$0.00	1691	$96.39	$0.00
Food Stores	98	$225.18	$5.51	$219.68	6079	$168.82	$35.98
Funeral Service and Crematories	111	$20.76	$0.00	$20.76	527	$13.75	$0.59
Furniture & Home Furnishings Stores	42	$51.59	$4.19	$47.40	1447	$33.48	$8.09
Gas Production and Distribution	51	$220.61	$105.80	$114.81	231	$50.76	$14.04
General Merchandise Stores	47	$255.11	$5.01	$250.10	5663	$160.42	$40.71
Hospitals	76	$566.13	$0.76	$565.37	8010	$360.88	$2.03
Hotels and Lodging Places	230	$60.06	$24.33	$35.73	1328	$31.40	$4.04
Insurance Agents and Brokers	89	$128.79	$25.53	$103.26	2823	$99.95	$1.37
Insurance Carriers	136	$102.53	$11.30	$91.23	995	$51.16	$5.24
Job Trainings & Related Services	141	$9.30	$2.18	$7.12	278	$4.17	$0.02
Labor and Civic Organizations	122	$35.20	$0.18	$35.02	2438	$26.06	$0.00
Landscape and Horticultural Services	-	$27.22	$20.47	$6.75	1041	$15.94	$0.69
Laundry, Cleaning and Shoe Repair	517	$65.49	$10.54	$54.95	2903	$48.20	$1.67
Legal Services	76	$108.77	$41.72	$67.05	1267	$83.72	$0.98
Local, Interurban Passenger Transit	68	$27.15	$3.58	$23.57	678	$15.76	$0.56
Maintenance and Repair Oil and Gas	25	$140.24	$80.60	$59.64	1392	$80.93	$5.52
Maintenance and Repair Other Facilities	25	$197.39	$107.78	$89.60	3698	$132.39	$0.89
Maintenance and Repair, Residential	25	$150.44	$49.90	$100.54	1172	$38.89	$0.53
Management and Consulting Services	87	$63.45	$48.82	$14.64	916	$27.41	$0.36
Membership Sports and Recreation	427	$18.30	$0.67	$17.63	662	$9.29	$0.66
Miscellaneous Personal Services	129	$49.51	$3.03	$46.48	757	$12.68	$0.96
Miscellaneous Repair Shops	124	$89.28	$33.76	$55.53	1445	$39.07	$2.44
Miscellaneous Retail	132	$302.56	$18.22	$284.34	8197	$189.77	$46.23
Motion Pictures	113	$49.42	$29.83	$19.59	681	$14.27	$0.50
Motor Freight Transport and	85	$552.29	$327.96	$224.33	5528	$211.98	$6.66
New Government Facilities	63	$253.92	$0.00	$253.92	1766	$89.79	$1.41
New Highways and Streets	45	$62.12	$0.00	$62.12	601	$22.02	$0.36
New Industrial and Commercial	63	$245.85	$0.00	$245.85	2212	$79.69	$1.65
New Mineral Extraction Facilities	63	$151.21	$1.75	$149.46	2615	$89.41	$7.22
New Residential Structures	35	$477.59	$0.00	$477.59	3157	$80.99	$2.75
New Utility Structures	63	$105.86	$0.00	$105.86	1081	$40.36	$0.53
Noncomparable Imports	-	$0.00	$0.00	$0.00	0	$0.00	$0.00
Nursing and Protective Care	197	$128.02	$0.00	$128.02	4157	$92.54	$3.14
Other Business Services	84	$288.31	$170.22	$118.09	3403	$99.99	$3.64
Other Educational Services	116	$21.03	$3.34	$17.69	484	$6.85	$0.51
Other Federal Government Enterprises	-	$8.11	$4.21	$3.90	52	$2.12	$0.00
Other Medical and Health Services	168	$196.19	$23.54	$172.64	4625	$96.42	$3.01
Other Nonprofit Organizations	122	$18.13	$1.20	$16.93	632	$10.45	$0.13
Other State and Local Govt Enterprises	-	$145.57	$45.06	$100.50	785	$47.85	$0.00
Owner-occupied Dwellings	89	$982.84	$0.00	$982.84	0	$617.04	$127.44
Personnel Supply Services	484	$45.63	$39.61	$6.02	4353	$43.95	$0.87
Photofinishing, Commercial	112	$13.43	$9.30	$4.13	139	$4.67	$0.29
Pipe Lines, Except Natural Gas	49	$61.90	$4.19	$57.71	98	$42.98	$5.08
Portrait and Photographic Studios	184	$30.16	$1.85	$28.31	665	$15.04	$0.76
Racing and Track Operation	391	$0.51	$0.08	$0.43	8	$0.21	$0.10
Radio and TV Broadcasting	64	$111.96	$91.27	$20.69	675	$43.10	$1.58
Railroads and Related Services	68	$37.14	$25.10	$12.05	323	$10.45	$0.55
Real Estate	89	$780.12	$419.44	$360.68	4329	$462.62	$92.30
Religious Organizations	328	$11.19	$0.00	$11.19	84	$1.95	$0.00
Research, Development & Testing	123	$23.84	$18.55	$5.29	404	$12.81	$0.23
Residential Care	111	$20.00	$0.00	$20.00	728	$12.43	$0.17
Rest Of The World Industry	-	$0.00	$0.00	$0.00	0	$0.00	$0.00
Sanitary Services and Steam Supply	51	$24.77	$19.80	$4.98	104	$10.35	$4.54
Scrap	-	$0.00	$0.00	$0.00	0	$0.00	$0.00
Security and Commodity Brokers	59	$72.91	$49.73	$23.18	462	$21.03	$2.03
Services To Buildings	67	$95.59	$42.43	$53.16	2113	$48.14	$1.91
Social Services, N.E.C.	42	$99.65	$7.51	$92.14	2067	$33.18	$0.10
State & Local Government - Education	-	$890.42	$890.42	$0.00	24768	$890.42	$0.00
State & Local Government - Non-	-	$462.15	$462.15	$0.00	10817	$462.15	$0.00
State and Local Electric Utilities	-	$62.70	$16.25	$46.46	122	$25.30	$0.00
Theatrical Producers, Bands Etc.	36	$6.51	$4.20	$2.31	124	$1.27	$0.11
Transportation Services	40	$20.56	$14.53	$6.03	191	$15.35	$0.18
U.S. Postal Service	-	$75.73	$46.46	$29.28	999	$55.26	$0.00
Used and Secondhand Goods	-	$0.00	$0.00	$0.00	0	$0.00	$0.00
Watch, Clock, Jewelry and Furniture	50	$2.21	$0.02	$2.19	44	$0.71	$0.10
Water Supply and Sewerage Systems	51	$1.13	$0.32	$0.81	9	$0.61	$0.08
Water Transportation	353	$3.53	$1.88	$1.65	16	$0.80	$0.07
Wholesale Trade	43	$1,161.52	$648.53	$512.99	12458	$636.54	$165.58
Total	-	$15,543.31	$5,408.65	$10,134.65	224097	$9,007.85	$824.43

NEC = not elsewhere classified. "na" = not available.

Table A-4: Baseline Economic Data for Manufacturing Sectors, Region O (Year 2000, monetary figures reported in $millions)

Sector	Total Sales	Intermediate Sales	Final Sales	Jobs	Regional Income	Business Taxes
Agricultural Chemicals, N.E.C	$10.87	$7.70	$3.18	32	$6.35	$0.13
Aircraft	$7.55	$0.13	$7.42	26	$2.28	$0.09
Aircraft and Missile Equipment,	$4.73	$0.09	$4.64	27	$2.64	$0.05
Apparel Made From Purchased Materials	$1.47	$0.02	$1.45	15	$0.30	$0.00
Architectural Metal Work	$2.73	$0.06	$2.67	29	$1.49	$0.03
Automotive and Apparel Trimmings	$12.85	$0.72	$12.12	90	$2.54	$0.07
Bags, Plastic	$2.12	$0.02	$2.10	12	$0.52	$0.02
Ball and Roller Bearings	$1.64	$0.01	$1.64	13	$0.54	$0.01
Blinds, Shades, and Drapery Hardware	$0.77	$0.00	$0.77	11	$0.29	$0.00
Blowers and Fans	$3.07	$0.07	$2.99	27	$1.39	$0.03
Boat Building and Repairing	$1.47	$0.00	$1.47	12	$0.55	$0.01
Book Printing	$1.64	$0.26	$1.38	10	$0.65	$0.02
Book Publishing	$7.85	$0.51	$7.34	38	$1.99	$0.07
Bottled and Canned Soft Drinks & Water	$0.54	$0.01	$0.53	2	$0.02	$0.00
Brass, Bronze, and Copper Foundries	$1.17	$0.09	$1.07	34	$0.67	$0.01
Bread, Cake, and Related Products	$51.12	$14.00	$37.12	292	$18.69	$0.32
Broadwoven Fabric Mills and Finishing	$63.51	$4.90	$58.60	521	$20.32	$0.53
Brooms and Brushes	$10.28	$0.73	$9.55	111	$4.66	$0.13
Canned Fruits and Vegetables	$0.50	$0.00	$0.50	2	$0.15	$0.00
Canvas Products	$3.54	$2.03	$1.51	54	$1.50	$0.02
Chemical Preparations, N.E.C	$9.38	$5.88	$3.50	28	$2.89	$0.08
Cold Finishing Of Steel Shapes	$26.11	$4.08	$22.02	117	$7.39	$0.23
Commercial Fishing	$2.07	$0.23	$1.84	88	$1.88	$0.06
Commercial Printing	$41.84	$21.22	$20.62	361	$14.72	$0.44
Concrete Block and Brick	$5.68	$0.04	$5.64	34	$1.98	$0.09
Concrete Products, N.E.C	$8.15	$0.03	$8.12	71	$2.72	$0.10
Confectionery Products	$2.90	$0.01	$2.89	12	$0.67	$0.02
Construction Machinery and Equipment	$112.08	$3.36	$108.73	426	$24.12	$0.95
Cottonseed Oil Mills	$98.59	$11.66	$86.93	257	$12.06	$0.70
Cut Stone and Stone Products	$0.33	$0.00	$0.33	5	$0.15	$0.00
Dehydrated Food Products	$10.09	$0.09	$10.00	55	$3.10	$0.06
Dog, Cat, and Other Pet Food	$49.83	$0.04	$49.79	130	$4.88	$0.19
Electronic Computers	$1.87	$0.40	$1.47	9	$0.30	$0.01
Fabricated Plate Work (Boiler Shops)	$35.25	$0.59	$34.66	361	$19.68	$0.34
Fabricated Structural Metal	$46.68	$0.83	$45.85	274	$18.37	$0.47
Fabricated Textile Products, N.E.C.	$0.93	$0.19	$0.74	6	$0.28	$0.01
Farm Machinery and Equipment	$89.69	$29.11	$60.58	530	$22.54	$0.59
Fertilizers, Mixing Only	$24.92	$11.12	$13.80	74	$4.78	$0.28
Flour and Other Grain Mill Products	$157.93	$0.85	$157.08	505	$22.77	$0.76
Fluid Milk	$64.84	$3.52	$61.32	191	$6.78	$0.30
Fluid Power Pumps & Motors	$6.51	$0.20	$6.31	70	$2.49	$0.04
Food Preparations, N.E.C	$31.55	$0.13	$31.42	182	$8.27	$0.18
Food Products Machinery	$0.59	$0.34	$0.25	5	$0.31	$0.01
Forestry Products	$0.28	$0.00	$0.28	2	$0.21	$0.04
Frozen Fruits, Juices and Vegetables	$0.68	$0.02	$0.66	4	$0.12	$0.00
Frozen Specialties	$23.47	$0.19	$23.27	130	$7.95	$0.17
Furniture and Fixtures, N.E.C	$0.87	$0.17	$0.70	5	$0.19	$0.00
Games, Toys, and Childrens Vehicles	$0.12	$0.00	$0.11	1	$0.07	$0.00
Gaskets, Packing and Sealing Devices	$0.59	$0.01	$0.59	6	$0.16	$0.00
General Industrial Machinery, N.E.C	$69.79	$1.64	$68.16	387	$19.01	$0.49
Glass and Glass Products, Exc Containers	$0.81	$0.53	$0.28	7	$0.32	$0.01
Greenhouse and Nursery Products	$10.68	$4.61	$6.07	232	$3.45	$0.05
Hardware, N.E.C.	$0.70	$0.23	$0.47	5	$0.25	$0.01
Hosiery, N.E.C	$1.17	$0.03	$1.14	16	$0.35	$0.01
Household Cooking Equipment	$1.13	$0.01	$1.12	7	$0.22	$0.01
Industrial and Fluid Valves	$7.42	$1.52	$5.90	33	$1.73	$0.05
Industrial Gases	$2.57	$1.51	$1.06	22	$1.98	$0.06
Industrial Machines N.E.C.	$57.41	$0.84	$56.57	574	$23.42	$0.46
Industrial Patterns	$0.14	$0.00	$0.14	3	$0.07	$0.00
Internal Combustion Engines, N.E.C.	$1.10	$0.79	$0.30	3	$0.11	$0.01
Iron and Steel Forgings	$0.51	$0.15	$0.35	4	$0.21	$0.00
Lighting Fixtures and Equipment	$0.43	$0.01	$0.42	3	$0.12	$0.00
Manifold Business Forms	$6.46	$1.00	$5.46	44	$2.29	$0.08
Manufactured Ice	$0.90	$0.01	$0.89	18	$0.55	$0.01
Manufacturing Industries, N.E.C.	$2.45	$0.07	$2.38	24	$1.03	$0.03
Mechanical Measuring Devices	$1.84	$0.45	$1.39	16	$0.47	$0.01
Metal Coating and Allied Services	$2.33	$0.41	$1.92	18	$0.69	$0.02
Metal Doors, Sash, and Trim	$3.56	$0.11	$3.44	29	$1.64	$0.04
Millwork	$29.86	$13.37	$16.50	291	$11.28	$0.28
Miscellaneous Fabricated Wire Products	$4.42	$1.12	$3.29	46	$1.75	$0.03
Miscellaneous Plastics Products	$115.61	$2.21	$113.41	665	$32.69	$0.77
Miscellaneous Publishing	$10.74	$6.34	$4.39	63	$5.99	$0.13
Motor Homes	$1.04	$0.00	$1.04	6	$0.48	$0.00
Motor Vehicle Parts and Accessories	$2.54	$1.64	$0.90	12	$0.50	$0.01
Motorcycles, Bicycles, and Parts	$0.26	$0.00	$0.26	2	$0.05	$0.00
Motors and Generators	$0.64	$0.34	$0.30	6	$0.20	$0.01

Table A-4: Baseline Economic Data for Manufacturing Sectors, Region O (Year 2000, monetary figures reported in $millions)

Newspapers	$50.01	$32.00	$18.01	662	$21.88	$0.50
Nitrogenous and Phosphatic Fertilizers	$15.60	$7.05	$8.55	44	$3.61	$0.16
Nonmetallic Mineral Products, N.E.C.	$1.08	$0.02	$1.06	14	$0.37	$0.01
Oil Field Machinery	$3.25	$0.67	$2.58	34	$1.00	$0.02
Ophthalmic Goods	$1.05	$0.03	$1.02	12	$0.21	$0.01
Paints and Allied Products	$3.38	$0.06	$3.32	10	$1.05	$0.03
Paperboard Containers and Boxes	$3.33	$3.05	$0.29	16	$0.86	$0.03
Paving Mixtures and Blocks	$1.94	$1.83	$0.11	7	$0.72	$0.01
Periodicals	$1.34	$0.71	$0.62	9	$0.47	$0.01
Petroleum Refining	$89.84	$44.61	$45.23	35	$6.76	$0.47
Photographic Equipment and Supplies	$0.70	$0.10	$0.59	3	$0.08	$0.00
Pipe, Valves, and Pipe Fittings	$7.92	$1.62	$6.30	71	$2.86	$0.06
Plating and Polishing	$2.16	$0.32	$1.84	54	$1.73	$0.02
Pleating and Stitching	$0.40	$0.01	$0.39	6	$0.26	$0.00
Polishes and Sanitation Goods	$0.35	$0.06	$0.29	2	$0.22	$0.00
Potato Chips & Similar Snacks	$64.96	$0.47	$64.48	193	$23.18	$0.56
Power Transmission Equipment	$15.50	$0.21	$15.29	103	$4.86	$0.13
Prefabricated Metal Buildings	$5.91	$0.09	$5.83	40	$2.82	$0.06
Prefabricated Wood Buildings	$0.29	$0.00	$0.29	3	$0.08	$0.00
Prepared Feeds, N.E.C	$148.27	$7.56	$140.71	392	$16.78	$1.08
Pumps and Compressors	$43.52	$1.36	$42.15	187	$8.63	$0.28
Ready-mixed Concrete	$21.22	$0.11	$21.11	150	$6.42	$0.26
Reconstituted Wood Products	$0.83	$0.75	$0.08	4	$0.18	$0.01
Refrigeration and Heating Equipment	$0.47	$0.33	$0.14	2	$0.10	$0.00
Relays & Industrial Controls	$0.57	$0.31	$0.26	4	$0.12	$0.00
Salted and Roasted Nuts & Seeds	$28.48	$0.06	$28.42	74	$2.99	$0.15
Sausages and Other Prepared Meats	$2.98	$0.17	$2.81	15	$0.34	$0.01
Secondary Nonferrous Metals	$1.62	$0.03	$1.59	5	$0.09	$0.01
Semiconductors and Related Devices	$178.78	$36.10	$142.68	311	$115.85	$1.92
Service Industry Machines, N.E.C.	$0.84	$0.33	$0.51	5	$0.25	$0.01
Sheet Metal Work	$14.93	$0.33	$14.60	126	$5.26	$0.11
Shortening and Cooking Oils	$33.88	$6.98	$26.90	56	$4.72	$0.22
Signs and Advertising Displays	$9.20	$3.39	$5.81	100	$4.18	$0.10
Small Arms	$0.43	$0.00	$0.43	7	$0.31	$0.04
Special Dies and Tools and Accessories	$1.26	$0.95	$0.31	18	$0.56	$0.01
Special Industry Machinery N.E.C.	$78.28	$3.98	$74.30	215	$9.98	$0.29
Sporting and Athletic Goods, N.E.C.	$5.61	$0.03	$5.58	52	$2.03	$0.17
Steam Engines and Turbines	$0.53	$0.39	$0.15	2	$0.10	$0.00
Structural Wood Members, N.E.C	$0.21	$0.19	$0.01	2	$0.05	$0.00
Sugar	$39.82	$0.42	$39.40	104	$4.82	$0.22
Surface Active Agents	$9.83	$2.07	$7.76	19	$1.93	$0.06
Surgical and Medical Instrument	$0.44	$0.29	$0.15	3	$0.08	$0.00
Surgical Appliances and Supplies	$30.24	$7.09	$23.14	178	$5.20	$0.21
Textile Goods, N.E.C	$2.55	$0.06	$2.49	18	$0.35	$0.02
Transportation Equipment, N.E.C	$15.60	$0.16	$15.44	66	$3.46	$0.12
Truck Trailers	$9.15	$0.40	$8.75	63	$3.05	$0.04
Typesetting	$0.41	$0.16	$0.25	4	$0.18	$0.00
Upholstered Household Furniture	$0.42	$0.00	$0.42	6	$0.08	$0.00
Vegetable Oil Mills, N.E.C	$34.67	$2.29	$32.38	54	$1.01	$0.17
Wet Corn Milling	$97.44	$6.28	$91.15	143	$24.82	$0.63
Wines, Brandy, and Brandy Spirits	$1.77	$0.01	$1.76	7	$0.48	$0.31
Wood Household Furniture	$2.83	$0.04	$2.80	31	$1.08	$0.02
Wood Kitchen Cabinets	$0.27	$0.27	$0.00	3	$0.13	$0.00
Wood Pallets and Skids	$2.50	$1.93	$0.57	32	$1.08	$0.02
Wood Products, N.E.C	$6.26	$1.98	$4.28	59	$2.37	$0.06
Woodworking Machinery	$0.23	$0.02	$0.22	2	$0.10	$0.00
Yarn Mills and Finishing Of Textiles, N.E.C.	$5.10	$2.18	$2.93	45	$1.05	$0.04
Total	$2,480.17	$346.57	$2,133.60	11722	$673.44	$18.92

NEC = not elsewhere classified. "na" = not available.

Table A-5: Baseline Economic Data for Mining Sectors, Region O (Year 2000, monetary figures reported in $millions)

Sector	Total Sales	Intermediate Sales	Final Sales	Jobs	Regional Income	Business Taxes
Chemical, Fertilizer Mineral Mining	$1.16	$0.32	$0.83	12	$0.75	$0.05
Clay, Ceramic, Refractory Minerals	$0.88	$0.01	$0.88	2	$0.52	$0.03
Coal Mining	$2.84	$0.83	$2.01	9	$0.94	$0.36
Dimension Stone	$11.52	$0.20	$11.32	86	$7.02	$0.35
Gold Ores	$3.04	$2.67	$0.37	18	$0.42	$0.04
Iron Ores	$0.44	$0.01	$0.43	1	$0.07	$0.05
Metal Mining Services	$0.03	$0.02	$0.00	1	$0.00	$0.00
Misc. Nonmetallic Minerals, N.E.C.	$0.10	$0.00	$0.10	2	$0.06	$0.00
Natural Gas & Crude Petroleum	$1,469.57	$376.11	$1,093.46	3,052	$669.85	$78.60
Natural Gas Liquids	$9.55	$2.44	$7.10	8	$2.58	$0.41
Potash, Soda, and Borate Minerals	$13.77	$3.86	$9.91	30	$7.53	$0.48
Sand and Gravel	$11.47	$0.23	$11.25	116	$7.15	$0.36
Uranium-radium-vanadium Ores	$0.07	$0.06	$0.01	2	$0.02	$0.00
Total	$1,524.43	$386.77	$1,137.66	3,339	$696.91	$80.72

Table A-6: Baseline Economic Data for the Steam Electric Sector, Region L (Year 2000, monetary figures reported in $millions)

Sector	Total Sales	Intermediate Sales	Final Sales	Jobs	Regional Income	Business Taxes
Electric Services	$312.53	$81.44	$231.08	623	$223.50	$40.03

na = "not available"

Attachment B: Distribution of Economic Impacts by County

Tables B-1 and B-2 show economic impacts by county and water user group; however, **caution** is warranted. Figures shown for specific counties are *direct* impacts only. For the most part, figures reported in the main text for all water use categories uses include *direct and secondary* impacts. Secondary effects were estimated using regional level multipliers that treat water planning areas as aggregate and autonomous economies. Multipliers do not specify where secondary impacts will occur at a sub-regional level (i.e., in which counties or cities). All economic impacts that would accrue to a region as a whole due to secondary economic effects are reported in Tables B-1 and B-2 as "secondary regional level impacts."

For example, assume that in a given county (or city) water shortages caused significant reductions in output for a manufacturing plant. Reduced output resulted in lay-offs and lost income for workers and owners of the plant. This is a *direct* impact. Direct impacts were estimated at a county level; and thus one can say with certainty that direct impacts occurred in that county. However, secondary impacts accrue to businesses and households throughout the region where the business operates, and it is impossible using input-output models to determine where these businesses are located spatially.

The same logic applies to changes in population and school enrollment. Since employment losses and subsequent out-migration from a region were estimated using *direct* and *secondary* multipliers, it is impossible to say with any degree of certainty how many people a given county would lose regardless of whether the economic impact was direct or secondary. For example, assume the manufacturing plant referred to above is in County A. If the firm eliminated 50 jobs, one could state with certainty that water shortages in County A resulted in a loss of 50 jobs in that county. However, one could not unequivocally say whether 100 percent of the population loss due to lay-offs at the manufacturing would accrue to County A because many affected workers might commute from adjacent counties. This is particularly true in large metropolitan areas that overlay one or counties. Thus, population and school enrollment impacts cannot be reported at a county level.

Municipal

Impacts to the horticultural industry were estimated at the regional level only and are not include here.

Table B-1: Distribution of Economic Impacts by County: Water Intensive Commercial Uses (Municipal)						
Lost sales ($millions)						
County	2010	2020	2030	2040	2050	2060
Castro						
Direct	$0.00	$0.00	$2.53	$2.62	$5.13	$5.13
Secondary Regional Level Impacts	$0.00	$0.00	$1.41	$1.46	$2.85	$2.85
Crosby						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Dawson						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Floyd						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gaines						
Direct	$3.57	$3.36	$3.57	$3.72	$3.65	$3.65
Secondary Regional Level Impacts	$1.94	$1.82	$1.94	$2.02	$1.98	$1.98
Hales						
Direct	$0.00	$2.13	$2.23	$2.29	$2.23	$2.23
Secondary Regional Level Impacts	$0.00	$1.00	$1.04	$1.07	$1.04	$1.04
Hockley						
Direct	$4.80	$4.80	$4.91	$4.92	$4.49	$4.49
Secondary Regional Level Impacts	$2.63	$2.63	$2.69	$2.70	$2.46	$2.46
Lamb						
Direct	$0.00	$3.86	$4.06	$4.21	$4.14	$4.14
Secondary Regional Level Impacts	$0.00	$2.17	$2.28	$2.36	$2.32	$2.32
Lubbock						
Direct	$28.63	$29.92	$30.61	$30.73	$30.84	$30.84
Secondary Regional Level Impacts	$14.72	$15.39	$15.75	$15.80	$15.86	$15.86
Terry						
Direct	$0.00	$4.46	$4.57	$4.61	$4.22	$4.22
Secondary Regional Level Impacts	$0.00	$2.46	$2.52	$2.54	$2.32	$2.32
Parmer						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Yoakum						
Direct	$4.39	$9.62	$10.16	$10.74	$10.10	$10.10
Secondary Regional Level Impacts	$2.41	$5.27	$5.57	$5.88	$5.53	$5.53
Lost Income ($millions)						
County	2010	2020	2030	2040	2050	2060
Castro						
Direct	$0.00	$0.00	$1.17	$1.21	$2.42	$2.37
Secondary Regional Level Impacts	$0.00	$0.00	$0.65	$0.67	$1.31	$1.31
Crosby						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Dawson						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Floyd						

Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gaines						
Direct	$1.55	$1.46	$1.55	$1.62	$1.61	$1.59
Secondary Regional Level Impacts	$1.03	$0.97	$1.03	$1.07	$1.07	$1.05
Hales						
Direct	$0.00	$1.05	$1.10	$1.13	$1.12	$1.10
Secondary Regional Level Impacts	$0.00	$0.58	$0.61	$0.63	$0.62	$0.61
Hockley						
Direct	$2.04	$2.04	$2.09	$2.09	$2.01	$1.91
Secondary Regional Level Impacts	$1.38	$1.38	$1.42	$1.42	$1.36	$1.30
Lamb						
Direct	$0.00	$1.76	$1.85	$1.92	$1.91	$1.88
Secondary Regional Level Impacts	$0.00	$1.16	$1.22	$1.27	$1.26	$1.25
Lubbock						
Direct	$12.21	$12.76	$13.05	$13.10	$13.32	$13.15
Secondary Regional Level Impacts	$7.89	$8.24	$8.44	$8.47	$8.60	$8.50
Terry						
Direct	$0.00	$2.04	$2.09	$2.10	$2.04	$1.92
Secondary Regional Level Impacts	$0.00	$1.33	$1.36	$1.37	$1.33	$1.25
Parmer						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Yoakum						
Direct	$1.95	$4.27	$4.51	$4.77	$4.64	$4.48
Secondary Regional Level Impacts	$1.30	$2.85	$3.01	$3.18	$3.09	$2.99

Job Losses

County	2010	2020	2030	2040	2050	2060
Castro						
Direct	0	0	72	74	148	145
Secondary Regional Level Impacts	0	0	18	19	38	37
Crosby						
Direct	0	0	0	0	0	0
Secondary Regional Level Impacts	0	0	0	0	0	0
Dawson						
Direct	0	0	0	0	0	0
Secondary Regional Level Impacts	0	0	0	0	0	0
Floyd						
Direct	0	0	0	0	0	0
Secondary Regional Level Impacts	0	0	0	0	0	0
Gaines						
Direct	99	93	99	103	102	101
Secondary Regional Level Impacts	26	24	26	27	27	26
Hales						
Direct	0	64	67	68	68	67
Secondary Regional Level Impacts	0	14	15	15	15	15
Hockley						
Direct	132	132	135	135	130	123
Secondary Regional Level Impacts	34	34	35	35	34	32
Lamb						
Direct	0	112	118	122	122	120
Secondary Regional Level Impacts	0	29	31	32	32	31
Lubbock						
Direct	774	809	828	831	844	834
Secondary Regional Level Impacts	197	205	210	211	214	212
Terry						
Direct	0	130	133	134	130	123
Secondary Regional Level Impacts	0	33	34	34	33	31
Parmer						
Direct	0	0	0	0	0	0
Secondary Regional Level Impacts	0	0	0	0	0	0
Yoakum						
Direct	125	274	290	306	298	288
Secondary Regional Level Impacts	32	70	74	78	76	73

Lost Taxes ($millions)						
Castro						
Direct	$0.00	$0.00	$0.14	$0.14	$0.28	$0.28
Secondary Regional Level Impacts	$0.00	$0.00	$0.75	$0.77	$1.54	$1.52
Crosby						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Dawson						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Floyd						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Gaines						
Direct	$0.19	$0.18	$0.19	$0.19	$0.19	$0.19
Secondary Regional Level Impacts	$0.13	$0.12	$0.13	$0.13	$0.13	$0.13
Hales						
Direct	$0.00	$0.07	$0.07	$0.07	$0.07	$0.07
Secondary Regional Level Impacts	$0.00	$0.04	$0.04	$0.04	$0.04	$0.04
Hockley						
Direct	$0.26	$0.26	$0.26	$0.26	$0.25	$0.24
Secondary Regional Level Impacts	$0.18	$0.18	$0.18	$0.18	$0.17	$0.17
Lamb						
Direct	$0.00	$0.20	$0.21	$0.21	$0.21	$0.21
Secondary Regional Level Impacts	$0.00	$0.13	$0.14	$0.15	$0.15	$0.14
Lubbock						
Direct	$1.38	$1.44	$1.47	$1.48	$1.50	$1.48
Secondary Regional Level Impacts	$0.93	$0.97	$0.99	$1.00	$1.01	$1.00
Terry						
Direct	$0.00	$0.22	$0.23	$0.23	$0.22	$0.21
Secondary Regional Level Impacts	$0.00	$0.15	$0.15	$0.15	$0.15	$0.14
Parmer						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Yoakum						
Direct	$0.21	$0.46	$0.49	$0.52	$0.50	$0.49
Secondary Regional Level Impacts	$0.14	$0.32	$0.33	$0.35	$0.34	$0.33

Table B-2: Distribution of Economic Impacts by County: Non-Water Intensive Commercial and Domestic Uses (Municipal, $millions)

County	2010	2020	2030	2040	2050	2060
Castro	$0.00	$0.00	$0.00	$5.39	$5.49	$6.68
Crosby	$0.00	$0.00	$0.00	$0.03	$0.06	$0.05
Dawson	$0.00	$0.04	$0.13	$0.22	$0.22	$0.00
Floyd	$0.00	$0.00	$0.00	$0.26	$0.25	$0.22
Gaines	$0.00	$0.66	$0.71	$2.24	$2.29	$2.26
Hales	$0.00	$0.00	$2.33	$4.71	$4.79	$5.93

Hockley	$0.00	$1.22	$2.87	$3.32	$3.26	$3.12
Lamb	$0.00	$0.00	$1.93	$4.48	$5.88	$5.82
Lubbock	$0.00	$6.65	$8.51	$9.10	$10.25	$10.87
Terry	$0.00	$0.00	$0.00	$7.56	$8.76	$8.48
Parmer	$0.13	$0.58	$1.05	$1.46	$1.86	$1.87
Yoakum	$0.00	$0.00	$2.06	$5.80	$6.04	$5.85

Table B-3: Distribution of Economic Impacts by County: Lost Water Utility Revenues ($millions)

County	2010	2020	2030	2040	2050	2060
Castro	$0.00	$0.00	$1.25	$1.27	$1.55	$1.52
Crosby	$0.00	$0.00	$0.01	$0.02	$0.02	$0.01
Dawson	$0.01	$0.05	$0.08	$0.08	$0.00	$0.00
Floyd	$0.00	$0.00	$0.10	$0.09	$0.08	$0.07
Gaines	$0.49	$0.53	$0.55	$0.56	$0.56	$0.55
Hales	$0.00	$0.74	$1.49	$1.53	$1.80	$1.67
Hockley	$0.29	$0.30	$0.40	$0.39	$0.37	$0.42
Lamb	$0.00	$0.45	$1.05	$1.38	$1.37	$1.35
Lubbock	$1.78	$2.34	$2.44	$2.80	$2.90	$2.93
Terry	$0.00	$0.81	$1.78	$1.76	$1.70	$1.60
Parmer	$0.22	$0.39	$0.55	$0.69	$0.70	$0.68
Yoakum	$0.00	$0.49	$1.80	$1.87	$1.81	$1.75

Irrigation

Table B-4: Distribution of Economic Impacts by County: Irrigation

Lost sales ($millions)

County	2010	2020	2030	2040	2050	2060
Bailey						
Direct	5.6676	12.603	13.027	13.539	13.913	14.134
Secondary Regional Level Impacts	$4.17	$9.28	$9.59	$9.97	$10.25	$10.41
Briscoe						
Direct	$0.26	$0.52	$5.50	$6.43	$7.28	$7.40
Secondary Regional Level Impacts	$0.21	$0.42	$4.46	$5.22	$5.90	$6.00
Castro						
Direct	8.7538	11.937	34.261	47.792	49.821	51.005
Secondary Regional Level Impacts	$5.52	$7.53	$21.61	$30.15	$31.43	$32.18
Cochran						
Direct	4.9522	4.9433	4.9404	4.9375	22.235	21.93
Secondary Regional Level Impacts	$4.16	$4.15	$4.15	$4.15	$18.68	$18.43
Crosby						
Direct	$0.70	$0.70	$0.69	$0.69	$0.59	$0.59
Secondary Regional Level Impacts	$0.60	$0.59	$0.59	$0.58	$0.50	$0.50
Dawson						
Direct	$19.67	$20.64	$20.79	$21.07	$20.57	$20.11
Secondary Regional Level Impacts	$16.47	$17.29	$17.41	$17.65	$17.23	$16.84
Deaf Smith						
Direct	$10.07	$23.90	$28.38	$33.26	$33.31	$33.75
Secondary Regional Level Impacts	$5.62	$13.34	$15.84	$18.57	$18.60	$18.84
Dickens						
Direct	$0.42	$0.41	$0.81	$0.80	$0.79	$0.78
Secondary Regional Level Impacts	$0.33	$0.32	$0.64	$0.63	$0.62	$0.61
Floyd						
Direct	$10.75	$13.12	$27.90	$29.06	$29.21	$28.96
Secondary Regional Level Impacts	$8.72	$10.65	$22.64	$23.58	$23.71	$23.50
Gaines						
Direct	$4.48	$6.75	$18.18	$17.97	$20.55	$23.00
Secondary Regional Level Impacts	$3.74	$5.64	$15.18	$15.00	$17.16	$19.21
Garza						
Direct	$0.26	$0.23	$0.22	$0.15	$0.14	$0.14
Secondary Regional Level Impacts	$0.14	$0.12	$0.11	$0.08	$0.08	$0.07
Hale						
Direct	$0.00	$2.60	$15.90	$50.56	$57.12	$58.97
Secondary Regional Level Impacts	$0.00	$2.10	$12.83	$40.80	$46.09	$47.59
Hockley						
Direct	$9.83	$12.14	$27.67	$30.61	$30.41	$30.76
Secondary Regional Level Impacts	$8.22	$10.15	$23.14	$25.60	$25.43	$25.72
Lamb						
Direct	$11.00	$15.86	$42.06	$51.96	$56.50	$59.47
Secondary Regional Level Impacts	$8.46	$12.20	$32.36	$39.97	$43.47	$45.75
Lubbock						
Direct	$4.38	$12.07	$14.44	$34.55	$34.14	$34.75
Secondary Regional Level Impacts	$3.66	$10.08	$12.05	$28.83	$28.49	$29.00
Motley						
Direct	$0.09	$0.09	$0.09	$0.09	$0.08	$0.08
Secondary Regional Level Impacts	$0.07	$0.07	$0.07	$0.07	$0.07	$0.07
Parmer						
Direct	$10.21	$42.41	$46.77	$46.79	$46.81	$46.84
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Swisher						
Direct	$0.96	$2.74	$4.55	$5.21	$5.54	$5.76
Secondary Regional Level Impacts	$0.68	$1.95	$3.24	$3.71	$3.94	$4.10
Terry						
Direct	$10.10	$10.05	$10.00	$9.94	$9.91	$9.87
Secondary Regional Level Impacts	8.4917	8.448	8.403	8.3554	8.3258	8.2985
Yoakum						

Direct	$1.32	$1.26	$1.15	$1.12	$1.09	$1.06
Secondary Regional Level Impacts	$1.10	$1.05	$0.96	$0.93	$0.90	$0.88
Lost Income ($millions)						
County	2010	2020	2030	2040	2050	2060
Bailey						
Direct	$1.08	$2.40	$2.48	$2.57	$2.65	$2.69
Secondary Regional Level Impacts	$2.26	$5.03	$5.20	$5.41	$5.55	$5.64
Briscoe						
Direct	$0.06	$0.12	$1.24	$1.44	$1.63	$1.66
Secondary Regional Level Impacts	$0.11	$0.23	$2.43	$2.84	$3.22	$3.27
Castro						
Direct	$1.63	$2.22	$6.36	$8.87	$9.25	$9.47
Secondary Regional Level Impacts	$2.98	$4.07	$11.67	$16.28	$16.98	$17.38
Cochran						
Direct	$1.15	$1.15	$1.15	$1.14	$5.15	$5.08
Secondary Regional Level Impacts	$2.26	$2.26	$2.26	$2.26	$10.17	$10.03
Crosby						
Direct	$0.17	$0.16	$0.16	$0.16	$0.14	$0.14
Secondary Regional Level Impacts	$0.33	$0.32	$0.32	$0.32	$0.28	$0.27
Dawson						
Direct	$4.54	$4.76	$4.80	$4.86	$4.75	$4.64
Secondary Regional Level Impacts	$8.89	$9.34	$9.40	$9.53	$9.30	$9.09
Deaf Smith						
Direct	$1.79	$4.24	$5.04	$5.90	$5.91	$5.99
Secondary Regional Level Impacts	$3.01	$7.14	$8.47	$9.93	$9.95	$10.08
Dickens						
Direct	$0.07	$0.07	$0.14	$0.14	$0.14	$0.14
Secondary Regional Level Impacts	$0.18	$0.17	$0.34	$0.34	$0.33	$0.33
Floyd						
Direct	$2.43	$2.96	$6.30	$6.56	$6.59	$6.54
Secondary Regional Level Impacts	$4.76	$5.82	$12.36	$12.88	$12.95	$12.84
Gaines						
Direct	$1.03	$1.55	$4.17	$4.13	$4.72	$5.28
Secondary Regional Level Impacts	$2.01	$3.03	$8.18	$8.07	$9.23	$10.34
Garza						
Direct	$0.03	$0.03	$0.02	$0.02	$0.02	$0.02
Secondary Regional Level Impacts	$0.07	$0.06	$0.06	$0.04	$0.04	$0.04
Hale						
Direct	$0.00	$0.59	$3.61	$11.48	$12.97	$13.39
Secondary Regional Level Impacts	$0.00	$1.15	$7.01	$22.31	$25.20	$26.02
Hockley						
Direct	$2.28	$2.82	$6.43	$7.11	$7.07	$7.15
Secondary Regional Level Impacts	$4.48	$5.54	$12.62	$13.96	$13.87	$14.03
Lamb						
Direct	$2.36	$3.40	$9.00	$11.12	$12.10	$12.73
Secondary Regional Level Impacts	$4.61	$6.65	$17.63	$21.78	$23.68	$24.92
Lubbock						
Direct	$1.01	$2.79	$3.34	$8.00	$7.90	$8.04
Secondary Regional Level Impacts	$2.00	$5.51	$6.59	$15.76	$15.57	$15.85
Motley						
Direct	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
Secondary Regional Level Impacts	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
Parmer						
Direct	$2.04	$8.47	$9.34	$9.34	$9.35	$9.35
Secondary Regional Level Impacts	$3.75	$15.56	$17.16	$17.16	$17.17	$17.18
Swisher						
Direct	$0.19	$0.55	$0.91	$1.05	$1.11	$1.16
Secondary Regional Level Impacts	$0.37	$1.06	$1.76	$2.01	$2.14	$2.22
Terry						
Direct	$2.33	$2.32	$2.31	$2.30	$2.29	$2.28
Secondary Regional Level Impacts	$4.60	$4.58	$4.55	$4.52	$4.51	$4.49
Yoakum						
Direct	$0.30	$0.29	$0.26	$0.25	$0.25	$0.24
Secondary Regional Level Impacts	$0.59	$0.56	$0.52	$0.50	$0.49	$0.47

