5.0 Methodology and Results

The following sections describe the methods used by the Planning Groups to assess current and projected population, water demand, water supplies, surpluses and needs, water management strategies, and costs of implementing water management strategies. A Statewide summary of the results of these assessments is also included.

5.1 Population Projections

Key Finding The population of Texas is expected to almost double in the next 50 years, from nearly 21 million in 2000 to about 40 million in 2050.

The 2000 Census indicates that Texas currently ranks as the second-most-populated state in the nation, at more than 20.8 million. Predicting how the population of Texas might grow in the future is extremely important for water planning. A larger population will, after all, require more water for municipal use, therefore increasing stress on existing water resources. Effective planning requires accurate estimates of population that can be used to assess potential future water demand.

Senate Bill 1 directed the Planning Groups to use consensus-based population projections that were developed for the 1997 State Water Plan, which, in turn, had been developed using the 1990 Census. The TWDB recognized that revision to the population projections for the 1997 State Water Plan might be necessary when conditions changed or when new information became available. TWDB staff, in coordination with staff from the TNRCC and TPWD, worked with the Planning Groups to address requests for revisions to the 1997 State Water Plan population projections.

TWDB staff calculated the population projections for the 1997 State Water Plan by using a cohort-component procedure. This procedure used the separate cohorts (age, sex, race, and ethnic groups) and components of cohort change (fertility rates, survival rates, and migration rates) to estimate future county populations. The most likely migration scenario (people moving into and out of the counties) was chosen on the basis of recent and prospective growth trends. A projected county population was then allocated to each city containing 500 or more people on the basis of each city's historic share of the county population. The rural population was calculated as the difference between the total of the projected population of the cities and the total projected county population.

The TWDB considered revisions to population projections from the 1997 State Water Plan in cases where

- it could be verified that the current population (during review period of 1998-1999) exceeded the projected population for 2000,
- the population was growing at a rate faster than what was previously projected to occur between 1990 and 2000,
- additional area had been annexed to a city, or
- the Planning Group could provide additional information that it deemed important.

This consensus process resulted in projections indicating that the population of Texas will nearly double over the 50-year period, increasing from 20.8 million in 2000 to 39.6 million in 2050 (Table 5-1, Figure 5-1). Most of the growth is expected to occur in the eastern two-thirds of the State, specifically in the Rio Grande region and in the areas surrounding Dallas-Fort Worth, Houston, and Austin.

Table 5-1. Projected population through 2050 for different planning areas.

Region	2000	2010	2020	2030	2040	2050
A	379,018	416,870	453,496	481,637	515,393	552,072
B	197,793	204,521	210,634	213,261	215,196	216,914
C	5,012,860	5,882,173	6,931,543	7,850,797	8,778,041	9,481,157
D	687,105	757,522	821,294	887,169	952,818	1,017,477
E	800,857	957,785	1,124,070	1,301,033	1,440,518	1,587,097
F	638,203	704,249	766,269	823,181	877,342	921,907
G	1,672,819	2,007,668	2,362,341	2,639,033	2,882,090	3,096,910
H	4,780,084	5,692,447	6,830,796	7,846,384	8,838,048	9,700,277
I	1,042,411	1,141,521	1,245,963	1,349,417	1,454,738	1,562,154
J	120,510	145,747	159,075	173,151	190,814	210,085
K	1,041,948	1,243,247	1,505,722	1,751,931	1,923,941	2,107,106
L	2,132,188	2,575,370	3,084,848	3,617,995	4,103,765	4,527,361
M	1,264,582	1,600,077	1,976,791	2,425,604	2,735,506	3,046,680
N	569,292	645,175	724,702	797,761	872,568	943,912
O	474,897	510,605	540,942	560,759	575,188	586,156
P	50,366	52,164	53,817	55,757	57,851	60,124
Total:	**20,864,933**	**24,537,141**	**28,792,303**	**32,774,870**	**36,413,817**	**39,617,389**

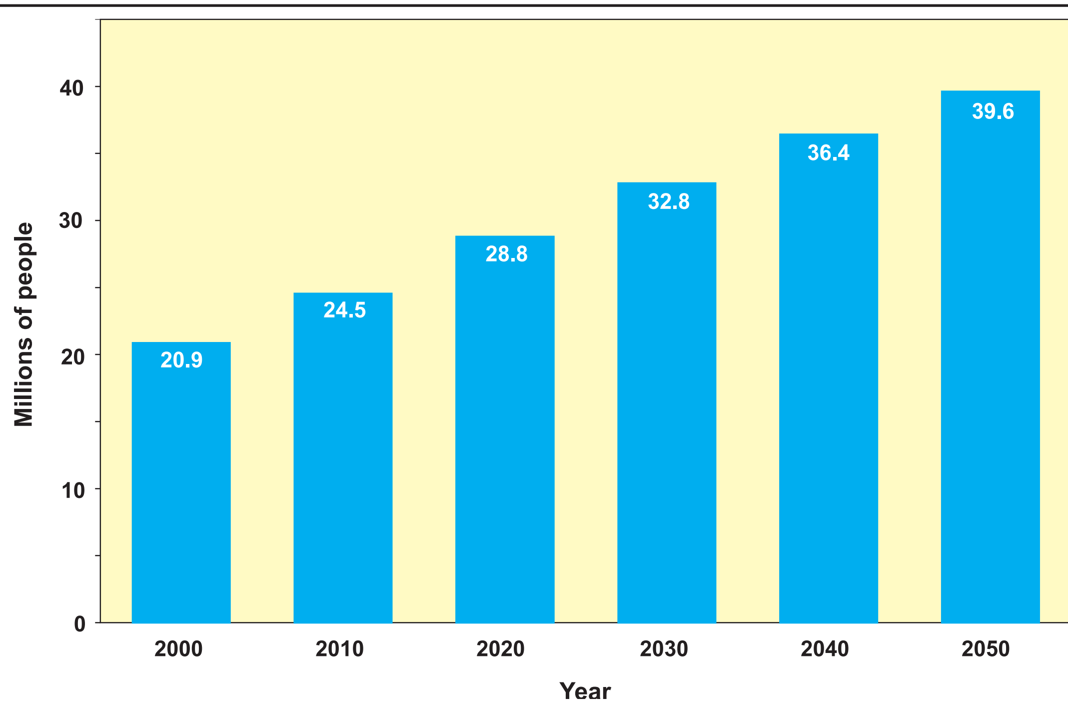

Figure 5-1. Projected population growth in Texas.

5.1.1 TWDB Projections and the 2000 Census

The TWDB has been projecting population growth in Texas for the past 45 years. A comparison of previous projections with the actual population from the 2000 Census shows that the TWDB's previous projections, ranging from 20 to 40 years in the future from the base census data, have been remarkably accurate.

The 1968 State Water Plan, based on 1960 Census data, projected the 2000 population of Texas to be 21.2 million, only 1.7 percent greater than the actual 2000 population of 20.85 million. The 1984 State Water Plan projections were based on 1980 Census data and projected that the 2000 population would fall in the range of 19.57 to 21.24 million. The 1990 State Water Plan, again based on 1980 Census data, projected the 2000 population to be 20.99 million, only 0.7 percent greater than the actual population.

A comparison of 1997 State Water Plan projections for 2000 and the 2000 Census is useful for identifying counties that may have significant errors in population projection. At the Statewide level, the TWDB projections for 2000 differed from the 2000 Census by only 13,113, a 0.063-percent difference. The percent differences between TWDB projections and the 2000 Census for individual counties and cities in certain cases are much larger than for the State as a whole. The prediction of population changes due to natural causes, the increase or decrease in population due to recent births minus recent deaths, is more reliable and straightforward than the prediction of migration. Because fertility and mortality are likely to stay the same or change at a much slower rate, they are more predictable from historical patterns. Net migration, however, can be sporadic. Unanticipated economic booms and busts may lead to surges or lulls in net migration rates.

Of all Texas counties, 165 had populations of more than 10,000 in 2000. For these counties, the TWDB's population projection for 2000 averaged 0.1 percent lower than the 2000 Census. For the 89 counties that had populations of less than 10,000, the TWDB's projection averaged 6.8 percent higher than the 2000 Census. TWDB projections were greater than the Census in 160 counties and less than the Census in 94 counties (Figures 5-2, 5-3). Counties west of Interstate Highway (IH) 35 were overprojected by 6.6 percent, whereas counties east of and including IH 35 were underprojected by nearly the same amount.

5.2 Water Demand Projections

> **Key Finding Total projected demand for water is expected to increase 18 percent, from nearly 17 million acre-feet in 2000 to 20 million acre-feet in 2050 (Tables 5-2, 5-3).**

Projecting water demands in the future is one of the fundamental elements of water supply planning. At the beginning of the planning process in 1998, the Planning Groups were provided with the water demand projections used in the 1997 State Water Plan for all water users within their planning areas. As was the case with population projections, the Planning Groups reviewed the water demand projections, focusing on areas where changed conditions or new information might justify revisions to the projections. Demand projections under drought conditions for municipal, manufacturing, steam-electric power, mining, irrigation, and livestock uses were reviewed during this effort (Figures 5-4, 5-5).

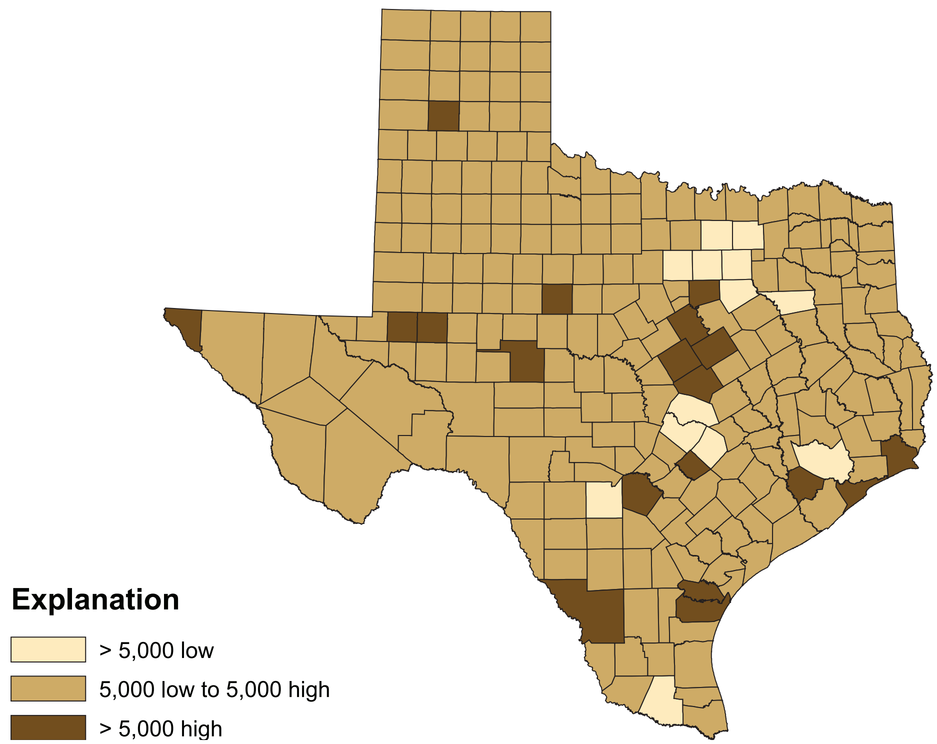

Figure 5-2. Numerical difference between TWDB's projection for 2000 and the 2000 Census.

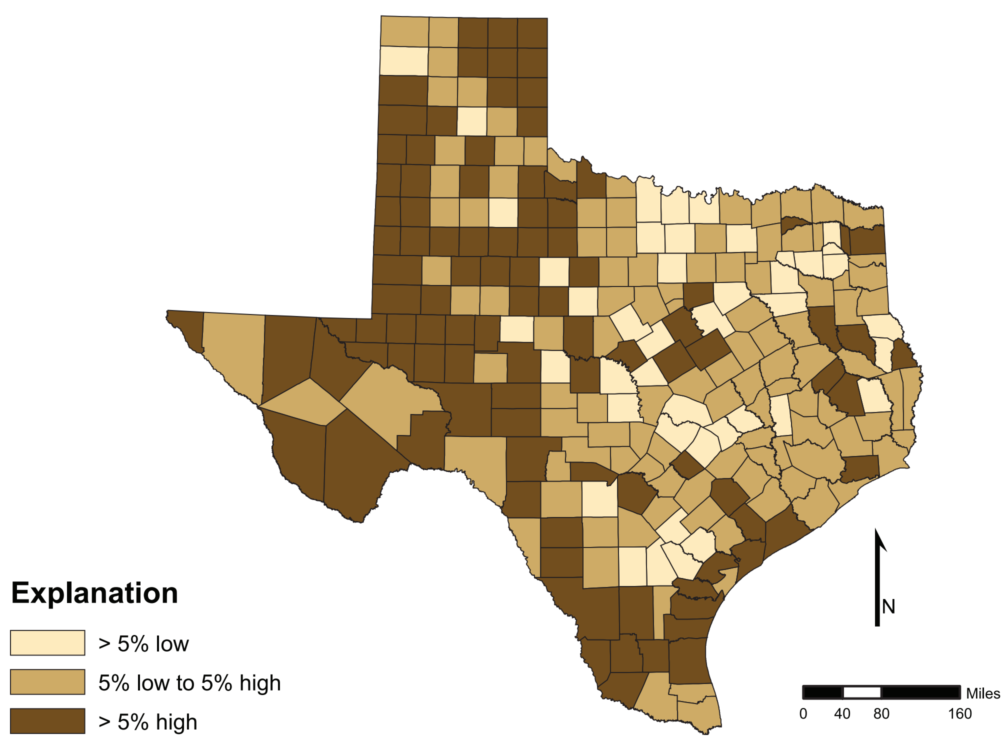

Figure 5-3. Percent difference between TWDB's projection for 2000 and the 2000 Census.

Table 5-2. Population and water use in 1990, with projections of future population and annual water demand for 2000-2050.