Job Losses						
County	2010	2020	2030	2040	2050	2060
Bailey						
Direct	80	177	198	190	195	198
Secondary Regional Level Impacts	66	148	165	158	163	165
Briscoe						
Direct	3	6	88	76	87	88
Secondary Regional Level Impacts	3	7	98	85	96	98
Castro						
Direct	108	147	629	589	614	629
Secondary Regional Level Impacts	86	117	500	468	488	500
Cochran						
Direct	63	63	279	63	282	279
Secondary Regional Level Impacts	68	68	300	68	304	300
Crosby						
Direct	7	7	6	7	6	6
Secondary Regional Level Impacts	10	10	8	10	8	8
Dawson						
Direct	316	332	323	339	331	323
Secondary Regional Level Impacts	261	274	267	280	273	267
Deaf Smith						
Direct	136	322	454	448	449	454
Secondary Regional Level Impacts	85	202	285	281	282	285
Dickens						
Direct	8	8	14	15	15	14
Secondary Regional Level Impacts	5	5	10	10	10	10
Floyd						
Direct	117	142	314	315	317	314
Secondary Regional Level Impacts	144	176	388	390	392	388
Gaines						
Direct	76	120	402	321	362	402
Secondary Regional Level Impacts	59	88	300	234	268	300
Garza						
Direct	4	4	2	2	2	2
Secondary Regional Level Impacts	2	1	1	1	1	1
Hale						
Direct	0	27	601	516	582	601
Secondary Regional Level Impacts	0	35	788	676	764	788
Hockley						
Direct	115	142	359	357	355	359
Secondary Regional Level Impacts	135	167	423	421	418	423
Lamb						
Direct	126	182	683	597	649	683
Secondary Regional Level Impacts	138	199	745	651	708	745
Lubbock						
Direct	47	130	375	372	368	375
Secondary Regional Level Impacts	61	167	480	477	472	480
Motley						
Direct	2	2	2	2	2	2
Secondary Regional Level Impacts	1	1	1	1	1	1
Parmer						
Direct	116	484	534	533	534	534
Secondary Regional Level Impacts	111	459	507	506	507	507
Swisher						
Direct	12	34	71	65	69	71
Secondary Regional Level Impacts	11	31	66	60	64	66
Terry						
Direct	150	149	147	148	147	147
Secondary Regional Level Impacts	136	135	133	134	133	133
Yoakum						
Direct	23	21	18	19	19	18
Secondary Regional Level Impacts	17	16	14	15	14	14
Lost Taxes ($millions)						

County	2010	2020	2030	2040	2050	2060
Bailey						
Direct	$0.10	$0.22	$0.23	$0.24	$0.24	$0.25
Secondary Regional Level Impacts	$0.21	$0.46	$0.47	$0.49	$0.51	$0.52
Briscoe						
Direct	$0.01	$0.01	$0.11	$0.13	$0.15	$0.15
Secondary Regional Level Impacts	$0.01	$0.02	$0.22	$0.25	$0.29	$0.29
Castro						
Direct	$0.16	$0.21	$0.61	$0.85	$0.89	$0.91
Secondary Regional Level Impacts	$0.28	$0.38	$1.10	$1.54	$1.60	$1.64
Cochran						
Direct	$0.10	$0.10	$0.10	$0.10	$0.46	$0.45
Secondary Regional Level Impacts	$0.20	$0.20	$0.20	$0.20	$0.91	$0.89
Crosby						
Direct	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
Secondary Regional Level Impacts	$0.03	$0.03	$0.03	$0.03	$0.02	$0.02
Dawson						
Direct	$0.42	$0.44	$0.44	$0.45	$0.44	$0.43
Secondary Regional Level Impacts	$0.82	$0.86	$0.86	$0.87	$0.85	$0.83
Deaf Smith						
Direct	$0.18	$0.43	$0.51	$0.60	$0.60	$0.61
Secondary Regional Level Impacts	$0.30	$0.71	$0.84	$0.99	$0.99	$1.00
Dickens						
Direct	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
Secondary Regional Level Impacts	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03
Floyd						
Direct	$0.22	$0.26	$0.56	$0.58	$0.59	$0.58
Secondary Regional Level Impacts	$0.42	$0.51	$1.09	$1.14	$1.14	$1.13
Gaines						
Direct	$0.10	$0.14	$0.39	$0.38	$0.44	$0.49
Secondary Regional Level Impacts	$0.19	$0.28	$0.76	$0.75	$0.86	$0.96
Garza						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.01	$0.01	$0.01	$0.00	$0.00	$0.00
Hale						
Direct	$0.00	$0.05	$0.32	$1.02	$1.15	$1.19
Secondary Regional Level Impacts	$0.00	$0.10	$0.62	$1.97	$2.22	$2.29
Hockley						
Direct	$0.20	$0.25	$0.57	$0.63	$0.63	$0.63
Secondary Regional Level Impacts	$0.40	$0.49	$1.12	$1.24	$1.23	$1.24
Lamb						
Direct	$0.21	$0.31	$0.81	$1.00	$1.09	$1.15
Secondary Regional Level Impacts	$0.41	$0.60	$1.58	$1.95	$2.12	$2.23
Lubbock						
Direct	$0.09	$0.25	$0.29	$0.70	$0.70	$0.71
Secondary Regional Level Impacts	$0.18	$0.48	$0.58	$1.39	$1.37	$1.39
Motley						
Direct	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Secondary Regional Level Impacts	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Parmer						
Direct	$0.19	$0.80	$0.88	$0.88	$0.88	$0.88
Secondary Regional Level Impacts	$0.35	$1.44	$1.58	$1.58	$1.59	$1.59
Swisher						
Direct	$0.02	$0.05	$0.09	$0.10	$0.10	$0.11
Secondary Regional Level Impacts	$0.03	$0.10	$0.16	$0.18	$0.20	$0.20
Terry						
Direct	$0.21	$0.21	$0.21	$0.21	$0.21	$0.21
Secondary Regional Level Impacts	$0.17	$0.17	$0.17	$0.17	$0.17	$0.16
Yoakum						
Direct	$0.03	$0.03	$0.02	$0.02	$0.02	$0.02
Secondary Regional Level Impacts	$0.05	$0.05	$0.05	$0.05	$0.05	$0.04

Attachment C: Allocation of Economic Impacts by River Basin

Tables C-1 and C-2 distribute regional economic and social impacts by major river basin. Impacts were allocated based on distribution of water shortages among counties. For instance, if 50 percent of water shortages in River Basin A and 50 percent occur in River Basin then impacts were split equally among the two basins.

Municipal

Table C-1: Distribution of Impacts among Major River Basins (Municipal Uses)						
Lost Output (Total Sales, $millions)						
Basin	2010	2020	2030	2040	2050	2060
Brazos	$67.34	$98.24	$113.57	$116.99	$119.15	$118.75
Colorado	$0.00	$67.75	$76.09	$75.58	$78.14	$80.82
Red	$67.34	$30.49	$29.93	$32.34	$32.58	$30.09
Llano Estacado	$0.00	$0.00	$7.54	$9.07	$8.43	$7.85
Canadian	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Lost Income ($millions)						
Basin	2010	2020	2030	2040	2050	2060
Brazos	$30.25	$54.11	$72.91	$94.22	$100.64	$101.55
Colorado	$0.00	$37.32	$48.85	$60.87	$66.00	$69.11
Red	$30.25	$16.80	$19.22	$26.05	$27.52	$25.73
Llano Estacado	$0.00	$0.00	$4.84	$7.30	$7.12	$6.71
Canadian	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Job Losses						
	2010	2020	2030	2040	2050	2060
Basin	1,460	2,116	2,359	2,419	2,512	2,458
Brazos	0	1,459	1,581	1,563	1,647	1,673
Colorado	1,460	657	622	669	687	623
Red	0	0	157	188	178	162
Llano Estacado	0	0	0	0	0	0
Canadian	0	0	0	0	0	0
Lost Business Taxes ($millions)						
	2010	2020	2030	2040	2050	2060
Brazos	$0.00	$3.29	$3.94	$3.88	$4.53	$4.60
Colorado	$3.43	$1.48	$1.55	$1.66	$1.89	$1.71
Red	$0.00	$0.00	$0.39	$0.47	$0.49	$0.45
Llano Estacado	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Canadian	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Irrigation

Table C-2: Distribution of Impacts among Major River Basins (Irrigation)

Lost Output (Total Sales, $millions)

Basin	2010	2020	2030	2040	2050	2060
Brazos	$0.00	$67.75	$76.09	$75.58	$78.14	$80.82
Colorado	$67.34	$30.49	$29.93	$32.34	$32.58	$30.09
Red	$0.00	$0.00	$7.54	$9.07	$8.43	$7.85
Llano Estacado	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Canadian	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Lost Income ($millions)

Basin	2010	2020	2030	2040	2050	2060
Brazos	$0.00	$37.32	$48.85	$60.87	$66.00	$69.11
Colorado	$30.25	$16.80	$19.22	$26.05	$27.52	$25.73
Red	$0.00	$0.00	$4.84	$7.30	$7.12	$6.71
Llano Estacado	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Canadian	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Job Losses

Basin	2010	2020	2030	2040	2050	2060
Brazos	0	1,459	1,581	1,563	1,647	1,673
Colorado	1,460	657	622	669	687	623
Red	0	0	157	188	178	162
Llano Estacado	0	0	0	0	0	0
Canadian	0	0	0	0	0	0

Lost Business Taxes ($millions)

Basin	2010	2020	2030	2040	2050	2060
Brazos	$0.00	$3.37	$4.07	$4.02	$4.68	$4.75
Colorado	$3.48	$1.52	$1.60	$1.72	$1.95	$1.77
Red	$0.00	$0.00	$0.40	$0.48	$0.50	$0.46
Llano Estacado	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Canadian	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

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Appendix D

Example Municipal Water Conservation Plan

Appendix D

City of Lubbock

Water Conservation And Drought Contingency Plan

Lubbock, Texas

May 2005

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Contents

Water Conservation Plan

Drought Contingency Plan

Attachment A

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Water Conservation Plan
for the
City Of Lubbock

Section I: Declaration of Policy, Purpose and Intent

The purpose of the Water Conservation Plan (the Plan) is to promote the wise and responsible use of water by (1) implementing structural programs that result in quantifiable water conservation results, (2) developing, maintaining, and enforcing water conservation policies and ordinances, and (3) supporting public education programs that educate customers about water and wastewater facilities operations, water quantity and quality, water conservation and non-point source protection.

Section II: Utility Profile

Population. The City of Lubbock (Lubbock) is the eleventh largest city in the State of Texas and the largest city in West Texas. Lubbock's population in 2000 was 199,564. It is projected to be 215,447 by 2010.

Customer Data and Water Use Data. Lubbock's water customers are predominately characterized as residential (85%), small commercial (10%) and municipal (4%). Other customer user classes include industrial, schools, wholesale, and irrigation.

Water Supply System Data. Lubbock's primary source of water is the Canadian River Municipal Water Authority (CRMWA) which delivers raw water from its Lake Meredith reservoir, located on the Canadian River about 50 miles north of Amarillo, and the Williams Groundwater Well Field in Roberts County. Typically, CRMWA provides approximately 80 percent of Lubbock's water supply needs, with the balance being supplied by well water from the city-owned Sandhills Well Field located primarily in Bailey County.

Surface water is treated at the Lubbock Water Treatment Plant (the Plant). The Plant's capacity is 61.4 million gallons daily with a hydraulic peak capacity of 75 million gallons. Water treatment components include disinfection, coagulation, taste and odor control, flocculation, sedimentation, filtration and, as necessary, post-disinfection. Lubbock's ground water supply requires minimal treatment (chlorine) before introduction into the distribution system.

The Plant has a 1,200 acre-feet open storage reservoir, which permits storage of raw water during non-peak periods, and 8.5 million gallons clear well storage for treated water. In addition, thirteen ground storage reservoirs and five elevated steel storage tanks provide storage capacity of *66,700,000* gallons. The water distribution system extends throughout Lubbock and is designed for expansion. Present pumping capacity is *106 million* gallons a day.

Long Term Water Supply Source. The Lake Alan Henry reservoir is located about 65 miles southeast of Lubbock and was planned and constructed to meet long-term water supply needs. It is estimated that the Lake Alan Henry reservoir will provide Lubbock with a water supply of 20.1 million gallons daily.

Wastewater System Data. Lubbock's wastewater treatment system provides for the collection, treatment, and disposal of wastewater. Wastewater is delivered to the Southeast Water Reclamation Plant (SEWRP) through 900 miles of collection lines and 21 lift stations. The SEWRP treats approximately 7.3 billion gallons of wastewater each year (20,000,000 gallons per day). Wastewater treatment components include one bio tower process and two activated sludge processes. The SEWRP has an average daily flow design capacity of 31.5 million gallons. Treated effluent is reused by agricultural irrigation on Lubbock's land application sites and as industrial cooling water. It is also disposed of by discharge in the North Fork of the Double Mountain Fork of the Brazos River at FM 400. Sludge is disposed of in Lubbock's municipal landfill.

Section III: Water Conservation Goals

Lubbock's average daily water usage of approximately 190 gallons per capita per day (gpcd) is slightly higher than the state average of 150 gpcd. Lubbock is situated in an arid region that requires more water per capita for landscape irrigation than many parts of the State. Evidence of landscape irrigation demand is apparent when comparing the winter per capita usage of *139 gal/day* to the summer per capita usage of *184 gal/day*. Water conservation goals are as follows:

- Reduce annual per capita water use to 170 gallons per person per day (10 percent) by the year 2010.
- Reduce annual per capita water use to 150 gallons per person per day (20 percent) by the year 2020.

Section IV: Metering Devices

It is Lubbock's policy to purchase meters that meet at least the minimum standards developed by the American Water Works Association.

Section V: Universal Metering

It is Lubbock's policy to individually meter all water usage, except for fire protection, including all new construction within the city limits. Combined with an aggressive leak detection and repair program and a computerized billing system, Lubbock's universal metering program has resulted in a water delivery accuracy rate well above the national standard of 90 percent. Lubbock's meter replacement and repair schedule is as follows:

Meter Type	Replacement/Rehab Period
Master Meter	Meters are tested at least annually and replaced as necessary
Two-inch and larger	Meters are tested at least annually and replaced as necessary
One-inch and smaller	Meters are tested at least every 10 years and replaced as necessary

Section VI: Measures to Determine and Control Unaccounted-for Uses of Water

It is Lubbock's policy to investigate customer complaints of low pressure and possible leaks, to visually inspect suspected leaks and to track water delivery to customers. Lubbock utilizes a record management system which tracks water pumped, water delivered, water sales and water losses. This information is used to evaluate the integrity of the water distribution system.

Section VII: Water Conservation Program

The City of Lubbock water conservation program is comprised of three main strategies in the following order of priority: (1) structural changes to water use, (2) administrative water conservation efforts, and (3) public education efforts. It is the intent of the water conservation plan to focus efforts in that order.

Structural Changes. Structural changes are those programs that result in a physical modification of water use devices or practices; such as, plumbing retrofit or rehab programs. It is the intent that these programs result in definable and quantifiable water conservation amounts. Structural programs are, but not limited to, the following:

1. Plumbing retrofit programs. The City of Lubbock will support plumbing retrofit programs to replace higher water using devices, such as, toilets, faucets, urinals, etc.
2. Rebate programs. Lubbock will support programs to provide financial incentives to replace higher water using devices with lower water using devices. These programs may include, but not be limited to, residential dishwashing and clothes washing machine replacement, commercial clothes washing machine replacement, restaurant prewash valve replacement, replacement of landscape irrigation systems with drip or subsurface systems, and reduction in the amount of water consuming landscape.
3. Rehabilitation programs. Lubbock will support the rehabilitation of its own water supply, storage and distribution system to minimize water loss due to leaks. Lubbock will support and encourage rehabilitation of private water systems to minimize water loss and water waste. Lubbock will actively engage its customers in this effort by providing free water audits.
4. Reclaimed water programs. Lubbock will support the expanded and continued use of reclaimed water for a substitute for potable water use.

Administrative Changes. Administrative changes are programs, policies, and rules that support water conservation efforts. Lubbock's administrative program may include, but is not limited to, the following:

1. Development and implementation of water conserving water rates. This may include, but not be limited to, seasonal rates, excessive use charges, or increasing block rates.
2. Implementation of plumbing codes that are more stringent on water conservation than the City adopted plumbing code.
3. Review and revision of all city codes that could affect the use of water.
4. Active enforcement of rules, codes, and regulations on water conservation.

Education. Lubbock will support programs to educate the public on the wise use of water. Major components of the education program include, but are not limited to, the following:

1. Presentation of water conservation issues in the Kindergarten through 12th grade public and private education system.
2. Education of the general public on the need for and practices of water conservation through public service announcements, participation in home and garden shows, etc.

Section VIII: Water Rate Structure

In 1992, Lubbock implemented a uniform, non-declining rate structure, with each additional 1,000 gallons costing no less per unit than the prior unit.

Section IX: Means of Implementation and Enforcement

Enforcement. The Plan will be enforced by (1) providing service taps only to customers complying with adopted ordinances, (2) maintaining a non-declining rate structure, (3) discontinuing service to those customers who do not pay their water bills until payment is made, and (4) certifying only new construction that conforms to adopted ordinances.

Section X: Coordination with Regional Planning Group

The service area of Lubbock is located within the Llano Estacado Regional Planning Area and Lubbock has provided a copy of this Plan to the Llano Estacado Regional Planning Group.

Section XI: Additional Water Contract Requirements

Wholesale Water Supply Contracts. It is Lubbock's policy to include in every wholesale water supply contract entered into or renewed after official adoption of the Plan, and including any contract extension, that each successive wholesale customer develop and implement a water conservation plan or water conservation measures using applicable elements in 30 TAC 288, Subchapter A. If the wholesale customer intends to resell the water, then the contract between Lubbock and the wholesale customer must provide that the contract for the resale of the water must have water conservation requirements so that each successive customer in the resale of the water will be required to implement water conservation measures in accordance with 30 TAC 288, Subchapter A.

Section XII: Revisions to the Water Conservation Plan

The City Manager of the City of Lubbock shall review and update, as appropriate, the Plan at least every five (5) years, based on new or updated information, such as the adoption or revision of the regional water plan.

Section XIII: Severability

It is hereby to be the intention of Lubbock that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and if, any phrase, clause, sentence, paragraph or section shall be declared unconstitutional by the valid judgement or decree of any court of competent jurisdiction, such unconstitutionality shall not effect any of the remaining phrases, clauses, sentences, paragraphs or sections of this Plan, since the same would not have been enacted by Lubbock without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph or section.

Drought Contingency Plan
for the
City Of Lubbock

Section I: Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the City of Lubbock (Lubbock) hereby adopts the following regulations and restrictions on the delivery and consumption of water.

Water uses regulated or prohibited under this Drought Contingency Plan (the Plan) are considered to be non-essential and continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in Section XII of this Plan.

Section II: Public Involvement

Opportunity for the public to provide input into the preparation of the Plan was provided by Lubbock by posting the draft Plan on the Internet, City Hall in the Public Information Office, and by posting notice of a public meeting held March 23, 2004 in the City of Lubbock City Council Chambers.

Section III: Public Education

The City of Lubbock will periodically provide the public with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the water use restrictions to be implemented in each stage. This information will be provided by means, including but not limited to, public service announcements, newspaper notice, utility bill inserts, and educational presentations.

Section IV: Coordination with Regional Water Planning Groups

The service area of Lubbock is located within the Llano Estacado Regional Planning Area and Lubbock has provided a copy of this Plan to the Llano Estacado Regional Planning Group.

Section V: Authorization

The City Manager (the Manager) or his/her designee is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The Manager or his/her designee shall have the authority to initiate or terminate water shortage or other water supply emergency response measures as described in this Plan.

Section VI: Application

The provisions of this Plan shall apply to all persons, customers, and property utilizing water provided by Lubbock. The terms "person" and "customer" as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section VII: Definitions

For the purposes of this Plan the following definitions shall apply:

Aesthetic water use: water use for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

Conservation: those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative use.

Customer: any individual, corporation, partnership, association, and any other legal entity utilizing water provided by Lubbock.

Domestic water use: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution.

Landscape irrigation use: water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf course greens, tees, and fairways, parks, and rights-of-way and medians.

Non-essential water use: water uses that are not essential nor required for the protection of public health, safety, and welfare, including:

(a) irrigation of landscape areas, including parks, athletic fields, and golf courses, except otherwise provided under this Plan;
(c) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle;
(d) use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
(e) use of water to wash down buildings or structures for purposes other than immediate fire protection;
(f) flushing gutters or permitting water to run or accumulate in any gutter or street;
(g) use of water to fill, refill, or add to any indoor or outdoor swimming pools or jacuzzi-type pools;
(h) use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic life;
(i) failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s)

.

Section VIII: Requirements for Initiation and Termination of Water Shortage Conditions and Implementation of Water Use Restrictions

After official determination by the Manager, or his or her designee, that the public water supply is or will be limited, or that demand is or is projected to exceed supply, the Manager will declare and classify the water shortage condition using the requirements for initiation identified in Drought Contingency Plan Attachment A. The Manager, or his or her designee, will monitor the water supply on a daily basis and, according to the requirements for initialization for each stage, shall determine that mild, chronic, or acute/emergency water shortage conditions exist. Upon public notice the Manager, or his or her designee, will implement the appropriate water use restrictions found in Drought Contingency Plan Attachment A.

Section IX: Wholesale Water Customers

It is Lubbock's policy to include in every wholesale water supply contract entered into or renewed after official adoption of the Plan, and including any contract extension, that each successive wholesale customer develop and implement a drought contingency program or mechanisms for responding to reductions in water supply. If the wholesale customer intends to resell the water, then the contract between Lubbock and the wholesale customer must provide that the contract for the resale of the water must include mechanisms for responding to reductions in water supply.

Section X: Public Notification

Informing the Public. Public service radio and television announcements and/or news print notifications will be made giving customers details of the expected condition, promoting public participation, and advising customers of the possible penalties as appropriate. The local newspaper will be utilized for long-range information distribution.

Initiation Procedure. Public service radio and television announcements will be made that a water shortage condition has been declared. The announcement will detail the conditions and actions to be taken by customers. The public will be kept informed for the duration of the emergency. The local newspaper will be utilized for long-range information distribution.

Termination Procedure. Public service radio and television announcements will be made that a water shortage condition has been rescinded and reclassified as appropriate.

Section XI: Variances

The Manager, or his/her designee, may, in writing, grant a temporary variance for existing water uses otherwise prohibited under this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance and if one or more of the following conditions are met:

1. Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.
2. Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this ordinance shall file a petition for variance with the Manager after the Plan or a particular water shortage condition response stage has been invoked. All petitions for variances shall be reviewed by the Manager, or his/her designee, and shall include the following:

1. Name and address of the petitioner(s).
2. Purpose of water use.
3. Specific provision(s) of the Plan from which the petitioner is requesting relief.
4. Detailed statement as to how the specific provision of the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.
5. Description of the relief requested.
6. Period of time for which the variance is sought.
7. Alternative water use restrictions or other measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.
8. Other pertinent information.

Variances granted by Lubbock shall be subject to the following conditions, unless waived or modified by the Manager or his/her designee:

1. Variances granted shall include a timetable for compliance.
2. Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section XII: Enforcement

Water customers and other users of Lubbock's water that do not comply with this ordinance shall be subject to a penalty and fine as set forth in Section 1-4 of the Code of Ordinances of the City of Lubbock for each day of non-compliance; and/or disconnection; or discontinuance by Lubbock of water service to such water customers and other users.

Section XIII: Revisions to the Drought Contingency Plan

The Manager or his/her designee shall review and update, as appropriate, the Plan at least every five (5) years, based on new or updated information, such as the adoption or revision of the regional water plan or changes in law or regulation.

Section XIV: Severability

It is hereby declared to be the intention of Lubbock that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable, and if any phrase, clause, sentence, paragraph or section shall be declared unconstitutional by the judgement or decree of any court of competent jurisdiction, such unconstitutionality shall not effect any of the remaining phrases, clauses, sentences, paragraphs or sections of this Plan, since the same would have been enacted by the governing body of Lubbock without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph or section.

City of Lubbock
Drought Contingency Plan
Attachment A
Description of Water Shortage Conditions and Water Use Restrictions

Stage 1 Mild Water Shortage Conditions

Requirements for Initiation – Any one of the following requirements is sufficient for initiation of the water use restrictions:

1. Water demand is approaching the maximum safe demand of the water supply system;
2. Supply lake levels are low enough to cause concern for future water supply;
3. Water supplies are adequate but water levels, reservoir capacities, or groundwater supplies are low enough that there is a real possibility that the supply situation may degrade if the drought or emergency condition continues.

Water Use Restrictions

1. City water customers will be asked to voluntarily refrain from or significantly limit water uses defined as aesthetic, domestic, landscape irrigation, and other nonessential uses. The City Manager of the City of Lubbock (the Manager) will make suggestions on ways to limit such uses.
2. The objective of these water use restrictions is a 5 percent reduction in annual average demand and a 10 percent reduction in peak day demand.
3. All City of Lubbock operations will adhere to the water use restrictions established by the Manager.
4. The City of Lubbock will request that all customers and other users of city water practice water conservation measures.
5. The Manager may implement additional water use restrictions as necessary.

Conditions for Termination

Stage 1 water restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the Manager.

Stage 2 Chronic Water Shortage Conditions

Requirements for Initiation – Any one of the following requirements is sufficient for initiation of the water use restrictions:

1. Water demand reaches the maximum safe demand of the water supply system; or
2. Supply levels from lakes, wells, and/or groundwater are low enough and continue to decline to cause concern for future water supply; or have been reduced due to mechanical failure or other means.

Water Use Restrictions

1. Stage 1 restrictions remain in effect.
2. Landscape irrigation will be restricted as follows:
    a. From 6:00 pm to 10:00 am on designated days,

b. Designated water days for residential customers are as follows:
    i. Sunday for even numbered addresses,
    ii. Saturday for odd numbered addresses,
c. Designated water days for commercial, industrial and institutional customers are as follows:
    i. Tuesday
d. Designated water day for users other than those designated above is Wednesday.
e. Designated water days for City Parks, Educational facilities are as follows:
    i. Facilities north of 34th Street and west of Indiana Ave.: Monday
    ii. Facilities north of 34th Street and east of Indiana Ave.: Tuesday
    iii. Facilities south of 34th Street and east of Indiana Ave.: Wednesday
    iv. Facilities south of 34th Street and west of Indiana Ave.: Thursday

3. Use of city water to wash any motorized vehicle, motorbike, boat, trailer, airplane, motor home, camper, or other vehicle is prohibited except under the following conditions:
    a. During the hours from 6:00 pm to 10:00 am and using prescribed water use practices,
    b. Prescribed vehicle water use practices are using a hand-held bucket and hand-held hose with an automatic shutoff nozzle.
    c. Commercial vehicle washing operations may occur anytime provided the facility uses water recirculation,
    d. Washing of vehicles to protect the health, safety and welfare of the public; such as, emergency vehicles, garbage trucks, food transport vehicles, etc., are exempt from these restrictions.
4. Recreational use of water is not allowed except on designated water use days (as defined in item 2) where water levels in existing recreational facilities may be maintained. Recreational water use includes, but is not limited to, swimming pools, Jacuzzi's, hot tubs, wading pools, and fountains.
5. Operation of an ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountain or ponds are equipped with a recirculation system.
6. Use of water from fire hydrants shall be limited to fire fighting or other related activities necessary to maintain public health, safety and welfare. Use of water from fire hydrants for construction purposes is allowed under permit by the City of Lubbock.
7. All restaurants are prohibited from serving water to patrons except upon request,
8. Hotels and motels are required to implement water conserving measures. Such measures include, but are not limited to, the following:
    a. Changing sheets only when requested by the guest,
    b. Replacing towels and wash clothes only when requested by the guest.
9. Nonessential use of water is prohibited. Examples of nonessential water uses are as follows:
    a. Washing down sidewalks, driveways or other impervious areas, except where necessary to remove contaminants from chemical spills,
    b. Washing down buildings or structures for purposes other than fire fighting,
    c. Flushing gutters or allowing water to accumulate or flow down any gutter or street,
    d. Failure to repair a leak within five (5) calendar days after having been made aware of the leak.
10. The City of Lubbock may reduce water system pressure to conserve water.
11. The Manager may implement additional water use restrictions as necessary.

<u>Conditions for Termination</u>

Stage 2 water restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the Manager. When Stage 2 is terminated, Stage 1 automatically becomes in effect.

Stage 3 Acute or Emergency Water Shortage Conditions

Requirements for Initiation – Any one of the following requirements is sufficient for initiation of the water use restrictions:

1. Water demand has exceeded the maximum safe supply capability of the water supply or distribution system;
2. Supply lake or groundwater levels are low enough to result in the potential inability to provide further supply;
3. There has been a failure in a major water supply or transmission component; such as, a pumping system, supply line, transmission or distribution pipeline, or storage reservoir, that causes a severe limit on the ability of the water system to meet the demand.

Water Use Restrictions

1. All Stage 2 water restrictions remain in effect.
2. All outdoor water use is prohibited except where necessary to protect the health, safety, and welfare of the public.
3. No new landscape material may be installed.
4. Operation of ornamental fountains or ponds is prohibited except where necessary to preserve aquatic life.
5. The Manager may implement additional water use restrictions as necessary.

Conditions for Termination

Stage 3 water restrictions may be rescinded when all initiation conditions have ceased to exist as determined by the Manager. Upon cessation of Stage 3, Stage 2 water use restrictions become effective.

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Appendix E

Derivation of Volume of Water in Storage Bailey County Example

Appendix E
Derivation of Volume of Water in Storage and Supply and Demand (LERWPG Regional Water Plan 2006)

by
Judy A. Reeves, Ph.D.
High Plains Underground Water Conservation District #1
May, 2005

Volume of water in storage, supply, and demand are values that provide the scientific backbone of any water plan. These values indicate the amount of groundwater available from an aquifer, the amount of water available to user groups, and the amount of water that user groups have determined necessary to sustain lifestyles and a standard of living. Each of the values can be provided as a historic, current, or future (projected) value.

There are numerous methods used to calculate the volume of water in storage and quantities of supply and demand for an aquifer. This appendix describes the volume of water in storage and the supply and demand values derived for the 2006 Llano Estacado Regional Water Planning Area (LERWPA) Regional Water Plan. The State of Texas stipulates that the three values be presented on a county-by-county basis. In this appendix, Bailey County is used as an example to illustrate the "by county" calculation process.

For each county, one of three methods was used to calculate volume of water in storage. Because volume of water in storage is directly related to supply, the outcome of the calculation method will be reflected in the supply values.

Volume of Water in Storage

Volume of water in storage is calculated three ways in the 2006 Regional Water Plan. HDR, the planning group's contractor, refers to the three different volumes as Volume V1, Volume V2, and Volume V3, as described below. Table 1 lists the V1, V2 and V3 designations applied to the counties in this water plan.

Volume V1: V1 is a volume derived from two surfaces, the base of the Ogallala (the same base of aquifer surface used in the Groundwater Availability Model (GAM) 04-05) and the water table surface (the output of head values in the GAM model for a particular time step). The surfaces are derived by interpolating the point data (for the water table surface) and the line data (for the base of the aquifer) to raster grid cells. For each raster cell, the elevation of the base of the aquifer is then subtracted from the elevation of the water table. The difference is then multiplied by the specific yield (the same *Sy* used in the GAM) and the area of the grid (1 mile by 1 mile). The total volume of water in storage in each county is the sum of the volumes for each raster cell. Volume V1 is therefore a GAM-derived volume of water in storage.

Table 1
County Volume Designations
2006 Regional Water Plan

V1	V2	V3
Briscoe	Cochran	Bailey
Castro	Dickens	Gaines
Crosby	Garza	Parmer
Dawson	Lynn	
Deaf Smith	Motley	
Floyd	Yoakum	
Hale		
Hockley		
Lamb		
Lubbock		
Swisher		
Terry *		

* (changed from V2 by request of the South Plains Water District)

Volume V2: The Llano Estacado Regional Water Planning Group (LERWPG) requested the Texas Water Development Board (TWDB) to tabulate the volume of water in storage using a "non-GAM" method. This has been referred to as the "mass balance" method[1] or "V2". To derive V2, the volume of water in storage in 1995[2] was used as the starting point and projected out to the year 2000[3]. Water demands approved by the TWDB on September 17, 2003 for the years 2000 to 2060 were subtracted from the 2000 base value on a yearly basis. The only input value was average recharge from the GAM. This approach completely ignores the spatial distributions of storage, pumpage, and recharge in the counties.

Volume V3: Volume V3 is calculated as the midpoint of V1 and V2 until the time when the only water left in the aquifer is the amount recharged, after which the volume of water in storage follows the same trend as the GAM trend line.

[1] Richard Smith of the TWDB GAM modeling group performed the "mass balance" calculations. Since it was conducted by the GAM modeling group, GAM number 04-07 was assigned to the report documenting the calculations. Although there is a GAM number, it is NOT a set of values derived from a groundwater model.

[2] In 1995, the High Plains Underground Water Conservation District #1 used a planimeter method to derive the volumes of water in each county of the Llano Estacado Regional Water Planning Group. At the time of the request for the "mass balance" calculations, the 1995 data was considered the most accurate volume data set available.

[3] 1996 to 2000 volumes were calculated by subtracting annual water use numbers generated by Dr. Stephen Amosson and others for the Southern Ogallala GAM (Blandford, R.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater Availability of the Southern Ogallala Aquifer in Texas and New Mexico: Numerical Simulations Through 2050) and adding average recharge from GAM 04-05 on an annual basis.

Derivation of Volume of Water in Storage in Bailey County

Bailey County is used to illustrate the derivation of volume of water in storage (V1 vs. V2 vs. V3) and subsequently supply. Demand is derived independently of volume of water in storage and supply. Empirical data for the years 1990 to 2004 in Bailey County is provided to illustrate actual volumes of water in storage. From the empirical data we can see the actual aquifer trend from 1990 through 2004 and get a better sense of how the projected data fits with historical data.

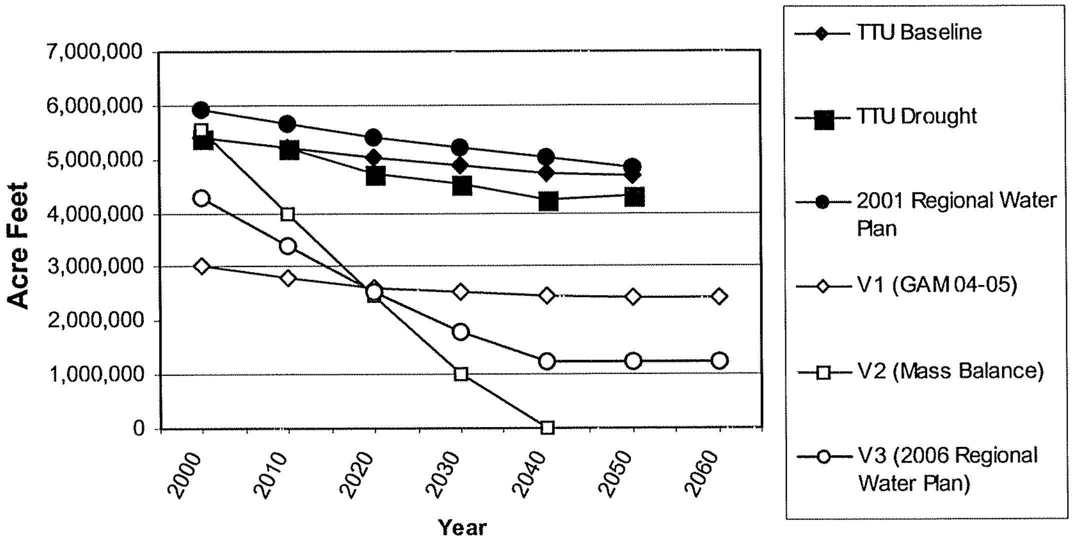
Figure 1 compares volume of water in storage in Bailey County using various calculation methods. The two lines on the graph labeled TTU Baseline and TTU Drought are volumes calculated by the Texas Tech University Water Resources Center for the Llano Estacado Regional Water Planning Group (LERWPG) in 2001[4]. The LERWPG requested that several scenarios be modeled, including a baseline simulation and a drought simulation. The TTU modelers used a MODFLOW groundwater model that was designed to meet stringent calibration requirements stipulated by the LERWPG. As shown on the graph, the volumes for the baseline and drought scenarios start in 2000 at approximately 5.4 million acre-feet. After drought conditions are introduced in the year 2015, the two lines diverge and the volumes are reduced to 4.7 (baseline) and 4.3 (drought) million acre-feet.

The LERWPG elected not to use the results of the TTU model in the 2001 Llano Estacado Regional Water Plan. Instead, the planning group used what has been referred to as the "cedar pencil model" which was primarily based on a depletion estimate of 10% per decade. An initial starting point for volume came from the planimetered value performed by the High Plains Water District in 1995[5]. The "cedar pencil model" was not a numerical groundwater model, but rather a rough projected estimate. Those counties that showed actual increases in storage between 1985 and 1995 (Briscoe, Cochran, Crosby, Dickens, Garza, Hockley, Lynn, however not Dawson and Gaines counties) were estimated to remain constant throughout the planning period.

[4] Stovall, J., Rainwater, K., and Frailey, S., 2001, Groundwater Modeling for the Southern High Plains: Submitted to the Llano Estacado Regional Water Planning Group, 298p.

[5] The planimeter method uses a drafting instrument called a planimeter to trace the perimeter of a defined contour interval on a saturated thickness map, thereby determining the area on the map that has a saturated thickness in the range between two contour lines. As commonly done today, the determination of areal extent was done using AutoCAD™, rather than the planimeter tool. The 1995 calculations were based on the saturated thickness maps from the High Plains Underground Water Conservation District #1 Hydrologic Atlases (Don McReynolds, 1995). The areas were then multiplied by the mean saturated thickness and a representative specific yield (15%) to obtain the volume of water in storage. This procedure was used for each contour interval on the mapped area of interest. Finally, the volumes calculated for each contour interval were summed to give the total volume in each county.
The planimeter method can be very accurate for the year that the saturated thickness was mapped. Potential errors in the volumetric calculations are introduced in measurements of water table elevations, accuracy of the base of the aquifer map, accuracy of the saturated thickness map, contouring techniques, and representativeness of the specific yield value.

Figure 1
Bailey County Volume of Water in Storage



The 2000 volume estimated for Bailey County in the 2001 Regional Water Plan was approximately 5.9 million acre feet, compared to 4.8 million acre feet in the year 2050. These volumes are labeled "2001 Regional Water Plan" on Figure 1.

In 1997, Senate Bill 1 was enacted which, among other things, stipulated that numerical groundwater models were to be developed for all major aquifers. Groundwater Availability Model (GAM) results were to be used for regional water planning, unless better data could be documented. The Groundwater Availability Model for the Southern Ogallala aquifer was completed in 2003[6] by Daniel B. Stephens and Associates under contract to the Texas Water Development Board. The GAM for the Southern Ogallala aquifer had less stringent calibration standards than the TTU model, consequently, the GAM model did not simulate actual aquifer conditions as closely as the TTU model in all counties. In counties where the GAM did replicate the actual water table fairly well, the volumes of water in storage are fairly accurate. In counties where the water table generated by the model was appreciably above or below the observed water table, the volumes of water in storage can be very inaccurate (either resulting in too much or too little water in storage).