	1990	2000	2010	2020	2030	2040	2050
Population	16,986,510	20,864,933	24,537,141	28,792,303	32,774,870	36,413,817	39,617,389
Water use and demand by category (acre-feet):							
Municipal	3,196,775	4,232,056	4,805,100	5,411,198	6,024,533	6,558,065	7,064,605
Manufacturing	1,559,973	1,809,190	2,015,510	2,138,378	2,247,948	2,448,825	2,660,680
Mining	148,839	253,149	245,618	244,708	252,063	252,079	244,329
Steam-Electric	425,945	607,527	831,301	917,994	1,007,424	1,057,929	1,134,644
Irrigation	10,123,335	9,686,983	9,408,736	9,111,517	8,814,113	8,649,991	8,497,706
Livestock	274,069	330,572	355,550	371,598	386,194	402,236	420,245
Total	**15,728,936**	**16,919,477**	**17,661,815**	**18,195,393**	**18,732,275**	**19,369,125**	**20,022,209**

Table 5-3. Projected demand for water for each planning area under drought conditions (AFY).

Region	2000	2010	2020	2030	2040	2050
A	1,718,402	1,744,732	1,759,864	1,773,591	1,791,838	1,812,949
B	169,573	184,578	185,634	187,202	185,026	183,213
C	1,376,373	1,695,661	1,944,893	2,149,826	2,368,188	2,536,902
D	579,094	648,780	659,667	676,002	696,862	717,874
E	509,426	513,743	531,667	554,565	568,098	585,742
F	881,499	884,291	883,376	887,016	892,376	900,230
G	726,080	832,642	904,736	948,190	990,383	1,034,599
H	2,248,339	2,414,582	2,589,090	2,757,451	2,947,886	3,158,793
I	836,663	934,259	987,922	1,049,991	1,106,477	1,171,117
J	44,624	47,559	48,337	50,025	52,434	55,308
K	979,913	1,005,527	1,036,302	1,079,337	1,094,030	1,123,307
L	1,325,692	1,369,930	1,423,763	1,503,847	1,583,209	1,656,739
M	1,803,291	1,757,448	1,698,077	1,643,617	1,688,276	1,737,924
N	223,797	235,698	246,030	265,732	288,605	309,754
O	3,257,253	3,151,717	3,054,849	2,963,665	2,872,080	2,793,000
P	239,458	240,668	241,186	242,218	243,357	244,758
Total	**16,919,477**	**17,661,815**	**18,195,393**	**18,732,275**	**19,369,125**	**20,022,209**

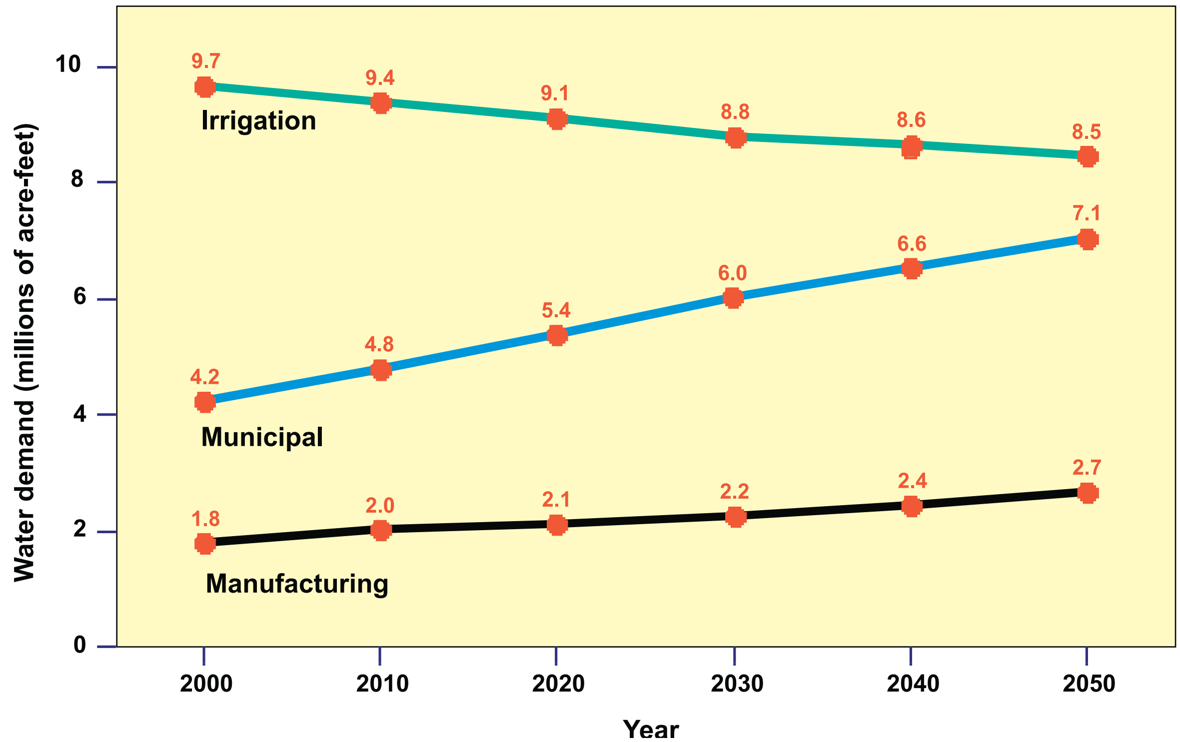

Figure 5-4. Projected water demand for irrigation, municipal, and manufacturing water uses during drought.

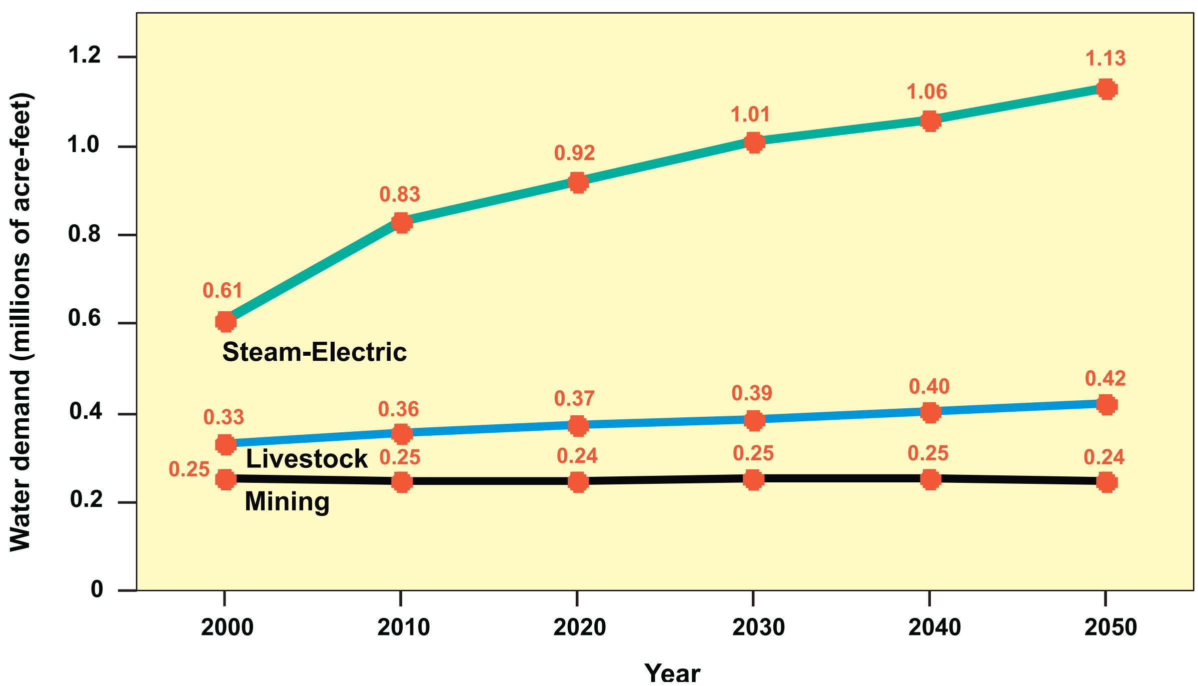

Figure 5-5. Projected water demand for steam-electric, livestock, and mining water users during drought.

5.2.1 Municipal Water Demand

Key Finding Statewide per capita water demand projections decrease by 22 gallons per capita per day over the 50-year planning period.

The amount of water used for municipal purposes in Texas depends primarily on population growth, climatic conditions, and water conservation practices. For planning purposes, municipal water use comprises both residential (single and multifamily housing) and commercial and institutional water uses. Commercial water use includes business establishments, excluding industrial water use. Residential, commercial, and institutional uses are categorized together because of the similarity of uses, all requiring water primarily for drinking, cleaning, sanitation, air conditioning, and outdoor use.

The methodology for forecasting municipal water demand relied on three primary components: (1) population projections, (2) forecasts of per capita water use, and (3) conservation.

5.2.1.1 Per Capita Water Use

Per capita water use is the average amount of water used by each person, which is based on calculation of total water used divided by population. Texas has a wide range of per capita water use because of the diversity of climatic conditions, population density, relative density of commercial businesses, consumers' ability to pay for water as indicated by average incomes, effectiveness of local conservation programs, and availability of water across the State. Climatic conditions also affect the varying quantities of water used annually. The frequency of rainfall plays a major role in the quantity of water used for municipal purposes, particularly for the outdoors. During below-normal rainfall conditions, people tend to use more water than during normal weather conditions. Below-normal rainfall was the basis for all municipal water demand projections in the 2002 State Water Plan, representing the requirement under Senate Bill 1 to plan for drought-of-record conditions (Texas Water Code §16.053(e)(4)).

Projections of per capita water demand made for the 1997 State Water Plan were used, according to Senate Bill 1, as the foundation for the 2002 State Water Plan. Thus, the basic methodology described herein for projecting per capita water demand may seem to rely on relatively old data, but they were the most recent available at that time. Provisions that allowed Planning Groups to use more recent data to request revisions to these projections are described later.

To best represent today's water use in plumbing, appliance, and conservation technology, the per capita water use for normal rainfall conditions was based on the average per capita water use for each city between 1987 and 1991, a time period that did not include extreme rainfall conditions in most areas of the State. The per capita water use for below-normal rainfall conditions was based on the highest per capita water use recorded by a city between 1982 and 1991, with 1982-1986 added into this part of the analysis because drought conditions were represented. For planning purposes, the per capita water use for below-normal rainfall was constrained to an upper limit of 25 percent above the calculated (5-year average) normal-condition per capita water use variable. This constraint was used as an adjustment for water conservation practices put in place after 1985.

Per capita water demand projections in Texas, under below-normal rainfall conditions, was about 181 gallons per capita per day (GPCD) in 2000, and is projected to decrease to 159 GPCD in 2050 (Table

5-4). In 2000, the highest and lowest per capita water demand projections were for the Plateau Region at 221 GPCD and the East Texas Region at 147 GPCD, respectively. By 2050, the highest and lowest per capita water demand projections are for Region C at 200 GPCD and the East Texas Region at 125 GPCD, respectively (Figure 5-6).

Per capita water use varies in major cities across the State, from a low of 120 GPCD in Killeen to a high of 275 GPCD in Richardson. Although there are several areas of low per capita water use in the State, areas of high per capita water use are still of concern. The Dallas-Fort Worth metropolitan area (currently at 260 and 230 GPCD, respectively), College Station (259 GPCD), and Midland (233 GPCD), are examples of high per capita water use areas. Pasadena (122 GPCD), El Paso (144 GPCD), Baytown (146 GPCD), San Antonio (173 GPCD), and Houston (180 GPCD) are noted for their low per capita water use. Caution should be used when comparing per capita water use between cities that may have significant differences in (1) climatic conditions such as rainfall and temperature, (2) concentration of commercial and institutional users, (3) incomes that reflect differences in ability to pay for water, (4) water utility rate structures, and (5) seasonal residents.

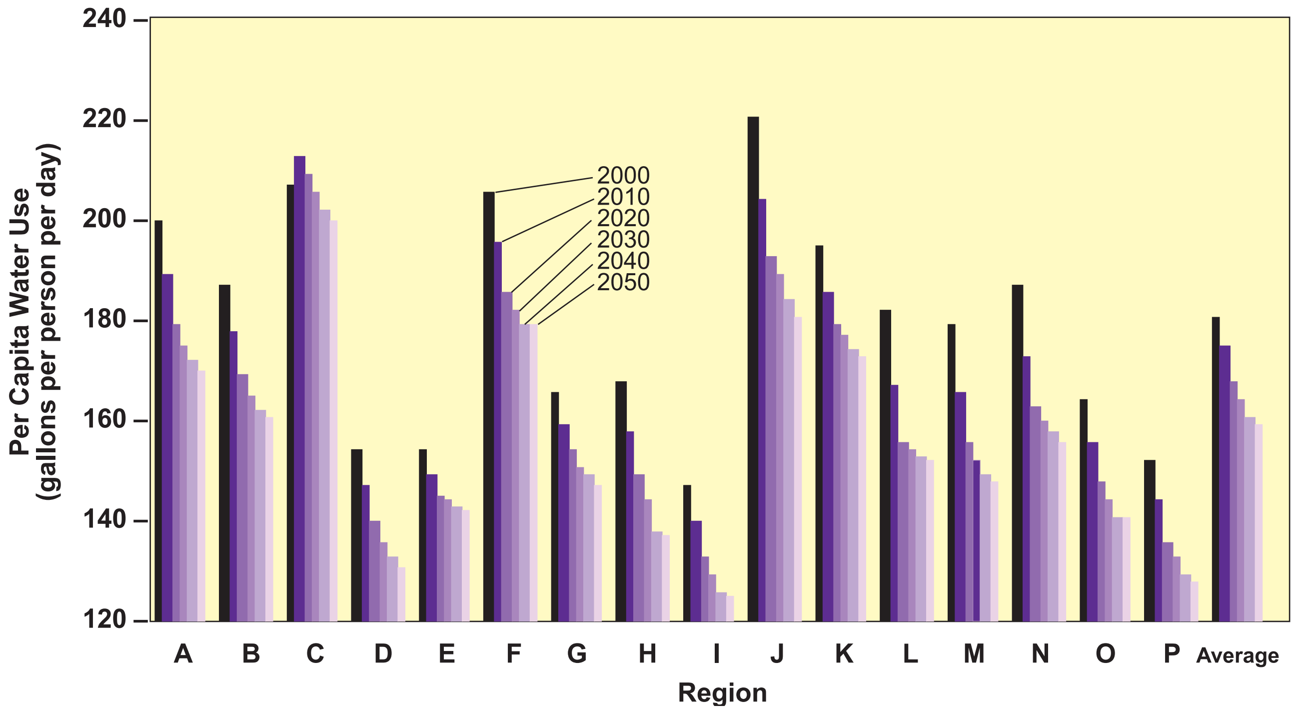

Figure 5-6. Regional per capita water demand projections for 2000-2050.