<u>Bailey County Volume V1.</u> Bailey County is an example of a county where the GAM does not accurately represent the aquifer. On Figure 1, the GAM derived volume of water in storage (V1) shows a year 2000 volume of approximately 3 million acre feet and a projected 2060 volume of about 2.4 million acre feet. The low volume in 2000 reflects a large number of cells that went dry by the year 2000 in the GAM. These dry cells are mainly located in the northwestern portion of Bailey County, an area that, in

[6] Blandford, R.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater Availability of the Southern Ogallala Aquifer in Texas and New Mexico: Numerical Simulations Through 2050.

actuality, has about 100 feet of saturated thickness. The result is that the GAM derived volume of water in storage (approximately 3 million acre feet) significantly under-represents the volume of water in Bailey County, beginning in 2000.

Bailey County Volume V2. The "mass balance" volume is presented as V2 on Figure 1. For this method, the starting volume of approximately 6 million acre feet in 1995 was projected to the year 2000 with a volume of 5.5 million acre feet. By subtracting the demand values on an annual basis (and adding the GAM derived recharge value), there is no water left in Bailey County by the year 2037.

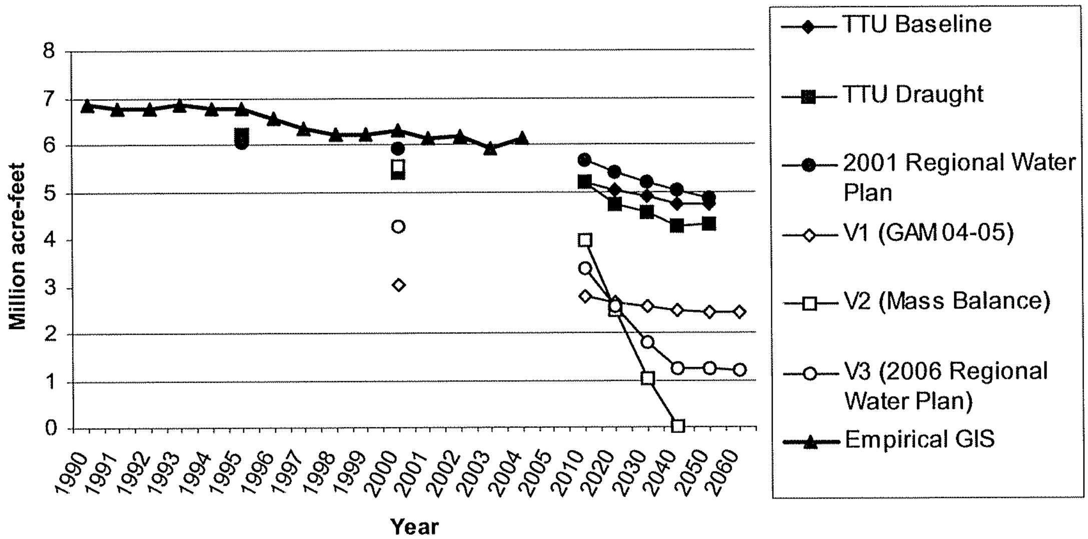
Bailey County Volume V3. Volume V3 is the volume chosen to represent Bailey County in the 2006 Regional Water Plan (Figure 1). Volume V3 is the mathematical midpoint between V1 and V2 through the year 2037, after which time the trend of the GAM model line (V1) is mimicked.

Discussion. How do we improve our understanding of the volume of water in storage in Bailey County? How do we get a sense which of the derived volumes most accurately represents the actual Ogallala aquifer conditions in Bailey County? One way is to look at actual data through time and plot the historical volumes on the same graph. Figure 2 shows the same volume trend lines as Figure 1, but adds a plot of the historical volumes from 1990 through 2004. Each year from 1990 through 2004, the High Plains Water District measured the depth to water in approximately 100 to 130 wells in Bailey County. To calculate the volume for each measurement year, a surface was created from the water level measurements to depict the actual water table in Bailey County. Using ArcGIS™ and ESRI Spatial Analyst™, the volume of water in the aquifer is determined by multiplying the difference between the base of the aquifer surface and the actual water table surface by the specific yield[7]. A raster grid cell size of 528 feet (or 0.1 mile) was used. The resultant volumes for the years 1990 to 2004 are presented in Figure 2 are labeled "Empirical GIS." These volumes are believed to be the most accurate volume calculations performed to date.

The actual data can be compared to the projected data from the models (e.g., TTU Baseline, TTU Drought, V1 (GAM 04-05)) or to the estimates using other techniques (e.g., 2001 Regional Water Plan, V2 (Mass Balance) or V3 (2006 Regional Water Plan)) to qualitatively determine if the projected lines "fit" the slope and magnitude of volumes indicted by the actual data. For example, in Figure 2, the projected trend lines with the most similar slope to actual data are the V1 (GAM 04-05) and TTU Baseline trend lines. Magnitude of volume is most closely replicated by the 2001 Regional Water Plan, TTU Baseline, and TTU Drought lines. Conversely, the most dissimilar slopes to the actual trend line are V2 (Mass Balance) and V3 (2006 Regional Water Plan)." The volumes that are most dissimilar to the historical values are V1 (GAM 04-05) and V3 (2006 Regional Water Plan)".

[7] Specific yield, or *Sy*, as used in GAM 04-05.

Figure 2
Bailey County Volume of Water in Storage



The distribution of the lines is not haphazard. The good correlation of the slope of the TTU and GAM model trend lines to the slope of the empirical data is due to the fact that models most closely replicate real conditions in the aquifer. This is precisely why we use models. However, if a model is not well calibrated (meaning that the model does not behave like the actual aquifer), the volume data will be skewed from the measured values. This is why the GAM 04-05 volume (V1) in Bailey County is only about half of the volume that the measured values indicate. The GAM in Bailey County was not well calibrated, and specifically, was plagued by what is known as the "dry cell phenomenon." For example, there were numerous 1 mile by 1 mile square cells in the model that showed no water in (i.e., went dry) in the year 2000; however, we know that, in actuality, there is water in that portion of the county, sometimes over 100 feet of water!

Supply

Water supply is defined as "the volume of water apportioned to a WUG[8] or WWP[9] from each currently existing, connected, and accessible water source, during drought-of-record conditions, taking into consideration all constraints that limit the supply amount. A supply is current if it is existing, connected, and accessible for use as of January 1, 2002 or anticipated to be existing, connected, and accessible for use at the conclusion of the current regional water planning cycle." [10]

In its simplest form, supply can be defined as the amount of *currently available* water from the High Plains (Ogallala) aquifer plus any other known source of water that can increase the available water to a particular county or river basin. Examples of other

[8] Water User Group
[9] Wholesale Water Provider
[10] Texas Water Development Board, 2002, Guidelines for Regional Water Plan Development, Exhibit B, p. 12.

sources of water used in the 2006 Regional Water Plan are from other contributing aquifers such as the Dockum, Seymour, or Edwards-Trinity (High Plains) aquifers, Ogallala aquifer water brought in from outside of the planning region such as from Roberts County, surface water such as Lake Meredith, Lake Mackenzie, Lake Alan Henry, or the White River Reservoir, water obtained from stock tanks and windmills, or reclaimed water from municipal, industrial or irrigation processes.

The tabulation of available water from these "other sources" is rather straightforward. It's the amount of water from the High Plains (Ogallala) aquifer that has caused much consternation. In the 2006 Regional Water Plan, supply from the High Plains (Ogallala) aquifer has been calculated three different ways, termed Supply V1, Supply V2, and Supply V3. The derivation of Supply V1, Supply V2, and Supply V3 are discussed below using Bailey County as an example.

Derivation of Supply in Bailey County

Bailey County Supply V1. Supply V1 is simply the volume of water that was pumped within the model (GAM 04-05) on an annual basis plus contributions from other known sources of water to the county or river basin. As an annual value, it is best to designate supply units in ac-ft/yr. Most of the supply in each county comes from the water that was pumped in the model. Therefore, if the model is not accurately depicting the response of the aquifer to pumping, then the supply number can be seriously flawed. Bailey County is an example of a county in which the model's pumping scenario does not mimic the actual pumping scenario in the aquifer.

Figure 3 shows the resultant Supply V1 for Bailey County starting with 85,719 ac-ft/yr in 2000 and reduced to 17,067 ac-ft/yr in 2060. A large number of model cells in Bailey County that should be available for pumping in the year 2000 are already dry cells, meaning that there is no pumping, and hence no supply from these cells. The problem in year 2000 propagates through the planning period out to year 2060. Since actual survey estimates of water use in Bailey County[11] for the year 2000 showed approximately 183,000 ac-ft, it goes without saying that the 85,719 ac-ft of supply indicated by the model grossly under represents supply in Bailey County.

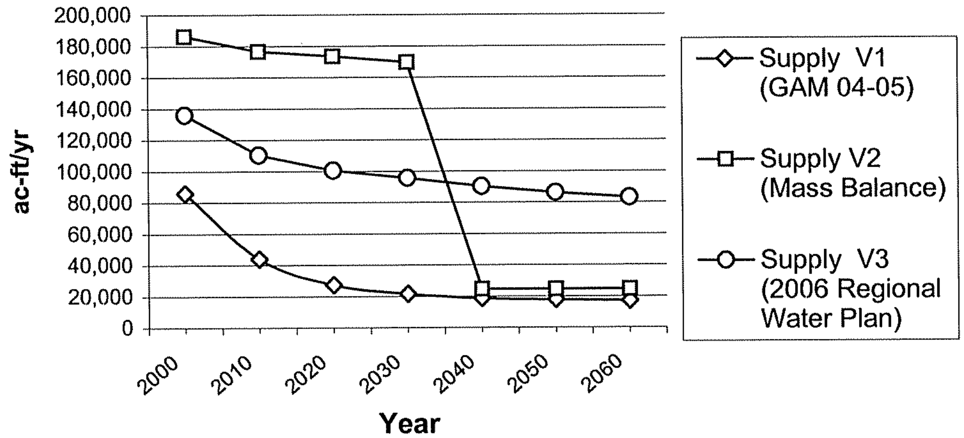
Bailey County Supply V2. Supply V2 is derived from the mass balance calculations performed by Richard Smith of the Texas Water Development Board. The values are a result of spreadsheet calculations and are not values derived from a numerical groundwater model. Supply V2 values are essentially set equal to the demand values up until the time when there is no water left in the aquifer. After all water is exhausted, only the GAM recharge value is added on an annual basis.

In Bailey County, no water is left in the aquifer by the year 2036, after which 24,599 ac-ft, or the average GAM recharge value, is added on an annual basis. Supply V2 is unrealistic because it is based on the premise that all future demands will be met at all well locations in Bailey County up until a time when there is not one drop of water left in the aquifer. We know that the aquifer will not behave this way. We know that in reality all wells are not created equal. Some demands on wells exceed (or will exceed)

[11] Performed mainly by the Natural Resource Conservation Service and reported in Texas Water Development Board Report 347 (2001).

the aquifer's capacity at a particular location, at which time the well will either go dry or the well must be pumped at a lower rate. In reality, wells in different locations will go dry at different times, pumping rates will vary, and some water will simply not be available for pumping due to hydraulic conditions of the aquifer.

Figure 3
Bailey County Supply



Bailey County Supply V3. Supply V3 is mathematically derived from Supply V1 and Supply V2. Supply V3 is the midpoint between Supply V1 and Supply V2 up until the time when the water in Supply V2 is exhausted, after which the Supply V3 line follows the trend of Supply V1.

The supply for Bailey County in the 2006 Regional Water Plan utilizes Supply V3. Supply V3 is viewed as a compromise for Bailey County, but the underlying problems associated with the Supply V1 and Supply V2 values must be recognized as part of the resultant Supply V3 value. In essence, Supply V3 is a midpoint between GAM generated values that grossly under represent supply (Supply V1) and the "mass balance" values (Supply V2) which represent an unrealistic aquifer.

Demand

Calculation of demand is specific to the various water user groups (WUGs), i.e., municipal water demand, irrigation water demand, manufacturing and mining water demands, or steam electric power generation water demands. For example, projections for municipal water use consider population growth, climatic conditions, and water conservation practices and are comprised of residential, commercial and institutional water users. Demand, like supply, is expressed in units of ac-ft/yr.

Irrigation water demands are based on a survey performed primarily by the Natural Resource Conservation Service (NRCS) – U.S. Department of Agriculture[12] in 2000. The NRCS estimated irrigated crop acreages and corresponding irrigation water application for each crop to obtain the demand values.

The 2006 Regional Water Plan presents water demand projections for six major water user groups: 1.) municipal; 2.) mining; 3.) livestock; 4.) irrigation; 5.) manufacturing; and 6.) steam-electric power generation. As shown in Table 2, demand values for irrigation far exceed other categories of demands.

Table 2
Bailey County Demand for Year 2000
(ac-ft/yr)

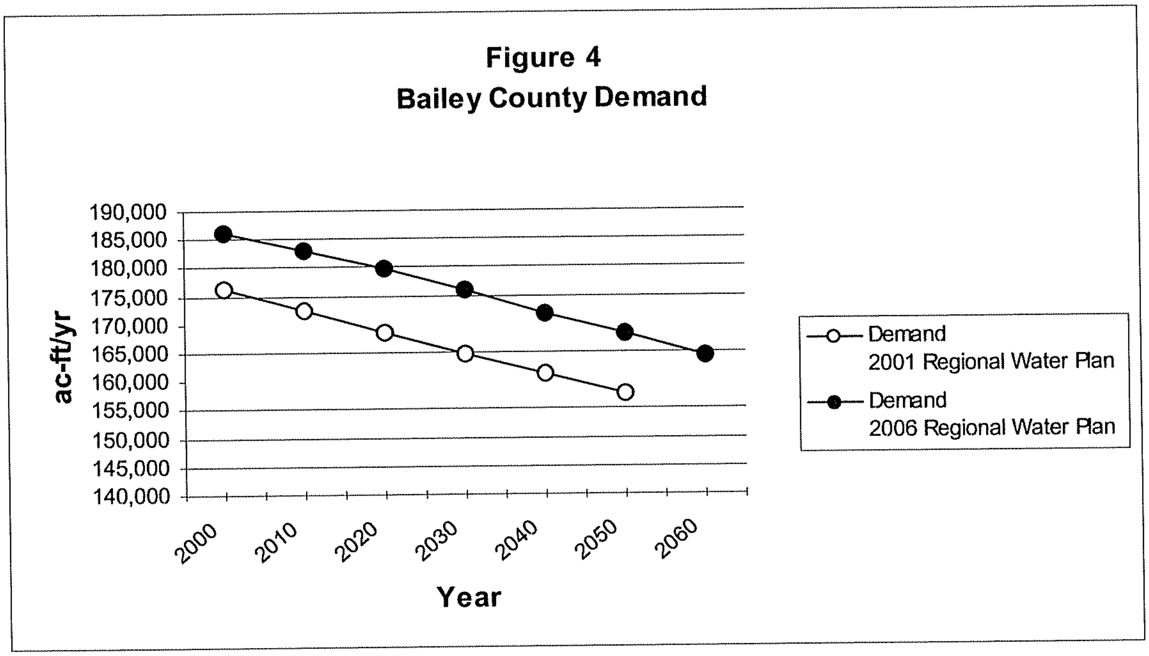
Municipal	1,310
Mining	0
Livestock	1,723
Irrigation	182,865
Manufacturing	264
Steam-Electric	0

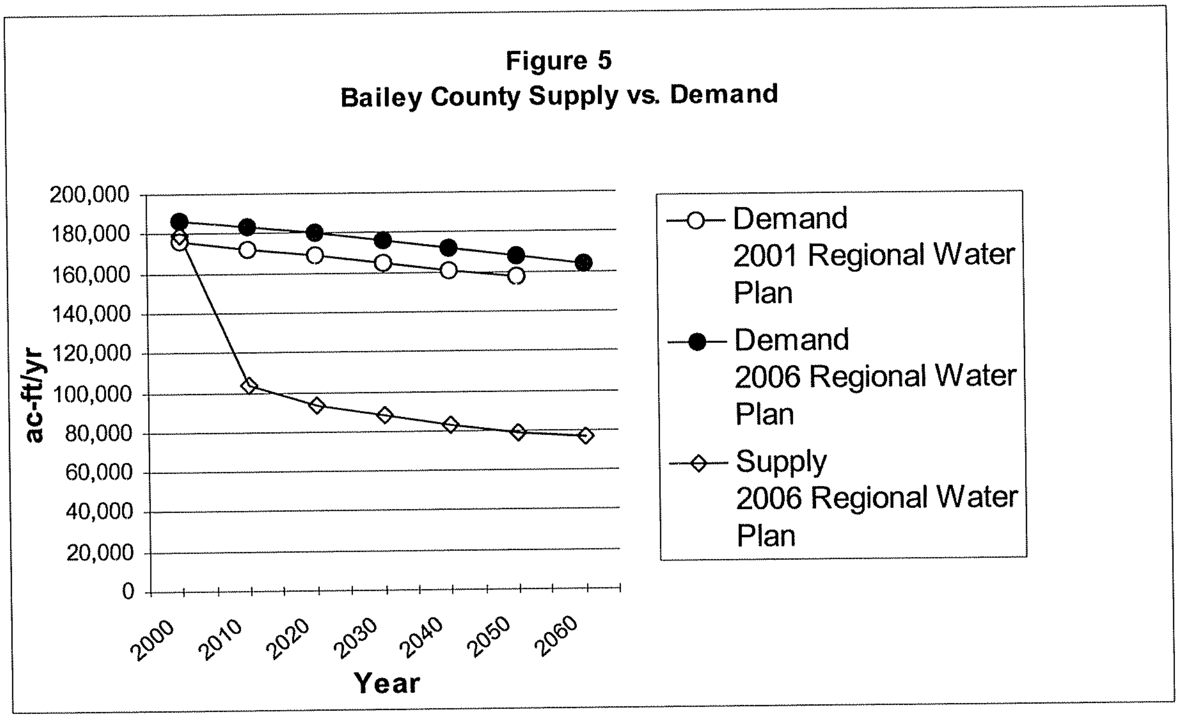
For the 2006 regional water plan, projections of irrigation water demand were made by TWDB using the projected irrigation water demand curves from the 2001 Regional Water Plan. The 2001 irrigation water demand projection for each county was shifted to the estimated quantity of irrigation water use for the year 2000. In the case of Bailey County, this caused an upward shift of the irrigation projected demand curve from 176,237 to 186,162 ac-ft for the year 2000 (Figure 4). This increased demand is considered by the TWDB as "dry weather irrigation demand" since year 2000 is considered "a dry year" on the Southern High Plains. However, "a dry year" designation must be tempered with the understanding that regional conditions may or may not reflect local conditions, since rainfall amounts are not ubiquitous over the planning region and that local variations in timing of the rainfall with respect to the crop season can critically affect irrigation demand.

Discussion

Figure 5 illustrates the difference between supply and demand in Bailey County in the 2006 Regional Water Plan. Although the demand numbers have been questioned as being unrepresentative of "normal" irrigation conditions on the Southern High Plains, it is apparent by looking at the magnitude of change made by the upward shift in the demand line from the 2001 to 2006 Regional Water Plan that the "demand side of the equation" is not the bad actor. Indeed, it is actually the limited supply and problems associated with derivation of the supply trend line that cause significant difference between supply and demand in Bailey County.

[12] Texas Water Development Board, 2001, Surveys of Irrigation in Texas: Texas Water Development Board Report 347, 102p.





The parameters, volume of water in storage, and supply are interrelated. The accuracy of one parameter directly affects the accuracy of the other parameter, and as such, improvements in the quality of the parameters are tantamount to the success of regional planning. In addition, modern modeling tools must be properly calibrated to observed conditions to be of any benefit in predictions of future behavior.

Appendix F

Surface Water Rights Information

Appendix F: Surface Water Rights of Region O

SEE PAGE 3 FOR CONTINUATION OF ROWS 1 THROUGH 78

Row No.	Water Right No	Type	Seq-uence	Permit No	Water Right Issue Date	Amend	Owner Name	Owner Type	Anount AcFt/yr	Use	Priority Date	Expire	Acreage	Reservoir Name
1	3703	6	1		2/20/1985		W T MILLEN	1	152.23	3	11/25/1968		152.23	
2	3703	6	2		2/20/1985		RINGLAND J C GATEWOOD ET UX	3	102.77	3	11/25/1968		102 77	
3	5099	6	1		8/7/1987		RAYMOND WARD	1	117	3	6/25/1962		138	GRAHAMS LAKE
4	5100	6	1		8/7/1987		FLOYD J RICHARDSON	1	19	3	9/16/1964		25	
5	5100	6	2		8/7/1987		FLOYD J RICHARDSON	1		7	9/16/1964			
6	5100	6	3		8/7/1987		BILLIE JEANE GRIFFIN	1		7	9/16/1964			
7	5103	6	1		8/7/1987		J A MAYFIELD	1	28	3	5/12/1964		82	KENT CR WS
8	5104	6	1		8/7/1987		BILLY M PIGG & WIFE	3	17	3	6/29/1964		49	
9	5105	6	1		8/7/1987		JOSEPHINE M MERRELL & HUSBAND	4	30	3	6/22/1964		30	
10	5105	6	2		8/7/1987		JOSEPHINE M MERRELL & HUSBAND	4		7	6/22/1964			
11	5106	6	1		8/7/1987		CHARLEY F TATE	1	80	3	5/4/1964		40	
12	5211	6	1		9/25/1987		MACKENZIE MWA	2	4000	1	6/26/1967			MACKENZIE RESERVOIR
13	5211	6	2		9/25/1987		MACKENZIE MWA	2		7	6/26/1967			MACKENZIE RESERVOIR
14	5211	6	3		9/25/1987		MACKENZIE MWA	2	1200	2	6/26/1967			MACKENZIE RESERVOIR
15	5212	6	1		9/25/1987		ROY MAYFIELD ESTATE	5	107	3	5/15/1967		130	
16	5219	6	1		9/25/1987		WM ELBERT & DORA HAWKINS	1		7	3/16/1964			
17	5220	6	1		9/25/1987		TEXAS PARKS & WILDLIFE DEPT	2	20	1	3/9/1964			
18	5220	6	2		9/25/1987		TEXAS PARKS & WILDLIFE DEPT	2		7	3/9/1964			
19	5267	6	1		8/7/1987		DALE SMITH	1	100	3	11/25/1963		100	
20	5267	6	2		8/7/1987		DALE SMITH	1		7	11/25/1963			
21	3675	6	1		2/20/1985		TOM MCGILL	1	86	3	6/30/1961		62	
22	3676	6	1		2/20/1985		THE TWELVE CO A TX CORP	2	10	3	9/29/1969		40	
23	3677	6	1		2/20/1985		WILMA LEMONS	1	31	3	2/9/1970		165	
24	3677	6	2		2/20/1985		KEITH DAVID LEMONS ET AL	4	31	3	2/9/1970		165	
25	3678	6	1		2/20/1985		ROY TAACK	1	40	3	10/9/1968		43	
26	3679	6	1		2/20/1985		L D AMERSON	1	3	3	6/25/1973		130	
27	3679	6	2		2/20/1985		L D AMERSON	1		7	6/25/1973			
28	4383	1	1	4064	1/10/1984		DAVID W SMITH ET UX	3	60	3	7/11/1983		200	
29	5187	6	1		9/25/1987		FLOYD COLE ESTATE	5	40	3	7/31/1967		100	
30	5196	6	1		9/25/1987		DAN J HEARD	1	124	3	5/31/1961		174	
31	5199	6	1		9/25/1987		CONE JOHNSON ET AL	4	66.3	3	3/1/1971		106.63	
32	5199	6	2		9/25/1987		CONE JOHNSON	1	89.03	3	3/1/1971		143.2	
33	5199	6	3		9/25/1987		ROXIE WYNN JOHNSON	1	107.67	3	3/1/1971		173 17	
34	3691	6	1		2/20/1985		HARRISON N WATSON JR ET AL	4	11	3	11/12/1963		75	
35	3692	6	1		2/20/1985		OTIS W ENGLISH JR ET AL	4	29	3	5/12/1953		12	
36	3693	6	1		2/20/1985		WHITE RIVER MWD	2	4000	1	9/22/1958			WHITE RIVER RESERVOIR
37	3693	6	2		2/20/1985		WHITE RIVER MWD	2	2000	4	9/22/1958			WHITE RIVER RESERVOIR
38	3694	6	1		2/20/1985		W C HUFFAKER JR	1	47	3	12/2/1966		47	
39	3695	6	1		2/20/1985		MARVIN SHURBET	1	80	3	9/29/1969		40	
40	3708	6	1		2/20/1985		DELTON CADDELL	1	120	3	8/1/1966		1250	
41	3709	6	1		2/20/1985		NATHANIEL CLARK WOOD JR ET UX	3	15	3	12/31/1967		15	
42	3709	6	2		2/20/1985		NATHANIEL CLARK WOOD JR ET UX	3	795	3	4/17/1968		1265	
43	3710	6	1		2/20/1985		R E JANES GRAVEL CO	2	450	4	4/17/1968			
44	3417	1	1	3122	5/21/1975		CITY OF LAMESA	2	918	3	3/24/1975		375	
45	5179	6	1		9/25/1987		RALPH R GRIGSBY JR ET AL	4	796	3	7/31/1966		835	
46	5182	6	1		9/25/1987		WALTER L KAUL & WIFE	3	37	3	7/31/1964		50	
47	5184	6	1		9/25/1987		CLARENCE W MARTIN ET UX	3	54	3	7/31/1964		73	
48	5184	6	2		9/25/1987		LAWRENCE J MARTIN ET UX	3		3	7/31/1964			
49	5185	6	1		9/25/1987		R L SIMPSON ET AL	4	125	3	6/30/1965		447	
50	3696	6	2		2/20/1985		O J & ELEANORA S BARRON	1	260	3	9/14/1965		248	
51	3697	6	1		2/20/1985		O J & ELEANORA S BARRON	1		7	8/28/1972			
52	3698	6	1		2/20/1985		O J & ELEANORA S BARRON	1	768	3	8/1/1966		412	
53	3699	6	1		2/20/1985		JOHN R & KATHRYN HUNTER	1	160	3	6/2/1969		80	
54	3699	6	2		2/20/1985		JOHN R & KATHRYN HUNTER	1		7	6/2/1969			
55	3700	6	1		2/20/1985		JESSE H & RUBY DAUGHERTY	1	160	3	11/17/1969		175	
56	5110	6	1		8/7/1987		TRUMAN ELLIS ET UX	3	40	3	1/1/1955		79	
57	3690	6	1		2/20/1985		CHARLES DONALD SCHULER	1	2	3	12/31/1960		5	
58	5101	6	1		8/7/1987		MICHAEL HOOD CHAMALES ET UX	3	20.77	3	5/25/1964		22 46	
59	5101	6	2		8/7/1987		MICHAEL HOOD CHAMALES ET UX	3		7	5/25/1964			
60	5101	6	3		8/7/1987		BOB MCWILLIAMS	1	16.23	3	5/25/1964		17 54	
61	5101	6	4		8/7/1987		BOB MCWILLIAMS	1		7	5/25/1964			
62	3711	6	1		2/20/1985		WHITE RIVER MWD	2	5600	1	1/20/1970	Const. by		POST DAM & RESERVOIR
63	3711	6	2		2/20/1985		WHITE RIVER MWD	2	1000	2	1/20/1970	07/24/2012		POST DAM & RESERVOIR
64	3711	6	3		2/20/1985		WHITE RIVER MWD	2	4000	4	1/20/1970	07/24/2012		POST DAM & RESERVOIR
65	3715	6	1		2/20/1985		CHARLES I SMITH	1	166	1	11/16/1927			
66	4155	1	1	4146	9/25/1984	A	BRAZOS RIVER AUTHORITY	2	35000	1	10/5/1981			LAKE ALAN HENRY
67	4155	1	2	4146	9/25/1984	A	BRAZOS RIVER AUTHORITY	2	21000	3	10/5/1981		10000	LAKE ALAN HENRY
68	4155	1	3	4146	9/25/1984	A	BRAZOS RIVER AUTHORITY	2	200	2	10/5/1981			LAKE ALAN HENRY
69	4155	1	4	4146	9/25/1984	A	BRAZOS RIVER AUTHORITY	2		7	10/5/1981			LAKE ALAN HENRY
70	5359	1	1	5359	8/28/1991	A	CITATION 1998 INVESTMENT LTD PARTERSHIP	2	200	4	5/19/1991			
71	3680	6	1		2/20/1985		K W CARSON	1	1	3	7/31/1978		141	
72	3681	6	1		2/20/1985		MARJORIE W HECK	1	1	3	12/19/1977		272	
73	3682	6	1		2/20/1985		RANDY FALKENBERG ET UX	3	28	3	4/1/1970		28	
74	3683	6	1		2/20/1985		HIGH PLAINS PAVERS INC	2	110	3	3/29/1976		188	
75	3684	6	1		2/20/1985		RICKY JOE JAMES	1	80	3	3/15/1976		140	
76	3685	6	1		2/20/1985		FRED KEESEE JR	1	150	3	7/14/1975		478	
77	3685	6	2		2/20/1985		FRED KEESEE JR	1	170	3	5/21/1979			
78	3686	6	1		2/20/1985		BILLY H TODD	1	120	3	11/15/1976		130	

SEE PAGE 3 FOR CONTINUATION OF ROWS 1 THROUGH 78

Row No.	Water Right No	Type	Seq-uence	Permit No	Water Right Issue Date	Amend	Owner Name	Owner Type	Anount AcFt/yr	Use	Priority Date	Expire	Acreage	Reservoir Name
79	3687	6	1		2/20/1985		JUDITH E BRUECHERT TRUST UTD FEB 11 1992	5	75	3	11/15/1976		209	
80	3688	6	1		2/20/1985		JOEL B MITCHELL	1	87	3	1/31/1963		160	
81	3689	6	1		2/20/1985		GLENITH B AMONETT	1	48	3	3/10/1969		65	
82	3704	6	1		2/20/1985		ANNA M JOHNSTON ET AL	4	50	3	6/30/1962		200	
83	4111	1	1	3813	6/23/1981		FRANKLIN G GABRIEL ET AL	4	8	3	3/24/1981		160	
84	4215	1	1	3915	11/3/1982		TEXAS DEPT OF CRIMINAL JUSTICE	2	60	3	5/10/1982		158	
85	4369	1	1	4035	10/7/1983		MAURICE HASTEY	1	200	3	5/31/1983		165	
86	5405	1	1	5405	6/16/1992		HORNE & OWEN	1	4	3	3/5/1992		32	
87	3705	6	1		2/20/1985		CITY OF LUBBOCK	2		7	4/6/1972			
88	3705	6	2		2/20/1985	A	CITY OF LUBBOCK	2	657.46	3	6/10/1996		154.58	RESERVOIR 1
89	3705	6	3		2/20/1985	A	CITY OF LUBBOCK	2	243.78	3	6/10/1996		91.42	RESERVOIR 2
90	3705	6	4		2/20/1985	A	CITY OF LUBBOCK	2	261.68	3	6/10/1996		98.13	RESERVOIR 6
91	3706	6	1		2/20/1985		LUBBOCK CO WCID 1	2		7	4/8/1957			
92	3707	6	1		2/20/1985		RANSOM CANYON	1	150	1	4/6/1972			LAKE RANSOM CANYON
93	3707	6	2		2/20/1985		RANSOM CANYON	1		7	8/25/1980			
94	3707	6	3		2/20/1985		RANSOM CANYON	1	4	3	8/25/1980			LAKE RANSOM CANYON
95	4340	1	1	3985	6/7/1983		CITY OF LUBBOCK	2	4480	2	3/7/1983			
96	4340	1	2	3985	6/7/1983		CITY OF LUBBOCK	2	18430	3	3/7/1983		10000	
97	3713	6	1		2/20/1985		GERALD HUFFAKER	1	140	3	6/30/1967		140	
98	4391	1	1	4127	7/30/1984		ROARING SPRINGS RANCH CLUB INC	2		7	8/22/1983			
99	5102	6	1		8/7/1987		NANCY HORNER ALLEN ET AL	4	50	1	3/11/1957			HORNER LAKE
100	5102	6	2		8/7/1987		NANCY HORNER ALLEN ET AL	4		7	3/11/1957			HORNER LAKE
101	5102	6	3		8/7/1987		NANCY HORNER ALLEN ET AL	4	33	3	3/11/1957		66	
102	5266	6	1		8/7/1987		J N FLETCHER & WIFE	3		7	4/19/1971			
103	3664	6	1		2/20/1985		TRUMAN & MARY ELLEN MCKILLIP	1	3	3	9/27/1976		33	
104	3665	6	1		2/20/1985		TRUMAN MCKILLIP	1	50	3	7/31/1978		98	
105	3666	6	1		2/20/1985		ARVEL & ETHEL MAE FLEMING	1	14	3	5/30/1966		30	
106	3667	6	1		2/20/1985		HELEN ARLINE ESTLACK ET VIR	6	125	3	4/17/1968		150	
107	3668	6	1		2/20/1985		ARLINE L HARTZOG JR ET UX	3	75	3	2/5/1968		204	
108	3669	6	1		2/20/1985		KUNTZ CATTLE COMPANY	2		8	6/6/1977			
109	3670	6	1		2/20/1985	A	RANDY K ROBERTS	1	120	3	11/17/1969		240	
110	3671	6	1		2/20/1985		J.W. GAMMON	1	338	3	3/10/1975		1300	
111	3672	6	1		2/20/1985		A. WAYNE CLARK	1	988	3	3/10/1975		600	
112	3673	6	1		2/20/1985		COX T-5 LTD	2	1248	3	3/10/1975		600	
113	3674	6	1		2/20/1985		JIM ROY DANIEL	1	26	3	3/10/1975		320	
114	5186	6	1		9/25/1987		HARLAND H FRYE ET AL	4	200	3	1/8/1962		1765	
115	2855	1	1	2616	10/27/1970		LELAND PAUL ROSSEAU ET UX	5	197	3	7/20/1970		207	
116	5197	6	1		9/25/1987	A	WILLIAM MASON BIVENS	1	42.72	3	2/18/1963		68.23	
117	5197	6	3		9/25/1987	A	ROYAL PLASTICS INC	2	106.28	3	2/18/1963		169.77	
118	5198	6	1		9/25/1987		WYLIE A BYRD	1	57	3	12/1/1969		114	
119	5200	6	1		9/25/1987		R L BRIGGS ET AL	4	12	3	12/1/1969		36	
120	5202	6	1		9/25/1987		PAUL ROUSSEAU ET AL	4	61	3	12/1/1969		122	
121	5203	6	1		9/25/1987		O B BARNES	1	26	3	12/1/1969		52	
122	5204	6	1		9/25/1987		RAY ANDREW BIVENS ESTATE	5	34	3	7/20/1970		100	
123	5205	6	1		9/25/1987		CITY OF TULIA	2		7	8/22/1938			
124	5206	6	1		9/25/1987		R B DAWSON JR ET AL	4	24	3	12/1/1969		48	
125	5207	6	1		9/25/1987		J E SIMPSON JR	1	8	3	12/1/1969		23	
126	5208	6	1		9/25/1987		LARRY NELSON FARMS INC	2	55	3	6/16/1970		241	
127	5209	6	1		9/25/1987		TULIA FEEDLOT INC	2	284	3	3/4/1968		400	
128	5210	6	1		9/25/1987		J E SIMPSON JR	1	60	3	12/1/1969		90	
129	3447	1	1	3150	7/18/1975		CITY OF BROWNFIELD	2	2000	3	5/5/1975		378	

SEE PAGE 4 FOR CONTINUATION OF ROWS 79 THROUGH 129

On Page 3, rows 1 through 78 are continued. On page 4 rows 79 through 129 are continued.

For example, one can see all of the information for Water Right Number 3703, the first right listed, by reading across row 1 on Page 1, and Row 1 on Page 3.

Lidewise, one can see all of the informnation for Water Right Number 3477, the final right listed, by reading row 129 on Page 2, and row 129 0n Page 4.