Table 5-4. Projected per capita water use for 40 largest cities of Texas under drought conditions, grouped and ordered by 2000 value. Values in gallons per person per day (GPCD).

City	2000	2010	2020	2030	2040	2050
10 Greatest Use						
Richardson	275	275	266	262	259	258
Dallas	260	275	275	272	268	264
College Station	259	225	236	236	239	235
Plano	259	272	265	260	258	258
Midland	233	222	211	208	205	205
Fort Worth	230	225	221	216	212	207
McAllen	230	218	209	205	201	200
Amarillo	223	212	202	199	196	195
San Angelo	221	210	200	196	194	193
Austin	213	204	197	194	192	191
20 Intermediate Use						
Denton	211	199	190	186	184	183
Irving	210	230	230	225	220	216
Lewisville	210	220	230	230	225	220
Abilene	208	206	206	204	202	200
Corpus Christi	207	193	183	181	180	179
Waco	207	197	189	185	182	181
Round Rock	203	190	167	166	166	182
Carrollton	200	200	200	195	190	180
Laredo	200	188	179	176	175	174
Wichita Falls	198	188	178	173	170	168
Odessa	193	183	174	170	167	166
Arlington	190	195	192	188	181	180
Brownsville	181	173	166	163	160	159
Longview	181	172	165	161	158	157
Tyler	181	172	164	145	144	142
Houston	180	172	165	162	153	152
San Antonio	173	159	150	148	147	146
Lubbock	168	160	152	149	146	145
Bryan	167	157	149	146	143	143
Mesquite	165	165	165	165	165	147
10 Least Use						
Beaumont	162	154	146	143	139	138
Garland	161	148	141	141	141	141
Grand Prairie	160	155	160	150	145	140
Port Arthur	157	149	143	139	135	134
Sugar Land	156	146	139	137	135	135
Victoria	153	142	134	132	131	130
Baytown	146	138	131	128	119	118
El Paso	144	144	144	144	144	144
Pasadena	122	115	108	105	98	97
Killeen	120	155	180	178	175	165
Texas	**181**	**175**	**168**	**164**	**161**	**159**

5.2.1.2 Conservation

Water conservation, in part, means using water more efficiently. Conservation decreases per capita water use and allows the same water resource to be used by a greater number of people and for a variety of beneficial uses. Expected water savings from municipal water conservation were based on assumptions regarding the rate of implementation of indoor water-efficient plumbing fixtures and the rate of implementation of conservation measures in seasonal, dry-year irrigation and for other municipal water uses.

A driving force in expected municipal water savings was the effect produced by the State Water Saving Performance Standards for Plumbing Fixtures Act passed in 1991. This act established water-saving performance standards for plumbing fixtures that are manufactured or made available for sale in Texas, including showerheads, faucets and faucet aerators, and toilets and urinals. The 1992 Energy Policy and Conservation Act established similar standards on a nationwide basis. The water savings from implementation of these acts are not only substantial and economically sound (save costs), but they do not require day-to-day behavior changes by the consumer, decrease the larger year-round base water use, and occur with a relatively high degree of predictability. By 2050, annual water savings resulting from conservation in municipal use is projected to be approximately 976,000 acre-feet per year (AFY).

5.2.1.3 Projections

Key Finding Total municipal water demand is projected to increase by 67 percent, from 4.23 million AFY in 2000 to 7.06 million AFY in 2050.

Municipal water demand is projected to increase by 67 percent while serving a population that is projected to nearly double (90-percent increase). Increased water conservation, resulting in decreased per capita water use, contributes to an increase in water use that is notably slower than the increase in population.

5.2.2 Manufacturing Water Demand

Key Finding Total demand for manufacturing water use in Texas is projected to increase by 47 percent, from 1.81 million AFY in 2000 to 2.66 million AFY in 2050.

The quantity of water required in the production of goods for domestic and foreign markets varies widely among manufacturing industries in Texas. Manufactured products range from food and clothing to refined chemical and petroleum products to computers and automobiles. Some processes require direct consumption of water as part of the manufacture of products. Others processes require very little water consumption but may require large volumes of water for cooling or cleaning purposes.

Five manufacturing industries accounted for approximately 90 percent of the 1.45 million AFY of water used by manufacturing industries in Texas in 1999: chemical product manufacturing, petroleum refining, pulp and paper production, primary metal manufacturing, and the manufacture of food and kindred products. The chemical and petroleum refining industries account for nearly 60 percent of the State’s annual manufacturing water use. Ten counties account for approximately 75 percent of the State's total manufacturing water use. These are:

- Harris
- Brazoria
- Jefferson
- Morris
- Cass
- Jasper
- Orange
- Galveston
- Harrison
- Milam

Future manufacturing water demand largely depends on technological changes in the production process, improvements in water-efficient technology, and the economic climate (expansion or contraction) of the market place. Technological changes in production and improvements in water-efficient technology affect how water is used in the production process.

Manufacturing water use projections are based on three specific assumptions regarding industry growth:

1. industry growth assumes future expansions of existing capacity within an industry, as well as new manufacturing facilities within the State;
2. historical interactions between the price of oil and industry activity are assumed to continue over the projection period; and
3. the types of industries that currently compose a county's manufacturing base are assumed to be those that will compose the county's manufacturing base in the future.

Manufacturing water use was projected over time at the county level by applying each industry's water use per unit of output to the industry's projected output. Industry-specific, water use efficiency estimates were developed, reducing each county's industry-specific, water use coefficient over time, according to expected scheduling of the expansion of new plants or significant rehabilitation of older plant processes. Projections of each industry's water use were then summed to obtain projections of total manufacturing water use for each county.

5.2.3 Irrigation Water Demand

Key Finding **Irrigation water demand is projected to decline by 12 percent, from 9.7 million AFY in 2000 to 8.5 million AFY in 2050.**

Irrigated agriculture has historically been the largest user of water across the State. In 1999, farmers used approximately 9.7 million AFY of water to grow a variety of crops on about 6.3 million acres of irrigated land. The value of irrigated crops accounts for more than half of the total value of crops grown in Texas, yet only about one-third of all crops harvested (based on acreage) are irrigated. Groundwater resources provide approximately 75 percent of the water used in irrigation, with surface water supplies accounting for the remaining 25 percent.

The TWDB developed irrigation demand projections using mathematical optimization models. These models estimated irrigation patterns that would be most profitable to producers, taking into account projected changes in profitability factors (such as farm prices and costs of production) and historical irrigated acreage and water use. Irrigation water demand projections were checked against historical cropping patterns, yields, and irrigation technological advances for trends and consistency. More efficient canal delivery systems have improved water use efficiencies of surface water irrigation (in 1995, about 622,000 AFY of water was lost in the diversion process from the source to the delivery point on the farm). More efficient on-farm irrigation systems have also improved the efficiency of groundwater irrigation. Other factors that contributed to decreased irrigation demands were declining groundwater supplies and the voluntary transfer of water rights historically used for irrigation to municipal uses.

5.2.4 Steam-Electric Power Water Demand

Key Finding Demand for water for steam-electric power generation is projected to increase by 86 percent, from 607,000 AFY in 2000 to 1.13 million AFY in 2050.

Although Texas is only the second-most-populous state in the United States, it is the largest generator and consumer of electricity and the largest user of coal-generated power. Because most of the State is included in its own power grid, most of its power needs are provided internally.

In determining current and future water use of steam-electric power generation, the TWDB relied on several types of information. Current water use for the base year 1990 was obtained for each plant from the TWDB's water use survey. Demands for many new plants, both completed and under construction, were identified by Planning Groups as part of the regional planning process. Future water demand was estimated using a combination of available information, including published materials on planned additions to existing plants, existing water rights permits, specific company information, lignite-resource ownership, and other related sources. Individual plant design, thermodynamic operating characteristics, energy-conservation strategies, and technological improvements were also evaluated to determine how water use would change over time.

5.2.5 Mining Water Demand

Key Finding Total demand for mining water use in Texas is projected to decline by four percent, from 253,000 AFY in 2000 to 244,000 AFY in 2050.

Besides Texas' production of crude petroleum and natural gas, the Texas mineral industry also produces a wide variety of important nonfuel minerals. Water is required in the mining of these minerals in processing, leaching to extract certain ores, controlling dust at the plant site, and reclamation.

Projections of mining water demand are derived from recent and historical data, trends in production, estimated total mineral reserves currently accessible, and rates of water use. These projections are tabulated by county, river or coastal basin, and climatic zones within basins. Tabulations of water use for each basin, zone, and county represent the sum of estimated water use for the production of fuels and nonfuels where this mineral production has historically occurred and where the estimated mineral reserves are sufficient to meet the demand. Estimates of water use for mining required two basic assumptions: location of mines within the basin zone would remain constant and each basin would retain its share of Statewide production.

Although mining is an important industry in Texas, water for mining represents only about 1 percent of total water use in Texas. Mining water use is expected to decline largely because of expected declines in petroleum production.

5.2.6 Livestock Water Demand

Key Finding Livestock water demand is projected to increase by 27 percent, from 330,000 AFY in 2000 to 420,000 AFY in 2050.

Texas is the nation's largest livestock producer, accounting for approximately 11 percent of total U.S. production. Livestock and related products were valued at approximately $8.4 billion in 1999, representing 65 percent of the total value derived from all agricultural operations in Texas. Cattle and calf operations dominate livestock production at a value of $6.1 billion, representing 47 percent of all agricultural production. The livestock industry consumes a relatively small amount of water. In 1999, total livestock production consumed approximately 345,300 acre-feet of water in Texas, representing about 2 percent of total water use.

Livestock water consumption is estimated from water consumption per animal unit for a livestock type and total number of livestock. Texas A&M University Cooperative Extension Service provided information on water use rates in gallons per day per head for each type of livestock: cattle, poultry, sheep and lambs, hogs and pigs, horses, and goats. The Texas Agricultural Statistics Service provided current and historical numbers of livestock by livestock type and county. Water use rates were then multiplied by the number of livestock for each livestock type for each county. Livestock numbers were projected to remain constant over time in most areas of the state, with significant increases projected only for the Panhandle, Llano Estacado, and East Texas Planning Groups.

5.2.7 Criteria for Revision of Water Demand Projections

The TWDB recognized that revisions to projections from the 1997 State Water Plan might be necessary when conditions had changed or when new information was available. TWDB staff, in coordination with staff from the TNRCC and TPWD, worked with the Planning Groups to address requests for revisions to the 1997 State Water Plan projections. A standardized process was developed to identify specific criteria for determining whether the 1997 State Water Plan projections should be revised and the data necessary to justify any changes to these projections. The TWDB considered revisions to projections of water demand if the Planning Groups provided data to show where relevant conditions had changed or new information was now available.

5.3 Water Supply Projections

Key Finding Water supplies from existing sources are expected to decrease 19 percent, from 17.8 million AFY in 2000 to 14.5 million AFY in 2050.

A primary goal of Senate Bill 1 planning was to determine the volume and location of water supplies from existing sources and the total amount of water available for use. Water supplies from existing sources are the amounts of water that can be used if water rights, water quality, infrastructure limitations, and contract restrictions are taken into account. The total amount of water available for use, or water availability, is the amount of water that could be used if the infrastructure were built to transport that water to users.

Planning Groups assessed water supplies from existing sources and the total amount of water available for use that would be available during a drought-of-record. Senate Bill 1 required planning for the drought-of-record. This is an important requirement because it helps communities prepare for the continually recurring droughts in Texas.

5.3.1 Groundwater

Key Finding Water supplies from existing groundwater sources are expected to decrease 19 percent, from 8.8 million AFY in 2000 to 7.2 million AFY in 2050.

Groundwater supplied 58 percent of the 16.0 million acre-feet of water used in the State in 1999. About 78 percent of the 9.3 million acre-feet of water produced from aquifers in 1999 was used for irrigation. Approximately 36 percent of water used for municipal needs is from groundwater sources because most of the large cities rely on surface water sources to meet their large demands. Most of the western half of the State and a good part of the eastern half of the State rely primarily on groundwater resources (Figure 5-7).

5.3.1.1 Aquifers of Texas

Key Finding The TWDB has added the Yegua-Jackson aquifer as a minor aquifer of Texas.

The TWDB has assigned a major and minor status to most of the State's aquifers on the basis of quantity of water supplied by each aquifer. Major aquifers tend to be large, regional aquifers that can produce large amounts of water (Figure 5-8). Minor aquifers tend to be smaller and produce less water (Figure 5-9).

On the basis of recent hydrogeologic studies and reviews of groundwater production data, the TWDB is designating the Yegua Formation and the Jackson Group as a minor aquifer, *the Yegua-Jackson aquifer*. The primary rationale for this designation is that water use from the Yegua-Jackson aquifer ranks in the upper half of annual water use for the minor aquifers, with more than 11,000 acre-feet of water produced in 1997. In addition, a review of the TWDB Groundwater Well Database indicates that there are currently more than 1,450 wells producing from the Yegua-Jackson aquifer.

The Yegua-Jackson aquifer extends in a narrow band from the Rio Grande and Mexico across the State to the Sabine River and Louisiana (Figures 5-9, 5-10). Although the occurrence, quality, and quantity of water from this aquifer are erratic, domestic and livestock supplies are available from shallow wells over most of its extent. Locally water for municipal, industrial, and irrigation purposes is available. Yields of most wells are small, less than 50 gallons per minute, but in some areas, yields of adequately constructed wells may range to more than 500 gallons per minute.

The Yegua-Jackson aquifer consists of complex associations of sand, silt, and clay deposited during the Tertiary Period. Net freshwater sands are generally less than 200 feet deep at any location within the aquifer. Water quality varies greatly within the aquifer, and shallow occurrences of poor-quality water are not uncommon. In general, however, small to moderate amounts of usable quality water can be found within shallow sands (less than 300 feet deep) over much of the Yegua-Jackson aquifer.

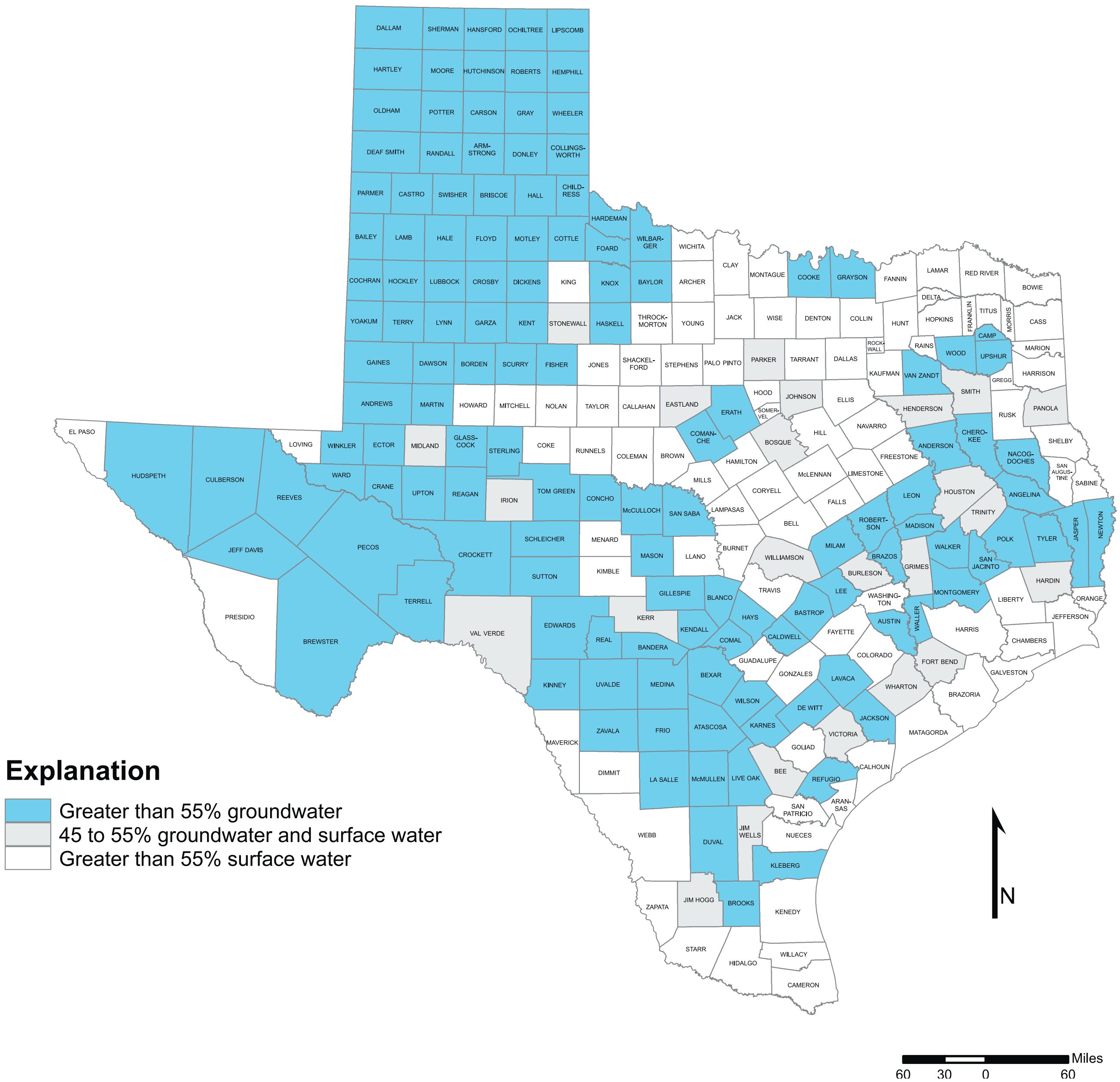

Figure 5-7. Analysis of total 1999 water use by county in Texas, illustrating dominant supply source. Analysis is based on TWDB Water Use Survey results and, although certain areas of the state did experience drought conditions during 1999, the water use patterns illustrated on this map do not uniformly illustrate water use during drought.

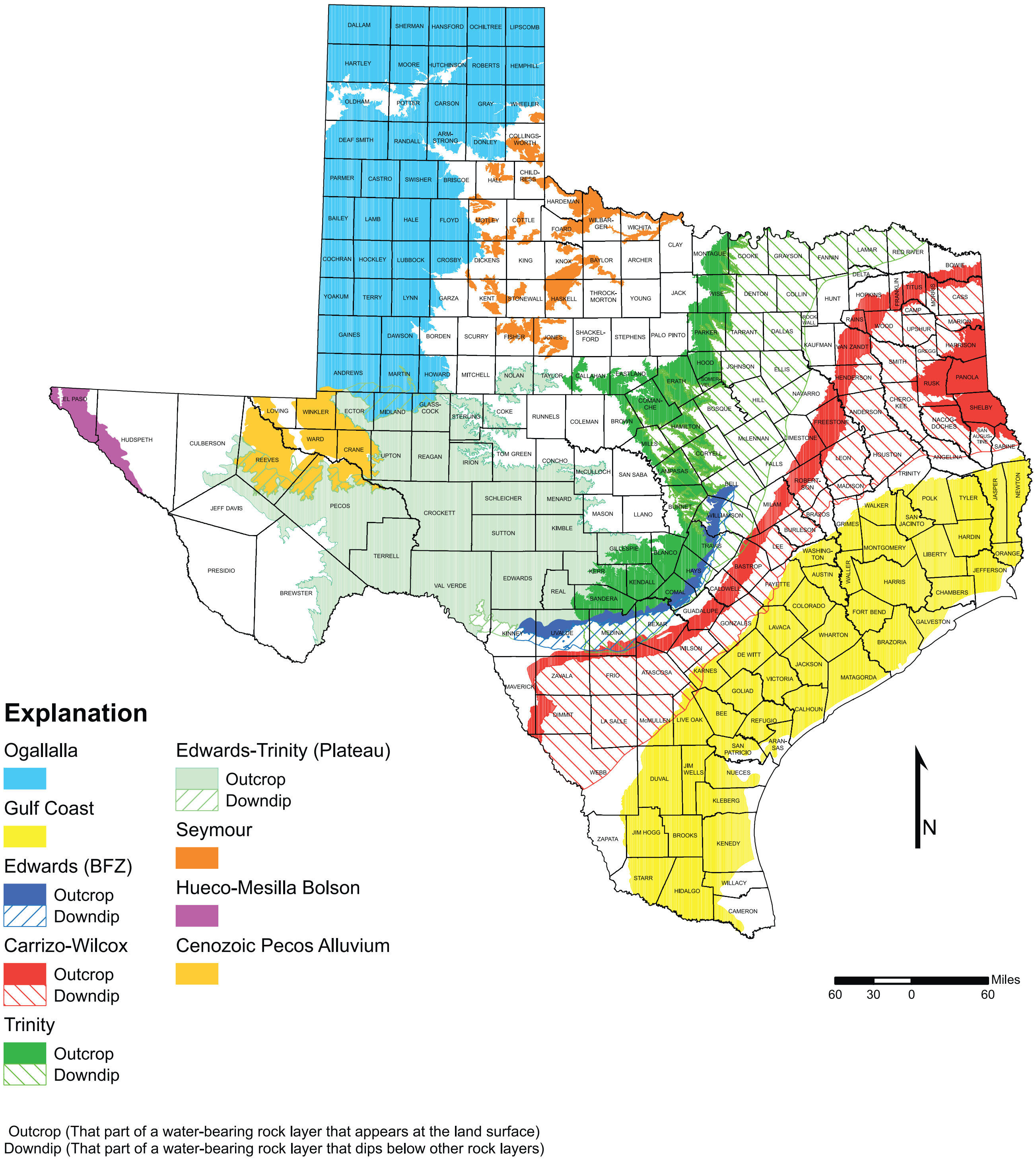

Figure 5-8. The major aquifers of Texas.

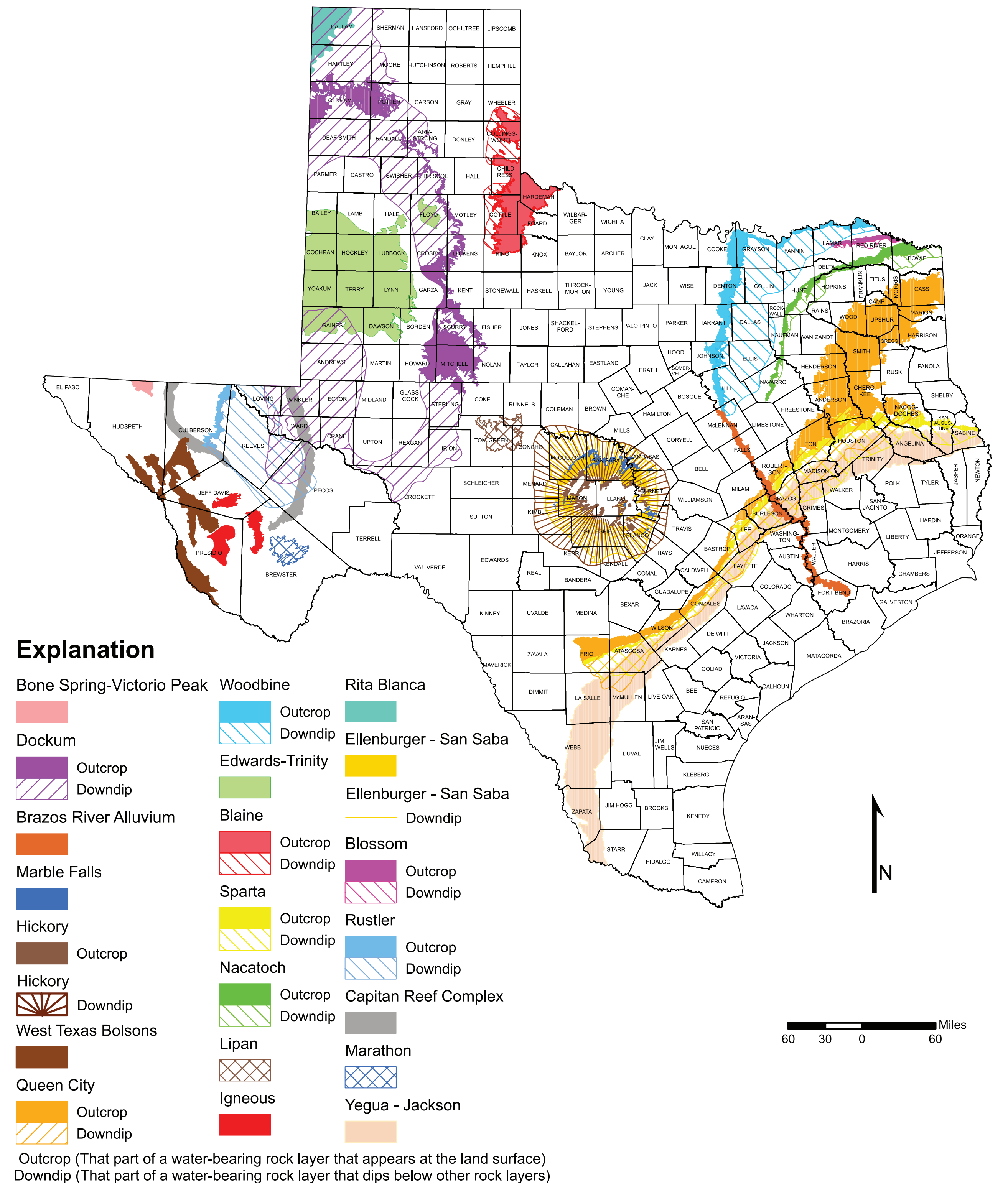

Figure 5-9. The minor aquifers of Texas.