Row No.	Water Right No	Type	Reservoir Capacity (Ac-Ft)	Basin	River Order	Plan Region Code	SWRA	Unamed Trib of (Y/N)	Stream Name	County	Remarks
1	3703	6		12	9900000000	O			BLACKWATER DRAW	Bailey	
2	3703	6		12	9900000000	O			BLACKWATER DRAW	Bailey	
3	5099	6	718	2	5170000000	O			LTL COTTONWOOD	Briscoe	
4	5100	6		2	5157000000	O		Y	LOS LINGOS CRK	Briscoe	
5	5100	6	179	2	5157000000	O		Y	LOS LINGOS CRK	Briscoe	
6	5100	6		2	5157000000	O		Y	LOS LINGOS CRK	Briscoe	RECREATIONAL USE OF RESERVOIR
7	5103	6	235	2	5134000000	O			KENT CRK	Briscoe	SCS SITE NO 1
8	5104	6		2	5132000000	O		Y	KENT CRK	Briscoe	
9	5105	6		2	5131750000	O			KENT CRK	Briscoe	
10	5105	6		2	5131750000	O			KENT CRK	Briscoe	
11	5106	6		2	5131500000	O		Y	KENT CRK	Briscoe	
12	5211	6	46,450	2	8375000000	O			TULE CRK	Briscoe	
13	5211	6		2	8375000000	O			TULE CRK	Briscoe	
14	5211	6		2	8375000000	O			TULE CRK	Briscoe	
15	5212	6		2	8370000000	O		Y	ROCK CRK	Briscoe	EXEMPT LAKE
16	5219	6		2	8222000000	O			HOLMES	Briscoe	EXEMPT LAKE
17	5220	6	1,184	2	8220000000	O			HOLMES	Briscoe	
18	5220	6		2	8220000000	O			HOLMES	Briscoe	
19	5267	6		2	5165000000	O			LTL COTTONWOOD	Briscoe	
20	5267	6	132	2	5165000000	O			LTL COTTONWOOD	Briscoe	
21	3675	6		12	5886800000	O			RUNNING WATER DRAW	Castro	
22	3676	6		12	5885500000	O			N FRK RUNNING WATER DRAW	Castro	
23	3677	6		12	5885000000	O			N FRK RUNNING WATER DRAW	Castro	
24	3677	6		12	5885000000	O			N FRK RUNNING WATER DRAW	Castro	
25	3678	6		12	5884500000	O			N FRK RUNNING WATER DRAW	Castro	
26	3679	6		12	5884400000	O			N FRK RUNNING WATER DRAW	Castro	
27	3679	6		12	5884400000	O			N FRK RUNNING WATER DRAW	Castro	
28	4383	1	200	12	5886850000	O			RUNNING WATER DRAW	Castro	
29	5187	6	8	2	8976000000	O			FRIO DRAW	Castro	
30	5196	6	19	2	8975000000	O		Y	FRIO DRAW	Castro	
31	5199	6	173	2	8462500000	O			N TULE DRAW	Castro	& CO 219. 2 PRIORITY DATES
32	5199	6		2	8462500000	O			N TULE DRAW	Castro	& CO 219. 2 PRIORITY DATES
33	5199	6	90	2	8462500000	O			N TULE DRAW	Castro	& CO 219 2 PRIORITY DATES
34	3691	6		12	5870000000	O		Y	CRAWFISH DRAW	Crosby	
35	3692	6	14	12	5860000000	O			WHITE RIVER	Crosby	
36	3693	6	44,897	12	5850000000	O			WHITE RIVER	Crosby	
37	3693	6		12	5850000000	O			WHITE RIVER	Crosby	
38	3694	6		12	5904000000	O			YELLOWHOUSE CRK	Crosby	
39	3695	6	1	12	5903500000	O			MCDONALD CRK	Crosby	
40	3708	6		12	9675000000	O			PLUM CRK	Crosby	
41	3709	6	5	12	9671100000	O			N FRK DBL MTN BRAZOS RIVER	Crosby	
42	3709	6	196	12	9671100000	O			N FRK DBL MTN BRAZOS RIVER	Crosby	
43	3710	6	196	12	9670000000	O			N FRK DBL MTN BRAZOS RIVER	Crosby	
44	3417	1	202	14	8626000000	O			SULPHUR SPRING	Dawson	750 FROM CRA, 168 TO CUSTOMERS, 4 RES
45	5179	6		2	8620100000	O			PALO DURO CRK	Deaf Smith	
46	5182	6	15	2	8983000000	O			TIERRA BLANCA	Deaf Smith	RATE COMBINED WITH ADJ 5183 & 5184
47	5184	6	40	2	8981000000	O			TIERRA BLANCA	Deaf Smith	JOINTLY OWNS 54 AF TO IRR 73 ACRES
48	5184	6		2	8981000000	O			TIERRA BLANCA	Deaf Smith	JOINTLY OWNS 54 AF TO IRR 73 ACRES
49	5185	6	7	2	8979500000	O			TIERRA BLANCA	Deaf Smith	
50	3696	6	634	12	5847000000	O			DUCK CRK	Dickens	
51	3697	6	338	12	5846500000	O			ROCK HOUSE	Dickens	
52	3698	6	2,249	12	5846000000	O			COTTONWOOD CRK	Dickens	
53	3699	6	437	12	5843000000	O			DOCKUM CRK	Dickens	
54	3699	6		12	5843000000	O			DOCKUM CRK	Dickens	
55	3700	6		12	5842700000	O			DOCKUM CRK	Dickens	
56	5110	6	104	2	5154000000	O			PATTON SPRING DRAW	Dickens	
57	3690	6		12	5870500000	O			CRAWFISH DRAW	Floyd	
58	5101	6		2	5155000000	O			ROBERTS CRK	Floyd	
59	5101	6		2	5155000000	O			ROBERTS CRK	Floyd	
60	5101	6		2	5155000000	O			ROBERTS CRK	Floyd	
61	5101	6		2	5155000000	O			ROBERTS CRK	Floyd	
62	3711	6	57,420	12	9661000000	O			N FRK DBL MTN BRAZOS RIVER	Garza	8/4/2005: CONSTR EXTENDED TO 7/24/2012
63	3711	6		12	9661000000	O			N FRK DBL MTN BRAZOS RIVER	Garza	8/4/2005: CONSTR EXTENDED TO 7/24/2012
64	3711	6		12	9661000000	O			N FRK DBL MTN BRAZOS RIVER	Garza	8/4/2005: CONSTR EXTENDED TO 7/24/2012
65	3715	6	526	12	9587000000	O			COON CRK	Garza	OWNERSHIP VERIFIED BUT PENDING
66	4155	1	115,937	12	9568000000	O	2		S FRK DBL MTN FRK BRAZOS RIVER	Garza	COS 153,85,132.AMEND 5/2/2005:CHG DIV PT
67	4155	1		12	9568000000	O	2		S FRK DBL MTN FRK BRAZOS RIVER	Garza	JUSTICEBURG.AMEND 5/2/2005:CHG DIV PT
68	4155	1		12	9568000000	O	2		S FRK DBL MTN FRK BRAZOS RIVER	Garza	AMEND 5/2/2005:CHG DIV PT
69	4155	1		12	9568000000	O	2		S FRK DBL MTN FRK BRAZOS RIVER	Garza	AMEND 5/2/2005:CHG DIV PT
70	5359	1		12	9591000000	O			S FRK DBL MTN FRK BRAZOS RIVER	Garza	AMEND 8/93; GOES W/WSC#1871
71	3680	6	3	12	5884280000	O			N FRK RUNNING WATER DRAW	Hale	
72	3681	6	1	12	5884100000	O			RUNNING WATER DRAW	Hale	
73	3682	6		12	5884000000	O			RUNNING WATER DRAW	Hale	
74	3683	6		12	5883500000	O			RUNNING WATER DRAW	Hale	
75	3684	6	3	12	5882970000	O			SLATON DRAW	Hale	
76	3685	6	200	12	5882900000	O			SLATON DRAW	Hale	
77	3685	6	224	12	5882900000	O			SLATON DRAW	Hale	
78	3686	6		12	5882400000	O			RUNNING WATER DRAW	Hale	

Row No.	Water Right No	Type	Reservoir Capacity (Ac-Ft)	Basin	River Order	Plan Region Code	SWRA	Unamed Trib of (Y/N)	Stream Name	County	Remarks
79	3687	6		12	5882200000	O			RUNNING WATER DRAW	Hale	
80	3688	6		12	5882100000	O			RUNNING WATER DRAW	Hale	
81	3689	6		12	5872000000	O			CRAWFISH DRAW	Hale	
82	3704	6	105	12	9780000000	O			BLACKWATER DRAW	Hale	
83	4111	1		12	5884050000	O			RUNNING WATER DRAW	Hale	OUT OF A 660 ACRE TRACT
84	4215	1		12	5882150000	O			RUNNING WATER DRAW	Hale	
85	4369	1		12	5881800000	O			RUNNING WATER DRAW	Hale	
86	5405	1		12	5881700000	O			RUNNING WATER DRAW	Hale	
87	3705	6	536	12	9760000000	O			YELLOW HOUSE DRAW	Lubbock	MULTIPLE (3) PRIORITY DATES
88	3705	6		12	9760000000	O			YELLOW HOUSE DRAW	Lubbock	AMENDED 2/28/97
89	3705	6		12	9760000000	O			YELLOW HOUSE DRAW	Lubbock	AMENDED 2/28/97
90	3705	6		12	9760000000	O			YELLOW HOUSE DRAW	Lubbock	AMENDED 2/28/97
91	3706	6	4,730	12	9715000000	O			N FRK DBL MTN BRAZOS RIVER	Lubbock	
92	3707	6	282	12	9700000000	O		Y	N FRK DBL MTN FRK BRAZOS RIVER	Lubbock	
93	3707	6	278	12	9700000000	O		Y	N FRK DBL MTN FRK BRAZOS RIVER	Lubbock	
94	3707	6	8	12	9700000000	O		Y	N FRK DBL MTN FRK BRAZOS RIVER	Lubbock	
95	4340	1		12	9759000000	O			EFFLUENT	Lubbock	& BA 2, COS 117, 171, 188, 153
96	4340	1		12	9759000000	O			EFFLUENT	Lubbock	
97	3713	6	430	12	9620000000	O			DBL MTN FRK BRAZOS RIVER	Lynn	
98	4391	1	51	2	5154810000	O		Y	TONGUE RIVER (S PEASE)	Motley	
99	5102	6	1,092	2	5150000000	O			CEDAR CRK	Motley	
100	5102	6		2	5150000000	O			CEDAR CRK	Motley	
101	5102	6		2	5150000000	O			CEDAR CRK	Motley	
102	5266	6		2	5154750000	O		Y	S PEASE RIVER	Motley	
103	3664	6		12	5891000000	O			CATFISH DRAW	Parmer	
104	3665	6		12	5890500000	O			CATFISH DRAW	Parmer	
105	3666	6		12	5890000000	O			CATFISH DRAW	Parmer	
106	3667	6		12	5889000000	O			CATFISH DRAW	Parmer	
107	3668	6		12	5888000000	O			CATFISH DRAW	Parmer	
108	3669	6	30	12	5887700000	O		Y	RUNNING WATER DRAW	Parmer	COA DOES NOT SPECIFY PURPOSE OF USE
109	3670	6		12	5887400000	O			RUNNING WATER DRAW	Parmer	AMEND 2/26/90
110	3671	6		12	5887220000	O			RUNNING WATER DRAW	Parmer	IMPOUNDMENT SEE 12-3673
111	3672	6		12	5887210000	O			RUNNING WATER DRAW	Parmer	IMPOUNDMENT SEE 12-3673
112	3673	6	4,427	12	5887190000	O			RUNNING WATER DRAW	Parmer	
113	3674	6		12	5887200000	O			RUNNING WATER DRAW	Parmer	IMPOUNDMENT SEE 12-3673
114	5186	6	492	2	8977000000	O			FRIO DRAW	Parmer	
115	2855	1	197	2	8401500000	O			N TULE DRAW	Swisher	
116	5197	6		2	8396000000	O			MIDDLE TULE DRAW	Swisher	2 EXEMPT LAKES-TULIA EFFLUENT, AMND 3/91
117	5197	6		2	8396000000	O			MIDDLE TULE DRAW	Swisher	2 EXEMPT LAKES-TULIA EFFLUENT, AMND 3/91
118	5198	6		2	8395500000	O			MIDDLE TULE DRAW	Swisher	2 EXEMPT LAKES
119	5200	6		2	8462050000	O			N TULE DRAW	Swisher	EXEMPT LAKE
120	5202	6		2	8460000000	O			N TULE DRAW	Swisher	3 EXEMPT LAKES
121	5203	6		2	8458000000	O			N TULE DRAW	Swisher	EXEMPT LAKE
122	5204	6		2	8401500000	O			N TULE DRAW	Swisher	EXEMPT LAKE
123	5205	6	500	2	8400000000	O			N TULE DRAW	Swisher	
124	5206	6		2	8388000000	O			TULE CRK	Swisher	EXEMPT LAKE
125	5207	6		2	8387000000	O			TULE CRK	Swisher	EXEMPT LAKE
126	5208	6		2	8386000000	O			S TULE DRAW	Swisher	EXEMPT LAKE
127	5209	6	294	2	8385000000	O			S TULE DRAW	Swisher	
128	5210	6		2	8379000000	O			S TULE DRAW	Swisher	EXEMPT LAKE
129	3447	1	39	14	8850000000	O			LOST DRAW	Terry	

Appendix G

Detailed Demand, Supply, and Needs Analysis for Wholesale Water Providers

Appendix G-1
WWP Customers

DBCUSTID	DBWWPID	wwp_name	sponsor_rwpg	RECIPIENT_NAME	RECIPIENT_ALPHA	wug_name	wug_rwpg	wug_basin	wug_county	city_id	wug_detail
194	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	ODONNELL	622000	O'DONNELL	O	BRAZOS	LYNN	0439	NONE
195	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	SLATON	801800	SLATON	O	BRAZOS	LUBBOCK	0563	NONE
196	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	ODONNELL	622000	O'DONNELL	O	BRAZOS	DAWSON	0439	NONE
197	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	LUBBOCK	518000	LUBBOCK	O	BRAZOS	LUBBOCK	0370	NONE
198	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	LEVELLAND	492400	LEVELLAND	O	BRAZOS	HOCKLEY	0354	NONE
199	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	LAMESA	483600	LAMESA	O	COLORADO	DAWSON	0343	NONE
200	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	BROWNFIELD	99200	BROWNFIELD	O	COLORADO	TERRY	0079	NONE
202	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	PLAINVIEW	684600	PLAINVIEW	O	BRAZOS	HALE	0471	NONE
208	10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	TAHOKA	842000	TAHOKA	O	BRAZOS	LYNN	0594	NONE
648	38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	TULIA	877200	TULIA	O	RED	SWISHER	0612	NONE
650	38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	FLOYDADA	290400	FLOYDADA	O	BRAZOS	FLOYD	0205	NONE
651	38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	LOCKNEY	507000	LOCKNEY	O	BRAZOS	FLOYD	0365	NONE
653	38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	SILVERTON	797800	SILVERTON	O	RED	BRISCOE	0561	NONE
1010	66	WHITE RIVER MWD	O	RALLS	717800	RALLS	O	BRAZOS	CROSBY	0491	NONE
1011	66	WHITE RIVER MWD	O	POST	692600	POST	O	BRAZOS	GARZA	0482	NONE
1014	66	WHITE RIVER MWD	O	SPUR	820200	SPUR	O	BRAZOS	DICKENS	0576	NONE
1016	66	WHITE RIVER MWD	O	CROSBYTON	193800	CROSBYTON	O	BRAZOS	CROSBY	0142	NONE
1149	98	LUBBOCK CITY OF	O	CITY OF LUBBOCK		LUBBOCK	O	BRAZOS	LUBBOCK	0370	NONE
1150	98	LUBBOCK CITY OF	O	BUFFALO SPRINGS LAKE WSC		COUNTY-OTHER	O	BRAZOS	LUBBOCK	0757	NONE
1151	98	LUBBOCK CITY OF	O	CITY OF RANSON CANYON		RANSOM CANYON	O	BRAZOS	LUBBOCK	0944	NONE
1152	98	LUBBOCK CITY OF	O	CITY OF SHALLOWATER		SHALLOWATER	O	BRAZOS	LUBBOCK	0553	NONE
1154	98	LUBBOCK CITY OF	O	LUBBOCK-REESE REDEVELOPMENT AUTHORITY		COUNTY-OTHER	O	BRAZOS	LUBBOCK	0757	NONE
1155	66	WHITE RIVER MWD	O	MINING		MINING	O	RED	CROSBY	1003	NONE
1156	66	WHITE RIVER MWD	O	MINING		MINING	O	BRAZOS	CROSBY	1003	NONE
1157	66	WHITE RIVER MWD	O	MINING		MINING	O	BRAZOS	DICKENS	1003	NONE
1158	66	WHITE RIVER MWD	O	MINING		MINING	O	BRAZOS	GARZA	1003	NONE

Appendix G-2
WWP Customer Demand

DBCUSTID	Cust_RWPG	recipient_name	WD2000	WD2010	WD2020	WD2030	WD2040	WD2050	WD2060	WWP_REG_COM	IS_CONTRACT	CONT_EXP
194	O	ODONNELL	148	144	146	142	138	130	121		C	9/9/9999
195	O	SLATON	827	907	889	870	849	837	836		C	9/9/9999
196	O	ODONNELL	20	17	17	17	17	16	16		C	9/9/9999
197	O	LUBBOCK	33771	41123	41123	41123	41123	41123	41123		C	9/9/9999
198	O	LEVELLAND	1867	2310	2362	2369	2322	2216	2107		C	9/9/9999
199	O	LAMESA	1677	2540	2573	2602	2603	2529	2433		C	9/9/9999
200	O	BROWNFIELD	1311	2747	2905	3047	3181	3185	3167		C	9/9/9999
202	O	PLAINVIEW	2735	4288	4490	4605	4635	4577	4488		C	9/9/9999
208	O	TAHOKA	374	492	504	490	478	453	421		C	9/9/9999
648	O	TULIA	417	417	417	417	417	417	417		C	9/9/9999
650	O	FLOYDADA	212	212	212	212	212	212	212		C	9/9/9999
651	O	LOCKNEY	150	150	150	150	150	150	150		C	9/9/9999
653	O	SILVERTON	85	85	85	85	85	85	85		C	9/9/9999
1010	O	RALLS	318	304	315	322	325	323	318		C	9/9/9999
1011	O	POST	967	633	644	618	581	551	514		C	9/9/9999
1014	O	SPUR	245	271	267	263	260	257	257		C	9/9/9999
1016	O	CROSBYTON	389	369	386	394	402	400	394		C	9/9/9999
1149	O	CITY OF LUBBOCK		41765	42580	42652	42033	42349	41915		N	
1150	O	BUFFALO SPRINGS LAKE WSC		807	807	807	807	807	807		C	9/9/9999
1151	O	CITY OF RANSON CANYON		440	569	698	825	953	1004		C	9/9/9999
1152	O	CITY OF SHALLOWATER		344	367	377	371	379	371		C	9/9/9999
1154	O	LUBBOCK-REESE REDEVELOPMENT AUTHORITY		7	7	7	7	7	7		C	9/9/9999
1155	O	MINING		41	20	11	5	0	0		C	9/9/9999
1156	O	MINING		71	34	20	8	0	0		C	9/9/9999
1157	O	MINING		98	47	27	12	0	0		C	9/9/9999
1158	O	MINING		752	361	211	90	0	0		C	9/9/9999
2761	O	LUBBOCK		961	961	961	961	961	961		C	9/9/9999

Appendix G-3
WWP Customer Supply

DBWWPID	wwp_name	sponsor_rwpg	DBCUSTID	recipient_name	DBSOID	so_name	so_rwpg	so_basin	so_county	so_id	IS_IBT	WWP_REG_COM	WPS2010	WPS2020	WPS2030	WPS2040	WPS2050	WPS2060
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	194	ODONNELL	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		173	173	173	173	173	173
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	194	ODONNELL	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		91	91	91	91	61	61
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	195	SLATON	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		739	739	739	739	739	739
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	195	SLATON	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		630	630	630	630	150	150
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	196	ODONNELL	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		38	38	38	38	38	38
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	196	ODONNELL	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		20	20	20	20	20	20
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	197	LUBBOCK	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		22808	22679	22550	22423	22295	22244
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	197	LUBBOCK	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		16018	16017	13632	11248	10065	10065
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	198	LEVELLAND	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		2120	2120	2120	2120	2120	2120
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	198	LEVELLAND	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		1116	1116	1116	1116	688	688
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	199	LAMESA	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		1656	1656	1656	1656	1656	1656
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	199	LAMESA	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		872	872	872	872	672	672
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	200	BROWNFIELD	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		1670	1670	1670	1670	1670	1670
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	200	BROWNFIELD	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		879	879	879	879	879	879
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	202	PLAINVIEW	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		2805	2805	2805	2805	2805	2805
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	202	PLAINVIEW	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		1476	1476	1476	1476	1076	1076
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	208	TAHOKA	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		350	350	350	350	350	350
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	208	TAHOKA	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		184	184	184	184	110	110
98	LUBBOCK CITY OF	O	1149	CITY OF LUBBOCK	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		27712	27712	27712	27712	27712	27712
98	LUBBOCK CITY OF	O	1149	CITY OF LUBBOCK	879	ALAN HENRY LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12510	N		0	0	0	0	0	0
98	LUBBOCK CITY OF	O	1149	CITY OF LUBBOCK	950	OGALLALA AQUIFER	A	CANADIAN	ROBERTS	19721	N		14823	14823	14823	14823	14823	14823
98	LUBBOCK CITY OF	O	1149	CITY OF LUBBOCK	1790	OGALLALA AQUIFER	O	BRAZOS	BAILEY	00921	N		8353	8516	8350	8407	8470	8383
98	LUBBOCK CITY OF	O	1150	BUFFALO SPRINGS LAKE WSC	1804	OGALLALA AQUIFER	O	BRAZOS	LUBBOCK	15221	N		807	807	807	807	807	807
98	LUBBOCK CITY OF	O	1151	CITY OF RANSON CANYON	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		440	569	698	825	953	1004
98	LUBBOCK CITY OF	O	1152	CITY OF SHALLOWATER	23	MEREDITH LAKE/RESERVOIR	A	CANADIAN	RESERVOIR	01030	Y		187	187	187	187	187	187
98	LUBBOCK CITY OF	O	1154	LUBBOCK-REESE REDEVELOPMENT AUTHORITY	1790	OGALLALA AQUIFER	O	BRAZOS	BAILEY	00921	N		7	7	7	7	7	7
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	648	TULIA	861	MACKENZIE LAKE/RESERVOIR	O	RED	RESERVOIR	02020	N		0	0	0	0	0	0
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	650	FLOYDADA	861	MACKENZIE LAKE/RESERVOIR	O	RED	RESERVOIR	02020	Y		0	0	0	0	0	0
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	651	LOCKNEY	861	MACKENZIE LAKE/RESERVOIR	O	RED	RESERVOIR	02020	Y		0	0	0	0	0	0
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	653	SILVERTON	861	MACKENZIE LAKE/RESERVOIR	O	RED	RESERVOIR	02020	N		0	0	0	0	0	0
66	WHITE RIVER MWD	O	1010	RALLS	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		318	318	318	318	0	0
66	WHITE RIVER MWD	O	1011	POST	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		1021	973	493	12	0	0
66	WHITE RIVER MWD	O	1014	SPUR	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		271	267	263	260	106	0
66	WHITE RIVER MWD	O	1016	CROSBYTON	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		389	389	389	389	389	8
66	WHITE RIVER MWD	O	1155	MINING	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	Y		0	0	0	0	0	0
66	WHITE RIVER MWD	O	1156	MINING	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		0	0	0	0	0	0
66	WHITE RIVER MWD	O	1157	MINING	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		0	0	0	0	0	0
66	WHITE RIVER MWD	O	1158	MINING	878	WHITE RIVER LAKE/RESERVOIR	O	BRAZOS	RESERVOIR	12020	N		0	0	0	0	0	0

Appendix G-4
WWP Customer Needs

DBWWPID	wwp_name	sponsor_rwpg	DBCUSTID	RECIPIENT_NAME	RECIPIENT_ALPHA	WUG_Name	County_Name	Basin_Name	R2010	R2020	R2030	R2040	R2050	R2060	wug_detail
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	194	ODONNELL	622000	O'DONNELL	LYNN	BRAZOS	120	118	122	126	104	113	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	195	SLATON	801800	SLATON	LUBBOCK	BRAZOS	462	480	499	520	52	53	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	196	ODONNELL	622000	O'DONNELL	DAWSON	BRAZOS	41	41	41	41	42	42	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	197	LUBBOCK	518000	LUBBOCK	LUBBOCK	BRAZOS	-2297	-2427	-4941	-7452	-8763	-8814	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	198	LEVELLAND	492400	LEVELLAND	HOCKLEY	BRAZOS	926	874	867	914	592	701	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	199	LAMESA	483600	LAMESA	DAWSON	COLORADO	-12	-45	-74	-75	-201	-105	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	200	BROWNFIELD	99200	BROWNFIELD	TERRY	COLORADO	-198	-356	-498	-632	-636	-618	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	202	PLAINVIEW	684600	PLAINVIEW	HALE	BRAZOS	-7	-209	-324	-354	-696	-607	NONE
10	CANADIAN RIVER MUNICIPAL WATER AUTHORITY	A	208	TAHOKA	842000	TAHOKA	LYNN	BRAZOS	42	30	44	56	7	39	NONE
98	LUBBOCK CITY OF	O	1149	CITY OF LUBBOCK		LUBBOCK	LUBBOCK	BRAZOS	9123	8471	8233	8909	8656	9003	NONE
98	LUBBOCK CITY OF	O	1150	BUFFALO SPRINGS LAKE WSC		COUNTY-OTHER	LUBBOCK	BRAZOS	0	0	0	0	0	0	NONE
98	LUBBOCK CITY OF	O	1151	CITY OF RANSON CANYON		RANSOM CANYON	LUBBOCK	BRAZOS	0	0	0	0	0	0	NONE
98	LUBBOCK CITY OF	O	1152	CITY OF SHALLOWATER		SHALLOWATER	LUBBOCK	BRAZOS	-157	-180	-190	-184	-192	-184	NONE
98	LUBBOCK CITY OF	O	1154	LUBBOCK-REESE REDEVELOPMENT AUTHORITY		COUNTY-OTHER	LUBBOCK	BRAZOS	0	0	0	0	0	0	NONE
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	648	TULIA	877200	TULIA	SWISHER	RED	-417	-417	-417	-417	-417	-417	NONE
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	650	FLOYDADA	290400	FLOYDADA	FLOYD	BRAZOS	-212	-212	-212	-212	-212	-212	NONE
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	651	LOCKNEY	507000	LOCKNEY	FLOYD	BRAZOS	-150	-150	-150	-150	-150	-150	NONE
38	MACKENZIE MUNICIPAL WATER AUTHORITY	O	653	SILVERTON	797800	SILVERTON	BRISCOE	RED	-85	-85	-85	-85	-85	-85	NONE
66	WHITE RIVER MWD	O	1010	RALLS	717800	RALLS	CROSBY	BRAZOS	14	3	-4	-7	-323	-318	NONE
66	WHITE RIVER MWD	O	1011	POST	692600	POST	GARZA	BRAZOS	388	329	-125	-569	-551	-514	NONE
66	WHITE RIVER MWD	O	1014	SPUR	820200	SPUR	DICKENS	BRAZOS	0	0	0	0	-151	-257	NONE
66	WHITE RIVER MWD	O	1016	CROSBYTON	193800	CROSBYTON	CROSBY	BRAZOS	20	3	-5	-13	-11	-386	NONE
66	WHITE RIVER MWD	O	1155	MINING		MINING	CROSBY	RED	-41	-20	-11	-5	0	0	NONE
66	WHITE RIVER MWD	O	1156	MINING		MINING	CROSBY	BRAZOS	-71	-34	-20	-8	0	0	NONE
66	WHITE RIVER MWD	O	1157	MINING		MINING	DICKENS	BRAZOS	-98	-47	-27	-12	0	0	NONE
66	WHITE RIVER MWD	O	1158	MINING		MINING	GARZA	BRAZOS	-752	-361	-211	-90	0	0	NONE

Appendix H

IFR Questionnaire

The Honorable ____________________
Address

Dear Mayor ___________:

The Initially Prepared 2006 Llano Estacado Regional Water Plan was released on June 1, 2005 for public review and comment. The Initially Prepared Regional Water Plan, as required by State law, includes specific water management strategies for every Water User Group (e.g., municipality, or water_-supply corporation) with a need for water (projected water shortage) over the next fifty-five years that cannot be met from existing supply systems available at this time. The plan also includes the projected costs for building and operating new supply systems (water management strategies) during the fifty-five-year planning period.

Senate Bill 2 (77^{th} Legislature) added a requirement that regional water planning groups include a chapter describing the financing needed to implement the recommended water management strategies [31 TAC 357.7 (a)(14)]. The description shall include how Water User Groups (Cities and/or other Public Water Suppliers) propose to pay for the water management strategies in the regional water plans. We solicit your help in completing the enclosed survey that the Llano Estacado Regional Water Planning Group is required to conduct in order to obtain information about the financing of water infrastructure projects included in the 2006 Regional Water Plan. On the Survey Form, the recommended water management strategies for your water supply system, together with the estimated capital costs, and date(s) implementation are needed have been listed. A copy of the plans for other Water User Groups of the county in which you are located is enclosed for your information. ***In case yours is not the correct office to respond to this Survey, please forward it to the appropriate office for the response needed by the Llano Estacado Regional Water Planning Group.***

The answers to the surveys now being conducted across the state may result in new forms of State financial assistance. We think this could be an important step in helping achieve future goals for water development, and your ideas about the best role for State financing are critical to the effectiveness of this Infrastructure Financing Survey.

I ask your full cooperation in completing the Infrastructure Financing Survey and returning it to **Mr. Carmon McCain, High Plains Underground Water Conservation District No 1, 2930 Avenue Q, Lubbock, Texas 79411, by September 30, 2005.** Telephone: 806/762-0181; Fax 806/762-1834.

Once we have all the survey forms, we will compile the information in a table format (as specified by the TWDB) and include the results as Section 9 of the 2006 Llano Estacado Regional Water Plan.

Thank you for your assistance.

H. P. "Bo" Brown, Chair
Llano Estacado Regional Water Planning Group

Attachments (2)
Survey Form
Copy of County Water Plan

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) Name of Water User Group

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Total Cost of Capital Improvements			

Are you planning to implement the recommended projects/strategies? Yes____ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed). ____________________

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the Llano Estacado Regional Water Planning Group, as listed above?
Please indicate:
(1) Funding source(s)[1] by checking the corresponding row(s), and
(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Name	Title	Phone No.

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

Appendix I

Detailed IFR Responses

Spreadsheet for Compiling Infrastructure Finance Data from Political Subdivision with Needs

RWPG	Name of Political Subdivision	Recommended Project/Strategy	Implementation Date	Capital Cost to be paid by Political Subdivision)	ID # from DB07	Planning on Implementing the recommended Strategy? (Y/N)	IF 'NO' If 'no' explaination of how they will meet future water needs.	IF 'YES'-----> % Cash Reserves	% Bonds	% Bank Loans	% Government Programs - Federal	% Government Programs - State	% Other	Other' explanation	TOTAL % (should be 100%)	Name of Contact Person	Title	Phone
O	Canadian River MWA	CRMWA Expand Groundwater Supply	2007	$ 59,052,000	O7	Y			100%						100%	Kent Satterwhite	General Manager	(806) 865-3325
O	City of Dimmitt	Local Groundwater Development	2015	$ 3,405,336	O2	Y					100%				100%	David Dennorm	City Manager	(806) 647-2155
O	City of Farwell	Local Groundwater Development	2015	$ 619,608	O2	Y		10%	30%		19%		41%	Texas Community Block Gran	100%		Mayor	(806) 481-3626
O	City of Friona	Local Groundwater Development	2007	$ 1,615,812	O2	Y			85%		15%				100%	Rick Oller	City Engineer	(806) 748-5700
O	City of Idalou	Local Groundwater Development	2035	$ 596,508	O2	Y			25%			75%			100%	Russell Hamilton	City Administator	(806) 842-2531
O	City of Kress	Local Groundwater Development	2007	$ 578,424	O2	Y			85%		15%				100%	Kenny Hughes	City Administator	(806) 684-2525
O	City of Lorenzo	Local Groundwater Development	2025	$ 276,408	O2	Y					50%	50%			100%	Dorothy Bristow	City Administator	(806) 634-5596
O	City of Lubbock	Lake Alan Henry Pipeline	2020	$174,909,000	O4	Y			100%						100%	Ches Carthel		
O	City of Lubbock	City of Lubbock Well Field	2007	$ 7,718,000	O5	Y			100%						100%	Ches Carthel		
O	City of Lubbock	Expand Capacity of Bailey Co. Well Field	2007	$ 2,541,000	O6	Y			100%						100%	Ches Carthel		
O	City of Lubbock	Brackish Groundwater Desalination	2010	$ 6,894,600		Y			100%						100%	Ches Carthel		
O	City of Lubbock	Jim Bertram Lake System Expansion	2020	$150,759,000		Y			100%						100%	Ches Carthel		
O	City of Lubbock	North Fork Scalping Operation	2050	$ 50,055,000		Y			100%						100%	Ches Carthel		
O	City of Morton	Local Groundwater Development	2015	$ 922,944	O2	Y		25%			25%	25%	25%		100%		Mayor	(806) 266-8850
O	City of Olton	Local Groundwater Development	2025	$ 922,944	O2	Y		20%			40%	40%			100%	Marvin Tillman	City Manager	(806) 285-2611
O	City of Petersburg	Local Groundwater Development	2045	$ 265,452	O2	Y		10%			10%	80%			100%	Marie Parr	City Manager	
O	City of Ropesville	Local Groundwater Development	2025	$ 276,408	O2	Y		10%			90%				100%	Sue Coker	City Secretary	(806) 562-3531
O	City of Shallowater	Local Groundwater Development	2007	$ 375,804	O2	N	Contract with City of Lubbock								0%	Fred Sultan	City Engineer	(806) 543-6965
O	City of Sudan	Local Groundwater Development	2015	$ 596,508	O2	N									0%	Mechele Edwards	City Secretary	(806) 227-2122
O	City of Sundown	Local Groundwater Development	2015	$ 753,720	O2	Y			34%		33%	33%			100%	Brad Stafford	City Administator	(806) 229-3131
O	City of Wilson	Local Groundwater Development	2015	$ 276,408	O2	Y		5%			95%				100%	Roy Isham	Water Superintendent	(806) 628-6221
O	City of Wolfforth	Local Groundwater Development	2007	$ 3,957,513	O2	Y		2%	50%			48%			100%	Frankie Pettman	City Administator	(806) 866-4215
O	Lake Alan Henry WSD	Supply from Lake Alan Henry	2007	$ 5,613,000	O3	Y					50%	50%			100%	Odie Hood	Board Chairman	(806) 629-4473
															0%			
															0%			

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **FARWELL**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	O1
Local Groundwater Development	2015	$619,608	O2
Total Cost of Capital Improvements		$619,608	

Are you planning to implement the recommended projects/strategies? Yes ✓ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the Llano Estacado Regional Water Planning Group, as listed above?
Please indicate:
(1) Funding source(s)[1] by checking the corresponding row(s), and
(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	60,000	10%
Bonds (General Obligation and Contract Revenue)	189,608	30%
Bank Loans		
Federal Government Programs FLB	120,000	19%
State Government Programs; i.e.; TWDB Funding Sources		
Other Texas Community Block Grant	250,000	41%
Total (Sum should equal 100 %)		100%

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Name	Title	Phone No.
[signature]	Mayor	806-481-3620

Please Return by September 30, 2005 to

Herb Grubb
HDR Engineering, Inc
4401 West Gate Blvd # 400
Austin, Texas 78745

REC'D OCT 28 2005

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) **PETERSBURG**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	01
Local Groundwater Development	2045	$265,452	02
Total Cost of Capital Improvements		$265,452	

Are you planning to implement the recommended projects/strategies? Yes XX No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	X	10
Bonds (General Obligation and Contract Revenue)	——	-0-
Bank Loans	——	-0-
Federal Government Programs	X	10
State Government Programs; i.e.; TWDB Funding Sources	X	80
Other		
Total (Sum should equal 100 %)		100

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

Office Rural Community Affairs

Person Completing this form:

Name	Title	Phone No.
Marie Parr	City Manager	10/20/2005

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

RECEIVED 10/24/05
SENT TO HDR 10/26/05

REC'D OCT 26 2005

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) **IDALOU**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2035	$596,508	02
Total Cost of Capital Improvements		$596,508	

Are you planning to implement the recommended projects/strategies? Yes____ No____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed). Not sure but more than likely will follow plan

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)	✓	25%
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources	✓	75%
Other		
Total (Sum should equal 100 %)		100%

[1] Funding source refers to the initial capital funds needed to contract or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

State Revolving Fund - Could be 100% / Could use General Obligation Bonds if lower interest rate.

Person Completing this form:

Russell Hamilton	City Administrator	892-2531
Name	Title	Phone No.

Please Return by September 30, 2005 to

Mr. Carmon McCain

High Plains UWCD No. 1

2930 Avenue Q

Lubbock, Texas 79411

SENT TO HERB 10/24/05

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) ROPESVILLE

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2025	$276,408	02
Total Cost of Capital Improvements		$276,408	

Are you planning to implement the recommended projects/strategies? Yes √ No ___

If "no," please describe how you will meet your future water needs? (Use additional pages if needed). Government grant with match

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the Llano Estacado Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	12500.00	10
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs	97369.92	
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)	276408	

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form: [signature] City Secretary 806 562 3531

Name | Title | Phone No.

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **CRMWA**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
CRMWA Expand Groundwater Supply	2007	$59,052,000	O7
Total Cost of Capital Improvements		$59,052,000	

Are you planning to implement the recommended projects/strategies? Yes X No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to ~~finance the proposed total cost~~ of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		100
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		100

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Kent Satterwhite	GM	865-3325
Name	Title	Phone No.

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No 1
2930 Avenue Q
Lubbock, Texas 79411

◇◇◇◇

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **DIMMITT**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	01
Local Groundwater Development	2015	$3,405,336	02
Total Cost of Capital Improvements		$3,405,336	

Are you planning to implement the recommended projects/strategies? **Yes____** **No ____**

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs	✓	100
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

David Denman — **Name**

City Manager — **Title**

806) 647-2155 — **Phone No.**

Please Return by September 30, 2005 to

Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) FRIONA

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	01
Local Groundwater Development	2007	$1,615,812	02
Completion of System Loop + New Well	2005	1,200,000	02
Total Cost of Capital Improvements		$1,615,812	

Are you planning to implement the recommended projects/strategies? Yes ✓ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)	PRIVATE MKT.	85
Bank Loans		
Federal Government Programs	ORCA GRANT	15
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		100

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

TWDB shall be consulted for possible funding for water supply development.

Person Completing this form:

Name	Title	Phone No.
Rich Oller, P.E.	City Engineer	806-748-5700

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) KRESS

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2007	$578,424	O2
Total Cost of Capital Improvements		$578,424	

Are you planning to implement the recommended projects/strategies? Yes____ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

The City of KRESS is currently working on two water well projects. If completed this will add two wells for a total of 5 wells. Additional wells on one well site may be possible.

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Kenny Hughes	City Administrator	806 684-2525
Name	Title	Phone No.

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Mr. Carmon McCain
High Plains UWCD No. 1
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Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) **LORENZO**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2025	$276,408	O2
Total Cost of Capital Improvements		$276,408	

Are you planning to implement the recommended projects/strategies? Yes ✓ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs	TCDP	100
State Government Programs; i.e.; TWDB Funding Sources	TWDB	100
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Dorothy Bristow — Name
City Admin — Title
806-634-5596 — Phone No.

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No 1
2930 Avenue Q
Lubbock, Texas 79411

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INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **MORTON**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	O1
Local Groundwater Development	2015	$922,944	O2
Total Cost of Capital Improvements		$922,944	

Are you planning to implement the recommended projects/strategies? Yes X No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	X	25%
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs	X	25%
State Government Programs; i.e.; TWDB Funding Sources	X	25%
Other	X	25%
Total (Sum should equal 100 %)		100%

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

[signature]	Mayor	806-266-8850
Name	Title	Phone No.

Please Return by September 30, 2005 to
Mr Carmon McCain
High Plains UWCD No 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **OLTON**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	O1
Local Groundwater Development	2025	$922,944	O2
Total Cost of Capital Improvements		$922,944	

Are you planning to implement the recommended projects/strategies? Yes ✓ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	Reserves	20%
Bonds (General Obligation and Contract Revenue)		-0-
Bank Loans		-0-
Federal Government Programs		40%
State Government Programs; i.e.; TWDB Funding Sources		40%
Other		-0-
Total (Sum should equal 100 %)		100%

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

TCDP Fund's Require A 10% Minimum Match.

Person Completing this form:

[signature] — **Name**

City Mgr. — **Title**

806-285-2611 — **Phone No.**

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
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Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) SHALLOWATER

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2007	$375,804	O2
Total Cost of Capital Improvements		$375,804	

Are you planning to implement the recommended projects/strategies? Yes____ No X

If "no," please describe how you will meet your future water needs? (Use additional pages if needed). Work out agreement w/ City of Lubbock & their surplus.

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?
Please indicate:
(1) Funding source(s)[1] by checking the corresponding row(s), and
(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Name	Title	Phone No.
FRED SULTAN, P.E.	CITY ENGINEER	806-543-1965

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **SUDAN**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	O1
Local Groundwater Development	2015	$596,508	O2
Total Cost of Capital Improvements		$596,508	

Are you planning to implement the recommended projects/strategies? **Yes____** **No X**

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Mechele Edwards	City Secretary	227-2112
Name	Title	Phone No.

Please Return by September 30, 2005 to

Mr. Carmon McCain
High Plains UWCD No 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **SUNDOWN**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Municipal Water Conservation	2007	$0	O1
Local Groundwater Development	2015	$753,720	O2
Total Cost of Capital Improvements		$753,720	

Are you planning to implement the recommended projects/strategies? Yes ✓ No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)	✓	34%
Bank Loans		
Federal Government Programs	✓	33%
State Government Programs; i.e.; TWDB Funding Sources	✓	33%
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

TCDP Grants, TWDB,

Person Completing this form:

Brad Stafford	City Administrator	(806) 229-3131
Name	Title	Phone No.

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) WILSON

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2015	$276,408	O2
Purchase from City of Lubbock	2007		O8
Total Cost of Capital Improvements		$276,408	

Are you planning to implement the recommended projects/strategies? Yes X No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	$14,162.00	5
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs	$262,246.00	95
State Government Programs; i.e.; TWDB Funding Sources		
Other		
Total (Sum should equal 100 %)	$276,408.00	100

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)
See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Roy Isham	Water Superintendent	(806) 628-6221
Name	**Title**	**Phone No.**

Please Return by September 30, 2005 to
Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

REC'D OCT 11 2005

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) WOLFFORTH

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Local Groundwater Development	2007	$3,957,513	O2
Total Cost of Capital Improvements		$3,957,513	

Are you planning to implement the recommended projects/strategies? Yes x No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	x	2%
Bonds (General Obligation and Contract Revenue)	x	50%
Bank Loans		
Federal Government Programs		
State Government Programs; i.e.; TWDB Funding Sources	x	48%
Other		
Total (Sum should equal 100 %)		100%

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If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

Drinking Water State Revolving Fund Loan Program 50%

Rural Water Assistance Fund Program 50%

Person Completing this form:

Name	Title	Phone No.
Frankie Pettman	City Administrator	806-866-4215

Please Return by September 30, 2005 to

Mr. Carmon McCain

High Plains UWCD No. 1

2930 Avenue Q

Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group **(Region O)**

Political Subdivision (WUG or WWP) **LAKE ALAN HENRY WSD**

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Supply from Lake Alan Henry	2007	$5,613,000	O3
Total Cost of Capital Improvements		$5,613,000	

Are you planning to implement the recommended projects/strategies? Yes ✓* No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

*Subject to getting an agreeable contract with City of Lubbock

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the ~~South Central Texas Texas~~ Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves		
Bonds (General Obligation and Contract Revenue)		
Bank Loans		
Federal Government Programs		50%
State Government Programs; i.e.; TWDB Funding Sources		50%
Other		
Total (Sum should equal 100 %)		

[1] Funding source refers to the initial capital funds needed to construct or implement a project, not the means of paying off loans or bonds used for the construction or implementation.

If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed)

See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Name	Title	Phone No.
[signature]	Chairman LAHWD Board	806-629-4473

Please Return by September 30, 2005 to

Mr. Carmon McCain
High Plains UWCD No. 1
2930 Avenue Q
Lubbock, Texas 79411

INFRASTRUCTURE FINANCING SURVEY

To Obtain Financing Information from Political Subdivisions with Water Needs

Llano Estacado Regional Water Planning Group (Region O)

Political Subdivision (WUG or WWP) LUBBOCK

Recommended Project/Water Management Strategy	Implementation Date	Capital Cost to be Paid by Political Subdivision	ID # from DB07
Lake Alan Henry Pipeline	2045	$174,909,000	O4
City of Lubbock Well Field	2007	$7,718,000	O5
Lubbock Expand Capacity of Bailey County Well Field	2007	$2,541,000	O6
CRMWA Expand Capacity of Groundwater Supply	2007	$0	O7
Lubbock Brackish Groundwater Desalination	2010	$6,894,600	To be added
Lubbock Jim Bertram Lake System (JBS) Expansion	2020	$150,759,000	To be added
Lubbock North Fork Scalping Operation	2020	$50,055,000	To be added
Total Cost of Capital Improvements		$392,876,600	

Are you planning to implement the recommended projects/strategies? Yes X No ____

If "no," please describe how you will meet your future water needs? (Use additional pages if needed).

If 'yes', how do you plan to finance the proposed total cost of capital improvements identified by the Llano Estacado Regional Water Planning Group, as listed above?

Please indicate:

(1) Funding source(s)[1] by checking the corresponding row(s), and

(2) Percent share of the total cost to be met by each funding source.

Potential Funding Sources	Source to be Used	Percent (%)
Cash Reserves	N/A	0
Bonds (General Obligation and Contract Revenue)	GO & Revenue Bond	100
Bank Loans	N/A	0
Federal Government Programs	N/A	0
State Government Programs; i.e.; TWDB Funding Sources	N/A	0
Other		0
Total (Sum should equal 100 %)		100

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If state government programs are to be utilized for funding, indicate the programs and the provisions (shares) of those programs. (Attach additional pages if needed) See TWDB web site www.twdb.state.tx.us/Assistance.)

Person Completing this form:

Name	Title	Phone No.
Chester Carthel, P.E.	Water Planning Eng.	806-775-2280

Please Return to

Herb Grubb

COL IFR.xls

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List of References

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Llano Estacado Region References

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Addendum Number 1
Llano Estacado Regional Water Plan
(Region O)

Pursuant to a request by the City of Lubbock to reexamine population projections, it was discovered that the Texas State Data Center had published a correction to 0.5 migration scenario projections for Lubbock County, based on corrected birth and survival rates, and corrections to special populations. The City of Lubbock thus presented a request to the LERWPG to add these increases to the originally-approved City of Lubbock projections.

The City of Lubbock also presented a request to use the TWDB-published GPCD from the year 1998 (209) as the base for calculating future water demands. It has been confirmed that 1998 had less rainfall than 2000, thus meeting the standard criteria for revision.

The City of Lubbock presented the information cited above to the LERWPG at the LERWPG's December 15, 2005 meeting. The LERWPG concurred with the City, approved the revised projections, and by letter of December 28, 2005, the LERWPG requested that the TWDB approve the revised projections for use in the 2006 Regional Water Plan. The original and revised projections are listed below:

Population Projections (Numbers of People)

	2000	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Original	199,564	210,658	218,471	222,680	223,370	226,395	224,074
Additions	0	6,316	9,525	12,471	16,221	16,436	24,548
Revised	199,564	216,974	227,996	235,151	239,591	242,831	248,622

Water Demand Projections (Acre-Feet)

	2000	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Original	40,460	41,765	42,580	42,652	42,033	42,349	41,915
Additions	0	8,057	9,007	9,764	10,567	10,691	12,390
Revised	40,460	49,822	51,587	52,416	52,600	53,040	54,305

Per Capita Water Use Projections (GPCD)

	2000/Base	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
Original	181	177	174	171	168	167	167
Additions	28	28	28	28	28	28	28
Revised	209	205	202	199	196	195	195

In separate action on December 15, 2005, the LERWPG approved the 2006 Regional Water Plan and directed the High Plains Underground Water Conservation District No. 1, and its Consultant, HDR Engineering, Inc. to prepare and submit the approved 2006 Regional Water Plan, together with an addendum for the City of Lubbock based upon the revised Population and

Water Demand Projections, as listed above. This Addendum to the January 2006 Llano Estacado Regional Water Plan (Region O) presents revisions to Population and Municipal Water Demand Projections for the City of Lubbock and changes to the regional water plan resulting therefrom.

Revised text of page ES-10 and ES-11.

Projections of Population and Water Demands

Population Projections

The TWDB provided population projections for the Llano Estacado Region for use in revising and updating the Regional Water Plan. Population of the Region was reported by the U.S. Census at 453,997 in 2000 and was projected to be 551,758 in 2060. Nearly 80 percent of the population of the region is projected to reside in the Brazos River Basin. The population projections for 53 individual cities, rural areas of each county, and parts of a county in each river basin area of the region were tabulated for use in developing the regional water plan.

Water Demand Projections

In addition to population projections, the TWDB prepared water demand projections for municipal, manufacturing, steam-electric power generation, irrigation, mining, and livestock uses. Municipal water demand includes residential and commercial water uses, and is projected to increase from 87,322 acft/yr in 2000 to 105,939 acft/yr on 2060. With low flow plumbing fixtures water conservation, per capita water use, in gallons per person per day, is projected to decline over the planning period, from 180 gallons per person per day to 160 gallons per person per day.

Total water use in the Llano Estacado Region was 4,530,041 acft in 2000, with projected water demands in 2060 of 3,716,726 acft. The quantity of projected water demands in 2060 are 109 acft/yr for the Canadian River Basin, 817,364 acft/yr for the Red River Basin, 2,189,053 acft/yr for the Brazos River Basin, and 710,260 acft/yr for the Colorado River Basin.

Revised text of page ES-12.

Projected Region O water demands for Canadian River Municipal Water Authority increase from 53,396 acft/yr of use in 2000 to 54,712 acft/yr in 2060. Water use from the City of

Lubbock system was 41,917 acft/yr in 2000, and is projected to increase to 56,516 acft/yr in 2060.

Revised text of page ES-13.

The projected total water demands for the Llano Estacado Region decrease from 4.39 million acft/yr in 2010 to 4.10 million acft/yr in 2030, and 3.72 million acft/yr in 2060. Under drought of record water supply conditions, and with no water management strategies in place, water needs (shortages) are projected to be 1.27 million acft/yr in 2010, increasing to 2.09 million acft/yr in 2030 and to 2.35 million acft/yr by 2060. The water needs assessment identified 35 municipalities and one water supply district, and 20 of the 21 counties with needs (shortages) during the years 2000 through 2060 planning period [Table ES-1 (Revised)].

Revised text on page ES-20

Municipal water is freshwater that meets drinking water standards. Such water is supplied by both public and private utilities. In areas not served by water utilities private wells supply individual households. The objective of the municipal water conservation water management strategy is to reduce per capita water use without adversely affecting the quality of life of the people involved. The municipal water conservation water management strategy is estimated to meet 5,809 acft/yr of municipal water needs in Region O in 2010, 10,583 acft/yr in 2020, 10,729 acft/yr in 2030, and 10,424 acft/yr in 2060 [Figure ES-2 (Revised)]. In terms of projected municipal water demand, the municipal water conservation water management strategy could meet about 9.8 percent of the projected municipal water demand of 105,939 acft/yr in 2060. The proposed municipal water conservation water management strategy has the potential to reduce municipal water demand from 99,435 acft/yr in 2010 to 93,626 acft/yr and in 2060 from 105,939 acft/yr to 95,515 acft/yr [Figure ES-2 (Revised)]. The municipal water conservation water management strategy has the potential to reduce per capita water use in the region from an average of 180 gallons per person per day in 2010 to 155 gallons per person per day in 2060. Municipal water conservation strategies are strongly recommended.

Figure ES-2 (Revised): Municipal Water Demand Without and With Water Conservation

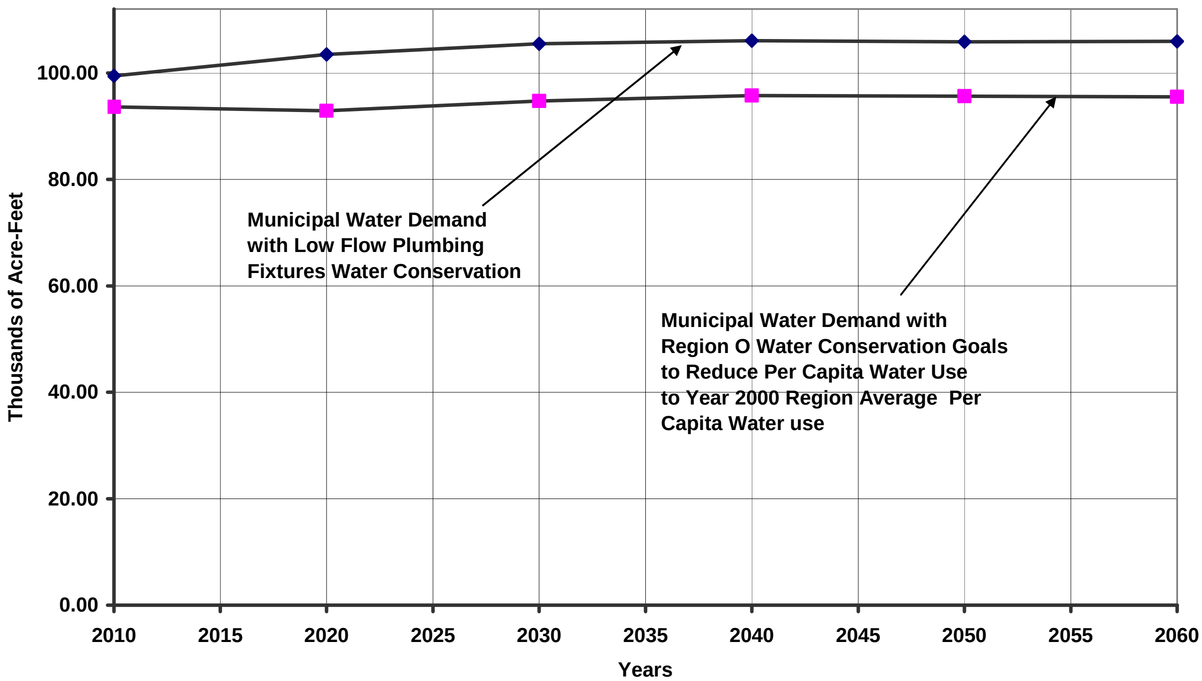

Table ES-1. (Revised)
Water User Groups with Projected Needs (Shortages)
Llano Estacado Region

City (County)	Year Shortage Develops	Shortage in 2060 (acft/yr)
Municipal Shortages		
Briscoe County Other (Quitaque)	2010	86
Silverton (Briscoe)	2010	108
Dimmitt (Castro)	2030	1,130
Hart (Castro)	2050	256
Morton (Cochran)	2020	496
Crosbyton Crosby)	2060	336
Lorenzo (Crosby)	2030	108
Ralls (Crosby)	2030	318
Spur (Dickens)	2050	257
Lockney (Floyd)	2030	212
Seagraves (Gaines)	2010	499
Post (Garza)	2040	206
Lake Alan Henry WSD (Garza)	2010	22
Abernathy (Hale & Lubbock)	2020	700
Hale Center (Hale)	2030	498
Petersburg (Hale)	2050	306
Anton (Hockley)	2010	243
Ropesville (Hockley)	2030	81
Smyer (Hockley)	2060	62
Sundown (Hockley)	2020	316
Amherst (Lamb)	2020	181
Earth (Lamb)	2040	276
Sudan (Lamb)	2020	243
Idalou (Lubbock)	2040	272
Lubbock (Lubbock)	2010	13,613
New Deal (Lubbock)	2020	20
Shallowater (Lubbock)	2010	184
Wolfforth (Lubbock)	2010	1,787
Wilson (Lynn)	2020	55
Farwell (Parmer)	2020	371
Friona (Parmer)	2030	791
Kress (Swisher)	2010	96

County	Year Shortage Develops	Shortage in 2060 (acft/yr)
Municipal Shortages	**Continued**	
Tulia (Swisher)	2010	417
Brownfield (Terry)	2020	457
Denver City (Yoakum)	2030	1,141
Plains (Yoakum)	2020	457
Total Municipal Shortages		**26,601**
Irrigation Shortages		
Bailey	2005	93,597
Briscoe	2005	14,581
Castro	2005	351,768
Cochran	2005	72,644
Crosby	2005	7,960
Dawson	2005	73,240
Deaf Smith	2005	240,650
Dickens	2005	2,737
Floyd	2005	100,072
Gaines	2005	140,268
Garza	2005	3,212
Hale	2005	223,093
Hockley	2005	80,584
Lamb	2005	253,586
Lubbock	2005	96,308
Lynn		0
Motley	2005	1,025
Parmer	2005	350,632
Swisher	2005	107,552
Terry	2005	90,149
Yoakum	2005	18,485
Total Irrigation Shortages		**2,322,143**

Revised text of page 2-1.

2.1 Population Projections

The 2000 Census of Population and Housing by the U.S. Bureau of the Census indicates that Texas is the state with the second highest number of people among the states in the nation, with a population of 20.85 million. The population of the Llano Estacado Region was reported at 453,997 in 2000 and is projected to be 551,758 in 2060 [Figure 2-1 (Revised) and Table 2-2 (Revised)], with nearly 80 percent of the population of the region projected to reside in the Brazos River Basin. The population projections for 53 individual cities and 35 rural areas of each county and part of county of each river basin area of the region are shown in Table 2-3 (Revised).

Figure 2-1 (Revised): Summary of Llano Estacado Region's Projected Population

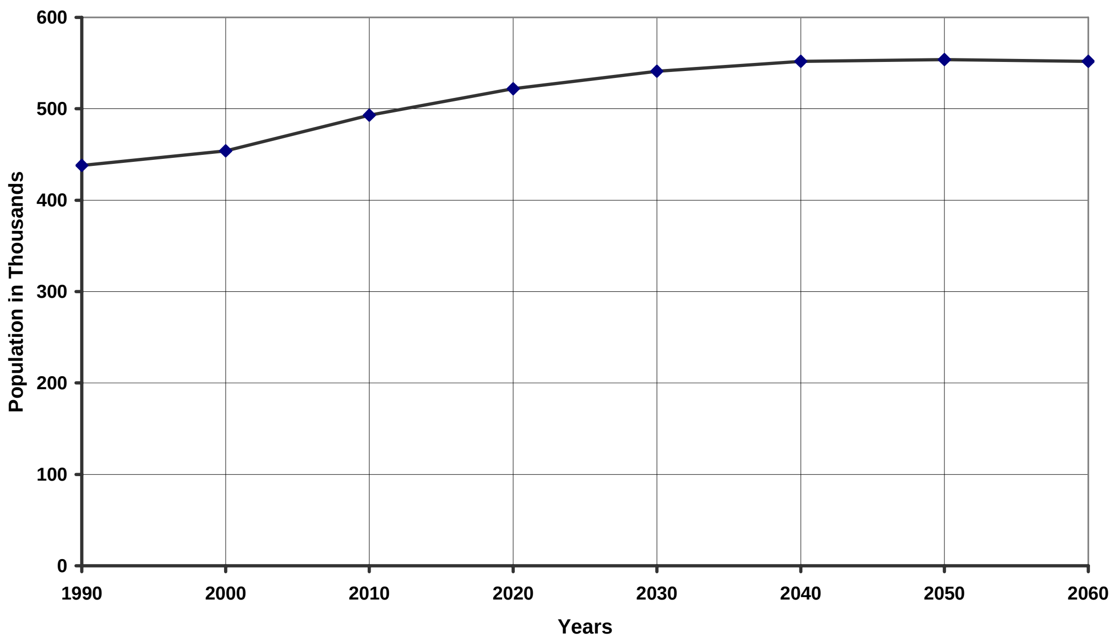

Table 2-2. (Revised)
Population Projections[1]
Llano Estacado Region
Individual Counties with River Basin Summaries

County Number	County	Total in 1990	Total in 2000	Projections					
				2010	2020	2030	2040	2050	2060
Counties									
1	Bailey	7,064	6,594	7,060	7,558	7,875	8,207	8,238	8,086
2	Briscoe	1,971	1,790	1,862	1,899	1,865	1,779	1,747	1,700
3	Castro	9,070	8,285	9,070	9,762	10,224	10,587	10,567	10,381
4	Cochran	4,377	3,730	4,086	4,338	4,449	4,375	4,193	3,989
5	Crosby	7,304	7,072	7,678	8,174	8,514	8,856	8,873	8,731
6	Dawson	14,349	14,985	15,523	16,010	16,421	16,665	16,268	15,652
7	Deaf Smith	19,153	18,561	20,533	22,685	24,568	26,152	26,716	26,911
8	Dickens	2,571	2,762	2,712	2,661	2,547	2,375	2,304	2,221
9	Floyd	8,497	7,771	8,173	8,580	8,723	8,793	8,491	8,053
10	Gaines	14,123	14,467	16,130	17,663	18,774	19,560	19,434	19,169
11	Garza	5,143	4,872	5,072	5,265	5,158	4,961	4,733	4,416
12	Hale	34,671	36,602	39,456	42,103	44,034	45,204	44,940	44,069
13	Hockley	24,199	22,716	24,432	25,495	26,114	26,141	25,129	23,896
14	Lamb	15,072	14,709	15,515	16,500	17,355	17,995	17,900	17,668
15	Lubbock	222,636	242,628	265,547	280,449	289,694	294,476	299,218	303,857
16	Lynn	6,758	6,550	6,969	7,280	7,243	7,216	6,891	6,413
17	Motley	1,532	1,426	1,409	1,359	1,262	1,143	1,060	1,008
18	Parmer	9,863	10,016	10,641	11,302	11,585	11,666	11,301	10,674
19	Swisher	8,133	8,378	8,772	9,103	9,329	9,423	9,250	8,849
20	Terry	13,218	12,761	13,804	14,778	15,704	16,608	16,700	16,607
21	Yoakum	8,786	7,322	8,183	8,966	9,470	10,006	9,738	9,408
	Total	438,490	453,997	492,627	521,930	540,908	552,188	553,691	551,758
River Basin Summary[2]									
	Canadian	27	3	4	5	6	7	7	7
	Red	37,848	36,821	39,679	42,590	44,763	46,309	46,383	45,720
	Brazos	346,335	365,628	397,123	419,631	433,432	440,715	442,945	443,096
	Colorado	54,280	51,545	55,821	59,704	62,707	65,157	64,356	62,935
	Total	438,490	453,997	492,627	521,930	540,908	552,188	553,691	551,758

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basins tabulations of counties, cities, and rural areas.

Source: TWDB, Consensus Projections adopted by the TWDB, September 17, 2003.

Table 2-3. (Revised)
Population Projections
Llano Estacado Region
River Basins, Counties, and Cities[1]

Basin-County-City	Census 1990	Census 2000	Projections 2010	2020	2030	2040	2050	2060
Canadian Basin (part)								
Deaf Smith (part)								
Rural	27	3	4	5	6	7	7	7
Total	27	3	4	5	6	7	7	7
Canadian Basin Total	**27**	**3**	**4**	**5**	**6**	**7**	**7**	**7**
Red Basin (part)								
Briscoe (all)								
Silverton	779	771	802	818	803	766	752	732
Rural	1,192	1,019	1,060	1,081	1,062	1,013	995	968
Total	1,971	1,790	1,862	1,899	1,865	1,779	1,747	1,700
Castro (part)								
Rural	1,509	1,472	1,611	1,734	1,817	1,880	1,877	1,844
Total	1,509	1,472	1,611	1,734	1,817	1,880	1,877	1,844
Crosby (part)								
Rural	44	6	6	7	7	7	8	7
Total	44	6	6	7	7	7	8	7
Deaf Smith (part)								
Hereford	14,745	14,597	15,090	15,628	16,099	16,495	16,636	16,685
Rural	4,381	3,961	5,439	7,052	8,463	9,650	10,073	10,219
Total	19,126	18,558	20,529	22,680	24,562	26,145	26,709	26,904
Dickens (part)								
Rural	295	272	264	256	237	209	197	184
Total	295	272	264	256	237	209	197	184
Floyd (part)								
Rural	898	748	787	826	840	847	817	775
Total	898	748	787	826	840	847	817	775
Hale (part)								
Rural	46	0	0	0	0	0	0	0
Total	46	0	0	0	0	0	0	0
Motley (all)								
Matador	790	740	732	708	662	606	567	542
Rural	742	686	677	651	600	537	493	466
Total	1,532	1,426	1,409	1,359	1,262	1,143	1,060	1,008

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Table 2-3 (Revised) Continued

Basin-County-City	Census 1990	Census 2000	Projections 2010	2020	2030	2040	2050	2060
Parmer (part)								
Friona	3,688	3,854	4,094	4,349	4,458	4,489	4,348	4,107
Rural	1,012	790	840	891	913	919	892	842
Total	4,700	4,644	4,934	5,240	5,371	5,408	5,240	4,949
Swisher (part)								
Happy		612	641	665	681	688	676	646
Kress	739	652	683	708	726	733	720	689
Tulia	4,699	5,117	5,358	5,560	5,698	5,755	5,650	5,405
Rural	2,289	1,524	1,595	1,656	1,697	1,715	1,682	1,609
Total	7,727	7,905	8,277	8,589	8,802	8,891	8,728	8,349
Red Basin Total	**37,848**	**36,821**	**39,679**	**42,590**	**44,763**	**46,309**	**46,383**	**45,720**
Brazos Basin (part)								
Bailey (all)								
Muleshoe	4,571	4,530	4,850	5,192	5,410	5,638	5,659	5,555
Rural	2,493	2,064	2,210	2,366	2,465	2,569	2,579	2,531
Total	7,064	6,594	7,060	7,558	7,875	8,207	8,238	8,086
Castro (part)								
Dimmitt	4,408	4,375	4,790	5,155	5,399	5,591	5,580	5,482
Hart	1,221	1,198	1,312	1,412	1,478	1,531	1,528	1,501
Rural	1,932	1,240	1,357	1,461	1,530	1,585	1,582	1,554
Total	7,561	6,813	7,459	8,028	8,407	8,707	8,690	8,537
Cochran (part)								
Morton	2,597	2,249	2,464	2,616	2,683	2,638	2,528	2,405
Rural	1001	963	1,055	1,120	1,148	1,129	1,083	1,030
Total	3,598	3,212	3,519	3,736	3,831	3,767	3,611	3,435
Crosby (part)								
Crosbyton	2,026	1,874	2,035	2,166	2,256	2,347	2,351	2,314
Lorenzo	1,208	1,372	1,490	1,586	1,652	1,718	1,721	1,694
Ralls	2,172	2,252	2,445	2,603	2,711	2,820	2,826	2,780
Rural	1,854	1,568	1,702	1,812	1,888	1,964	1,967	1,936
Total	7,260	7,066	7,672	8,167	8,507	8,849	8,865	8,724
Dawson (part)								
O'Donnell		111	115	119	122	123	121	116
Rural	116	145	150	154	158	161	157	151
Total	116	256	265	273	280	284	278	267

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Table 2-3 (Revised) Continued

Basin-County-City	Census		Projections					
	1990	2000	2010	2020	2030	2040	2050	2060
Dickens (part)								
Spur	1,300	1,088	1,088	1,088	1,088	1,088	1,088	1,088
Rural	976	1,402	1,360	1,317	1,222	1,078	1,019	949
Total	2,276	2,490	2,448	2,405	2,310	2,166	2,107	2,037
Floyd (part)								
Floydada	3,896	3,676	3,866	4,059	4,126	4,159	4,017	3,809
Lockney	2,207	2,056	2,162	2,270	2,308	2,326	2,246	2,131
Rural	1,496	1,291	1,358	1,425	1,449	1,461	1,411	1,338
Total	7,599	7,023	7,386	7,754	7,883	7,946	7,674	7,278
Garza (part)								
Post	3,768	3,708	3,860	4,007	3,926	3,776	3,602	3,361
Rural	1,370	1,164	1,212	1,258	1,232	1,185	1,131	1,055
Total	5,138	4,872	5,072	5,265	5,158	4,961	4,733	4,416
Hale (part)								
Abernathy (part)	2,132	2,131	2,297	2,451	2,564	2,632	2,616	2,566
Hale Center	2,067	2,263	2,439	2,603	2,722	2,795	2,779	2,725
Petersburg	1,292	1,262	1,360	1,452	1,518	1,559	1,549	1,519
Plainview	21,700	22,336	24,078	25,693	26,871	27,585	27,424	26,893
Rural	7,434	8,610	9,282	9,904	10,359	10,633	10,572	10,366
Total	34,625	36,602	39,456	42,103	44,034	45,204	44,940	44,069
Hockley (part)								
Anton	1,212	1,200	1,291	1,347	1,380	1,381	1,327	1,262
Levelland	13,986	12,866	13,838	14,440	14,791	14,806	14,233	13,534
Ropesville		517	556	580	594	595	572	544
Smyer		480	516	539	552	553	532	506
Rural	6,806	5,860	6,302	6,577	6,736	6,743	6,481	6,164
Total	22,004	20,923	22,503	23,483	24,053	24,078	23,145	22,010
Lamb (all)								
Amherst	742	791	834	887	933	968	963	950
Earth	1,228	1,109	1,170	1,244	1,308	1,357	1,350	1,332
Littlefield	6,489	6,507	6,864	7,299	7,678	7,961	7,919	7,816
Olton	2,116	2,288	2,413	2,567	2,700	2,799	2,784	2,748
Sudan	983	1,039	1,096	1,166	1,226	1,271	1,264	1,248
Rural	3,514	2,975	3,138	3,337	3,510	3,639	3,620	3,574
Total	15,072	14,709	15,515	16,500	17,355	17,995	17,900	17,668

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Table 2-3 (Revised) Continued

Basin-County-City	**Census**		**Projections**					
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Lubbock (all)								
Abernathy (part)	588	708	808	878	916	922	949	928
Idalou	2,074	2,157	2,226	2,275	2,301	2,305	2,324	2,310
Lubbock	186,206	199,564	216,974	227,996	235,151	239,591	242,831	248,622
New Deal	521	708	863	972	1,031	1,041	1,083	1,051
Ransom Canyon	763	1,011	1,461	1,911	2,361	2,811	3,261	3,433
Shallowater	1,708	2,086	2,400	2,621	2,740	2,760	2,846	2,780
Slaton	6,078	6,109	6,135	6,153	6,163	6,165	6,172	6,167
Wolfforth	1,941	2,554	9,360	11,457	12,047	12,645	13,270	13,566
Rural	22,757	27,731	25,320	26,186	26,984	26,236	26,482	25,000
Total	222,636	242,628	265,547	280,449	289,694	294,476	299,218	303,857
Lynn (part)								
O'Donnell		900	958	1,000	995	992	947	881
Tahoka	2,868	2,910	3,096	3,234	3,218	3,206	3,061	2,849
Wilson	568	532	566	591	588	586	560	521
Rural	2,213	2,160	2,298	2,402	2,389	2,379	2,273	2,115
Total	5,649	6,502	6,918	7,227	7,190	7,163	6,841	6,366
Parmer (part)								
Bovina	1,549	1,874	1,991	2,115	2,168	2,183	2,114	1,997
Farwell	1,373	1,364	1,449	1,539	1,578	1,589	1,539	1,454
Rural	2,241	2,134	2,267	2,408	2,468	2,486	2,408	2,274
Total	5,163	5,372	5,707	6,062	6,214	6,258	6,061	5,725
Swisher (part)								
Kress		174	182	189	194	196	192	184
Rural	406	299	313	325	333	336	330	316
Total	406	473	495	514	527	532	522	500
Terry (part)								
Rural	168	93	101	107	114	122	122	121
Total	168	93	101	107	114	122	122	121
Brazos Basin Total	**346,335**	**365,628**	**397,123**	**419,631**	**433,432**	**440,715**	**442,945**	**443,096**
Colorado Basin (part)								
Cochran (part)								
Rural	779	518	567	602	618	608	582	554
Total	779	518	567	602	618	608	582	554
Dawson (part)								
Lamesa	10,809	9,952	10,309	10,633	10,906	11,068	10,804	10,395
Rural	3,424	4,777	4,949	5,104	5,235	5,313	5,186	4,990
Total	14,233	14,729	15,258	15,737	16,141	16,381	15,990	15,385

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Table 2-3 (Revised) Concluded

Basin-County-City	**Census**		**Projections**					
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Gaines (all)								
Seagraves	2,398	2,334	2,602	2,850	3,029	3,156	3,135	3,093
Seminole	6,342	5,910	6,589	7,216	7,669	7,991	7,939	7,831
Rural	5,383	6,223	6,939	7,597	8,076	8,413	8,360	8,245
Total	14,123	14,467	16,130	17,663	18,774	19,560	19,434	19,169
Garza (part)								
Rural	5	0	0	0	0	0	0	0
Total	5	0	0	0	0	0	0	0
Hockley (part)								
Sundown	1,759	1,505	1,619	1,689	1,730	1,732	1,665	1,583
Rural	436	288	310	323	331	331	319	303
Total	2,195	1,793	1,929	2,012	2,061	2,063	1,984	1,886
Lynn (part)								
O'Donnell (part)	968							
Rural	141	48	51	53	53	53	50	47
Total	1,109	48	51	53	53	53	50	47
Terry (part)								
Brownfield	9,560	9,488	10,263	10,988	11,676	12,348	12,417	12,348
Meadow	547	658	712	762	810	856	861	856
Rural	2,943	2,522	2,728	2,921	3,104	3,282	3,300	3,282
Total	13,050	12,668	13,703	14,671	15,590	16,486	16,578	16,486
Yoakum (all)								
Denver City	5,145	3,985	4,454	4,880	5,154	5,446	5,300	5,120
Plains	1,422	1,450	1,621	1,776	1,875	1,982	1,928	1,863
Rural	2,219	1,887	2,108	2,310	2,441	2,578	2,510	2,425
Total	8,786	7,322	8,183	8,966	9,470	10,006	9,738	9,408
Colorado Basin Total	**54,280**	**51,545**	**55,821**	**59,704**	**62,707**	**65,157**	**64,356**	**62,935**
Llano Estacado Region	**438,490**	**453,997**	**492,627**	**521,930**	**540,908**	**552,188**	**553,691**	**551,758**
River Basin Summary								
Canadian	27	3	4	5	6	7	7	7
Red	37,848	36,821	39,679	42,590	44,763	46,309	46,383	45,720
Brazos	346,335	365,628	397,123	419,631	433,432	440,715	442,945	443,096
Colorado	54,280	51,545	55,821	59,704	62,707	65,157	64,356	62,935
Llano Estacado Region	**438,490**	**453,997**	**492,627**	**521,930**	**540,908**	**552,188**	**553,691**	**551,758**

[1] Parts of Canadian, Red, Brazos, and Colorado River Basins.

Source: TWDB; Consensus Projections adopted by the TWDB, September 17, 2003.

Revised text of page 2-10.

2.2 Municipal Water Demand Projections

In the Llano Estacado Region, with low flow plumbing fixtures water conservation, per capita water use, the basic municipal water use planning statistic, is projected to decline over the planning period from 180 gpcd in 2010 to 171 gpcd in 2060 [Figure 2-2 (Revised)]. Total municipal water demand is projected to increase by 7.1 percent per year between 2000 and 2060, from 87,322 acft/yr in 2000 to 105,939 acft/yr in 2060 [Figure 2-2 (Revised) and Table 2-4 (Revised)]. The projected municipal water demand for individual counties of the region is shown in [Table 2-4 (Revised)]. Since Lubbock County has the largest population, it also has the largest projected water demand, with 53.1 percent of the regional total in 2000 and 58.4 percent in 2060 [Table 2-4 (Revised)].

Figure 2-2 Revised. Projected Per Capita Water Use and Municipal Water Demand: Llano Estacado Region -- 1990 to 2060

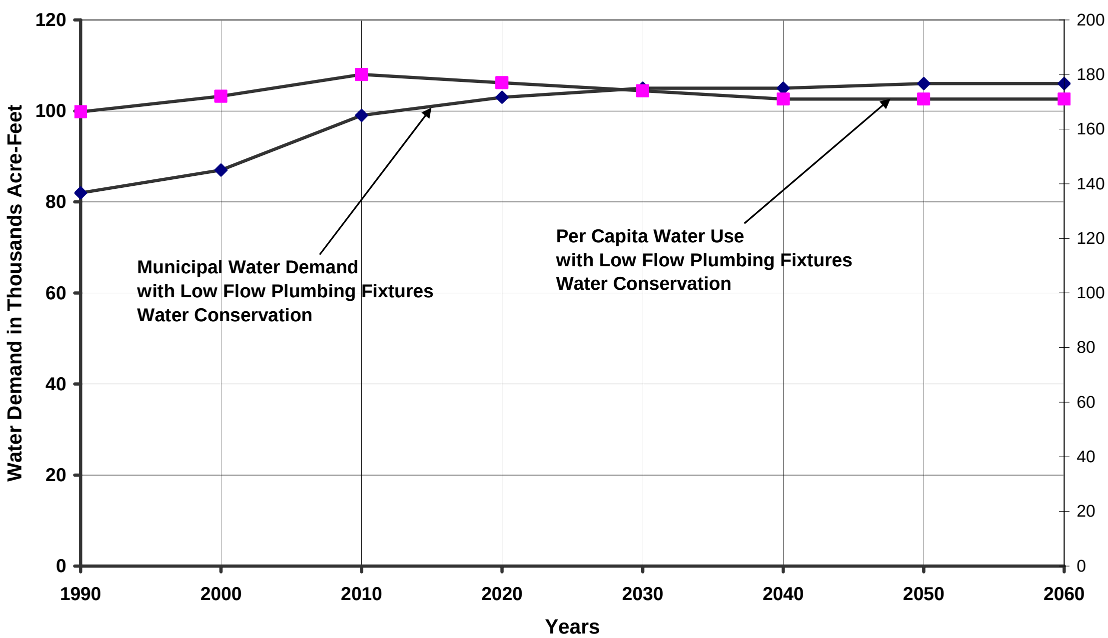

Table 2-4. (Revised)
Municipal Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County Number	County	Total in 1990 (acft)	Total in 2000 (acft)	Projections					
				2010	2020	2030	2040	2050	2060
Counties									
1	Bailey	1,425	1,310	1,369	1,440	1,473	1,508	1,505	1,477
2	Briscoe	323	306	311	311	299	280	270	263
3	Castro	1,567	1,653	1,764	1,866	1,920	1,952	1,937	1,904
4	Cochran	931	763	816	853	860	831	792	753
5	Crosby	1,195	1,104	1,159	1,207	1,233	1,252	1,245	1,226
6	Dawson	2,285	3,126	3,185	3,220	3,254	3,245	3,151	3,031
7	Deaf Smith	4,409	4,136	4,378	4,627	4,852	5,032	5,088	5,119
8	Dickens	508	554	538	520	495	462	445	432
9	Floyd	1,185	1,181	1,211	1,232	1,222	1,203	1,153	1,093
10	Gaines	2,920	3,139	3,417	3,683	3,850	3,957	3,909	3,856
11	Garza	959	777	787	798	766	720	681	635
12	Hale	6,375	6,370	6,677	6,982	7,160	7,198	7,105	6,967
13	Hockley	3,755	3,800	3,953	4,040	4,050	3,966	3,784	3,599
14	Lamb	2,652	3,349	3,467	3,624	3,756	3,833	3,793	3,745
15	Lubbock	42,342	46,408	56,596	58,856	59,878	60,071	60,719	61,897
16	Lynn	942	973	1,009	1,026	995	967	916	852
17	Motley	302	387	377	360	330	295	272	259
18	Parmer	2,248	1,875	1,951	2,029	2,040	2,016	1,940	1,832
19	Swisher	1,523	1,476	1,515	1,532	1,540	1,525	1,488	1,423
20	Terry	1,947	3,038	3,210	3,387	3,547	3,696	3,697	3,676
21	Yoakum	1,815	1,597	1,745	1,879	1,954	2,031	1,966	1,900
	Total	81,608	87,322	99,435	103,472	105,474	106,040	105,856	105,939
River Basin Summary[2]									
	Canadian	3	0	1	1	1	1	1	1
	Red	7,927	7,548	7,875	8,177	8,378	8,474	8,417	8,301
	Brazos	64,091	68,459	79,564	82,673	84,037	84,194	84,293	84,773
	Colorado	9,587	11,315	11,995	12,621	13,058	13,371	13,145	12,864
	Total	81,608	87,322	99,435	103,472	105,474	106,040	105,856	105,939

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Source: TWDB; Consensus Projections adopted by the TWDB, September 17, 2003.

Revised text of page 2-32.

2.8 Total Water Demand Projections

Total water demand projections for the Llano Estacado Region are the sum of water demand projections for municipal, industrial, steam-electric power generation, mining, irrigation, and total livestock water demand projections [Tables 2-4 (Revised) through 2-8, and 2-17], and are shown in Table 2-19 (Revised) and Figure 2-6 (Revised). Total water use in 2000 was estimated at 4,530,041 acft/yr [Table 2-19 (Revised)]. Projected total water demand for the region is 4,100,102 acft/yr in 2030 and 3,716,726 acft/yr in 2060 [Table 2-19 (Revised) and Figure 2-6 (Revised)]. Projections of future water demands for municipal, industrial, steam-electric power, and livestock increase, while projections for irrigation and mining purposes decrease. The reasons for the decline in the projections of demand in future years for irrigation are predictions of increased efficiency in irrigation, economic factors adversely affecting the profitability of irrigation in future years, and expectation of decreased government programs supporting agricultural incomes. Projections for mining water demand decrease due to the expectation that secondary recovery of crude petroleum using water flooding will decrease in future years as this method is phased out or is no longer a viable technology for the industry in the Llano Estacado Region.

Projections of future water demands for the Llano Estacado Region show irrigation demand at 95.98 percent of total demand in 2000 and 93.47 percent in 2060 [Table 2-20 (Revised)]. Municipal demand, as a percent of total demand, increases from 1.93 percent in 2000 to 2.85 percent in 2060 [Table 2-20 (Revised)], with beef cattle feedlot livestock demand as a percent of total demand increasing from 0.58 percent in 2000 to 1.23 percent in 2060 [Table 2-20 (Revised)].

Table 2-19. (Revised)
Total Water Demand Projections
Llano Estacado Region[1]
Individual Counties with River Basin Summaries

County	Total in 1990 (acft)	Total in 2000 (acft)	Projections					
			2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
County								
Bailey	224,374	186,163	182,975	179,809	175,778	171,857	168,000	164,230
Briscoe	40,283	26,952	26,009	25,098	24,208	23,343	22,519	21,728
Castro	361,423	513,023	496,271	479,787	462,573	446,046	430,142	414,954
Cochran	35,222	123,115	118,458	113,812	109,413	105,101	100,941	96,980
Crosby	108,032	113,728	109,195	104,855	100,704	96,718	92,875	89,186
Dawson	42,279	152,146	142,886	134,322	126,713	119,536	112,731	106,469
Deaf Smith	298,239	388,353	379,773	371,001	361,006	351,358	341,958	332,953
Dickens	5,875	10,825	10,473	10,143	9,847	9,557	9,293	9,052
Floyd	134,278	239,572	230,437	221,609	212,983	204,699	196,724	189,064
Gaines	400,317	424,778	403,246	381,382	360,671	341,024	322,724	305,980
Garza	6,447	14,563	13,355	12,367	11,559	10,810	10,133	9,573
Hale	471,380	378,473	367,443	356,656	345,690	334,956	324,460	314,394
Hockley	100,912	183,873	176,008	168,498	161,523	154,600	148,146	142,378
Lamb	369,020	402,158	388,810	375,942	365,728	356,641	348,744	342,327
Lubbock	277,626	298,052	294,310	283,145	272,983	262,845	253,993	246,610
Lynn	41,302	121,566	115,095	108,962	103,132	97,611	92,372	87,405
Motley	4,817	10,200	9,922	9,645	9,370	9,094	8,839	8,604
Parmer	484,388	425,089	423,148	420,744	417,040	413,368	409,700	406,154
Swisher	144,439	176,303	175,997	169,314	174,762	174,022	173,280	172,531
Terry	134,843	207,229	196,691	186,781	177,460	168,629	160,130	152,106
Yoakum	127,991	133,881	127,955	122,581	116,958	112,056	107,784	104,047
Total	3,813,487	4,530,041	4,388,457	4,236,453	4,100,102	3,963,870	3,835,486	3,716,726
River Basin Summary[2]								
Canadian	79	73	89	100	101	103	104	109
Red	758,998	939,865	920,955	898,344	879,612	858,122	837,297	817,303
Brazos	2,331,816	2,618,292	2,544,992	2,463,630	2,391,307	2,319,167	2,251,395	2,189,053
Colorado	722,594	971,811	922,422	874,378	829,082	786,478	746,689	710,260
Total	3,813,487	4,530,041	4,388,457	4,236,453	4,100,102	3,963,870	3,835,486	3,716,726

[1] As specified in TWDB Rules, 31 Texas Administrative Code, Regional Water Planning Areas, March 11, 1998.
[2] See Table 2-21 for River Basin tabulations of counties, cities, and rural areas.