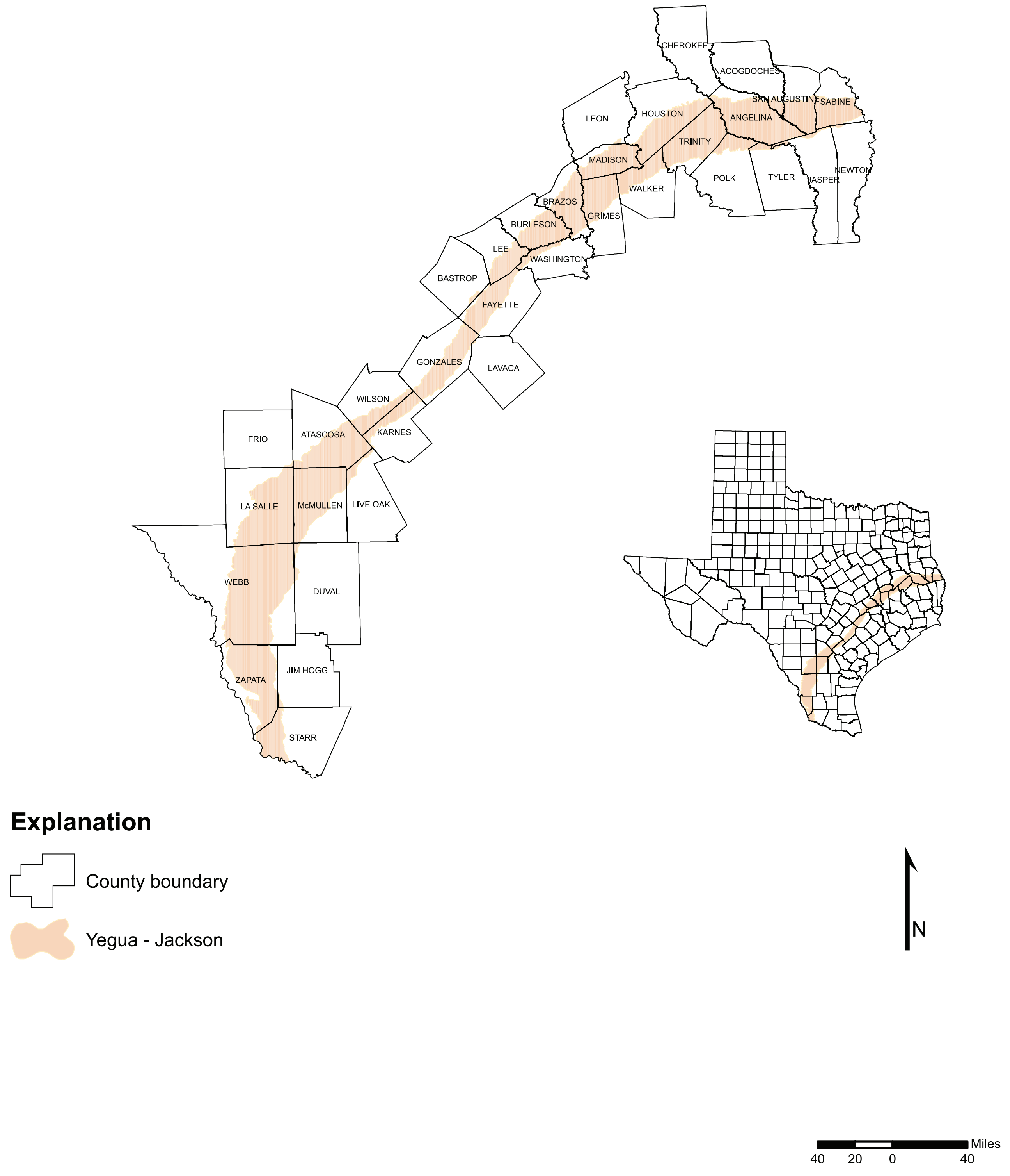

Figure 5-10. Location of the Yegua-Jackson aquifer in Texas.

5.3.1.2 Groundwater Availability

Groundwater availability represents the total amount of water available for use from an aquifer under a development scenario selected by the Planning Groups. One example of a development scenario is systematic depletion, in which a specified volume of the aquifer is drained over a period of time. Another example is a situation in which pumping is not allowed to be greater than recharge. In this case, the aquifer generally holds much more water than the annual recharge amount. Most of the Planning Groups estimated groundwater availability using either recharge or systematic depletion. The South Central Texas Region used 340,000 AFY as the groundwater availability for the San Antonio segment of the Edwards aquifer. This is a temporary value until a better value is attained through the process of developing the Habitat Conservation Plan required by U.S. Fish and Wildlife Service. Region H used values of availability for the Gulf Coast aquifer to minimize or prevent land subsidence.

Total current groundwater availability as assessed by the Planning Groups is about 14.9 million AFY (Figure 5-11). **This availability decreases to 13.1 million AFY by 2050 because of projected decreases in availability in the Ogallala, Gulf Coast, Hueco-Mesilla Bolson, and Carrizo-Wilcox aquifers** (Figure 5-12).

5.3.1.3 Groundwater Supplies

Groundwater supplies represent the amount of water that can be accessed with existing infrastructure, such as wells and pipelines. Planning Groups estimated that the groundwater supplies from existing sources were about 8.8 million AFY in 2000 and would decline 19 percent to about 7.2 million AFY by 2050 (Figure 5-13, Table 5-5). The decline in supply is due primarily to a reduction in supply from the Ogallala aquifer as a result of depletion (about 1.2 million AFY in 2050) and reductions in supply from the Gulf Coast, Hueco-Mesilla Bolson, and Carrizo-Wilcox aquifers (about 200,000 AFY, 140,000 AFY, and 89,000 AFY in 2050, respectively). The decline in supply from the Ogallala aquifer is due to the Llano Estacado Planning Group's reducing the net depletion rate by 10 percent per decade to reflect increased conservation and declining well yields.

The largest percent decline in supply is in the Hueco-Mesilla Bolson aquifer, where supply decreases from a high of about 200,000 AFY in 2020 to 0 AFY in 2030. This decline is due to pumping of most of the remaining freshwater in the aquifer. Between 2000 and 2050, 13 of the 30 aquifers (major and minor) show a decline in water supplies, five aquifers show an increase, and 12 aquifers remain the same. Increases in groundwater supplies are due to increased pumping of existing well infrastructure.

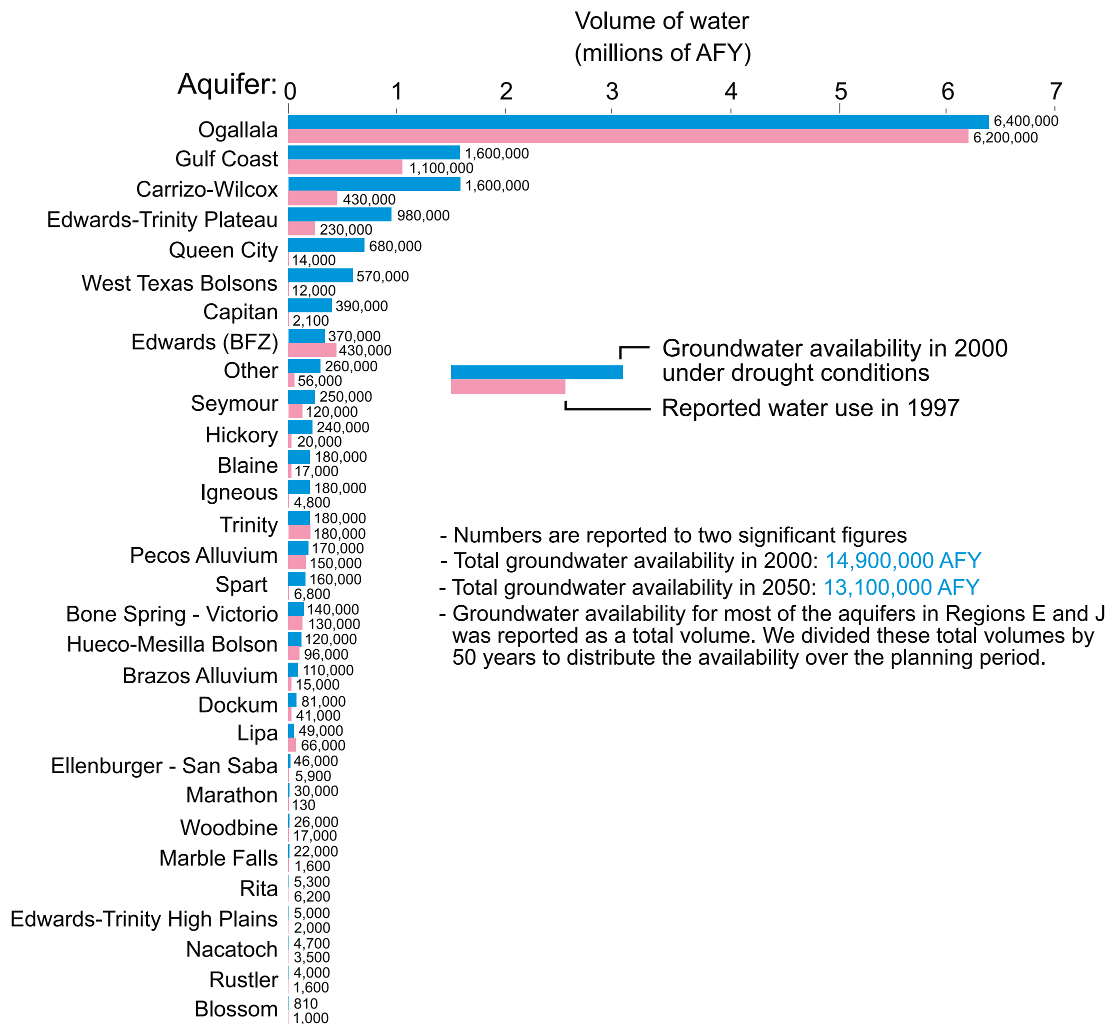

Figure 5-11. Groundwater availability for aquifers of Texas under drought conditions as reported by Planning groups.

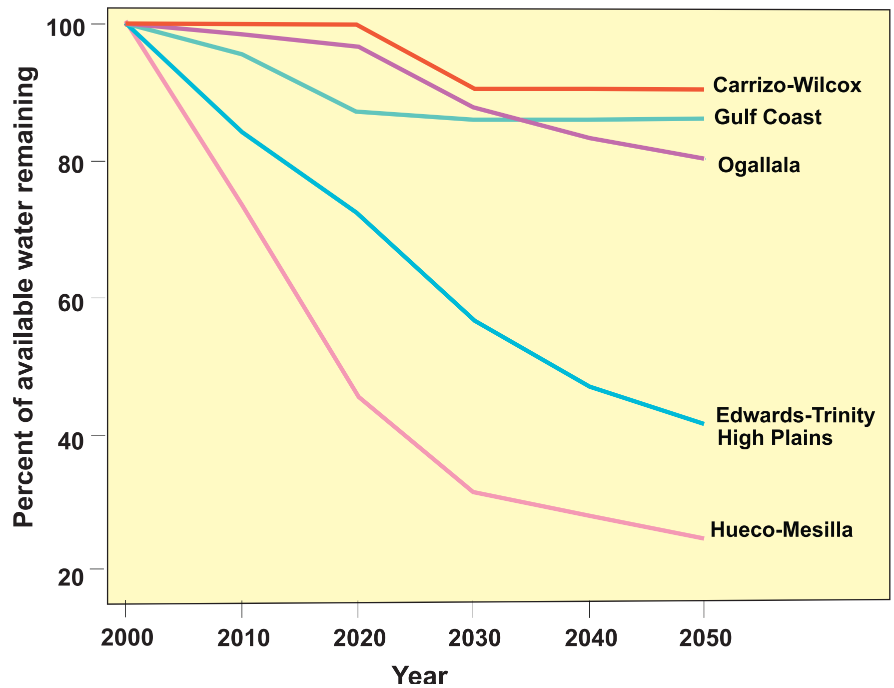

Figure 5-12. Percent of available groundwater remaining for the Carrizo-Wilcox, Gulf Coast, Ogallala, Edwards-Trinity High Plains, and Hueco-Mesilla Bolson aquifers through 2050. Major and minor aquifers not shown do not have appreciable declines of availability. Water availability in the Hueco-Mesilla Bolson aquifer includes some brackish water.

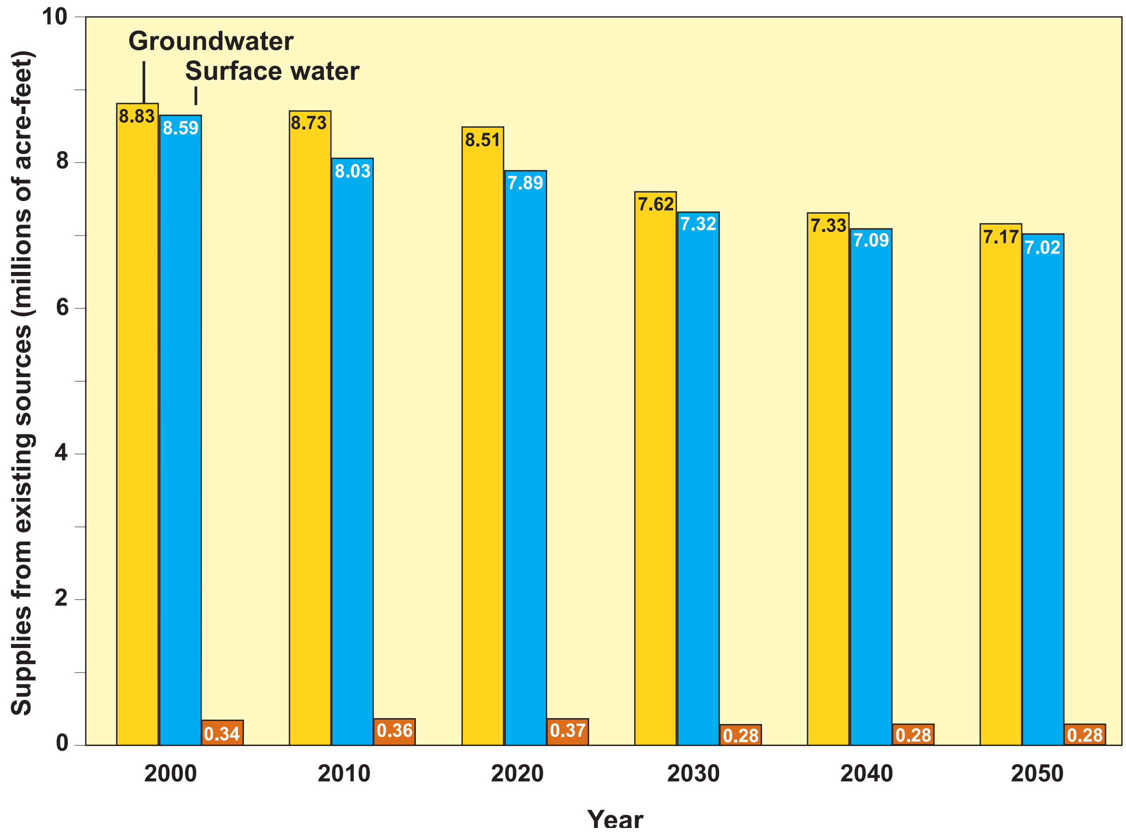

Figure 5-13. Current groundwater, surface water, and wastewater reuse supplies from existing sources through 2050 under drought conditions.

Table 5-5. Groundwater supplies from existing sources under drought conditions for the different aquifers, as reported by Planning Groups.