Table 2-20. (Revised)
Composition of Projected Total Water Demand
Llano Estacado Region
2000, 2030, and 2060

Purpose of Use	2000		2030		2060	
	acft	% of total	(acft)	% of total	(acft)	% of total
Municipal	87,322	1.93%	105,474	2.57%	105,939	2.85%
Industrial	10,064	0.22%	13,540	0.33%	15,999	0.43%
Steam-Electric Power	25,618	0.57%	30,188	0.74%	49,910	1.34%
Mining	21,436	0.47%	6,359	0.16%	258	0.01%
Irrigation	4,347,877	95.98%	3,882,780	94.69%	3,474,163	93.47%
Beef Feedlot Livestock	26,215	0.58%	38,035	0.93%	45,512	1.23%
Range & All Other Livestock	11,510	0.25%	23,727	0.58%	24,946	0.67%
Total	4,530,041	100.00%	4,100,102	100.00%	3,716,726	100.00%

Figure 2-6 (Revised). Total Water Demand Projections:
Llano Estacado Region -- 1990 -- 2060

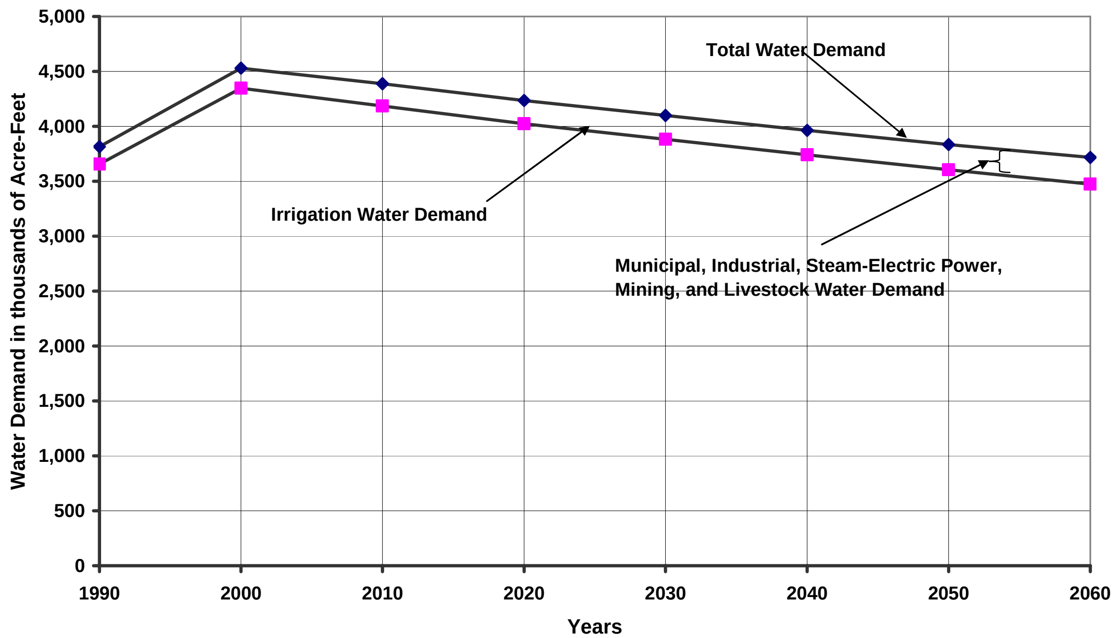

Table 2-21. (Revised)Water Demand Projections
Llano Estacado Region
River Basins, Counties, and Cities[1]

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Canadian Basin (part)								
Deaf Smith (part)								
Rural (Municipal)	3	0	1	1	1	1	1	1
Total Municipal Demand	3	0	1	1	1	1	1	1
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	0	0	0	0	0	0	0	0
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	76	73	88	99	100	102	103	108
Total Demand	79	73	89	100	101	103	104	109
Canadian Basin Total	**79**	**73**	**89**	**100**	**101**	**103**	**104**	**109**
Red Basin (part)								
Briscoe County (all)								
(Left Blank Intentionally)								
Silverton (Municipal)	135	126	128	128	123	115	111	108
Rural (Municipal)	188	180	183	183	176	165	159	155
Total Municipal Demand	323	306	311	311	299	280	270	263
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	39,592	26,329	25,373	24,453	23,566	22,710	21,886	21,091
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	368	317	325	334	343	353	363	374
Total Demand	40,283	26,952	26,009	25,098	24,208	23,343	22,519	21,728
Castro County (part)								
Rural (Municipal)	221	247	263	278	285	288	286	281
Total Municipal Demand	221	247	263	278	285	288	286	281
Manufacturing Demand	392	95	112	121	128	136	142	152
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	115,892	166,251	159,877	153,748	147,853	142,184	136,733	131,491
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	2,689	3,145	3,834	4,299	4,563	4,845	5,143	5,461
Range & All Other Livestock Demand	855	215	653	1,116	1,118	1,123	1,129	1,133
Total Demand	120,049	169,952	164,739	159,562	153,948	148,576	143,433	138,518
Crosby County (part)								
Rural (Municipal)	5	1	1	1	1	1	1	1
Total Municipal Demand	5	1	1	1	1	1	1	1
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	2,113	2,243	2,152	2,066	1,982	1,903	1,826	1,752
Mining Demand	291	70	41	20	11	5	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	4	3	3	3	4	4	4	4
Total Demand	2,413	2,317	2,197	2,090	1,998	1,913	1,831	1,757

Continued on next page

Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Deaf Smith (part)								
Hereford (Municipal)	3,869	3,564	3,634	3,694	3,751	3,788	3,801	3,813
Rural (Municipal)	537	572	743	932	1,100	1,243	1,286	1,305
Total Municipal Demand	4,406	4,136	4,377	4,626	4,851	5,031	5,087	5,118
Manufacturing Demand	498	1,234	1,454	1,594	1,710	1,821	1,917	2,055
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	285,459	372,827	361,015	349,580	338,504	327,780	317,396	307,341
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	6,534	7,041	8,583	9,623	10,216	10,846	11,514	12,224
Range & All Other Livestock Demand	1,263	3,043	4,257	5,478	5,623	5,779	5,941	6,105
Total Demand	298,160	388,281	379,686	370,901	360,904	351,257	341,855	332,843
Dickens County (part)								
Rural (Municipal)	34	45	43	41	38	33	30	28
Total Municipal Demand	34	45	43	41	38	33	30	28
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	2,055	4,079	3,957	3,839	3,725	3,614	3,506	3,400
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	213	230	233	239	246	251	258	264
Total Demand	2,302	4,354	4,233	4,119	4,009	3,898	3,794	3,692
Floyd County (part)								
Rural (Municipal)	107	103	106	107	106	104	100	95
Total Municipal Demand	107	103	106	107	106	104	100	95
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	59,268	106,659	102,411	98,332	94,415	90,654	87,044	83,577
Mining Demand	30	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	259	272	317	364	368	376	386	393
Total Demand	59,664	107,034	102,834	98,803	94,889	91,134	87,530	84,065
Hale County (part)								
Rural (Municipal)	6	0	0	0	0	0	0	0
Total Municipal Demand	6	0	0	0	0	0	0	0
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	4,619	3,677	3,555	3,437	3,323	3,213	3,107	3,004
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	0	2	3	4	4	4	4	3
Total Demand	4,625	3,679	3,558	3,441	3,327	3,217	3,111	3,007
Motley County (all)								
Matador (Municipal)	221	239	234	224	207	187	174	166
Rural (Municipal)	81	148	143	136	123	108	98	93
Total Municipal Demand	302	387	377	360	330	295	272	259
Manufacturing Demand	0	5	6	6	6	6	6	6
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	3,883	9,168	8,894	8,628	8,372	8,121	7,877	7,641
Mining Demand	23	15	9	4	3	1	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	609	625	636	647	659	671	684	698
Total Demand	4,817	10,200	9,922	9,645	9,370	9,094	8,839	8,604

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Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Parmer County (part)								
Friona (Municipal)	912	803	835	872	879	870	838	791
Rural (Municipal)	138	106	110	113	112	110	106	100
Total Municipal Demand	1,050	909	945	985	991	980	944	891
Manufacturing Demand	1,502	2,070	2,427	2,617	2,772	2,921	3,051	3,261
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	137,750	120,480	119,201	117,935	116,683	115,444	114,219	113,006
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	1,975	2,046	2,494	2,797	2,968	3,153	3,347	3,553
Range & All Other Livestock Demand	322	283	616	948	957	974	995	1,012
Total Demand	142,599	125,788	125,683	125,281	124,371	123,471	122,555	121,723
Swisher County (part)								
Happy		107	109	110	111	110	108	103
Kress (Municipal)	101	80	82	82	83	81	79	76
Tulia (Municipal)	1,062	1,020	1,050	1,065	1,072	1,064	1,038	993
Rural (Municipal)	310	207	211	211	211	207	202	193
Total Municipal Demand	1,473	1,414	1,452	1,468	1,477	1,462	1,427	1,365
Manufacturing Demand	3	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	79,600	97,872	97,313	93,233	96,205	95,655	95,108	94,565
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	2,412	2,499	3,047	3,416	3,626	3,850	4,087	4,339
Range & All Other Livestock Demand	598	444	513	617	636	657	678	699
Total Demand	84,086	102,230	102,325	98,733	101,944	101,624	101,300	100,968
Red Basin Total								
Total Municipal Demand	7,927	7,548	7,875	8,177	8,378	8,474	8,417	8,301
Manufacturing Demand	2,395	3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	730,231	909,585	883,748	855,251	834,628	811,278	788,702	766,868
Mining Demand	344	85	50	24	14	6	0	0
Beef Feedlot Livestock Demand	13,610	14,731	17,958	20,134	21,374	22,693	24,091	25,576
Range & All Other Livestock Demand	4,491	5,433	7,556	9,751	9,958	10,192	10,440	10,685
Total Demand	758,998	940,787	921,186	897,674	878,968	857,527	836,767	816,905
Brazos Basin (part)								
Bailey County (all)								
Muleshoe (Municipal)	1,073	979	1,027	1,082	1,109	1,137	1,135	1,114
Rural (Municipal)	352	331	342	358	364	371	370	363
Total Municipal Demand	1,425	1,310	1,369	1,440	1,473	1,508	1,505	1,477
Manufacturing Demand	147	264	303	316	326	335	343	365
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	220,775	182,865	178,478	174,197	170,018	165,939	161,958	158,071
Mining Demand	20	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	938	971	1,184	1,327	1,409	1,496	1,588	1,686
Range & All Other Livestock Demand	1,069	752	1,640	2,529	2,552	2,578	2,604	2,632
Total Demand	224,374	186,162	182,974	179,809	175,779	171,856	167,998	164,231

Continued on next page

Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Castro County (part)								
Dimmitt (Municipal)	894	975	1,041	1,103	1,137	1,159	1,150	1,130
Hart (Municipal)	187	223	238	251	258	262	260	256
Rural (Municipal)	265	208	222	234	240	243	241	237
Total Municipal Demand	1,346	1,406	1,501	1,588	1,635	1,664	1,651	1,623
Manufacturing Demand	1,785	1,637	1,923	2,082	2,213	2,337	2,445	2,617
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	235,297	337,541	324,598	312,154	300,186	288,677	277,609	266,966
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	1,902	2,225	2,712	3,040	3,228	3,427	3,638	3,862
Range & All Other Livestock Demand	1,044	261	798	1,360	1,364	1,364	1,365	1,367
Total Demand	241,374	343,070	331,532	320,224	308,626	297,469	286,709	276,436
Cochran County (part)								
Morton (Municipal)	631	499	535	560	565	547	521	496
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Rural (Municipal)	176	172	183	191	192	185	176	167
Total Municipal Demand	807	671	718	751	757	732	697	663
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	20,915	76,790	73,825	70,978	68,239	65,604	63,071	60,636
Mining Demand	0	16	14	10	8	6	4	2
Beef Feedlot Livestock Demand	496	514	627	703	746	792	841	893
Range & All Other Livestock Demand	67	45	69	110	114	116	118	118
Total Demand	22,285	78,037	75,253	72,552	69,864	67,250	64,731	62,312
Crosby County (part)								
Crosbyton (Municipal)	409	351	369	386	394	402	400	394
Lorenzo (Municipal)	227	260	275	288	296	302	301	296
Ralls (Municipal)	313	290	304	315	322	325	323	318
Rural (Municipal)	241	202	210	217	220	222	220	217
Total Municipal Demand	1,190	1,103	1,158	1,206	1,232	1,251	1,244	1,225
Manufacturing Demand	7	5	6	6	6	6	6	6
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	103,521	109,892	105,465	101,215	97,138	93,223	89,469	85,866
Mining Demand	552	119	71	34	20	8	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	349	292	298	303	310	318	325	332
Total Demand	105,619	111,411	106,998	102,764	98,706	94,806	91,044	87,429
Dawson (part)								
O'Donnell		17	17	17	17	17	17	16
Rural (Municipal)	14	18	18	18	19	18	18	17
Total Municipal Demand	14	35	35	35	36	35	35	33
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	391	1,460	1,378	1,300	1,227	1,158	1,093	1,031
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	2	1	1	2	1	2	2	2
Total Demand	407	1,496	1,414	1,337	1,264	1,195	1,130	1,066

Continued on next page

Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Dickens County (part)								
Dickens (Municipal)	99							
Spur (Municipal)	251	275	271	267	263	260	257	257
Rural (Municipal)	124	234	224	212	194	169	158	147
Total Municipal Demand	474	509	495	479	457	429	415	404
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	2,724	5,407	5,246	5,089	4,938	4,791	4,647	4,508
Mining Demand	13	165	98	47	27	12	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	362	391	401	408	417	427	437	449
Total Demand	3,573	6,472	6,240	6,023	5,839	5,659	5,499	5,361
Floyd County (part)								
Floydada (Municipal)	570	663	680	696	693	685	657	623
Lockney (Municipal)	321	237	242	244	240	234	224	212
Rural (Municipal)	187	178	183	185	183	180	172	163
Total Municipal Demand	1,078	1,078	1,105	1,125	1,116	1,099	1,053	998
Manufacturing Demand	1	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	72,438	130,361	125,168	120,184	115,397	110,800	106,387	102,150
Mining Demand	33	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	854	885	1,079	1,210	1,285	1,364	1,448	1,537
Range & All Other Livestock Demand	210	213	251	287	296	301	306	314
Total Demand	74,614	132,538	127,604	122,807	118,094	113,564	109,194	104,999
Garza County (part)								
Post (Municipal)	770	623	631	642	616	579	549	512
Rural (Municipal)	188	154	156	156	150	141	132	123
Total Municipal Demand	958	777	787	798	766	720	681	635
Manufacturing Demand	2	2	2	2	2	2	2	2
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	4,383	12,165	11,451	10,783	10,148	9,556	8,997	8,471
Mining Demand	575	1,264	752	361	211	90	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	528	355	363	423	432	442	453	465
Total Demand	6,446	14,563	13,355	12,367	11,559	10,810	10,133	9,573
Hale County (part)								
Abernathy (part) (Municipal)	395	461	486	508	526	531	525	514
Hale Center (Municipal)	410	446	470	493	509	513	507	498
Petersburg (Municipal)	222	276	289	304	313	316	312	306
Plainview (Municipal)	4,421	4,078	4,288	4,490	4,605	4,635	4,577	4,488
Rural (Municipal)	921	1,109	1,144	1,187	1,207	1,203	1,184	1,161
Total Municipal Demand	6,369	6,370	6,677	6,982	7,160	7,198	7,105	6,967
Manufacturing Demand	1,521	2,605	2,993	3,188	3,339	3,482	3,604	3,840
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	457,312	364,023	351,961	340,300	329,026	318,124	307,583	297,392
Mining Demand	166	258	88	34	19	0	0	0
Beef Feedlot Livestock Demand	1,173	1,185	1,445	1,620	1,720	1,826	1,939	2,058
Range & All Other Livestock Demand	214	353	721	1,090	1,099	1,109	1,119	1,130
Total Demand	466,755	374,794	363,885	353,214	342,363	331,739	321,350	311,387

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Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Hockley County (part)								
Anton (Municipal)	200	250	263	270	272	268	256	243
Levelland (Municipal)	2,377	2,219	2,310	2,362	2,369	2,322	2,216	2,107
Ropesville		85	89	91	91	89	85	81
Smyer		67	69	70	70	68	65	62
Rural (Municipal)	771	814	840	855	853	831	791	753
Total Municipal Demand	3,348	3,435	3,571	3,648	3,655	3,578	3,413	3,246
Manufacturing Demand	67	53	61	65	68	71	73	78
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	83,764	157,496	151,336	145,420	139,735	134,269	129,019	123,974
Mining Demand	2,465	3,302	2,358	1,510	981	378	19	0
Beef Feedlot Livestock Demand	331	343	418	468	497	528	561	595
Range & All Other Livestock Demand	199	221	226	273	280	286	292	299
Total Demand	90,174	164,850	157,970	151,385	145,216	139,110	133,377	128,192
Lamb County (all)								
Amherst (Municipal)	147	163	168	176	182	185	183	181
Earth (Municipal)	312	248	257	268	277	283	280	276
Littlefield (Municipal)	1,010	1,480	1,530	1,602	1,660	1,694	1,676	1,655
Olton (Municipal)	457	474	492	512	532	542	536	529
Sudan (Municipal)	283	218	226	236	244	249	246	243
Rural (Municipal)	443	766	794	830	861	880	872	861
Total Municipal Demand	2,652	3,349	3,467	3,624	3,756	3,833	3,793	3,745
Manufacturing Demand	753	426	490	519	541	562	580	618
Steam-Electric Power Demand	12,587	17,990	17,827	17,663	20,651	24,292	28,731	34,142
Irrigation Demand	351,050	377,893	363,313	349,294	335,816	322,858	310,401	298,425
Mining Demand	76	88	52	25	15	6	0	0
Beef Feedlot Livestock Demand	1,502	1,328	1,619	1,815	1,927	2,046	2,172	2,306
Range & All Other Livestock Demand	400	1,084	2,042	3,001	3,022	3,044	3,067	3,091
Total Demand	369,020	402,158	388,810	375,941	365,728	356,641	348,744	342,327
Lubbock County (all)								
Abernathy (part) (Municipal)	109	153	171	182	188	186	190	186
Idalou (Municipal)	356	288	289	288	281	274	273	272
Lubbock (Municipal)	36,656	40,460	49,822	51,587	52,416	52,600	53,040	54,305
New Deal (Municipal)	96	126	149	165	173	173	178	173
Ransom Canyon (Municipal)	162	310	440	569	698	825	953	1,004
Reese Redevelopment (Municipal)	657							
Shallowater (Municipal)	325	311	344	367	377	371	379	371
Slaton (Municipal)	865	931	907	889	870	849	837	836
Wolfforth (Municipal)	337	412	1,468	1,758	1,822	1,884	1,962	2,006
Rural (Municipal)	2,779	3,417	3,006	3,051	3,053	2,909	2,907	2,744
Total Municipal Demand	42,342	46,408	56,596	58,856	59,878	60,071	60,719	61,897
Manufacturing Demand	1,469	1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric Power Demand	1,715	5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation Demand	230,717	242,978	229,267	216,397	204,248	192,782	181,961	171,747
Mining Demand	191	352	209	101	59	25	0	0
Beef Feedlot Livestock Demand	689	714	870	976	1,036	1,100	1,168	1,240
Range & All Other Livestock Demand	503	258	265	272	280	289	298	308
Total Demand	277,626	298,052	294,310	283,145	272,983	262,845	253,993	246,610

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Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 2000 (acft)	Projections (acft) 2010	2020	2030	2040	2050	2060
Lynn County (part)								
O'Donnell		139	144	146	142	138	130	121
Tahoka (Municipal)	488	473	492	504	490	478	453	421
Wilson (Municipal)	53	65	67	68	65	63	60	55
Rural (Municipal)	278	290	299	301	292	282	267	249
Total Municipal Demand	819	967	1,002	1,019	989	961	910	846
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	39,616	119,289	112,870	106,796	101,054	95,614	90,473	85,610
Mining Demand	116	66	39	19	11	5	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	235	128	132	136	139	144	149	153
Total Demand	40,786	120,450	114,043	107,970	102,193	96,724	91,532	86,609
Parmer County (part)								
Bovina (Municipal)	316	309	321	334	335	330	317	300
Farwell (Municipal)	410	370	388	405	410	408	393	371
Rural (Municipal)	472	287	297	305	304	298	286	270
Total Municipal Demand	1,198	966	1,006	1,044	1,049	1,036	996	941
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	337,250	294,969	291,836	288,738	285,673	282,640	279,639	276,670
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	2,719	2,817	3,434	3,849	4,087	4,338	4,606	4,890
Range & All Other Livestock Demand	622	549	1,189	1,832	1,860	1,883	1,903	1,931
Total Demand	341,789	299,301	297,464	295,463	292,669	289,897	287,144	284,432
Swisher County (part)								
Kress		21	22	22	22	22	21	20
Rural (Municipal)	50	41	41	42	41	41	40	38
Total Municipal Demand	50	62	63	64	63	63	61	58
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	60,050	73,834	73,412	70,333	72,575	72,161	71,749	71,338
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	253	178	197	183	179	174	170	167
Total Demand	60,353	74,074	73,672	70,580	72,817	72,398	71,980	71,563
Terry County (part)								
Rural (Municipal)	21	13	14	14	15	16	15	15
Total Municipal Demand	21	13	14	14	15	16	15	15
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	6,595	10,157	9,636	9,142	8,674	8,229	7,807	7,407
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	5	4	7	10	8	12	10	7
Total Demand	6,621	10,174	9,657	9,166	8,697	8,257	7,832	7,429

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Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 1996 (acft)	Projections (acft) 2000	2010	2020	2030	2040	2050
Brazos Basin Total								
Total Municipal Demand	64,091	68,459	79,564	82,673	84,037	84,194	84,293	84,773
Manufacturing Demand	5,752	6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric Power Demand	14,302	23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation Demand	2,226,798	2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
Mining Demand	4,207	5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock Demand	10,604	10,983	13,388	15,009	15,935	16,917	17,960	19,068
Range & All Other Livestock Demand	6,062	5,085	8,600	12,220	12,354	12,488	12,618	12,763
Total Demand	2,331,816	2,617,601	2,544,992	2,463,630	2,391,307	2,319,167	2,251,395	2,189,053
Colorado Basin (part)								
Cochran County (part)								
Rural (Municipal)	124	92	98	102	103	99	95	90
Total Municipal Demand	124	92	98	102	103	99	95	90
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	11,764	43,195	41,527	39,925	38,384	36,902	35,478	34,108
Mining Demand	924	1,704	1,448	1,022	852	639	426	256
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	125	87	132	212	210	210	211	214
Total Demand	12,937	45,078	43,205	41,261	39,549	37,850	36,210	34,668
Dawson County (part)								
Lamesa (Municipal)	1,827	2,486	2,540	2,573	2,602	2,603	2,529	2,433
Rural (Municipal)	444	605	610	612	616	607	587	565
Total Municipal Demand	2,271	3,091	3,150	3,185	3,218	3,210	3,116	2,998
Manufacturing Demand	44	101	119	129	137	144	150	162
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	38,706	144,579	136,425	128,736	121,478	114,628	108,167	102,071
Mining Demand	654	2,728	1,624	779	455	195	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	197	150	154	156	161	164	168	172
Total Demand	41,872	150,649	141,472	132,985	125,449	118,341	111,601	105,403
Gaines County (all)								
Seagraves (Municipal)	555	416	449	482	502	513	506	499
Seminole (Municipal)	1,676	2,019	2,214	2,401	2,525	2,605	2,579	2,544
Rural (Municipal)	689	704	754	800	823	839	824	813
Total Municipal Demand	2,920	3,139	3,417	3,683	3,850	3,957	3,909	3,856
Manufacturing Demand	303	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	392,950	414,772	393,170	372,693	353,283	334,884	317,442	300,908
Mining Demand	3,340	6,071	5,746	4,011	2,493	1,084	217	0
Beef Feedlot Livestock Demand	482	500	609	683	725	770	817	868
Range & All Other Livestock Demand	322	296	304	312	320	329	338	348
Total Demand	400,317	424,778	403,246	381,382	360,671	341,024	322,724	305,980

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Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 1996 (acft)	Projections (acft) 2000	2010	2020	2030	2040	2050
Garza County (part)								
Rural (Municipal)	1	0	0	0	0	0	0	0
Total Municipal Demand	1	0	0	0	0	0	0	0
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	0	0	0	0	0	0	0	0
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	0	0	0	0	0	0	0	0
Total Demand	1	0	0	0	0	0	0	0
Hockley (part)								
Sundown (Municipal)	353	325	341	350	353	347	332	316
Rural (Municipal)	54	40	41	42	42	41	39	37
Total Municipal Demand	407	365	382	392	395	388	371	353
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	9,204	17,500	16,815	16,158	15,526	14,919	14,335	13,775
Mining Demand	1,087	1,114	796	509	331	127	6	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	40	44	45	55	55	56	57	59
Total Demand	10,738	19,023	18,038	17,114	16,307	15,490	14,769	14,187
Lynn County (part)								
Left Blank Intentionally								
Rural (Municipal)	123	6	7	7	6	6	6	6
Total Municipal Demand	123	6	7	7	6	6	6	6
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	372	1,083	1,025	970	918	868	822	777
Mining Demand	0	15	9	4	2	1	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	21	11	11	11	12	12	13	14
Total Demand	516	1,115	1,052	992	938	887	841	797
Terry County (part)								
Brownfield (Municipal)	1,481	2,593	2,747	2,905	3,047	3,181	3,185	3,167
Meadow (Municipal)	87	70	73	75	78	80	79	79
Rural (Municipal)	358	362	376	393	407	419	418	415
Total Municipal Demand	1,926	3,025	3,196	3,373	3,532	3,680	3,682	3,661
Manufacturing Demand	0	1	1	1	1	1	1	1
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	125,306	192,984	183,089	173,702	164,797	156,348	148,332	140,726
Mining Demand	822	930	554	266	155	66	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	168	115	194	274	278	277	283	289
Total Demand	128,222	197,055	187,034	177,616	168,763	160,372	152,298	144,677

Continued on next page

Table 2-21 (Revised) Continued

Basin/County/City/Rural	Total in 1990 (acft)	Total in 1996 (acft)	Projections (acft) 2000	2010	2020	2030	2040	2050
Yoakum County (all)								
Denver City (Municipal)	1,079	955	1,043	1,126	1,172	1,220	1,181	1,141
Plains (Municipal)	438	378	416	448	468	488	473	457
Rural (Municipal)	298	264	286	305	314	323	312	302
Total Municipal Demand	1,815	1,597	1,745	1,879	1,954	2,031	1,966	1,900
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation Demand	122,409	127,059	120,979	115,187	109,674	104,426	99,427	94,668
Mining Demand	3,473	3,159	2,416	1,524	706	204	56	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	294	214	218	273	278	282	288	293
Total Demand	127,991	133,881	127,955	122,581	116,958	112,056	107,784	104,047
Colorado Basin Total								
Total Municipal Demand	9,587	11,315	11,995	12,621	13,058	13,371	13,145	12,864
Manufacturing Demand	347	102	120	130	138	145	151	163
Steam-Electric Power Demand	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation Demand	700,711	941,172	893,030	847,371	804,060	762,975	724,003	687,033
Mining Demand	10,300	15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock Demand	482	500	609	683	725	770	817	868
Range & All Other Livestock Demand	1,167	918	1,059	1,292	1,314	1,331	1,358	1,389
Total Demand	722,594	971,580	922,003	873,931	828,635	786,021	746,227	709,759
Llano Estacado Region River Basin Totals								
Canadian River Basin (part)								
Total Municipal Demand	3	0	1	1	1	1	1	1
Manufacturing Demand	0	0	0	0	0	0	0	0
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	0	0	0	0	0	0	0	0
Mining Demand	0	0	0	0	0	0	0	0
Beef Feedlot Livestock Demand	0	0	0	0	0	0	0	0
Range & All Other Livestock Demand	76	73	88	99	100	102	103	108
Total Demand	79	73	89	100	101	103	104	109
Red River Basin (part)								
Total Municipal Demand	7,927	7,548	7,875	8,177	8,378	8,474	8,417	8,301
Manufacturing Demand	2,395	3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric Power Demand	0	0	0	0	0	0	0	0
Irrigation Demand	730,231	909,585	883,748	855,251	834,628	811,278	788,702	766,868
Mining Demand	344	85	50	24	14	6	0	0
Beef Feedlot Livestock Demand	13,610	14,731	17,958	20,134	21,374	22,693	24,091	25,576
Range & All Other Livestock Demand	4,491	5,433	7,556	9,751	9,958	10,192	10,440	10,685
Total Demand	758,998	940,787	921,186	897,674	878,968	857,527	836,767	816,905
Brazos River Basin (part)								
Total Municipal Demand	64,091	68,459	79,564	82,673	84,037	84,194	84,293	84,773
Manufacturing Demand	5,752	6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric Power Demand	14,302	23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation Demand	2,226,798	2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
Mining Demand	4,207	5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock Demand	10,604	10,983	13,388	15,009	15,935	16,917	17,960	19,068
Range & All Other Livestock Demand	6,062	5,085	8,600	12,220	12,354	12,488	12,618	12,763
Total Demand	2,331,816	2,617,601	2,544,992	2,463,630	2,391,307	2,319,167	2,251,395	2,189,053

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Table 2-21 (Revised) Concluded

Basin/County/City/Rural	Total in 1990 (acft)	Total in 1996 (acft)	Projections (acft) 2000	2010	2020	2030	2040	2050
Colorado River Basin (part)								
Total Municipal Demand	9,587	11,315	11,995	12,621	13,058	13,371	13,145	12,864
Manufacturing Demand	347	102	120	130	138	145	151	163
Steam-Electric Power Demand	0	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation Demand	700,711	941,172	893,030	847,371	804,060	762,975	724,003	687,033
Mining Demand	10,300	15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock Demand	482	500	609	683	725	770	817	868
Range & All Other Livestock Demand	1,167	918	1,059	1,292	1,314	1,331	1,358	1,389
Total Demand	722,594	971,580	922,003	873,931	828,635	786,021	746,227	709,759
Llano Estacado Region Total								
Total Municipal Demand	81,608	87,322	91,378	94,465	95,710	95,473	95,165	93,549
Manufacturing Demand	8,494	10,064	11,778	12,749	13,540	14,296	14,945	15,999
Steam-Electric Power Demand	14,302	25,618	25,645	25,821	30,188	35,511	42,000	49,910
Irrigation Demand	3,657,740	4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163
Mining Demand	14,851	21,436	16,324	10,280	6,359	2,852	728	258
Beef Feedlot Livestock Demand	24,696	26,214	31,955	35,826	38,035	40,380	42,869	45,512
Range & All Other Livestock Demand	11,796	11,510	17,303	23,362	23,726	24,114	24,520	24,945
Total Demand	3,813,487	4,530,041	4,380,400	4,227,445	4,090,338	3,953,303	3,824,795	3,704,336
River Basin Summary								
Canadian	79	73	89	100	101	103	104	109
Red	758,998	940,787	921,186	897,674	878,968	857,527	836,767	816,905
Brazos	2,331,816	2,617,601	2,544,992	2,463,630	2,391,307	2,319,167	2,251,395	2,189,053
Colorado	722,594	971,580	922,003	873,931	828,635	786,021	746,227	709,759
Llano Estacado Region Total	3,813,487	4,530,041	4,388,457	4,236,453	4,100,102	3,963,870	3,835,486	3,716,726

[1] Parts of the Canadian, Red, Brazos, and Colorado River Basins.

Source: TWDB, Consensus Projections adopted by the TWDB, September 17, 2003.

Revised text on page 2-36.

Total water use in the Llano Estacado Region was 4,530,041 acft/yr in 2000, with projected 2060 water demands of 3,716,726 acft/yr. The quantity of projected water demands in 2060 are 109 acft/yr for the Canadian River Basin areas of the Region, 816,905 acft/yr for the Red River Basin areas of the Region, 2,189,053 acft/yr for the Brazos River Basin areas of the Region, and 709,759 acft/yr for the Colorado River Basin areas of the Region.

Revised text on page 2-50.

2.10.2 City of Lubbock

The City of Lubbock has wholesale water supply contracts with Buffalo Springs Lake Water Supply Corporation, Lake Ransom Canyon, Shallowater, Lubbock-Reese Redevelopment Authority, and is in the process of negotiating a wholesale water supply contract with the Lake Alan Henry Water Supply District. In addition, Lubbock has a contract to supply water to the City of Littlefield in cases of emergency. Total water use by Lubbock and its customers was 49,917 acft in 2000 [Table 2-22 (Revised)]. Projected water demand by Lubbock and its customers in 2030 is 54,327 acft/yr and in 2060 is 56,516 acft/yr [Table 2-22 (Revised)]

Table 2-22. (Revised)
Water Demand Projections for Wholesale Water Providers
Llano Estacado Region

Wholesale Water Providers with Lists of Customers	*Total in 1990 (acft)*	*Total in 2000 (acft)*	*Projections 2010 (acft)*	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
Canadian River Municipal Water Authority (CRMWA)								
City of Brownfield	1,481	2,593	2,747	2,905	3,047	3,181	3,185	3,167
City of Lamesa	1,827	2,486	2,540	2,573	2,602	2,603	2,529	2,433
City of Levelland	2,377	2,219	2,310	2,362	2,369	2,322	2,216	2,107
City of Lubbock	36,656	40,460	41,765	42,580	42,652	42,033	42,349	41,915
City of O'Donnell	121	156	161	163	159	155	147	137
City of Plainview	4,421	4,078	4,288	4,490	4,605	4,635	4,577	4,488
City of Slaton	865	931	907	889	870	849	837	836
City of Tahoka	488	473	492	504	490	478	453	421
Llano Estacado Region (Region O) Total	48,236	53,396	55,210	56,466	56,794	56,256	56,293	55,504
Panhandle Region (Region A) Total								
CRMWA Total								
City of Lubbock								
City of Lubbock Municipal	36,656	40,460	49,822	51,587	52,416	52,600	53,040	54,305
Buffalo Springs Lake Water Supply Corp. Mun.[2]	807	807	807	807	807	807	807	807
Ransom Canyon	162	310	440	569	698	825	953	1,004
Shallowater	0	311	344	367	377	371	379	371
Lake Alan Henry Water District[2]	22	22	22	22	22	22	22	22
Lubbock-Reese Redevelopment Authority[2]	7	7	7	7	7	7	7	7
Lubbock Total	37,654	41,917	51,442	53,359	54,327	54,632	55,208	56,516
Mackenzie Municipal Water Authority (MMWA)								
City of Floydada	570	663	680	696	693	685	657	623
City of Lockney	321	237	242	244	240	234	224	212
City of Silverton	135	126	128	128	123	115	111	108
City of Tulia	1,062	1,020	1,050	1,065	1,072	1,064	1,038	993
MMWA Total	2,088	2,046	2,100	2,133	2,128	2,098	2,030	1,936

Continued on next page

Table 2-22 (Revised) Concluded

Wholesale Water Providers with Lists of Customers	*Total in 1990 (acft)*	*Total in 2000 (acft)*	*Projections 2010 (acft)*	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
White River Municipal Water District (WRMWD)								
City of Crosbyton								
Municipal	409	351	369	386	394	402	400	394
Industrial	0	0	0	0	0	0	0	0
City of Post								
Municipal	770	623	631	642	616	579	549	512
Industrial	2	2	2	2	2	2	2	2
City of Ralls								
Municipal	313	290	304	315	322	325	323	318
Industrial	6	5	6	6	6	6	6	6
City of Spur								
Municipal	251	275	271	267	263	260	257	257
Industrial	0	0	0	0	0	0	0	0
Mining								
Crosby County		189	112	54	31	13	0	0
Dickens county		165	98	47	27	12	0	0
Garza County		1,264	752	361	211	90	0	0
WRMWD								
Municipal	1,743	1,539	1,575	1,610	1,595	1,566	1,529	1,481
Industrial	8	7	8	8	8	8	8	8
Mining	0	1,618	962	462	269	115	0	0
WRMWD Total	1,751	3,164	2,545	2,080	1,872	1,689	1,537	1,489

Revised text on page 4-2.

Total estimated water supply in the Llano Estacado Region in 2000 was 4,655,113 acft and in 2060 is 1,442,745 acft [Table 4-22 (Revised)]. The projected water supply in 2060 is 90,443 acft for municipal use, 15,999 acft for industrial use, 49,910 acft for steam-electric use, 1,194,864 acft for irrigation use, 258 acft for mining use, 45,512 acft for beef feedlot livestock use, 12,112 acft for dairies, and 12,833 acft for range and other livestock use. In 2010, the Llano Estacado Region is projected to have a municipal water surplus of 8,956 acft and an irrigation water shortage of 1,242,250 acft; in 2060 the region is projected to have a municipal water shortage of 15,496 acft and an irrigation water shortage of 2,279,299 acft [Table 4-22 (Revised)].