	Groundwater supplies from existing sources (AFY)						
Aquifer	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**%**
Blaine	25,850	25,819	25,733	25,712	25,691	25,667	↓ 1
Blossom	438	434	432	430	428	424	↓ 3
Bone Spring-Victorio Peak	140,077	140,077	140,077	140,077	140,077	140,077	– 0
Brazos River Alluvium	79,329	86,818	87,205	87,205	87,205	87,205	↑ 10
Capitan Reef	2,968	2,968	2,968	2,968	2,968	2,968	– 0
Carrizo-Wilcox	652,241	651,042	649,617	563,001	562,670	562,378	↓ 14
Cenozoic Pecos Alluvium	101,386	101,404	101,225	101,238	101,245	101,245	– 0
Dockum	29,250	29,753	29,943	31,356	31,175	31,821	↑ 9
Edwards-BFZ	360,831	360,831	360,831	360,831	360,831	360,831	– 0
Edwards-Trinity High Plains	4,944	4,160	3,580	2,802	2,335	2,065	↓ 58
Edwards-Trinity Plateau	226,540	225,385	224,140	222,873	221,602	220,374	↓ 3
Ellenburger-San Saba	22,580	22,573	22,563	22,557	22,558	22,564	– 0
Gulf Coast	1,366,916	1,314,340	1,186,813	1,169,000	1,167,532	1,167,110	↓ 15
Hickory	50,699	46,142	46,120	46,122	46,124	46,133	↓ 9
Hueco-Mesilla Bolson	150,034	177,485	205,153	7,685	7,882	8,099	↓ 95
Igneous	11,452	11,467	11,595	11,680	11,808	11,951	↑ 4

Table 5-5. *(continued)*

Aquifer	2000	2010	2020	2030	2040	2050		%
	Groundwater supplies from existing sources (AFY)							
Lipan	43,908	43,880	43,852	43,824	43,796	43,769	–	0
Marathon	130	130	130	130	130	130	–	0
Marble Falls	16,718	16,718	16,718	16,718	16,718	16,718	–	0
Nacatoch	3,529	3,923	3,965	3,780	3,668	3,486	↓	1
Ogallala	5,000,097	4,908,269	4,788,255	4,210,930	3,922,178	3,785,409	↓	24
Other	115,270	115,450	115,555	115,699	115,813	116,287	↑	1
Queen City	26,983	41,720	41,704	41,701	40,604	28,689	↑	6
Rita Blanca	5,248	5,199	5,177	5,160	5,137	5,157	↓	2
Rustler	52	52	52	52	52	52	–	0
Seymour	150,741	150,651	150,567	148,240	148,170	148,094	↓	2
Sparta	40,034	39,696	39,682	41,156	40,587	40,079	–	0
Trinity	156,832	157,090	156,992	152,158	152,097	150,317	↓	4
West Texas Bolson	22,728	22,728	22,728	22,728	22,728	22,728	–	0
Woodbine	22,932	22,882	22,834	22,845	22,798	22,825	–	0
Total	**8,830,737**	**8,729,086**	**8,506,206**	**7,620,658**	**7,326,607**	**7,174,652**	**↓**	**19**

% represents the percent change from 2000 through 2050. The preceding symbol indicates whether supplies from the aquifer are expected to decline (↓), increase (↑), or remain the same (–) from 2000 through 2050. Supplies that do not change by more than 0.5 percent are shown as remaining the same. Supplies for the Hueco-Mesilla Bolson include some brackish water. The Yegua-Jackson aquifer is not included in this table because the Planning Groups reported these supplies in a generic “other aquifer” category. Supplies from the Yegua-Jackson aquifer will be identified in the next regional water plans.

5.3.2 Surface Water

Key Finding Water supplies from existing surface water sources are expected to decrease 18 percent, from around 8.6 million AFY in 2000 to 7.0 million AFY in 2050

About 42 percent of the total 16.0 million acre-feet of water used by the State in 1999 was surface water. Surface water supplies account for about 70 percent of all water used for municipal, manufacturing, and steam-electric power generation, primarily because of current infrastructure, as well as natural access and treatability. Most of the north-central area of the State, the Gulf Coast area, and the Lower Rio Grande Valley rely primarily on surface water resources (Figure 5-7).

Surface water supplies represent the amount of water that can currently be used from rivers and reservoirs. A reservoir may have much more water available than can be currently used because of limited infrastructure. For example, Lake Palestine has 236,000 acre-feet of water availability (firm yield). Most of this has been allocated to Dallas and its suburbs; however, because no conveyance is in place to get the water from the lake to users, only 14,000 AFY of water supply is currently usable through conveyances.

5.3.2.1 River Basins

There are 23 major river basins in Texas (Figure 5-14). All rivers in Texas basically flow from northwest to southeast or from west to east, as determined by underlying geographic and geologic conditions. The basin areas vary largely from a few hundred to close to 50,000 square miles. Because of the different meteorological and geographical conditions, the surface water runoff produced from precipitation varies from basin to basin. In addition to the runoff produced from the basin areas within the Texas border, five river basins (Canadian, Red, Brazos, Colorado, and Rio Grande) also receive streamflows brought in by the five rivers as they enter the State.

Water availability, water conveyance facility condition, and water rights or contracts determine the current water supply. The surface water availability index and the surface water supply index (per square mile) are illustrated in Figures 5-15 and 5-16, respectively. The surface water supply index is a measure of the density of the water supply of the river basins. Most coastal basins have fairly low surface water supply (index less than 5 AFY/square mile) because of the lack of water supply facilities such as reservoirs. The river basins in the east have high index numbers because of their rich natural water availability (Figure 5-16) and existing water supply facilities.

5.3.2.2 Reservoirs

In Texas, about 440 reservoirs have more than 1,000 acre-feet of conservation storage capacity (see Plate insert), and of those, 211 reservoirs have greater than 5,000 acre-feet of conservation storage capacity. These 211 represent a total reservoir conservation storage capacity of 41.5 million acre-feet.

5.3.2.3 Surface Water Availability and Supplies

Texas currently has approximately 14.9 million AFY of total surface water available (Figure 5-17), but only 8.6 million AFY may be currently used because of restrictions in infrastructure capacity, water permits, and contracts. In 2050, total surface water available is projected to decrease by almost 500,000 AFY to approximately 14.4 million AFY. Current surface water supplies will decrease by 1.6 million AFY to 7.0 million AFY if conveyance systems remain unchanged and contracts that expire during the 50-year planning horizon are not renewed (Table 5-6, Figure 5-13). A significant portion of the surface water currently being used is conveyed through interbasin transfers (Figure 5-18, Table 5-7).

From 2000 through 2050, 22 river basins will have stable or declining surface water supplies (Table 5-6). Reservoir sedimentation is the primary reason for the decline in surface water availability. Where sedimentation rates are unavailable, supplies are projected to remain stable. In basins where increases are projected, they occur in livestock or other local supplies.

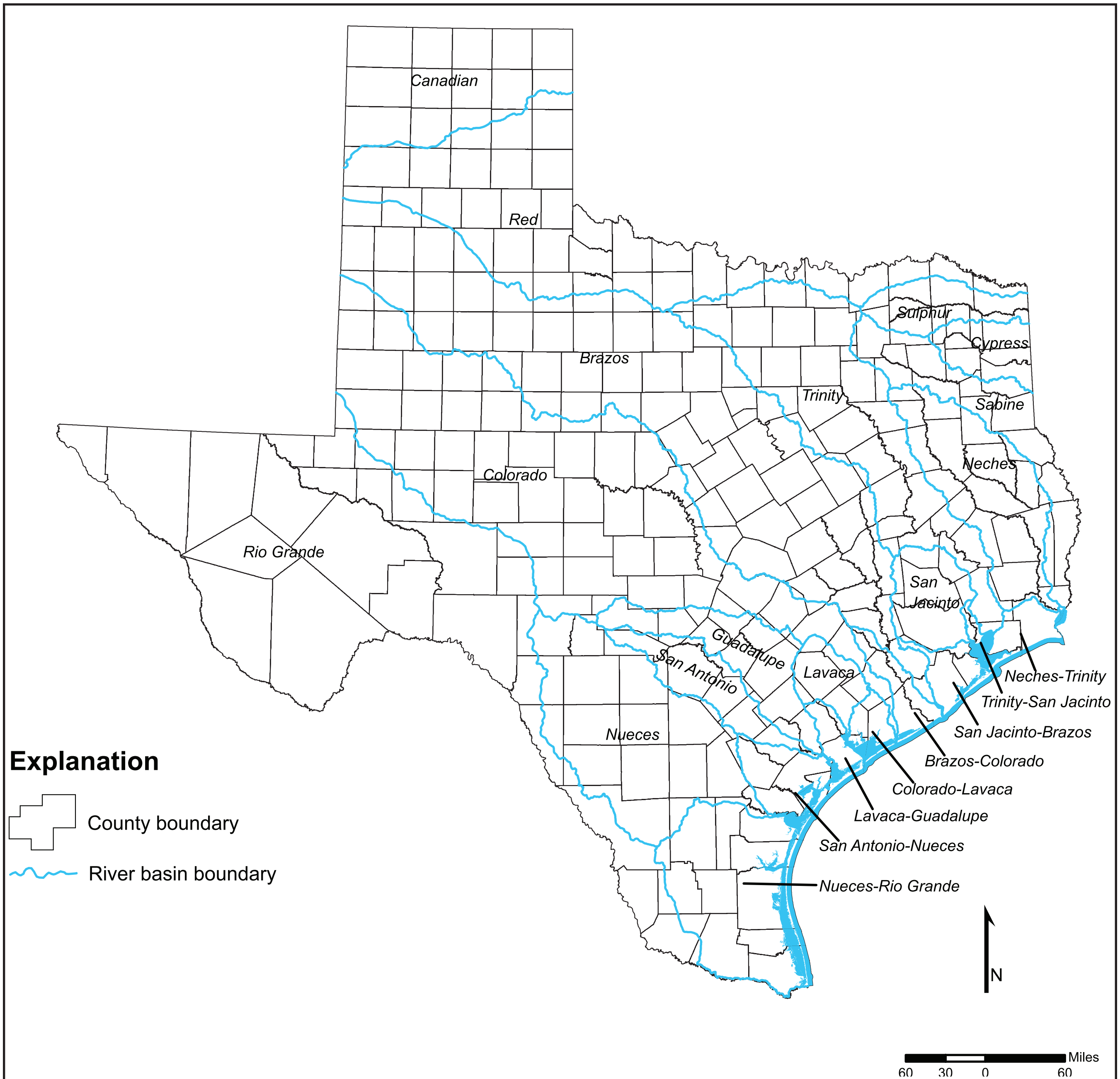

Figure 5-14. Major river basins of Texas.

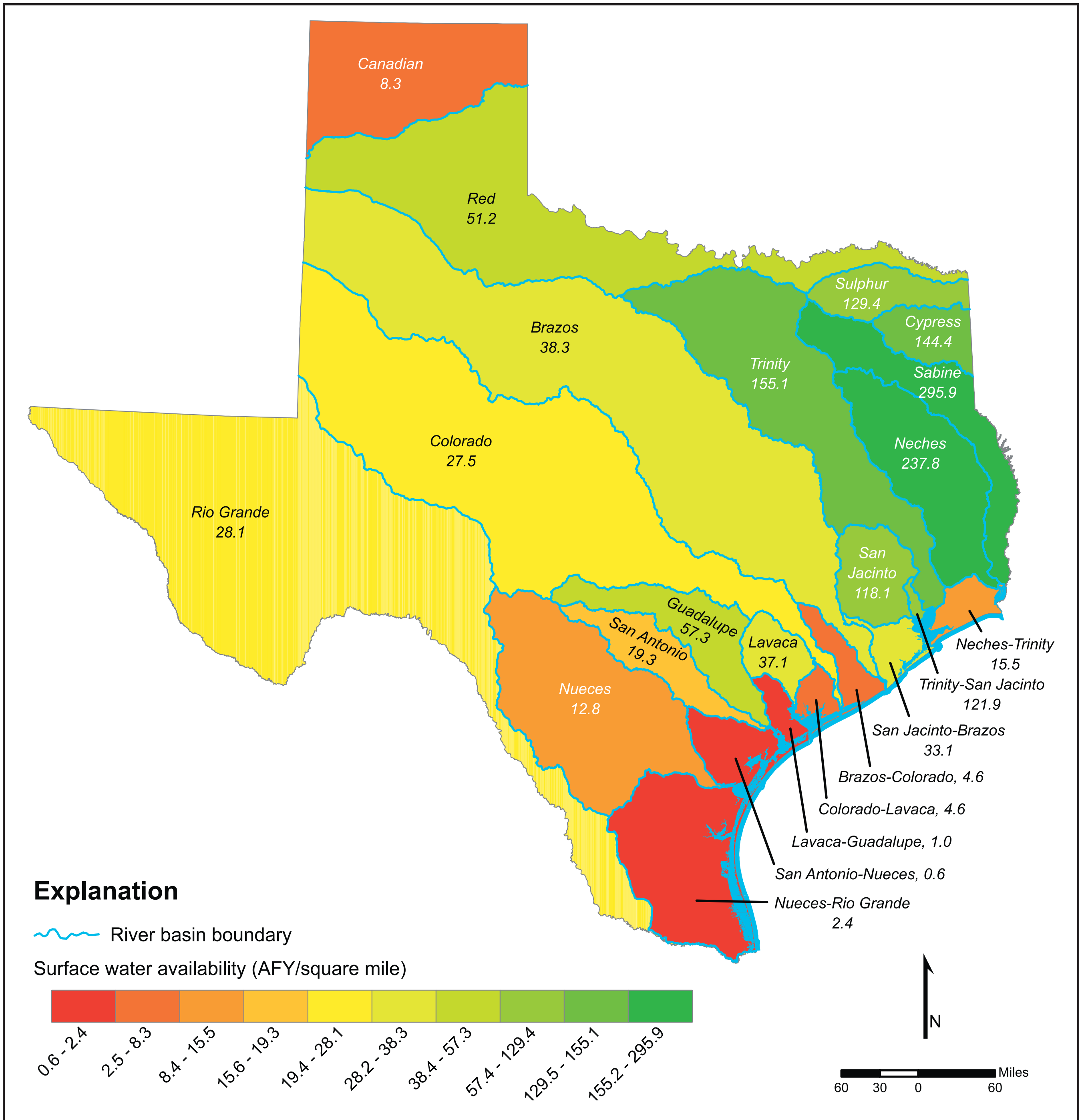

Figure 5-15. Surface water availability index.

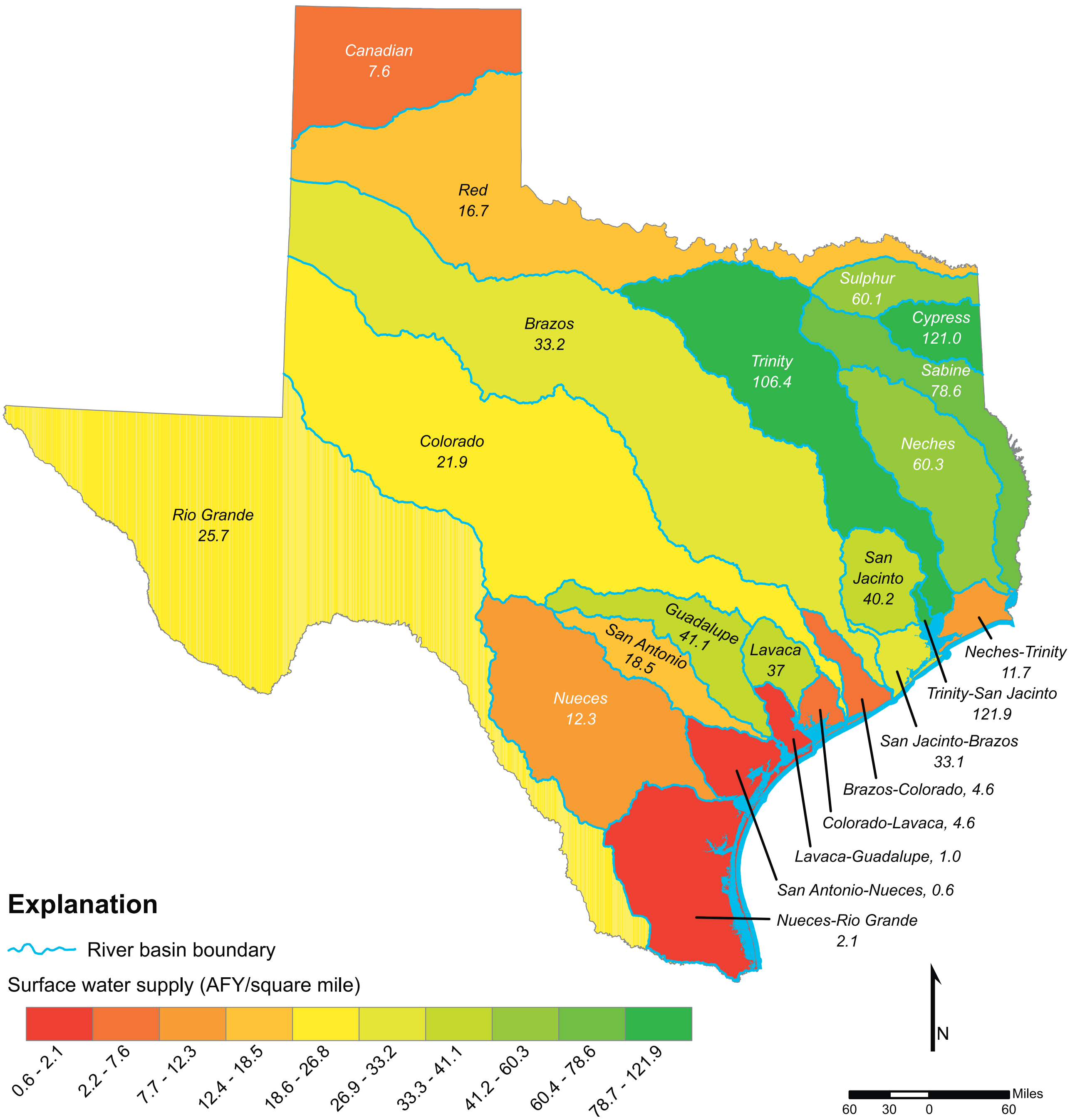

Figure 5-16. Surface water supply index.

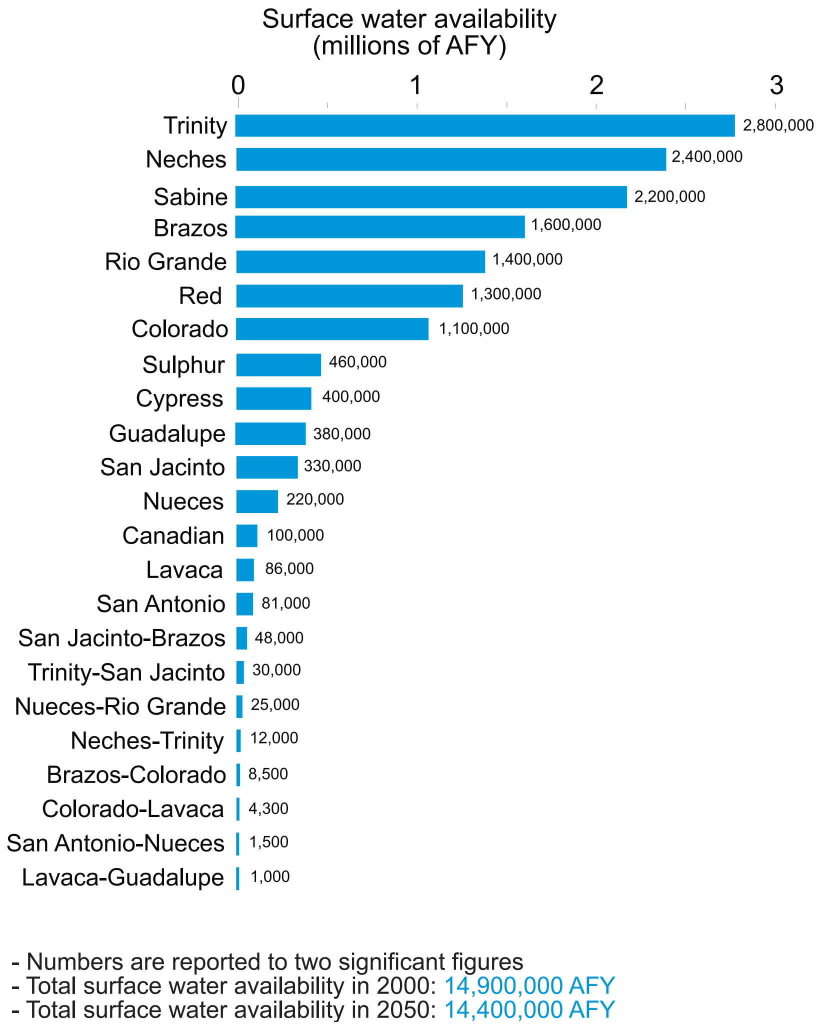

Figure 5-17. Surface water availability for the different river basins in 2000 under drought conditions.

Table 5-6. Surface water supplies from existing sources under drought conditions for the different river basins, as reported by Planning Groups.

	Surface water supplies from existing sources (AFY)						
River Basin	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**%**
Brazos	1,423,071	1,340,258	1,304,120	1,274,376	1,188,820	1,177,277	↓ 17
Brazos-Colorado	8,490	8,616	8,657	8,618	8,669	8,811	↑ 4
Canadian	96,590	97,009	97,079	96,767	96,761	96,751	- 0
Colorado	879,400	853,578	833,914	779,738	776,240	783,641	↓ 11
Colorado-Lavaca	4,304	4,304	4,304	4,304	4,304	4,304	- 0
Cypress	340,333	340,075	340,684	329,711	321,376	301,565	↓ 11
Guadalupe	275,650	267,762	267,762	267,762	267,173	262,173	↓ 5
Lavaca	87,304	87,307	87,307	87,307	45,467	45,467	↓ 48
Lavaca-Guadalupe	1,000	1,000	1,000	1,000	1,000	1,000	- 0
Neches	604,037	206,107	206,258	206,228	206,311	206,294	↓ 66
Neches-Trinity	8,977	8,961	8,953	8,945	8,944	8,943	- 0
Nueces	212,012	209,152	206,292	203,463	200,603	197,743	↓ 7

Table 5-6. *continued*

River Basin	Surface water supplies from existing sources (AFY) 2000	2010	2020	2030	2040	2050	%
Nueces-Rio Grande	18,341	18,341	18,341	18,341	18,341	18,341	- 0
Red	409,195	404,253	399,455	394,459	369,217	367,154	↓ 10
Rio Grande	1,238,743	1,221,873	1,169,666	1,079,380	1,013,848	932,510	↓ 25
Sabine	583,897	546,866	535,439	526,626	513,049	513,896	↓ 12
San Antonio	77,501	77,501	77,501	77,501	77,501	77,501	- 0
San Antonio-Nueces	1,478	1,478	1,478	1,478	1,478	1,478	- 0
San Jacinto	112,662	110,337	64,317	12,199	11,294	11,282	↓ 90
San Jacinto-Brazos	47,692	47,786	47,802	47,617	47,618	47,797	- 0
Sulphur	217,275	215,885	214,064	212,595	211,980	211,180	↓ 3
Trinity	1,912,777	1,929,214	1,970,309	1,652,144	1,668,423	1,709,838	↓ 11
Trinity-San Jacinto	30,109	30,111	30,124	30,123	30,122	30,120	- 0
Total	**8,590,838**	**8,027,774**	**7,894,826**	**7,320,682**	**7,088,539**	**7,015,066**	**↓ 18**

% represents the percent change from 2000 through 2050. The preceding symbol indicates whether supplies from the river basin are expected to decline (↓), increase (↑), or remain the same (-) from 2000 through 2050. Supplies that do not change by more than 0.5 percent are shown as remaining the same.

Table 5-7. Existing interbasin transfers*.

ID	Source	Destination
1	Lake Meredith	City of Amarillo
2	Lake Meredith	City of Lubbock
3	Lake Meredith	Cities of Lamesa, O'Donnel and Brownfield
4	Mackenzie Reservoir	Cities of Floydada and Lockney
5	Megargel Creek Lake	City of Megargel and service area
6	Lake Kickapoo	City of Olney
7	Lakes Cooper and Olney	City of Olney
8	Moss Reservoir	City of Gainesville
9	Lake Texoma	Lake Lavon
10	Pat Mayse Reservoir	Service area
11	Lake Crook	City of Paris
12	Bringle Lake	City of Texarkana
13	Cooper Lake	Lake Lavon, service area
14	Cooper Lake	Lake Lavon
15	Cooper Lake	Lake Lavon, City of Irving and its service areas
16	Lake Sulphur Springs	City of Sulphur Springs
17	Lake Wright Patman	City of Texarkana and customers
18	Lake Wright Patman	City of Atlanta
19	Lake Cypress Springs	City of Winnsboro
20	Lake Cypress Springs	Mount Vernon WTP
21	Lake O' the Pines	City of Longview
22	Big Cypress Bayou	City of Marshall
23	Lake Tawakoni	Commerce WTP
24	Lake Tawakoni	Dallas WTP or Lake Ray Hubbard
25	Lake Fork Reservoir	Dallas via Lake Tawakoni
26	Lake Tawakoni	Lake Terrell

Table 5-7. *continued*

ID	Source	Destination
27	Lake Tawakoni	Wills Point
28	Lake Fork Reservoir	Service area
29	Village Creek	City of Van
30	Toledo Bend Reservoir	Service area
31	Lake Palestine	City of Dallas
32	Lake Athens	Athens WTP
33	Lake Palestine	Part Palestine
34	Lake Palestine	City of Tyler
35	Lake Tyler	City of Tyler
36	Lake Pinkston	Center WTP
37	Neches River and Pine Island Bayou (releases from Sam Rayburn and Steinhagen)	LNVA service area within Chambers, Liberty, and Jefferson Counties
38	Neches River	Implied service area
39	Neches River	Implied service area
40	Neches River	Alligator Bayou
41	Neches River	Beaumont service area
42	SCS Reservoir on Elm Fork Trinity River	City of Saint Jo
43	Lake Weatherford	City of Weatherford
44	Lake Lavon	Royse City and others
45	Houston County Lake	Highlands Reservoir, industries and irrigation
46	Lakes Livingston and Wallisville and Lake Houston (10-4965)	City of Houston service area
47	Lakes Livingston and Wallisville	City of Houston service area
48	Trinity River	San Jacinto River Authority
49	Lakes Livingston and Wallisville	Service area
50	Trinity River	Devers Rice Growers
51	Lakes Livingston and Wallisville and Lake Houston (10-4965)	City of Houston service area
52	Lakes Livingston and Wallisville and Lake Houston (10-4965)	City of Houston service area
53	Lake Anahuac, Trinity River, and Trinity Bay	Chambers-Liberty Co. ND
54	Lake Houston	City of Houston service area (San Jacinto-Brazos)
54	Lake Houston	City of Houston service area (Trinity-San Jacinto)
55	Oyster Creek	Within property boundaries
56	Jones Creek and Oyster Creek	Service area
56	Jones Creek and Oyster Creek	Service area
56	Jones Creek and Oyster Creek	Service area
57	Freeport Harbor Channel	Brazos River
58	Lake Granbury	Service area
59	Sulphur Creek	Service area
60	Lake Mexia	City of Mexia and Mexia State School
61	Teague City Lake	City of Teague
62	Brazos River (COAs 5155-5165)	BRA service area

Table 5-7. *continued*

ID	Source	Destination
63	Brazos River	BRA service area
64	Brazos River	Service area
65	Brazos River	Brazoria County (?Fort Bend, Harris, and Galveston)
66	Brazos River	City of Freeport
67	Lake J.B. Thomas	Part of Fisher County
68	Oak Creek Reservoir	Lake Trammell and Sweetwater
69	O H Ivie Reservoir	City of Abilene and its customers
70	Lake Clyde	City of Clyde
71	Lake Travis	City of Leander
72	Lake Travis	City of Cedar Park
73	Lake Austin and Town Lake	Williamson County and possibly others
74	Colorado River and Eagle Lake	Lakeside Irrigation
75	Colorado River	Garwood rights to various recipients
75	Colorado River	Garwood rights to various recipients
76	Colorado River	Garwood rights to various recipients
76	Colorado River	Garwood rights to various recipients
77	Colorado River	Corpus Christi and its service areas
77	Colorado River	Corpus Christi and its service areas
78	Colorado River	South Texas Reservoir
79	Colorado River	Gulf Coast Water Division service area
80	Lavaca River	Within property boundaries
81	Lake Texana, Lavaca River	LNRA service area, including City of Corpus Christi and its service areas
82	Lavaca River, Dry Creek,	Within county boundaries
83	Garcitas Creek, Venado Creek Canyon Lake	Service area
84	Guadalupe River	Victoria and its service area
85	Guadalupe River	Plant (located out of basin)
86	Guadalupe River	Schwings Bayou (discharge point)
87	Elm Bayou	Irrigation
88	Guadalupe River	Calhoun County
89	Lake Medina and Lake Diversion	BMA Canals
90	San Antonio River	Elm Creek
91	Lake Corpus Christi	Beeville
92	City of Taft	Taft Drainage Canal
93	Lake Corpus Christi	Alice Terminal Reservoir
94	Calallen Reservoir	San Patricio MWD and Nueces County WCID #4
95	Nueces River	Rincon Bayou
96	Calallen Reservoir	South Texas Water Authority
97	Calallen Reservoir	Nueces County WCID #3 (Robstown and surrounding area)
98	Calallen Reservoir	Corpus Christi industries
99	Falcon and Amistad Reservoirs	Nueces-Rio Grande

* Based on water rights information provided primarily by TNRCC.