Table 4-15 (Revised). Projected Water Demands, Supplies, and Needs Lubbock County Llano Estacado Region

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
WATER SUPPLIES									
	Brazos Basin								
	Quantity in Storage[1]	Ogallala	7,439,809	6,632,577	5,611,743	4,952,167	4,159,806	4,141,607	4,114,001
	Quantity Pumped[2]	Ogallala	298,052	163,283	131,367	110,204	88,545	85,490	80,557
	Supply	(Ogallala)[3]	298,052	163,283	131,367	110,204	88,545	85,490	80,557
	Other Ground	Ogallala (CRMWA - Roberts Co.)	15,453	16,648	16,647	14,262	11,878	10,215	10,215
	Bailey County	Ogallala	8,092	8,353	8,516	8,530	8,407	8,470	8,383
	Local Surface	Stock Tanks and Windmills	258	265	272	280	289	298	308
	Other Surface	Lake Meredith (CRMWA)	28,948	24,174	24,174	24,174	24,174	24,174	24,174
	Other Surface	Lake Alan Henry	0	22,478	22,478	22,478	22,478	22,478	22,478
	Reclaimed Water (Lubbock-Electric Power)[4]		5,776	5,221	4,440	5,191	6,106	7,222	8,582
	Reclaimed Water (Lubbock-Irrigation)[4]		7,958	9,166	10,354	9,639	8,415	7,457	5,880
	Reclaimed Water[7]		4,209	4,209	4,209	4,209	4,209	4,209	4,209
	Total Supply		368,746	253,797	222,457	198,967	174,499	170,012	164,785
Data LERWPG									
Oct. 28, 04									
WATER DEMANDS									
Municipal Demand									
Brazos Basin									
Abernathy (part)			153	171	182	188	186	190	186
Idalou			288	289	288	281	274	273	272
Lubbock	Includes Reese Center	(Seven acre-feet per year)	40,460	49,822	51,587	52,416	52,600	53,040	54,305
New Deal			126	149	165	173	173	178	173
Ransom Canyon			310	440	569	698	825	953	1,004
Shallowater			311	344	367	377	371	379	371
Slaton			931	907	889	870	849	837	836
Wolfforth			412	1,468	1,758	1,822	1,884	1,962	2,006
Rural			3,417	3,006	3,051	3,053	2,909	2,907	2,744
	Subtotal		46,408	56,596	58,856	59,878	60,071	60,719	61,897
Total Municipal Demand			46,408	56,596	58,856	59,878	60,071	60,719	61,897
Municipal Existing Supply									
Brazos Basin									
Abernathy (part)		Ogallala	153	171	0	0	0	0	0
Idalou		Ogallala	288	289	288	281	0	0	0
Lubbock		Lake Meredith (CRMWA)[5]	27,712	22,808	22,679	22,550	22,423	22,295	22,244
		Ogallala (CRMWA - Roberts Co.)[5]	14,823	16,018	16,017	13,632	11,248	10,065	10,065
		Lake Alan Henry	0	0	0	0	0	0	0
		Ogallala (Bailey County)[6]	8,092	8,353	8,516	8,530	8,407	8,470	8,383
Lubbock Subtotal	Includes Reese Center		50,627	47,179	47,212	44,712	42,078	40,830	40,692
New Deal		Slaton (CRMWA)	126	153	153	153	153	153	153
Ransom Canyon		Lubbock (Lake Meredith)	310	440	569	698	825	953	1,004
Shallowater		Lubbock (Lake Meredith)	187	187	187	187	187	187	187
		Ogallala	311	0	0	0	0	0	0
Shallowater Subtotal			498	187	187	187	187	187	187
Slaton	1,198	Lake Meredith (CRMWA)[5]	739	739	739	739	739	739	739
	630	Ogallala (CRMWA - Roberts Co.)[5]	630	630	630	630	630	150	150
Slaton Subtotal	1,828		1,369	1,369	1,369	1,369	1,369	889	889
Wolfforth		Ogallala	412	371	334	300	270	243	219
Rural		Ogallala	3,417	3,006	3,051	3,053	2,909	2,907	2,744
	Subtotal		57,200	53,165	53,163	50,753	47,791	46,162	45,888
Total Municipal Existing Supply			57,200	53,165	53,163	50,753	47,791	46,162	45,888
Municipal Surplus/Shortage									
Brazos Basin									
Abernathy (part)			0	0	-182	-188	-186	-190	-186
Idalou			0	0	0	0	-274	-273	-272
Lubbock			10,167	-2,643	-4,375	-7,704	-10,522	-12,210	-13,613
New Deal			0	4	-12	-20	-20	-25	-20
Ransom Canyon			0	0	0	0	0	0	0
Shallowater			187	-157	-180	-190	-184	-192	-184
Slaton		To Post	438	462	480	499	520	52	53
Wolfforth			0	-1,097	-1,424	-1,522	-1,614	-1,719	-1,787
Rural			0	0	0	0	0	0	0
	Subtotal		10,792	-3,431	-5,693	-9,125	-12,280	-14,557	-16,009
Total Municipal Surplus/Shortage			10,792	-3,431	-5,693	-9,125	-12,280	-14,557	-16,009

Continued on next page

Table 4-15 (Revised) Continued

Basin		Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Municipal New Supply Need									
Brazos Basin									
Abernathy (part)			0	0	182	188	186	190	186
Idalou			0	0	0	0	274	273	272
Lubbock			0	2,643	4,375	7,704	10,522	12,210	13,613
New Deal			0	0	12	20	20	25	20
Ransom Canyon			0	0	0	0	0	0	0
Shallowater			0	157	180	190	184	192	184
Slaton			0	0	0	0	0	0	0
Wolfforth			0	1,097	1,424	1,522	1,614	1,719	1,787
Rural			0	0	0	0	0	0	0
	Subtotal		0	3,897	6,173	9,624	12,800	14,609	16,062
Total Municipal New Supply Need			0	3,897	6,173	9,624	12,800	14,609	16,062
Industrial Demand									
Brazos Basin			1,566	1,881	2,103	2,291	2,472	2,625	2,836
Total Industrial Demand			1,566	1,881	2,103	2,291	2,472	2,625	2,836
Industrial Existing Supply									
Brazos Basin		Ogallala	1,566	1,881	2,103	2,291	2,472	2,625	2,836
Total Industrial Existing Supply			1,566	1,881	2,103	2,291	2,472	2,625	2,836
Industrial Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Industrial Surplus/Shortage			0	0	0	0	0	0	0
Industrial New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Total Industrial New Supply Need			0	0	0	0	0	0	0
Steam-Electric Demand									
Brazos Basin			5,776	5,221	4,440	5,191	6,106	7,222	8,582
Total Steam-Electric Demand			5,776	5,221	4,440	5,191	6,106	7,222	8,582
Steam-Electric Existing Supply									
Brazos Basin		Reclaimed Water (From Lubbock)	5,776	5,221	4,440	5,191	6,106	7,222	8,582
Total Steam-Electric Existing Supply			5,776	5,221	4,440	5,191	6,106	7,222	8,582
Steam-Electric Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric Surplus/Shortage			0	0	0	0	0	0	0
Steam-Electric New Supply Need									
Brazos Basin			0	0	0	0	0	0	0
Total Steam-Electric New Supply Need			0	0	0	0	0	0	0
Irrigation Demand									
Brazos Basin			242,978	229,267	216,397	204,248	192,782	181,961	171,747
Total Irrigation Demand			242,978	229,267	216,397	204,248	192,782	181,961	171,747
Irrigation Supply									
Brazos Basin		Ogallala	290,713	149,228	116,139	95,080	73,499	70,102	65,351
		Reclaimed Water (Lubbock) [4]	7,958	9,166	10,354	9,639	8,415	7,457	5,880
		Reclaimed Water [7]	4,209	4,209	4,209	4,209	4,209	4,209	4,209
Total Irrigation Supply			302,880	162,603	130,702	108,928	86,123	81,768	75,440
Irrigation Surplus/Shortage									
Brazos Basin			59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Total Irrigation Surplus/Shortage			59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Mining Demand									
Brazos Basin			352	209	101	59	25	0	0
Total Mining Demand			352	209	101	59	25	0	0
Mining Supply									
Brazos Basin		Ogallala	352	209	101	59	25	0	0
Total Mining Supply			352	209	101	59	25	0	0
Mining Surplus/Shortage									
Brazos Basin			0	0	0	0	0	0	0
Total Mining Surplus/Shortage			0	0	0	0	0	0	0

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Table 4-15 (Revised) Continued

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Beef Feedlot Livestock Demand								
Brazos Basin		714	870	976	1,036	1,100	1,168	1,240
Total Beef Feedlot Livestock Demand		714	870	976	1,036	1,100	1,168	1,240
Beef Feedlot Livestock Supply								
Brazos Basin	Ogallala	714	870	976	1,036	1,100	1,168	1,240
Total Beef Feedlot Livestock Supply		714	870	976	1,036	1,100	1,168	1,240
Beef Feedlot Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Beef Feedlot Livestock Surplus/Shortage		0	0	0	0	0	0	0
Dairies Demand								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Demand		0	0	0	0	0	0	0
Dairies Supply								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Supply		0	0	0	0	0	0	0
Dairies Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Dairies Surplus/Shortage		0	0	0	0	0	0	0
Range & All Other Livestock Demand								
Brazos Basin		258	265	272	280	289	298	308
Total Range & All Other Livestock Demand		258	265	272	280	289	298	308
Range & All Other Livestock Supply								
Brazos Basin	Local	258	265	272	280	289	298	308
Total Range & All Other Livestock Supply		258	265	272	280	289	298	308
Range & All Other Livestock Surplus/Shortage								
Brazos Basin		0	0	0	0	0	0	0
Total Range & All Other Livestock Surplus/Shortage		0	0	0	0	0	0	0
Total Demand								
Municipal		46,408	56,596	58,856	59,878	60,071	60,719	61,897
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		242,978	229,267	216,397	204,248	192,782	181,961	171,747
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total County Demand		298,052	294,310	283,145	272,983	262,845	253,993	246,610
Total Supply								
Municipal		57,200	53,165	53,163	50,753	47,791	46,162	45,888
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		302,880	162,603	130,702	108,928	86,123	81,768	75,440
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total County Supply		368,746	224,214	191,757	168,539	143,905	139,242	134,293
Total Surplus/Shortage								
Municipal		10,792	-3,431	-5,693	-9,125	-12,280	-14,557	-16,009
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total County Surplus/Shortage		70,694	-70,096	-91,388	-104,445	-118,940	-114,751	-112,317

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Table 4-15 (Revised) Concluded

Basin	Source	Total in 2000 (acft)	2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Total Basin Demand								
Brazos								
Municipal		46,408	56,596	58,856	59,878	60,071	60,719	61,897
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		242,978	229,267	216,397	204,248	192,782	181,961	171,747
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total Brazos Basin Demand		298,052	294,310	283,145	272,983	262,845	253,993	246,610
Total Basin Supply								
Brazos								
Municipal		57,200	53,165	53,163	50,753	47,791	46,162	45,888
Industrial		1,566	1,881	2,103	2,291	2,472	2,625	2,836
Steam-Electric		5,776	5,221	4,440	5,191	6,106	7,222	8,582
Irrigation		302,880	162,603	130,702	108,928	86,123	81,768	75,440
Mining		352	209	101	59	25	0	0
Beef Feedlot Livestock		714	870	976	1,036	1,100	1,168	1,240
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		258	265	272	280	289	298	308
Total Brazos Basin Supply		368,746	224,214	191,757	168,539	143,905	139,242	134,293
Total Basin Surplus/Shortage								
Brazos								
Municipal		10,792	-3,431	-5,693	-9,125	-12,280	-14,557	-16,009
Industrial		0	0	0	0	0	0	0
Steam-Electric		0	0	0	0	0	0	0
Irrigation		59,902	-66,665	-85,695	-95,320	-106,660	-100,194	-96,308
Mining		0	0	0	0	0	0	0
Beef Feedlot Livestock		0	0	0	0	0	0	0
Dairies		0	0	0	0	0	0	0
Range & All Other Livestock		0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage		70,694	-70,096	-91,388	-104,445	-118,940	-114,751	-112,317

1 Calculated by the TWDB using Southern Ogallala Groundwater Availability Model; February 2003. Entry on Quantity in storage row in 2000 is GAM Run result for 2004.

2 Ibid.

3 Supply means quantity of water available from the Ogallala Aquifer in the year projected.

4 Total supply of reclaimed water is estimated at 50 percent of Lubbock's projected municipal water use shown as Lubbock municipal water demand. Reclaimed water is used for steam-electric power generation, with the remaineder used to irrigate hay and forage crops in Lubbock and Lynn Counties. Of the total, 6,496 acft/yr is shown as being transferred to Lynn County. See Table 4-16.

5 The city's supply from CRMWA. Since the city's supply from CRMWA exceeds CRMWA's delivery capacity, the city must have terminal storage in order to use its full supply from CRMWA.

6 The total groundwater supply available to Lubbock in Bailey County is 16,000 acft/yr, however, the City of Lubbock's policy is to obtain 20 percent of annual supply from Bailey County, which increases from an estimated 8,092 acft/yr in 2000 to an estimated 8,383 acft/yr in 2060.

7 Value is the sum of reclaimed water from the City of Idalou, City of Wolfforth, City of New Deal, City of Slaton, City of Shallowater, SPS, Environmental Protection Services of Lubbock, Acid Delinting Inc., Texas Winery Inc., Town & Country Mobile Home Park, Paymaster Oil Mill, Lubbock, Cooper ISD, Ransom, Canyon, Plains Coop Oil Mill, and Gifford Hill American. The quantity of reclaimed water from municipal sources for reuse was estimated as the lesser of 50 percent of the TWDB municipal water use for the year 2000 or the maximum waste discharge permit quantity of the TCEQ waste discharge permit. This value is held constant throughout the projection period. For all other entities, the quantity was calculated as 75 percent of the maximum waste discharge permit.

Revised text on page 4-84.

Of the four Wholesale Water Providers of the region, all are projected to have a water shortage during the planning period [Table 4-23 (Revised)].

Table 4-22. (Revised)
Projected Water Demands, Supplies, and Needs
River Basin and Llano Estacado Region Summaries
Llano Estacado Region

Basin	Total in 2000 (acft)	Projections					
		2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Canadian Basin Demand							
Municipal	0	1	1	1	1	1	1
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	0	0	0	0	0	0	0
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	220	281	317	326	336	344	353
Total Canadian Basin Demand	**220**	**282**	**318**	**327**	**337**	**345**	**354**
Canadian Basin Supply							
Municipal	0	1	1	1	1	1	1
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	0	0	0	0	0	0	0
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	220	281	317	326	336	344	353
Total Canadian Basin Supply	**220**	**282**	**318**	**327**	**337**	**345**	**354**
Canadian Basin Surplus/Shortage [1]							
Municipal	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	0	0	0	0	0	0	0
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	0	0	0	0	0	0	0
Total Canadian Basin Surplus/Shortage [1]	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Red Basin Demand							
Municipal	7,548	7,875	8,177	8,378	8,474	8,417	8,301
Industrial	3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric	0	0	0	0	0	0	0
Irrigation	909,585	883,748	855,251	834,628	811,278	788,702	766,868
Mining	85	50	24	14	6	0	0
Beef Feedlot Livestock	14,731	17,958	20,134	21,374	22,693	24,091	25,576
Dairies	166	2,116	4,067	4,066	4,068	4,070	4,072
Range & All Other Livestock	5,100	5,227	5,442	5,645	5,863	6,095	6,335
Total Red Basin Demand	**940,619**	**920,973**	**897,432**	**878,721**	**857,266**	**836,492**	**816,626**
Red Basin Supply (Unallocated)	25,349	25,240	25,429	17,452	17,514	17,577	17,649
Municipal	8,128	7,501	7,745	10,535	10,686	10,684	10,612
Industrial	3,404	3,999	4,338	4,616	4,884	5,116	5,474
Steam-Electric	0	0	0	0	0	0	0
Irrigation	932,227	549,954	386,184	287,354	226,910	217,108	203,342
Mining	85	50	24	14	6	0	0
Beef Feedlot Livestock	14,731	17,958	20,134	21,374	22,693	24,091	25,576
Dairies	166	2,116	4,067	4,066	4,068	4,070	4,072
Range & All Other Livestock	5,100	5,227	5,442	5,645	5,863	6,095	6,335
Total Red Basin Supply	**989,190**	**612,044**	**453,362**	**351,055**	**292,623**	**284,742**	**273,061**

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Table 4-22 Continued

Basin	Total in 2000 (acft)	Projections					
		2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Red Basin Surplus/Shortage [1]							
Municipal	580	-374	-432	2,157	2,212	2,267	2,311
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	22,642	-333,794	-469,067	-547,274	-584,368	-571,594	-563,526
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	0	0	0	0	0	0	0
Total Red Basin Surplus/Shortage [1]	**23,222**	**-334,168**	**-469,499**	**-545,117**	**-582,156**	**-569,327**	**-561,215**
Brazos Basin Demand							
Municipal	68,459	79,564	82,673	84,037	84,194	84,293	84,773
Industrial	6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric	23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation	2,497,120	2,409,240	2,322,320	2,244,092	2,166,425	2,091,863	2,020,262
Mining	5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock	10,983	13,388	15,009	15,936	16,917	17,960	19,067
Dairies	1,017	4,453	7,887	7,887	7,885	7,883	7,882
Range & All Other Livestock	4,088	4,210	4,446	4,575	4,717	4,856	5,001
Total Brazos Basin Demand	**2,617,622**	**2,545,242**	**2,464,860**	**2,392,506**	**2,320,333**	**2,252,509**	**2,190,073**
Brazos Basin Supply (Unallocated)	4,807	4,654	4,654	3,166	3,164	3,162	3,166
Municipal	93,648	88,663	86,165	80,541	75,960	71,345	69,549
Industrial	6,558	7,659	8,281	8,786	9,267	9,678	10,362
Steam-Electric	23,766	23,048	22,103	25,842	30,398	35,953	42,724
Irrigation	2,572,640	1,772,643	1,412,335	1,091,947	806,169	698,976	652,349
Mining	5,630	3,681	2,141	1,351	530	23	2
Beef Feedlot Livestock	10,983	13,388	15,009	15,936	16,917	17,960	19,067
Dairies	1,017	4,452	7,887	7,887	7,885	7,883	7,882
Range & All Other Livestock	4,088	4,210	4,446	4,575	4,717	4,856	5,001
Total Brazos Basin Supply	**2,723,137**	**1,922,399**	**1,563,021**	**1,240,031**	**955,006**	**849,837**	**810,102**
Brazos Basin Surplus/Shortage [1]							
Municipal	25,189	9,099	3,492	-3,496	-8,234	-12,948	-15,224
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	75,519	-636,597	-909,985	-1,152,145	-1,360,256	-1,392,887	-1,367,913
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	0	0	0	0	0	0	0
Total Brazos Basin Surplus/Shortage [1]	**100,707**	**-627,498**	**-906,493**	**-1,155,641**	**-1,368,490**	**-1,405,835**	**-1,383,137**
Colorado Basin Demand							
Municipal	11,315	11,995	12,621	13,058	13,371	13,145	12,864
Industrial	102	120	130	138	145	151	163
Steam-Electric	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation	941,172	893,030	847,371	804,060	762,975	724,003	687,033
Mining	15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock	500	609	683	725	770	817	868
Dairies	0	80	159	159	159	159	159
Range & All Other Livestock	918	936	1,045	1,068	1,086	1,113	1,144
Total Colorado Basin Demand	**971,580**	**921,959**	**873,842**	**828,548**	**785,935**	**746,140**	**709,673**
Colorado Basin Supply							
Municipal	12,294	12,226	11,747	10,724	10,762	10,422	10,280
Industrial	102	120	130	138	145	151	163
Steam-Electric	1,852	2,597	3,718	4,346	5,113	6,047	7,186
Irrigation	911,179	621,171	520,478	463,656	416,615	365,050	339,172
Mining	15,721	12,593	8,115	4,994	2,316	705	256
Beef Feedlot Livestock	500	609	683	725	770	817	868
Dairies	0	80	159	159	159	159	159
Range & All Other Livestock	918	936	1,045	1,068	1,086	1,113	1,144
Total Colorado Basin Supply	**942,566**	**650,331**	**546,075**	**485,810**	**436,966**	**384,465**	**359,228**

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Table 4-22 Concluded

Basin	Total in 2000 (acft)	Projections 2010 (acft)	2020 (acft)	2030 (acft)	2040 (acft)	2050 (acft)	2060 (acft)
Colorado Basin Surplus/Shortage [1]							
Municipal	979	231	-874	-2,334	-2,609	-2,723	-2,584
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	-29,993	-271,859	-326,893	-340,404	-346,360	-358,953	-347,861
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	0	0	0	0	0	0	0
Total Colorado Basin Surplus/Shortage [1]	**-29,014**	**-271,629**	**-327,767**	**-342,738**	**-348,969**	**-361,675**	**-350,444**
Llano Estacado Region Demand							
Municipal	87,322	99,435	103,472	105,474	106,040	105,856	105,939
Industrial	10,064	11,778	12,749	13,540	14,296	14,945	15,999
Steam-Electric	25,618	25,645	25,821	30,188	35,511	42,000	49,910
Irrigation	4,347,877	4,186,018	4,024,942	3,882,780	3,740,678	3,604,568	3,474,163
Mining	21,436	16,324	10,280	6,359	2,852	728	258
Beef Feedlot Livestock	26,215	31,955	35,826	38,035	40,380	42,869	45,512
Dairies	1,183	6,648	12,112	12,112	12,112	12,112	12,112
Range & All Other Livestock	10,326	10,653	11,250	11,614	12,001	12,408	12,833
Total Llano Estacado Region Demand	**4,530,041**	**4,388,457**	**4,236,453**	**4,100,102**	**3,963,870**	**3,835,486**	**3,716,726**
Llano Estacado Region Supply (Unallocated)	30,156	29,894	30,083	20,617	20,677	20,739	20,815
Municipal	114,070	108,391	105,658	101,801	97,409	92,452	90,443
Industrial	10,064	11,778	12,749	13,540	14,296	14,945	15,999
Steam-Electric	25,618	25,645	25,821	30,188	35,511	42,000	49,910
Irrigation	4,416,046	2,943,768	2,318,996	1,842,957	1,449,693	1,281,135	1,194,864
Mining	21,436	16,324	10,280	6,359	2,852	728	258
Beef Feedlot Livestock	26,215	31,955	35,826	38,035	40,380	42,869	45,512
Dairies	1,183	6,648	12,112	12,112	12,112	12,112	12,112
Range & All Other Livestock	10,326	10,653	11,250	11,614	12,001	12,408	12,833
Total Llano Estacado Region Supply	**4,655,113**	**3,185,056**	**2,562,776**	**2,077,223**	**1,684,932**	**1,519,388**	**1,442,745**
Llano Estacado Region Surplus/Shortage [1]							
Municipal	26,748	8,956	2,186	-3,673	-8,631	-13,404	-15,496
Industrial	0	0	0	0	0	0	0
Steam-Electric	0	0	0	0	0	0	0
Irrigation	68,169	-1,242,250	-1,705,946	-2,039,823	-2,290,985	-2,323,433	-2,279,299
Mining	0	0	0	0	0	0	0
Beef Feedlot Livestock	0	0	0	0	0	0	0
Dairies	0	0	0	0	0	0	0
Range & All Other Livestock	0	0	0	0	0	0	0
Total Llano Estacado Region Surplus/Shortage	**94,917**	**-1,233,294**	**-1,703,760**	**-2,043,496**	**-2,299,615**	**-2,336,837**	**-2,294,796**

[1] The values listed in this section of the table are not necessarily additive due to the fact that demands and supplies are not necessarily located in close proximity to each other.

Table 4-23. (Revised)
Projected Water Demands, Supplies and Needs for Wholesale Water Providers
Llano Estacado Water Planning Region

Wholesale Providers	*Total in 2000 (acft)*	*Projections*					
		2010 (acft)	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
Canadian River Municipal Water Authority (CRMWA)							
Lake Meredith System Supply	109,750	103,855	104,269	104,434	104,391	103,294	103,388
Supplies to Region O	47,731	**53,645**	**53,515**	**51,001**	**48,490**	**45,567**	**45,516**
Supplies to Region A	**49,163**	**49,003**	**49,020**	**46,405**	**43,789**	**41,615**	**41,615**
Surplus/Shortages (Needs)	**12,856**	**-1,207**	**-1,734**	**-7,028**	**-12,112**	**-16,742**	**-16,257**
City of Lubbock (Existing Supplies)							
CRMWA Supply	42,535	38,826	38,696	36,182	33,671	32,360	32,309
Bailey County Supply	8,092	8,353	8,516	8,530	8,407	8,470	8,383
Lake Alan Henry Supply	0	0	0	0	0	0	0
Total Supply (Existing)	50,627	47,179	47,212	44,712	42,078	40,830	40,692
Projected Demands (Lubbock and Customers)	41,910	51,442	53,359	54,327	54,632	55,208	56,516
Surplus/Shortages (Needs)	**8,717**	**-4,263**	**-6,147**	**-9,615**	**-12,554**	**-14,378**	**-15,824**
Mackenzie Municipal Water Authority (MMWA)							
Lake Mackenzie Supply	864	0	0	0	0	0	0
Projected Demands	2,046	2,100	2,133	2,128	2,098	2,030	1,936
Surplus/Shortages (Needs)	**-1,182**	**-2,100**	**-2,133**	**-2,128**	**-2,098**	**-2,030**	**-1,936**
White River Municipal Water District (WRMWD)							
White River Lake Supply	2,003	1,199	1,947	1,463	979	495	8
Groundwater Supply							
Total Supply	2,003	1,999	1,947	1,463	979	495	8
Projected Municipal Demands	3,164	2,545	2,080	1,872	1,689	1,537	1,489
Projected Mining and Industrial Demands	1,625	970	470	277	123	8	8
Total Demands	4,789	3,515	2,550	2,149	1,812	1,545	1,497
Surplus/Shortages (Needs)	**-2,786**	**-1,516**	**-603**	**-686**	**-833**	**-1,050**	**-1,489**
Information below is from Region A							
CRMWA Supplies to Region A							
Southwestern Public Service		905	0	0	0	0	0
Amarillo	42,964	40,532	41,454	38,839	36,223	34,049	34,049
Borger	700	3,000	3,000	3,000	3,000	3,000	3,000
Pampa	3,499	4,566	4,566	4,566	4,566	4,566	4,566
Region A CRMWA Supply Totals	**49,163**	**49,003**	**49,020**	**46,405**	**43,789**	**41,615**	**41,615**
CRMWA Supplies to Region O							
Brownfield	1,571	2,549	2,549	2,549	2,549	2,549	2,549
Lamesa	1,647	2,528	2,528	2,528	2,528	2,328	2,328
Levelland	1,842	3,236	3,236	3,236	3,236	2,808	2,808
Lubbock	37,182	38,826	38,696	36,182	33,671	32,360	32,309
O'Donnell – Dawson Co	20	58	58	58	58	58	58
O'Donnell – Lynn Co	145	264	264	264	264	234	234
Plainview	3,291	4,281	4,281	4,281	4,281	3,881	3,881
Slaton	914	1,369	1,369	1,369	1,369	889	889
Tahoka	379	534	534	534	534	460	460
Region O CRMWA Supply Totals	**46,991**	**53,645**	**53,515**	**51,001**	**48,490**	**45,567**	**45,516**
Meredith Safe Yield	69,750	63,750	63,750	63,750	63,750	63,750	63,750
Groundwater	40,000	40,000	40,000	35,000	30,000	35,031	25,031
CRMWA Total	**109,750**	**103,750**	**103,750**	**98,750**	**93,750**	**98,781**	**88,780**

Table 4.4-3 (Revised)
Municipal Water User Groups
Projected Per Capita Water Use with Low Flow Plumbing Fixtures
Llano Estacado Water Planning Region

			Per Capita Water Use With Low Flow Plumbing Fixtures							
	Water User Group*	County **	2000 gpcd	2010 gpcd	2020 gpcd	2030 gpcd	2040 gpcd	2050 gpcd	2060 gpcd	Year of Projected Need
1	MEADOW	TERRY	95	92	88	86	83	82	82	
2	COUNTY-OTHER	GAINES	101	97	94	91	89	88	88	
3	LOCKNEY	FLOYD	103	100	96	93	90	89	89	2030
4	WILSON	LYNN	109	106	102	99	96	95	95	2010
5	COUNTY-OTHER	LUBBOCK	110	106	104	101	99	98	98	
6	KRESS	SWISHER	110	107	104	102	99	98	98	2010
7	COUNTY-OTHER	DAWSON	113	110	107	105	102	101	101	
8	COUNTY-OTHER	CROSBY	115	110	107	104	101	100	100	
9	COUNTY-OTHER	HALE	115	110	107	104	101	100	100	
10	RALLS	CROSBY	115	111	108	106	103	102	102	2030
11	COUNTY-OTHER	GARZA	118	115	111	109	106	104	104	
12	IDALOU	LUBBOCK	119	116	113	109	106	105	105	2040
13	COUNTY-OTHER	LYNN	120	116	112	109	106	105	105	
14	COUNTY-OTHER	PARMER	120	117	113	110	107	106	106	
15	COUNTY-OTHER	SWISHER	121	118	114	111	108	107	107	
16	COUNTY-OTHER	FLOYD	123	120	116	113	110	109	109	
17	COUNTY-OTHER	HOCKLEY	124	119	116	113	110	109	109	
18	COUNTY-OTHER	YOAKUM	125	121	118	115	112	111	111	
19	SMYER	HOCKLEY	125	119	116	113	110	109	109	2050
20	COUNTY-OTHER	TERRY	128	123	120	117	114	113	113	
21	COUNTY-OTHER	DEAFSMITH	129	122	118	116	115	114	114	
22	SHALLOWATER	LUBBOCK	133	128	125	123	120	119	119	2010
23	SLATON	LUBBOCK	136	132	129	126	123	121	121	
24	O'DONNELL	DAWSON	138	134	130	127	124	123	123	
25	COUNTY-OTHER	BAILEY	143	138	135	132	129	128	128	
26	WOLFFORTH	LUBBOCK	144	140	137	135	133	132	132	2010
27	TAHOKA	LYNN	145	142	139	136	133	132	132	
28	SILVERTON	BRISCOE	146	143	140	137	134	132	132	2010
29	ROPESVILLE	HOCKLEY	147	143	140	137	134	133	133	2020
30	BOVINA	PARMER	147	144	141	138	135	134	134	
31	COUNTY-OTHER	DICKENS	149	147	144	142	140	138	138	
32	COUNTY-OTHER	CASTRO	150	146	143	140	137	136	136	
33	POST	GARZA	150	146	143	140	137	136	136	
34	LEVELLAND	HOCKLEY	154	149	146	143	140	139	139	
35	HAPPY	SWISHER	156	152	148	146	143	142	142	
36	COUNTY-OTHER	BRISCOE	158	154	151	148	145	143	143	2010
37	COUNTY-OTHER	COCHRAN	159	155	152	149	146	145	145	

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Table 4.4-3 Concluded

	Water User Group*	***County *****	***Per Capita Water Use With Low Flow Plumbing Fixtures***							***Year of Projected Need***
			2000 gpcd	***2010 gpcd***	***2020 gpcd***	***2030 gpcd***	***2040 gpcd***	***2050 gpcd***	***2060 gpcd***	
38	SEAGRAVES	GAINES	159	154	151	148	145	144	144	2010
39	NEW DEAL	LUBBOCK	159	154	152	150	148	147	147	2020
40	FLOYDADA	FLOYD	161	157	153	150	147	146	146	
41	PLAINVIEW	HALE	163	159	156	153	150	149	149	
42	HART	CASTRO	166	162	159	156	153	152	152	2040
43	CROSBYTON	CROSBY	167	162	159	156	153	152	152	
44	LORENZO	CROSBY	169	165	162	160	157	156	156	2040
45	HALE CENTER	HALE	176	172	169	167	164	163	163	2030
46	TULIA	SWISHER	178	175	171	168	165	164	164	
47	AMHERST	LAMB	184	180	177	174	171	170	170	2010
48	OLTON	LAMB	185	182	178	176	173	172	172	2020
49	ANTON	HOCKLEY	186	182	179	176	173	172	172	2010
50	FRIONA	PARMER	186	182	179	176	173	172	172	2010
51	SUDAN	LAMB	187	184	181	178	175	174	174	2010
52	COUNTY-OTHER	MOTLEY	193	189	186	183	180	178	178	
53	MULESHOE	BAILEY	193	189	186	183	180	179	179	
54	ABERNATHY	HALE	193	189	185	183	180	179	179	2010
55	SUNDOWN	HOCKLEY	193	188	185	182	179	178	178	2010
56	PETERSBURG	HALE	195	190	187	184	181	180	180	2050
57	MORTON	COCHRAN	198	194	191	188	185	184	184	2010
58	DIMMITT	CASTRO	199	194	191	188	185	184	184	2020
59	EARTH	LAMB	200	196	192	189	186	185	185	2030
60	LITTLEFIELD	LAMB	203	199	196	193	190	189	189	
61	LUBBOCK	LUBBOCK	209	205	202	199	196	195	195	2020
62	DENVER CITY	YOAKUM	214	209	206	203	200	199	199	2020
63	HEREFORD	DEAFSMITH	218	215	211	208	205	204	204	
64	LAMESA	DAWSON	223	220	216	213	210	209	209	2010
65	SPUR	DICKENS	226	222	219	216	213	211	211	
66	COUNTY-OTHER	LAMB	230	226	222	219	216	215	215	
67	PLAINS	YOAKUM	233	229	225	223	220	219	219	2010
68	FARWELL	PARMER	242	239	235	232	229	228	228	2010
69	BROWNFIELD	TERRY	244	239	236	233	230	229	229	2010
70	RANSOM CANYON	LUBBOCK	274	269	266	264	262	261	261	
71	MATADOR	MOTLEY	288	285	282	279	276	274	274	
72	SEMINOLE	GAINES	305	300	297	294	291	290	290	

* Listed in order of low to high per capita water use. If no date shown in right column, WUG has no projected need.

** Some water user groups are located in more than one county and more than one river basin. The county in which the major part of the service area is located is listed in the table.

Table 4.4-4 (Revised)
Municipal Water User Groups
Projected Per Capita Water Use with Low Flow Plumbing Fixtures and
Regional Planning Goal to Reduce Per Capita Water Use by One Percent per Year*
Llano Estacado Water Planning Region

			Water Use with Low Flow Plumbing Fixtures**							Water Use with Goal to Reduce by 1% per Year*					
Number	Water User Group	County	2000 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
1	Meadow	Terry	95	92	88	86	83	82	82	95	95	95	95	95	95
2	County-Other	Gaines	101	97	94	91	89	88	88	101	101	101	101	101	101
3	Lockney	Floyd	103	100	96	93	90	89	89	103	103	103	103	103	103
4	Wilson	Lynn	109	106	102	99	96	95	95	109	109	109	109	109	109
5	County-Other	Lubbock	110	106	104	101	99	98	98	110	110	110	110	110	110
6	Kress	Swisher	110	107	104	102	99	98	98	110	110	110	110	110	110
7	County-Other	Dawson	113	110	107	105	102	101	101	113	113	113	113	113	113
8	County-Other	Crosby	115	110	107	104	101	100	100	115	115	115	115	115	115
9	County-Other	Hale	115	110	107	104	101	100	100	115	115	115	115	115	115
10	Ralls	Crosby	115	111	108	106	103	102	102	115	115	115	115	115	115
11	County-Other	Garza	118	115	111	109	106	104	104	118	118	118	118	118	118
12	Idalou	Lubbock	119	116	113	109	106	105	105	119	119	119	119	119	119
13	County-Other	Lynn	120	116	112	109	106	105	105	120	120	120	120	120	120
14	County-Other	Parmer	120	117	113	110	107	106	106	120	120	120	120	120	120
15	County-Other	Swisher	121	118	114	111	108	107	107	121	121	121	121	121	121
16	County-Other	Floyd	123	120	116	113	110	109	109	123	123	123	123	123	123
17	County-Other	Hockley	124	119	116	113	110	109	109	124	124	124	124	124	124
18	County-Other	Yoakum	125	121	118	115	112	111	111	125	125	125	125	125	125
19	Smyer	Hockley	125	119	116	113	110	109	109	125	125	125	125	125	125
20	County-Other	Terry	128	123	120	117	114	113	113	128	128	128	128	128	128
21	County-Other	Deaf Smith	129	122	118	116	115	114	114	129	129	129	129	129	129
22	Shallowater	Lubbock	133	128	125	123	120	119	119	133	133	133	133	133	133
23	Slaton	Lubbock	136	132	129	126	123	121	121	136	136	136	136	136	136

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Table 4.4-4 Continued

Number	Water User Group	County	Water Use with Low Flow Plumbing Fixtures**							Water Use with Goal to Reduce by 1% per Year*					
			2000 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
24	O'Donnell	Dawson	138	134	130	127	124	123	123	138	138	138	138	138	138
25	County-Other	Bailey	143	138	135	132	129	128	128	143	143	143	143	143	143
26	Wolfforth	Lubbock	144	140	137	135	133	132	132	144	144	144	144	144	144
27	Tahoka	Lynn	145	142	139	136	133	132	132	145	145	145	145	145	145
28	Silverton	Briscoe	146	143	140	137	134	132	132	146	146	146	146	146	146
29	Ropesville	Hockley	147	143	140	137	134	133	133	147	147	147	147	147	147
30	Bovina	Parmer	147	144	141	138	135	134	134	147	147	147	147	147	147
31	County-Other	Dickens	149	147	144	142	140	138	138	149	149	149	149	149	149
32	County-Other	Castro	150	146	143	140	137	136	136	150	150	150	150	150	150
33	Post	Garza	150	146	143	140	137	136	136	150	150	150	150	150	150
34	Levelland	Hockley	154	149	146	143	140	139	139	154	154	154	154	154	154
35	Happy	Swisher	156	152	148	146	143	142	142	156	156	156	156	156	156
36	County-Other	Briscoe	158	154	151	148	145	143	143	158	158	158	158	158	158
37	County-Other	Cochran	159	155	152	149	146	145	145	159	159	159	159	159	159
38	Seagraves	Gaines	159	154	151	148	145	144	144	159	159	159	159	159	159
39	New Deal	Lubbock	159	154	152	150	148	147	147	159	159	159	159	159	159
40	Floydada	Floyd	161	157	153	150	147	146	146	161	161	161	161	161	161
41	Plainview	Hale	163	159	156	153	150	149	149	163	163	163	163	163	163
42	Hart	Castro	166	162	159	156	153	152	152	166	166	166	166	166	166
43	Crosbyton	Crosby	167	162	159	156	153	152	152	167	167	167	167	167	167
44	Lorenzo	Crosby	169	165	162	160	157	156	156	169	169	169	169	169	169
45	Hale Center	Hale	176	172	169	167	164	163	163	172	172	172	172	172	172
46	Tulia	Swisher	178	175	171	168	165	164	164	172	172	172	172	172	172
47	Amherst	Lamb	184	180	177	174	171	170	170	172	172	172	172	172	172
48	Olton	Lamb	185	182	178	176	173	172	172	172	172	172	172	172	172
49	Anton	Hockley	186	182	179	176	173	172	172	172	172	172	172	172	172
50	Friona	Parmer	186	182	179	176	173	172	172	172	172	172	172	172	172
51	Sudan	Lamb	187	184	181	178	175	174	174	172	172	172	172	172	172

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Table 4.4-4 Concluded

Number	Water User Group	County	Water Use with Low Flow Plumbing Fixtures**							Water Use with Goal to Reduce by 1% per Year*					
			2000 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
52	County-Other	Motley	193	189	186	183	180	178	178	175	172	172	172	172	172
53	Muleshoe	Bailey	193	189	186	183	180	179	179	175	172	172	172	172	172
54	Abernathy	Hale	193	189	185	183	180	179	179	175	172	172	172	172	172
55	Sundown	Hockley	193	188	185	182	179	178	178	175	172	172	172	172	172
56	Petersburg	Hale	195	190	187	184	181	180	180	176	172	172	172	172	172
57	Morton	Cochran	198	194	191	188	185	184	184	179	172	172	172	172	172
58	Dimmitt	Castro	199	194	191	188	185	184	184	180	172	172	172	172	172
59	Earth	Lamb	200	196	192	189	186	185	185	181	172	172	172	172	172
60	Littlefield	Lamb	203	199	196	193	190	189	189	184	172	172	172	172	172
61	Lubbock	Lubbock	209	205	202	199	196	195	195	188	172	172	172	172	172
62	Denver City	Yoakum	214	209	206	203	200	199	199	194	175	172	172	172	172
63	Hereford	Deaf Smith	218	215	211	208	205	204	204	197	178	172	172	172	172
64	Lamesa	Dawson	223	220	216	213	210	209	209	202	182	172	172	172	172
65	Spur	Dickens	226	222	219	216	213	211	211	204	185	172	172	172	172
66	County-Other	Lamb	230	226	222	219	216	215	215	208	188	172	172	172	172
67	Plains	Yoakum	233	229	225	223	220	219	219	211	191	172	172	172	172
68	Farwell	Parmer	242	239	235	232	229	228	228	219	198	179	172	172	172
69	Brownfield	Terry	244	239	236	233	230	229	229	221	200	180	172	172	172
70	Ransom Canyon	Lubbock	274	269	266	264	262	261	261	248	224	203	183	172	172
71	Matador	Motley	288	285	282	279	276	274	274	260	236	213	193	174	172
72	Seminole	Gaines	305	300	297	294	291	290	290	276	249	226	204	185	172

* Goal is to reduce per capita water use for WUGs with gpcd greater than regional average of 172 gpcd to year 2000 regional average of 172 gpcd.

** Per Capita Water Use in gallons per person per day (gpcd).

*** Listed in order of low to high per capita water use in year 2000. The 33 WUGs whose names are highlighted are projected to have needs (shortages) during the planning period.

**** Some Water User Groups are located in more than one county and more than one river basin. The county in which the major part of the service area is located is named in this table.