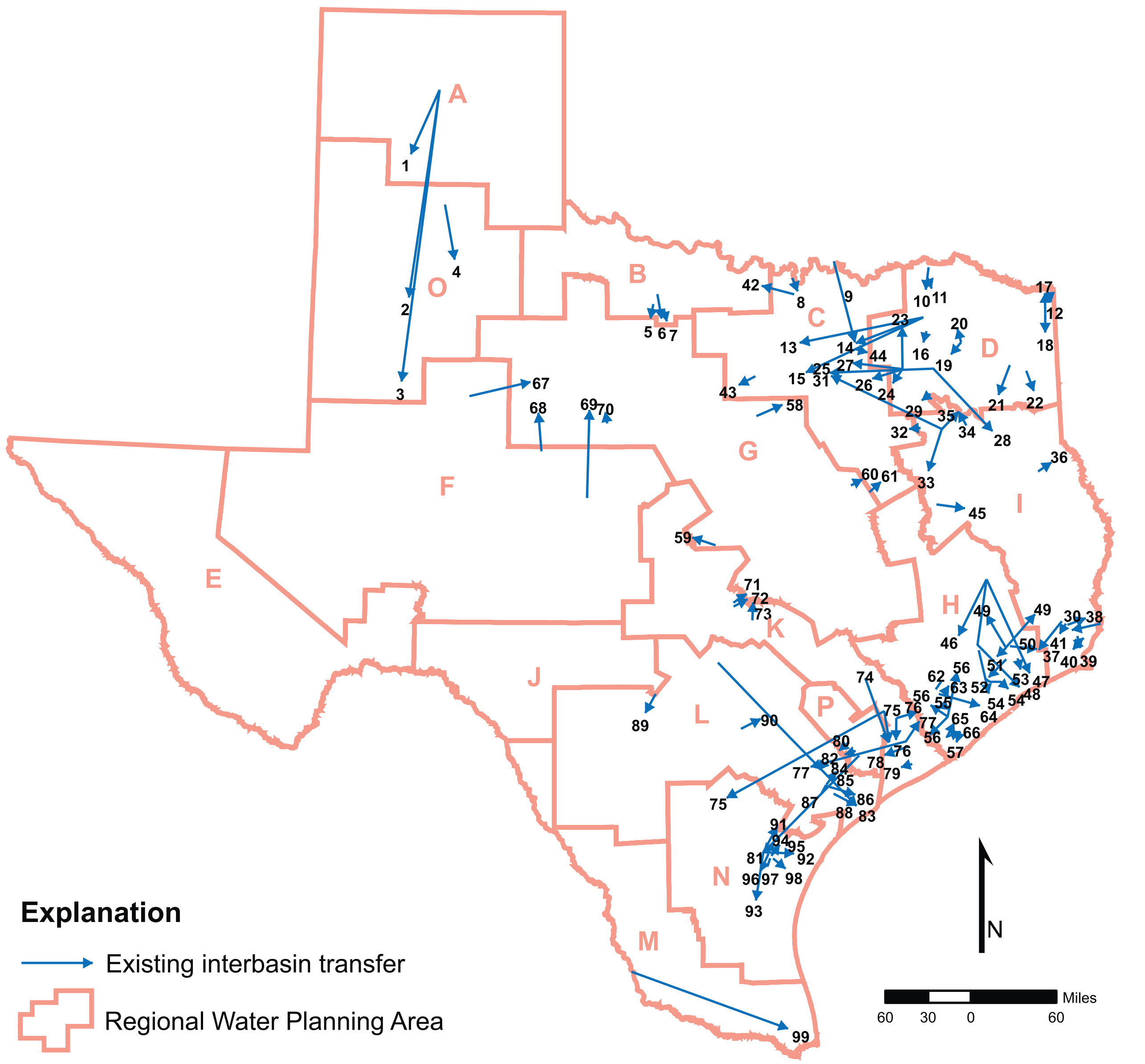

Figure 5-18. Existing interbasin transfers in the State. See Table 5-7 for descriptions of transfers (based on water rights information provided primarily by TNRCC).

5.3.3 Wastewater Reuse

Key Finding Water supplies from current wastewater reuse are projected to decrease 18 percent, from approximately 340,000 AFY in 2000 to 280,000 AFY in 2050.

Wastewater reuse can be categorized as municipal, industrial, agricultural, or a combination of approaches. In municipal and industrial applications, the term "reuse" generally refers to the process of using treated wastewater (reclaimed water) for a beneficial purpose. The degree of treatment depends on the proposed use for the reclaimed water. Examples of water reuse include municipal reclaimed water for golf course irrigation and treated industrial wastewater for manufacturing and cooling purposes. In agriculture, reuse could include the collection of surface runoff in ponds for supplemental irrigation or livestock watering.

From 2000 through 2050, wastewater reuse utilizing existing infrastructure is projected to decline from 340,000 AFY to 280,000 AFY (Table 5-8). The following regions include wastewater reuse as a current source of supply:

- Panhandle Region
- Rio Grande Region
- Region C
- Region F
- North East Texas Region
- South Central Texas Region
- Far West Texas Region
- Llano Estacado Region

Table 5-8. Groundwater, surface water, wastewater reuse, and total supplies from existing sources under drought conditions for different planning areas.

		Water supplies from existing sources (AFY)						
Region		**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**%**
A	Groundwater	1,990,104	2,007,968	1,995,763	1,524,435	1,332,412	1,281,767	↓ 36
	Surface water	112,774	113,135	113,111	112,756	112,730	112,719	- 0
	Reuse	25,378	26,659	27,978	29,506	31,501	34,021	↑ 34
	Total	**2,128,256**	**2,147,762**	**2,136,852**	**1,666,697**	**1,476,643**	**1,428,507**	↓ **33**
B	Groundwater	58,860	58,809	58,755	58,723	58,695	58,669	- 0
	Surface water	179,017	173,731	168,659	163,596	138,543	137,113	↓ 23
	Total	**237,877**	**232,540**	**227,414**	**222,319**	**197,238**	**195,782**	↓ **18**
C	Groundwater	73,590	73,432	73,444	68,977	68,989	68,943	↓ 6
	Surface water	1,108,659	1,098,679	1,084,119	1,079,007	1,071,955	1,065,760	↓ 4
	Reuse	58,600	54,100	49,200	44,700	45,200	45,429	↓ 22
	Total	**1,240,849**	**1,226,211**	**1,206,763**	**1,192,684**	**1,186,144**	**1,180,132**	↓ **5**
D	Groundwater	66,858	82,599	82,316	81,828	80,732	68,669	↑ 3
	Surface water	1,064,036	1,025,204	1,011,578	991,360	967,176	944,277	↓ 11
	Reuse	75,395	84,315	79,693	74,217	68,757	63,544	↓ 16
	Total	**1,206,289**	**1,192,118**	**1,173,587**	**1,147,405**	**1,116,665**	**1,076,490**	↓ **11**
E	Groundwater	343,905	371,371	399,167	201,784	202,109	202,469	↓ 41
	Surface water	28,516	28,516	28,516	28,516	28,516	28,516	- 0
	Reuse	62,203	72,628	85,800	0	0	0	↓ 100
	Total	**434,624**	**472,515**	**513,483**	**230,300**	**230,625**	**230,985**	↓ **47**
F	Groundwater	465,398	460,055	458,664	457,437	456,193	454,986	↓ 2
	Surface water	215,179	217,625	214,719	197,615	199,798	201,355	↓ 6
	Reuse	35,879	37,508	38,887	40,775	42,972	45,774	↑ 28
	Total	**716,456**	**715,188**	**712,270**	**695,827**	**698,963**	**702,115**	↓ **2**
G	Groundwater	518,519	518,519	518,519	518,519	518,519	518,519	- 0
	Surface water	906,194	899,058	896,441	866,186	779,854	775,875	↓ 14
	Total	**1,315,257**	**1,314,897**	**1,312,113**	**1,303,685**	**1,301,403**	**1,297,754**	↓ **1**
H	Groundwater	765,322	720,926	593,829	575,886	575,105	575,011	↓ 25
	Surface water	1,654,934	1,602,792	1,578,431	1,212,987	1,235,173	1,274,207	↓ 23
	Total	**2,420,256**	**2,323,718**	**2,172,260**	**1,788,873**	**1,810,278**	**1,849,218**	↓ **24**
I	Groundwater	208,763	208,754	208,747	208,740	208,736	208,731	- 0
	Surface water	748,552	350,409	351,321	349,721	351,042	353,383	↓ 53
	Total	**957,315**	**559,163**	**560,068**	**558,461**	**559,778**	**562,114**	↓ **41**

Table 5-8. *(continued)*

Region		**2000**	**2010**	**2020**	**2030**	**2040**	**2050**		**%**
		Water supplies from existing sources (AFY)							
J	Groundwater	67,472	67,472	67,472	67,472	67,472	67,472	-	0
	Surface water	18,439	18,439	18,439	18,439	18,439	18,439	-	0
	Total	**85,911**	**85,911**	**85,911**	**85,911**	**85,911**	**85,911**	**-**	**0**
K	Groundwater	307,249	308,560	310,069	311,555	312,520	312,996	↑	2
	Surface water	697,195	668,855	652,056	614,938	609,202	614,982	↓	12
	Total	**1,004,444**	**977,415**	**962,125**	**926,493**	**921,722**	**927,978**	**↓**	**8**
L	Groundwater	623,362	619,803	617,166	542,965	540,183	537,122	↓	14
	Surface water	372,617	364,732	364,732	364,732	364,143	359,143	↓	4
	Reuse	24,941	28,877	28,877	28,877	28,877	28,877	↑	16
	Total	**1,020,920**	**1,013,412**	**1,010,775**	**936,574**	**933,203**	**925,142**	**↓**	**9**
M	Groundwater	73,930	73,953	73,980	61,696	61,721	61,746	↓	16
	Surface water	1,190,745	1,173,875	1,121,668	1,031,413	965,881	884,543	↓	26
	Reuse	13,415	13,415	13,415	13,415	13,415	13,415	-	0
	Total	**1,278,090**	**1,261,243**	**1,209,063**	**1,106,524**	**1,041,017**	**959,704**	**↓**	**25**
N	Groundwater	76,229	76,229	76,229	76,229	76,229	76,229	-	0
	Surface water	195,872	193,012	190,152	187,292	184,432	181,572	↓	7
	Total	**272,101**	**269,241**	**266,381**	**263,521**	**260,661**	**257,801**	**↓**	**5**
O	Groundwater	3,003,482	2,892,957	2,784,459	2,676,668	2,579,113	2,493,225	↓	17
	Surface water	15,788	17,391	18,563	19,803	21,174	22,701	↑	44
	Reuse	45,575	46,156	46,481	47,178	47,636	48,398	↑	6
	Total	**3,064,845**	**2,956,504**	**2,849,503**	**2,743,649**	**2,647,923**	**2,564,324**	**↓**	**16**
P	Groundwater	187,694	187,679	187,627	187,744	187,879	188,098	-	0
	Surface water	82,321	82,321	82,321	82,321	40,481	40,481	↓	51
	Total	**270,015**	**270,000**	**269,948**	**270,065**	**228,360**	**228,579**	**↓**	**15**
Total									
	Groundwater	8,830,737	8,729,086	8,506,206	7,620,658	7,326,607	7,174,652	↓	19
	Surface water	8,590,838	8,027,774	7,894,826	7,320,682	7,088,539	7,015,066	↓	18
	Reuse	341,386	363,658	370,331	278,668	278,358	279,458	↓	18
Grand Total		**17,762,961**	**17,120,518**	**16,771,363**	**15,220,008**	**14,693,504**	**14,469,176**	**↓**	**19**

% represents the percent change from 2000 through 2050. The preceding symbol indicates whether supplies from the source are expected to decline (↓), increase (↑), or remain the same (-) from 2000 through 2050. Supplies that do not change by more than 0.5 percent are shown as remaining the same.

5.3.4 Total Supplies for the Planning Areas

Total water supplies for the State decline from about 17.8 million AFY in 2000 to 14.5 million AFY in 2050. Total supplies decline in 15 of the 16 regions and remain steady in 1 region. Groundwater supplies decrease in 8 regions, increase in 2 regions, and remain steady in 6 regions. Surface water supplies decrease in 12 regions, increase in 1 region, and remain steady or fluctuate slightly in 3 regions (Table 5-8).