Table 4.4-5 (Revised)
Additional Municipal Water User Group Water Conservation Needed to Meet Goals of Reducing Per Capita Water Use to Year 2000 Regional Average of 172 gpcd
Llano Estacado Water Planning Region

Number	Water User Group	County	Year 2000 (gpcd)	Plumbing Fixtures Potential (gpcd)	Additional Water Conservation Needed to Meet Region O Goals						Additional Water Conservation Potentials of Plumbing Fixture Retrofit					
					2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
1	Meadow	Terry	95	18	0	0	0	0	0	0	0	0	0	0	0	0
2	County-Other	Gaines	101	18	0	0	0	0	0	0	0	0	0	0	0	0
3	Lockney	Floyd	103	18	0	0	0	0	0	0	0	0	0	0	0	0
4	Wilson	Lynn	109	18	0	0	0	0	0	0	0	0	0	0	0	0
5	County-Other	Lubbock	110	18	0	0	0	0	0	0	0	0	0	0	0	0
6	Kress	Swisher	110	18	0	0	0	0	0	0	0	0	0	0	0	0
7	County-Other	Dawson	113	18	0	0	0	0	0	0	0	0	0	0	0	0
8	County-Other	Crosby	115	18	0	0	0	0	0	0	0	0	0	0	0	0
9	County-Other	Hale	115	18	0	0	0	0	0	0	0	0	0	0	0	0
10	Ralls	Crosby	115	18	0	0	0	0	0	0	0	0	0	0	0	0
11	County-Other	Garza	118	18	0	0	0	0	0	0	0	0	0	0	0	0
12	Idalou	Lubbock	119	18	0	0	0	0	0	0	0	0	0	0	0	0
13	County-Other	Lynn	120	18	0	0	0	0	0	0	0	0	0	0	0	0
14	County-Other	Parmer	120	18	0	0	0	0	0	0	0	0	0	0	0	0
15	County-Other	Swisher	121	18	0	0	0	0	0	0	0	0	0	0	0	0
16	County-Other	Floyd	123	18	0	0	0	0	0	0	0	0	0	0	0	0
17	County-Other	Hockley	124	18	0	0	0	0	0	0	0	0	0	0	0	0
18	County-Other	Yoakum	125	18	0	0	0	0	0	0	0	0	0	0	0	0
19	Smyer	Hockley	125	18	0	0	0	0	0	0	0	0	0	0	0	0
20	County-Other	Terry	128	18	0	0	0	0	0	0	0	0	0	0	0	0
21	County-Other	Deaf Smith	129	18	0	0	0	0	0	0	0	0	0	0	0	0
22	Shallowater	Lubbock	133	18	0	0	0	0	0	0	0	0	0	0	0	0

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Table 4.4-5 Continued

Number	Water User Group	County	Year 2000 (gpcd)	Plumbing Fixtures Potential (gpcd)	Additional Water Conservation Needed to Meet Region O Goals						Additional Water Conservation Potentials of Plumbing Fixture Retrofit					
					2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
23	Slaton	Lubbock	136	18	0	0	0	0	0	0	0	0	0	0	0	0
24	O'Donnell	Dawson	138	18	0	0	0	0	0	0	0	0	0	0	0	0
25	County-Other	Bailey	143	18	0	0	0	0	0	0	0	0	0	0	0	0
26	Wolfforth	Lubbock	144	18	0	0	0	0	0	0	0	0	0	0	0	0
27	Tahoka	Lynn	145	18	0	0	0	0	0	0	0	0	0	0	0	0
28	Silverton	Briscoe	146	18	0	0	0	0	0	0	0	0	0	0	0	0
29	Ropesville	Hockley	147	18	0	0	0	0	0	0	0	0	0	0	0	0
30	Bovina	Parmer	147	18	0	0	0	0	0	0	0	0	0	0	0	0
31	County-Other	Dickens	149	18	0	0	0	0	0	0	0	0	0	0	0	0
32	County-Other	Castro	150	18	0	0	0	0	0	0	0	0	0	0	0	0
33	Post	Garza	150	18	0	0	0	0	0	0	0	0	0	0	0	0
34	Levelland	Hockley	154	18	0	0	0	0	0	0	0	0	0	0	0	0
35	Happy	Swisher	156	18	0	0	0	0	0	0	0	0	0	0	0	0
36	County-Other	Briscoe	158	18	0	0	0	0	0	0	0	0	0	0	0	0
37	County-Other	Cochran	159	18	0	0	0	0	0	0	0	0	0	0	0	0
38	Seagraves	Gaines	159	18	0	0	0	0	0	0	0	0	0	0	0	0
39	New Deal	Lubbock	159	18	0	0	0	0	0	0	0	0	0	0	0	0
40	Floydada	Floyd	161	18	0	0	0	0	0	0	0	0	0	0	0	0
41	Plainview	Hale	163	18	0	0	0	0	0	0	0	0	0	0	0	0
42	Hart	Castro	166	18	0	0	0	0	0	0	0	0	0	0	0	0
43	Crosbyton	Crosby	167	18	0	0	0	0	0	0	0	0	0	0	0	0
44	Lorenzo	Crosby	169	18	0	0	0	0	0	0	0	0	0	0	0	0
45	Hale Center	Hale	176	18	0	0	0	0	0	0	0	0	0	0	0	0
46	Tulia	Swisher	178	18	3	0	0	0	0	0	3	0	0	0	0	0
47	Amherst	Lamb	184	18	8	5	2	0	0	0	8	5	2	0	0	0
48	Olton	Lamb	185	18	10	6	4	1	0	0	10	6	4	1	0	0
49	Anton	Hockley	186	18	10	7	4	1	0	0	10	7	4	1	0	0
50	Friona	Parmer	186	18	10	7	4	1	0	0	10	7	4	1	0	0

Continued on next page

Table 4.4-5 Concluded

Number	Water User Group	County	Year 2000 (gpcd)	Plumbing Fixtures Potential (gpcd)	Additional Water Conservation Needed to Meet Region O Goals						Additional Water Conservation Potentials of Plumbing Fixture Retrofit					
					2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)	2010 (gpcd)	2020 (gpcd)	2030 (gpcd)	2040 (gpcd)	2050 (gpcd)	2060 (gpcd)
51	Sudan	Lamb	187	18	12	9	6	3	2	2	12	9	3	3	3	2
52	County-Other	Motley	193	18	14	14	11	8	6	6	14	11	8	5	3	3
53	Muleshoe	Bailey	193	18	14	14	11	8	7	7	14	11	8	5	4	4
54	Abernathy	Hale	193	18	14	13	11	8	7	7	14	10	8	5	4	4
55	Sundown	Hockley	193	18	13	13	10	7	6	6	13	10	7	4	3	3
56	Petersburg	Hale	195	18	14	15	12	9	8	8	13	10	7	4	3	3
57	Morton	Cochran	198	18	15	19	16	13	12	12	14	11	8	5	4	4
58	Dimmitt	Castro	199	18	14	19	16	13	12	12	13	10	7	4	3	3
59	Earth	Lamb	200	18	15	20	17	14	13	13	14	10	7	4	3	3
60	Littlefield	Lamb	203	18	15	24	21	18	17	17	14	11	8	5	4	4
61	Lubbock	Lubbock	209	18	17	30	27	24	23	23	14	11	8	5	4	4
62	Denver City	Yoakum	214	18	15	31	31	28	27	27	13	10	7	4	3	3
63	Hereford	Deaf Smith	218	18	18	33	36	33	32	32	15	11	8	5	4	4
64	Lamesa	Dawson	223	18	18	34	41	38	37	37	15	11	8	5	4	4
65	Spur	Dickens	226	18	18	34	44	41	39	39	14	11	8	5	3	3
66	County-Other	Lamb	230	18	18	34	47	44	43	43	14	10	7	4	3	3
67	Plains	Yoakum	233	18	18	34	51	48	47	47	14	10	8	5	4	4
68	Farwell	Parmer	242	18	20	37	53	57	56	56	15	11	8	5	4	4
69	Brownfield	Terry	244	18	18	36	53	58	57	57	13	10	7	4	3	3
70	Ransom Canyon	Lubbock	274	18	21	42	61	79	89	89	13	10	8	6	5	5
71	Matador	Motley	288	18	25	46	66	83	100	102	15	12	9	6	4	4
72	Seminole	Gaines	305	18	24	48	68	87	105	118	13	10	7	4	3	3

* Listed in order of low to high per capita water use in year 2000.

Table 4.4-6 (Revised)
Water Conservation Potentials of
Plumbing Retrofit, Clothes Washer Retrofit, and Lawn Watering
Llano Estacado Water Planning Region

Water User Group		County	Water Conservation Potentials from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
1	Meadow	Terry	0	0	0	0	0	0
2	County-Other	Gaines	0	0	0	0	0	0
3	Lockney	Floyd	0	0	0	0	0	0
4	Wilson	Lynn	0	0	0	0	0	0
5	County-Other	Lubbock	0	0	0	0	0	0
6	Kress	Swisher	0	0	0	0	0	0
7	County-Other	Dawson	0	0	0	0	0	0
8	County-Other	Crosby	0	0	0	0	0	0
9	County-Other	Hale	0	0	0	0	0	0
10	Ralls	Crosby	0	0	0	0	0	0
11	County-Other	Garza	0	0	0	0	0	0
12	Idalou	Lubbock	0	0	0	0	0	0
13	County-Other	Lynn	0	0	0	0	0	0
14	County-Other	Parmer	0	0	0	0	0	0
15	County-Other	Swisher	0	0	0	0	0	0
16	County-Other	Floyd	0	0	0	0	0	0
17	County-Other	Hockley	0	0	0	0	0	0
18	County-Other	Yoakum	0	0	0	0	0	0
19	Smyer	Hockley	0	0	0	0	0	0
20	County-Other	Terry	0	0	0	0	0	0
21	County-Other	Deaf Smith	0	0	0	0	0	0
22	Shallowater	Lubbock	0	0	0	0	0	0
23	Slaton	Lubbock	0	0	0	0	0	0
24	O'Donnell	Dawson	0	0	0	0	0	0
25	County-Other	Bailey	0	0	0	0	0	0
26	Wolfforth	Lubbock	0	0	0	0	0	0
27	Tahoka	Lynn	0	0	0	0	0	0
28	Silverton	Briscoe	0	0	0	0	0	0
29	Ropesville	Hockley	0	0	0	0	0	0
30	Bovina	Parmer	0	0	0	0	0	0
31	County-Other	Dickens	0	0	0	0	0	0
32	County-Other	Castro	0	0	0	0	0	0

Continued on next page

Table 4.4-6 Concluded

	Water User Group	***County***	**Water Conservation Potentials from Plumbing Fixtures Retrofit and Lawn Watering**					
			2010 (acft/yr)	***2020 (acft/yr)***	***2030 (acft/yr)***	***2040 (acft/yr)***	***2050 (acft/yr)***	***2060 (acft/yr)***
33	Post	Garza	0	0	0	0	0	0
34	Levelland	Hockley	0	0	0	0	0	0
35	Happy	Swisher	0	0	0	0	0	0
36	County-Other	Briscoe	0	0	0	0	0	0
37	County-Other	Cochran	0	0	0	0	0	0
38	Seagraves	Gaines	0	0	0	0	0	0
39	New Deal	Lubbock	0	0	0	0	0	0
40	Floydada	Floyd	0	0	0	0	0	0
41	Plainview	Hale	0	0	0	0	0	0
42	Hart	Castro	0	0	0	0	0	0
43	Crosbyton	Crosby	0	0	0	0	0	0
44	Lorenzo	Crosby	0	0	0	0	0	0
45	Hale Center	Hale	0	0	0	0	0	0
46	Tulia	Swisher	18	0	0	0	0	0
47	Amherst	Lamb	7	5	2	0	0	0
48	Olton	Lamb	27	17	12	3	0	0
49	Anton	Hockley	14	11	6	2	0	0
50	Friona	Parmer	46	34	20	5	0	0
51	Sudan	Lamb	15	12	8	4	3	3
52	County-Other	Motley						
53	Muleshoe	Bailey	79	81	67	51	44	44
54	Abernathy	Hale	50	48	43	32	28	27
55	Sundown	Hockley	24	25	19	14	11	11
56	Petersburg	Hale	21	24	20	16	14	14
57	Morton	Cochran	41	56	48	38	34	32
58	Dimmitt	Castro	75	110	97	81	75	74
59	Earth	Lamb	20	28	25	21	20	17
60	Littlefield	Lamb	118	196	181	161	151	149
61	Lubbock	Lubbock	4,132	7,662	7,112	6,441	6,256	6,405
62	Denver City	Yoakum	77	169	179	171	160	155
63	Hereford	Deaf Smith	302	572	649	610	596	598
64	Lamesa	Dawson	212	400	501	471	448	431
65	Spur	Dickens	21	42	54	50	48	48
66	County-Other	Lamb						
67	Plains	Yoakum	33	68	106	107	102	98
68	Farwell	Parmer	33	64	94	101	97	91
69	Brownfield	Terry	211	448	687	802	793	788
70	Ransom Canyon	Lubbock	35	90	162	248	325	342
71	Matador	Motley	20	37	49	57	63	62
72	Seminole	Gaines	178	384	588	778	938	1,035
Total			**5,809**	**10,583**	**10,729**	**10,264**	**10,206**	**10,424**

Table 4.4-7. Costs of Plumbing Fixture and Clothes Washer Retrofit and Lawn Watering Water Conservation Llano Estacado Water Planning Region

	Water User Group	County	Estimated Costs of Water Conservation from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (dollars)	2020 (dollars)	2030 (dollars)	2040 (dollars)	2050 (dollars)	2060 (dollars)
1	Meadow	Terry	0	0	0	0	0	0
2	County-Other	Gaines	0	0	0	0	0	0
3	Lockney	Floyd	0	0	0	0	0	0
4	Wilson	Lynn	0	0	0	0	0	0
5	County-Other	Lubbock	0	0	0	0	0	0
6	Kress	Swisher	0	0	0	0	0	0
7	County-Other	Dawson	0	0	0	0	0	0
8	County-Other	Crosby	0	0	0	0	0	0
9	County-Other	Hale	0	0	0	0	0	0
10	Ralls	Crosby	0	0	0	0	0	0
11	County-Other	Garza	0	0	0	0	0	0
12	Idalou	Lubbock	0	0	0	0	0	0
13	County-Other	Lynn	0	0	0	0	0	0
14	County-Other	Parmer	0	0	0	0	0	0
15	County-Other	Swisher	0	0	0	0	0	0
16	County-Other	Floyd	0	0	0	0	0	0
17	County-Other	Hockley	0	0	0	0	0	0
18	County-Other	Yoakum	0	0	0	0	0	0
19	Smyer	Hockley	0	0	0	0	0	0
20	County-Other	Terry	0	0	0	0	0	0
21	County-Other	Deaf Smith	0	0	0	0	0	0
22	Shallowater	Lubbock	0	0	0	0	0	0
23	Slaton	Lubbock	0	0	0	0	0	0
24	O'Donnell	Dawson	0	0	0	0	0	0
25	County-Other	Bailey	0	0	0	0	0	0
26	Wolfforth	Lubbock	0	0	0	0	0	0
27	Tahoka	Lynn	0	0	0	0	0	0
28	Silverton	Briscoe	0	0	0	0	0	0
29	Ropesville	Hockley	0	0	0	0	0	0
30	Bovina	Parmer	0	0	0	0	0	0
31	County-Other	Dickens	0	0	0	0	0	0
32	County-Other	Castro	0	0	0	0	0	0
33	Post	Garza	0	0	0	0	0	0
34	Levelland	Hockley	0	0	0	0	0	0
35	Happy	Swisher	0	0	0	0	0	0

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Table 4.4-7 Concluded

Water User Group		County	Estimated Costs of Water Conservation from Plumbing Fixtures Retrofit and Lawn Watering					
			2010 (dollars)	2020 (dollars)	2030 (dollars)	2040 (dollars)	2050 (dollars)	2060 (dollars)
36	County-Other	Briscoe	0	0	0	0	0	0
37	County-Other	Cochran	0	0	0	0	0	0
38	Seagraves	Gaines	0	0	0	0	0	0
39	New Deal	Lubbock	0	0	0	0	0	0
40	Floydada	Floyd	0	0	0	0	0	0
41	Plainview	Hale	0	0	0	0	0	0
42	Hart	Castro	0	0	0	0	0	0
43	Crosbyton	Crosby	0	0	0	0	0	0
44	Lorenzo	Crosby	0	0	0	0	0	0
45	Hale Center	Hale	0	0	0	0	0	0
46	Tulia	Swisher	10,101	0	0	0	0	0
47	Amherst	Lamb	4,193	2,787	1,173	0	0	0
48	Olton	Lamb	15,163	9,679	6,787	1,759	0	0
49	Anton	Hockley	8,113	5,925	3,469	868	0	0
50	Friona	Parmer	25,727	19,130	11,206	2,821	0	0
51	Sudan	Lamb	8,265	6,594	3,959	2,396	1,817	1,568
52	County-Other	Motley						
53	Muleshoe	Bailey	44,053	42,868	34,469	25,293	21,831	21,430
54	Abernathy	Hale	27,248	24,686	21,580	15,566	13,449	13,182
55	Sundown	Hockley	13,688	12,884	9,935	6,682	5,377	5,112
56	Petersburg	Hale	11,503	12,377	10,078	7,411	6,390	6,267
57	Morton	Cochran	22,707	27,460	23,105	17,744	15,416	14,666
58	Dimmitt	Castro	41,337	53,182	45,521	36,599	33,021	32,441
59	Earth	Lamb	10,882	13,391	11,614	9,491	8,594	8,479
60	Littlefield	Lamb	64,725	92,969	83,321	71,384	66,031	65,173
61	Lubbock	Lubbock	2,060,997	3,401,772	3,097,619	2,737,439	2,633,015	2,695,807
62	Denver City	Yoakum	41,299	76,513	78,094	72,252	66,984	64,710
63	Hereford	Deaf Smith	161,472	259,950	282,905	258,767	250,525	251,263
64	Lamesa	Dawson	112,521	181,203	216,082	198,426	186,904	179,828
65	Spur	Dickens	11,331	18,807	23,019	20,968	19,601	19,601
66	County-Other	Lamb						
67	Plains	Yoakum	17,369	30,599	45,256	44,414	41,992	40,576
68	Farwell	Parmer	16,995	28,613	39,744	42,015	39,726	37,532
69	Brownfield	Terry	108,354	199,174	289,463	329,799	323,839	322,040
70	Ransom Canyon	Lubbock	16,898	38,910	67,875	101,807	132,633	139,628
71	Matador	Motley	10,028	16,265	20,641	23,283	25,752	25,161
72	Seminole	Gaines	86,784	166,714	244,685	317,131	379,477	418,268
Total			**2,951,753**	**4,742,452**	**4,671,600**	**4,344,315**	**4,272,374**	**4,362,732**

Revised text of page 4-104, last paragraph, and top of page 4-109

The municipal water conservation water management strategy is estimated to meet 5,809 acft/yr of municipal water needs in Region O in 2010, 10,583 acft/yr in 2020, 10,729 acft/yr in 2030, and 10,424 acft/yr in 2060 [Table 4.4-6 (Revised]. The values for each WUG having a projected need will be used as a water management strategy to meet a part of the WUG's projected water needs (shortages) in the Regional Water Plan, with the associated cost for the water conservation water management strategy as shown in Table 4.4-7 (Revised). Estimated cost of the water conservation water management strategy for the Region is $2,951,753 in 2010, and increases to $4,362,732 in 2060 [Table 4.4-7 (Revised]. Cost per acft in year 2010 is approximately $508, and in 2060 is approximately $419.

Revised text of pages 4-335, 4-336, 4-337, 4-338, and 4-339

4.5.15 Lubbock County Water Supply Plan

Table 4.5-59 (Revised) lists each water user group in Lubbock County and its corresponding surplus or shortage in years 2030 and 2060. For each water user group with a projected shortage, a water supply plan has been developed and is presented in the following subsections.

Table 4.5-59. (Revised)
Lubbock County Surplus/Shortage

Water User Group	Surplus/Shortage[1] 2030 (acft/yr)	Surplus/Shortage[1] 2060 (acft/yr)	Comment
City of Abernathy			See Hale County
City of Idalou	0	-272	Projected shortage – see plan below
City of Lubbock	-7,704	-13,613	Projected shortage – see plan below
City of New Deal	-20	-20	Projected shortage – see plan below
City of Ransom Canyon	0	0	Projected surplus
City of Shallowater	-190	-184	Projected shortage – see plan below
City of Slaton	499	533	Projected surplus
City of Wolfforth	-1,522	-1,787	Projected shortage – see plan below
County Other	0	0	No projected surplus/shortage
Industrial	0	0	No projected surplus/shortage
Steam Electric	0	0	No projected surplus/shortage
Mining	0	0	No projected surplus/shortage
Irrigation	-89,289	-90,742	Projected shortage –see plan below
Beef Feedlot Livestock	0	0	No projected surplus/shortage
Range & All Other Livestock	0	0	No projected surplus/shortage

[1] From Table 4-15, Section 4.1 – Water Needs Projections by Water User Group.

* Computations are at the county level of detail, and although the county data show a surplus or shortage, there no doubt are individual water users of each county who have a shortage when the county shows an overall surplus; e.g., the projected surplus water is not located such that those who have shortages can obtain it.

4.5.15.3 The City of Lubbock

4.5.15.3.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2015.

4.5.15.3.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Lubbock.

- Municipal water conservation, and
- Lake Alan Henry Pipeline
- City of Lubbock Well Field
- Lubbock Expand Bailey County Well Field
- CRMWA Expand Capacity of Groundwater Supply
- Lubbock Brackish Groundwater Desalination
- Jim Bertram Lake System Expansion, and
- Lubbock North Fork Scalping Operation.

4.5.15.3.3 Costs

Costs of the recommended plan for the City of Lubbock are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1 (Revised), Table 4.4-7 (Revised)
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-61 (Revised) for a cost summary of this option.

b. Lake Alan Henry Pipeline:
   - Cost Source: Section 4.4.3.2, Table 4.4-50
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $174,909,000
   - Annual Cost: See Table 4.5-61 (Revised) for a cost summary of this option.

c. City of Lubbock Well Field:
   - Cost Source: Section 4.4.3.3, Table 4.4-51
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $7,718,000
   - Annual Cost: See Table 4.5-61(Revised) for a cost summary of this option.

d. Lubbock Expand Capacity of Bailey County Well Field
   - Cost Source: Section 4.4.3.4, Table 4.4-52
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $2,541,000
   - Annual Cost: See Table 4.5-61 (Revised) for a cost summary of this option.

e. CRMWA Expand Capacity of Groundwater Supply
   - Cost Source: Section 4.4.3.5, Table 4.4-53
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: ($79,052,000 to expand 31,659 acft/yr and add 15,000 acft/yr to replace lost capacity; annual cost is $10,255,800; Lubbock share of expansion is 37.058 percent of cost and quantity.)
   - Annual Cost: See Table 4.5-61 for a cost summary of this option.

f. Lubbock Brackish Groundwater Desalination
   - Cost Source: Section 4.4.3.6, Table 4.4-54
   - Date to be Implemented: 2020
   - Total Project Cost: $10,051,230
   - Annual Cost: See Table 4.5-61 (Revised) for a cost summary of this option.

g. Lubbock Jim Bertram Lake System Expansion
   - Cost Source: Section 4.4.3.7. Table 4.4-57
   - Date to be Implemented: 2020
   - Total Project Cost: $150,759,000
   - Annual Cost: See Table 4.5-61 (Revised) for a cost summary of this option.

h. Lubbock North Fork Scalping Operation
   - Cost Source: Section 4.4.3.8. Table 4.4-63
   - Date to be Implemented: 2045
   - Total Project Cost: $50,055,000
   - Annual Cost: See Table 4.5-61 (Revised) for a cost summary of this option.

Table 4.5-61. (Revised)
Recommended Plan Costs by Decade for the City of Lubbock

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	2,643	4,375	7,704	10,522	12,210	13,613
Municipal Water Conservation (Strategy is included until the regional goal of 172 gpcd is reached)						
Quantity Available (acft/yr)	4,132	7,662	7,112	6,441	6,256	6,405
Annual Cost ($/yr) (millions)	$2.061	$3.402	$3.098	$2.737	$2.633	$2.696
Unit Cost ($/acft)	$499	$444	$436	$425	$421	$421
Lake Alan Henry Pipeline						
Quantity Available (acft/yr)	0	22,230	22,230	22,230	22,230	22,230
Annual Cost ($/yr) (millions)	—	$26.584	$26.584	$26.584	$26.584	$26.584
Unit Cost ($/acft)	—	$1,196	$1,196	$1,196	$1,196	$1,196
City of Lubbock Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr) (millions)	$1.644	$1.644	$1.644	$1.644	$1.644	$1.644
Unit Cost ($/acft)	$294	$294	$294	$294	$294	$294
Expand Bailey County Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr)	$213,000	$213,000	$213,000	$213,000	$213,000	$213,000
Unit Cost ($/acft)	$38	$38	$38	$38	$38	$38
CRMWA Expand Groundwater Supply (See 4.5.15.3.3e above)						
Quantity Available (acft/yr)	14,911	14,911	14,911	14,911	14,911	14,911
Annual Cost ($/yr) (millions)	$3.340	$3.340	$4.175	$2.222	$1.983	$1.431
Unit Cost ($/acft)*	$224	$224	$280	$149	$133	$96
Lubbock Brackish Groundwater Desalination						
Quantity Available (acft/yr)**	3,360	3,360	3,360	3,360	3,360	3,360
Annual Cost ($/yr) (millions)*	$1.700	$1.700	$1.700	$1.700	$1.700	$1.700
Unit Cost ($/acft)*	$506	$506	$506	$506	$506	$506
Lubbock Jim Bertram Lake System Expansion						
Quantity Available (acft/yr)**	0	21,200	21,200	21,200	21,200	21,200
Annual Cost ($/yr) (millions)*	—	$14.575	$14.575	$14.575	$14.575	$14.575
Unit Cost ($/acft)*	—	$688	$688	$688	$688	$688
Lubbock North Fork Scalping Operation						
Quantity Available (acft/yr)**	0	0	0	0	4,000	4,000
Annual Cost ($/yr) (millions)*	—	—	—	—	4.296	4.296
Unit Cost ($/acft)*	—	—	—	—	$1,074	$1,074

Revised text of pages 4-373, 4-374, 4-375, 4-376, and 4-377

4.5.22 Water Supply Plans for Wholesale Water Providers

Table 4.5-88 (Revised) lists each Wholesale Water Provider identified by the Llano Estacado RWPG and their corresponding surplus or shortage in years 2030 and 2060. Water supply plans have been developed for CRMWA, City of Lubbock, and WRMWD are described below. Mackenzie Municipal Water Authority is also projected have a shortage during the planning period; however no plan has been developed for this entity. Instead, a plan to develop locally available groundwater has been developed for each of the MMWA customers with a projected need.

Table 4.5-88. (Revised)
Wholesale Water Provider Surplus/Shortage

Water User Group	*Surplus/Shortage*[1]		*Comment*
	2030 (acft/yr)	2060 (acft/yr)	
Canadian River Municipal Water Authority (CRMWA)	772	-7,032	Projected shortage – see plan below
City of Lubbock	-9,615	-15,824	Projected shortage – see plan below
Mackenzie Municipal Water Authority (MMWA)	-2,128	-1,936	Projected shortage – see comment above
White River Municipal Water District (WRMWD)	-686	-1,489	Projected shortage – see plan below

[1] From Table 4-23, Section 4.2 – Water Needs Projections by Major Water Provider.

4.5.22.2 The City of Lubbock (See Sections 4.4.3 and 4.5.15.3)

4.5.22.2.1 Description of Supply

- **Source:** Ogallala Aquifer and Lake Meredith
- **Current Supply:** Adequate to meet demands through 2005.

4.5.22.2.2 Water Supply Plan

Working within the planning criteria established by the Llano Estacado RWPG and TWDB, the following water supply plan is recommended for the City of Lubbock.

- Municipal water conservation,
- Lake Alan Henry Pipeline,

- City of Lubbock Well Field,
- Lubbock Expand Bailey County Well Field,
- CRMWA Expand Capacity of Groundwater Supply,
- Lubbock Brackish Groundwater Desalination,
- Jim Bertram Lake System Expansion, and
- Lubbock North Fork Scalping Operation.

4.5.22.2.3 Costs

Costs of the recommended plan for the City of Lubbock are:

a. Municipal water conservation:
   - Cost Source: Section 4.4.1, Table 4.4-7 (Revised)
   - Date to be Implemented: Prior to 2010
   - Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

b. Lake Alan Henry Pipeline:
   - Cost Source: Section 4.4.3.2, Table 4.4-50
   - Date to be Implemented: Prior to 2020
   - Total Project Cost: $174,909,000
   - Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

c. City of Lubbock Well Field:
   - Cost Source: Section 4.4.3.3, Table 4.4-51
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $7,718,000
   - Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

d. Lubbock Expand Capacity of Bailey County Well Field
   - Cost Source: Section 4.4.3.4, Table 4.4-52
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: $2,541,000
   - Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

e. CRMWA Expand Capacity of Groundwater Supply
   - Cost Source: Section 4.4.3.5, table 4.4-53
   - Date to be Implemented: Prior to 2010
   - Total Project Cost: ($79,398,000 to expand 31,659 acft/yr and add 15,000 acft/yr to replace lost capacity; annual cost is $10,255,800; Lubbock share of expansion is 37.058 percent of cost and quantity.)
   - Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

f. Lubbock Brackish Groundwater Desalination
   - Cost Source: Section 4.4.3.6 table 4.4-54

- Date to be Implemented: Prior to 2010
- Total Project Cost: $10,051,230
- Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

g. Jim Bertram Lake System Expansion

- Cost Source: Section 4.4.3.7, table 4.4-57
- Date to be Implemented: Prior to 2020
- Total Project Cost: $150,759,000
- Annual Cost: See Table 4.5-90 for a cost summary of this option.

h. Lubbock North Fork Scalping Operation

- Cost Source: Section 4.4.3.8, table 4.4-62
- Date to be Implemented: Prior to 2045
- Total Project Cost: $50,055,000
- Annual Cost: See Table 4.5-90 (Revised) for a cost summary of this option.

Table 4.5-90 (Revised).
Recommended Plan Costs by Decade for the City of Lubbock (WWP)

Plan Element	2010	2020	2030	2040	2050	2060
Projected Shortage (acft/yr)	4,263	6,147	9,615	12,554	14,378	15,824
Municipal Water Conservation (Strategy is included until the regional goal of 172 gpcd is reached)						
Quantity Available (acft/yr)	4,132	7,662	7,112	6,441	6,256	6,405
Annual Cost ($/yr) (millions)	$2.061	$3.402	$3.098	$2.737	$2.633	$2.696
Unit Cost ($/acft)	$499	$444	$436	$425	$421	$421
Lake Alan Henry Pipeline						
Quantity Available (acft/yr)	0	22,230	22,230	22,230	22,230	22,230
Annual Cost ($/yr) (millions)	—	$26.584	$26.584	$26.584	$26.584	$26.584
Unit Cost ($/acft)	—	$1,196	$1,196	$1,196	$1,196	$1,196
City of Lubbock Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr) (millions)	$1.644	$1.644	$1.644	$1.644	$1.644	$1.644
Unit Cost ($/acft)	$294	$294	$294	$294	$294	$294
Expand Bailey County Well Field						
Quantity Available (acft/yr)	5,600	5,600	5,600	5,600	5,600	5,600
Annual Cost ($/yr)	$213,000	$213,000	$213,000	$213,000	$213,000	$213,000
Unit Cost ($/acft)	$38	$38	$38	$38	$38	$38
CRMWA Expand Groundwater Supply (See 4.5.15.3.3e above)						
Quantity Available (acft/yr)	14,911	14,911	14,911	14,911	14,911	14,911
Annual Cost ($/yr) (millions)	$3.340	$3.340	$4.175	$2.222	$1.983	$1.431
Unit Cost ($/acft)*	$224	$224	$280	$149	$133	$96
Lubbock Brackish Groundwater Desalination						
Quantity Available (acft/yr)**	3,360	3,360	3,360	3,360	3,360	3,360
Annual Cost ($/yr) (millions)*	1.700	1.700	1.700	1.700	1.700	1.700
Unit Cost ($/acft)*	$506	$506	$506	$506	$506	$506
Lubbock Jim Bertram Lake System Expansion						
Quantity Available (acft/yr)**	—	21,200	21,200	21,200	21,200	21,200
Annual Cost ($/yr) (millions)*	—	$14.575	$14.575	$14.575	$14.575	$14.575
Unit Cost ($/acft)*	—	$688	$688	$688	$688	$688
Lubbock North Fork Scalping Operation						
Quantity Available (acft/yr)**	0	0	0	0	4,000	4,000
Annual Cost ($/yr) (millions)*	—	—	—	—	$4.296	$4.296
Unit Cost ($/acft)*	—	—	—	—	$1,074	$1,074

Table 4-24 (Revised).
Projected Municipal and Irrigation Water Needs (Shortages) and Socioeconomic Impacts of Failing to Meet Projected Water Needs (Shortages)
Llano Estacado Water Planning Region

Counties	Units	Years					
		2010	2020	2030	2040	2050	2060
Projected Municipal Water Needs (shortages)							
Bailey	acft/yr	0	0	0	0	0	0
Briscoe	acft/yr	235	222	215	208	200	194
Castro	acft/yr	0	0	1,137	1,159	1,410	1,386
Cochran	acft/yr	0	560	565	547	521	496
Crosby	acft/yr	0	0	41	76	415	762
Dawson	acft/yr	0	0	0	0	0	0
Deaf Smith	acft/yr	0	0	0	0	0	0
Dickens	acft/yr	0	0	0	0	151	257
Floyd	acft/yr	0	0	240	234	244	212
Gaines	acft/yr	449	482	502	513	506	499
Garza	acft/yr	22	22	22	283	265	228
Hale	acft/yr	0	508	1,035	1,044	1,344	1,318
Hockley	acft/yr	263	620	716	704	673	702
Lamb	acft/yr	0	412	426	717	709	700
Lubbock	acft/yr	3,897	6,173	9,624	12,800	14,609	16,062
Lynn	acft/yr	0	68	65	63	60	55
Motley	acft/yr	0	0	0	0	0	0
Parmer	acft/yr	0	405	1,289	1,278	1,231	1,162
Swisher	acft/yr	521	521	522	520	517	513
Terry	acft/yr	0	115	280	435	458	457
Yoakum	acft/yr	0	448	1,640	1,708	1,654	1,598
Total Municipal Needs (Shortages)	**acft/yr**	**5,387**	**10,556**	**18,319**	**22,289**	**24,967**	**26,601**

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Table 4-24 continued

Counties	Units	Years					
		2010	2020	2030	2040	2050	2060
Projected Irrigation Water Needs (shortages)							
Bailey	acft/yr	85,285	92,076	92,835	94,094	94,354	93,597
Briscoe	acft/yr	0	4,822	12,136	13,651	14,886	14,581
Castro	acft/yr	146,143	192,522	265,683	355,947	357,456	351,768
Cochran	acft/yr	39,909	38,596	37,006	35,505	76,645	72,644
Crosby	acft/yr	10,888	10,431	10,185	9,728	8,353	7,960
Dawson	acft/yr	95,781	94,812	90,085	86,142	79,397	73,240
Deaf Smith	acft/yr	168,813	193,978	222,967	253,025	245,379	240,650
Dickens	acft/yr	3,407	3,266	3,133	2,999	2,868	2,737
Floyd	acft/yr	90,731	106,390	108,967	108,966	105,148	100,072
Gaines	acft/yr	67,572	105,734	119,738	127,900	134,572	140,268
Garza	acft/yr	4,712	4,301	3,995	3,721	3,455	3,212
Hale	acft/yr	20,936	55,454	139,354	206,865	224,491	223,093
Hockley	acft/yr	62,401	74,555	81,841	86,796	82,789	80,584
Lamb	acft/yr	114,256	158,591	202,325	240,170	250,798	253,586
Lubbock	acft/yr	66,665	85,695	95,320	106,660	100,194	96,308
Lynn	acft/yr	0	0	0	0	0	0
Motley	acft/yr	1,332	1,266	1,208	1,154	1,092	1,025
Parmer	acft/yr	160,682	331,096	361,917	358,080	354,283	350,632
Swisher	acft/yr	22,755	60,445	95,896	105,407	107,622	107,552
Terry	acft/yr	74,855	92,101	101,339	106,651	98,164	90,149
Yoakum	acft/yr	23,779	22,744	21,868	20,553	19,434	18,485
Total Irrigation Needs (Shortages)	**acft/yr**	**1,260,902**	**1,728,875**	**2,067,798**	**2,324,014**	**2,361,380**	**2,322,143**
Projected Total Water Demands (Table 4-22)	**acft/yr**	**4,380,400**	**4,227,446**	**4,090,338**	**3,953,303**	**3,824,795**	**3,704,336**
Projected Total Water Supplies (Table 4-22)	**acft/yr**	**3,185,430**	**2,562,776**	**2,077,223**	**1,684,932**	**1,519,388**	**1,442,745**
Projected Needs (Sum of Municipal and Irrigation Shortages)	**acft/yr**	**1,266,289**	**1,739,431**	**2,086,117**	**2,346,303**	**2,386,347**	**2,348,744**

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Table 4-24 continued

Counties	Units	Years					
		2010	2020	2030	2040	2050	2060
Socioeconomic Impacts of Shortages							
Irrigated Agriculture Water User Group							
Projected Needs (Shortages)	acft/yr	1,260,902	1,728,875	2,067,798	2,643,604	2,361,380	2,322,143
Sales (gross value)	$ Million/Yr	194.24	310.39	522.60	680.36	740.90	757.34
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	71.81	119.01	195.66	252.41	274.65	280.53
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	6.32	10.69	17.64	22.75	24.74	35.28
Jobs Lost	Number	2,910	4,800	10,980	9,900	10,750	10,980
Municipal Water User Group							
Projected Needs (Shortages)	acft/yr	2,744	6,181	11,147	12,309	15,142	13,260
Water Intensive Commercial Businesses							
Sales (gross value)	$ Million/Yr	63.08	88.89	95.84	97.65	99.65	99.17
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	29.35	41.9	45.15	46.02	47.72	46.68
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	3.41	4.72	5.76	5.88	6.77	6.63
Jobs Lost	Number	1,420	2,025	2,180	2,225	2,310	2,260
Horticulture Industry							
Sales (gross value)	$ Million/Yr	3.25	7.23	13.85	15.28	15.84	15.44
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	1.71	3.81	7.30	8.06	8.35	9.14
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	0.06	0.13	0.26	0.28	0.29	0.28
Jobs Lost	Number	90	205	390	430	450	440
Residential and Non-Water Intensive Commercial Users							
Expenses to Deal with Water shortages	$ Million/Yr	0.13	10.5	24.47	55.57	49.17	51.15

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Table 4-24 concluded

Counties	Units	Years					
		2010	**2020**	**2030**	**2040**	**2050**	**2060**
Water Utilities							
Revenue Losses	$ Million/Yr	2.79	6.1	11.49	12.46	12.85	12.55
Utility Tax Losses	$ Million/Yr	0.05	0.11	0.2	0.22	0.23	0.22
Regional Totals							
Projected Needs (Shortages)	acft/yr	1,247,401	1,715,918	2,060,306	2,318,554	2,356,613	2,318,266
Sales, Expenses to HH & Comm, & Util Revenue (gross value)	$ Million/Yr	263.49	423.11	668.25	861.32	918.41	935.65
Income (wages, salaries, benefits, corporate, rental, & interest)	$ Million/Yr	102.87	164.72	248.11	306.49	330.72	336.35
Business Taxes (sales, excise, fees, licenses, & other taxes)	$ Million/Yr	9.84	15.65	23.86	29.13	32.03	42.41
Jobs Lost	Number	4,420	7,030	13,550	12,555	13,510	13,680
Social Impacts							
Population Losses	Number	5,310	8,470	14,830	10,720	11,540	11,700
School Enrollment Declines	Number	1,245	1,995	3,590	2,320	2,495	2,530

Source: Norvel, Stuart and Kevin Kluge, Office of Water Resources Planning, "Socioeconomic Impacts of Unmet Water Needs in the Llano Estacado Water Planning Area," Texas Water Development Board, Austin, Texas, March 2005.

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