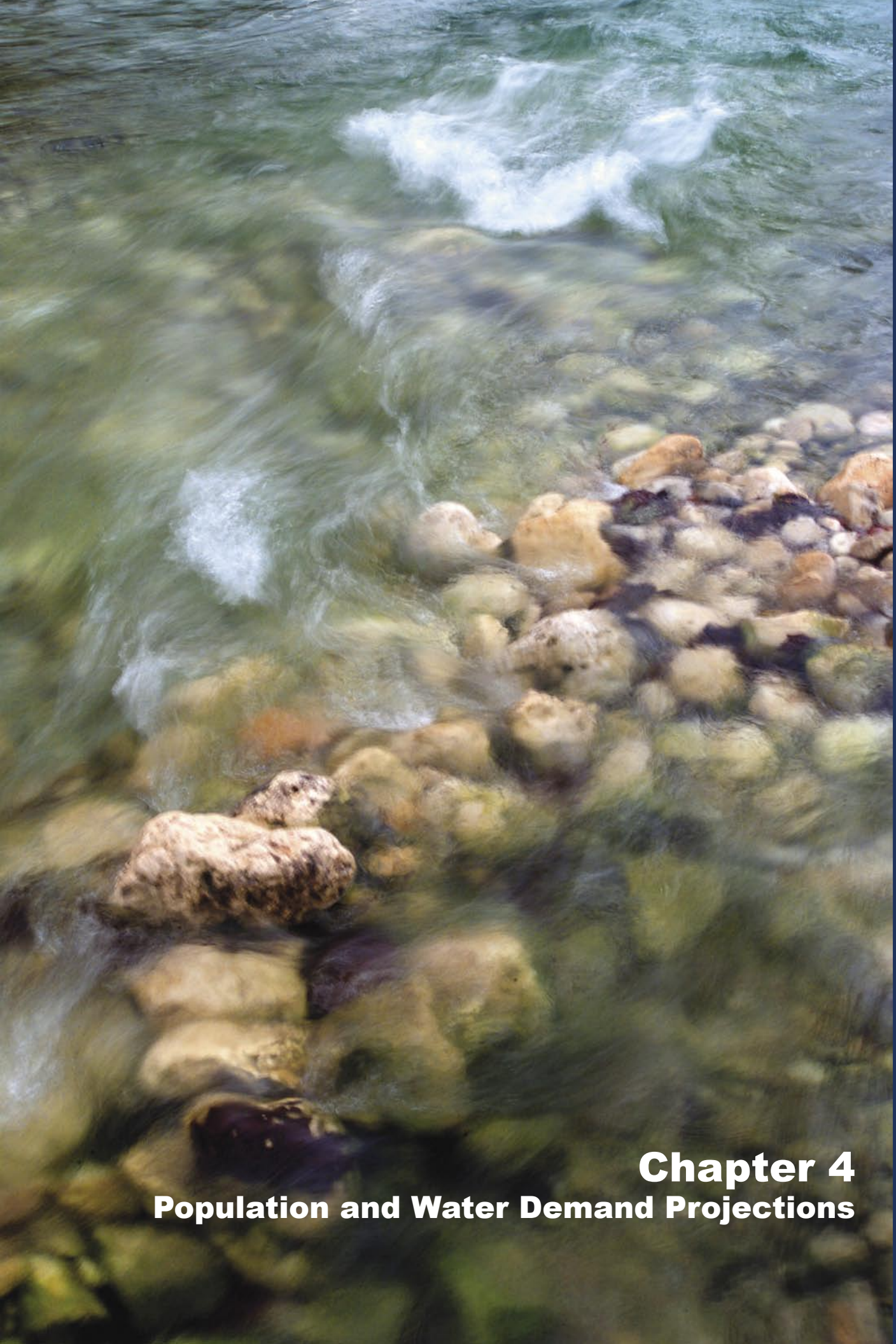


# Chapter 4
## Population and Water Demand Projections

# Chapter 4

# Population and Water Demand Projections

*Population in Texas is expected to more than double between the years 2000 and 2060, growing from 20,851,790 to 45,558,282. The growth rates, however, will vary considerably across the state. While some planning areas will double or even triple their populations, others will grow only slightly, and still others will lose population. Forty-three counties and 297 cities are projected to at least double their population, but another 45 counties and 137 cities are expected to lose population or remain the same. The rest are expected to grow slightly.*

*Although the population is projected to more than double over 60 years, water demand in Texas is projected to increase by only 27 percent, from almost 17 million acre-feet of water in 2000 to a projected demand of 21.6 million acre-feet in 2060. This smaller increase is primarily due to declining demand for agricultural irrigation water and increased emphasis on municipal water conservation.*

Determining the complex water needs for Texas' future first requires answering two vital questions: how many people will need water, and how much water will they need? The initial task in the water planning process is to answer those questions by reviewing and adopting estimates that accurately project the state's future population and water demand. These numbers become the starting point from which the planning groups can assess their future needs.

## 4.1 Population Projections

The State of Texas will continue to be one of the fastest growing states in the nation, with its population expected to more than double between the year 2000 (20,851,790) and the year 2060 (45,558,282) (Figure 4.1). Although all of the state's water planning areas will grow during that time, they will not all grow equally.

The planning areas that include many of the state's major metropolitan areas—Region C, Region E, Region G, Region H, Region K, and Region L—are all expected to at least double their population by 2060 (Table 4.1, Figure 4.2). Region M will grow even more rapidly, more than tripling its population. Forty-three of Texas' 254 counties and 297 of its cities are projected to at least double their population by 2060.

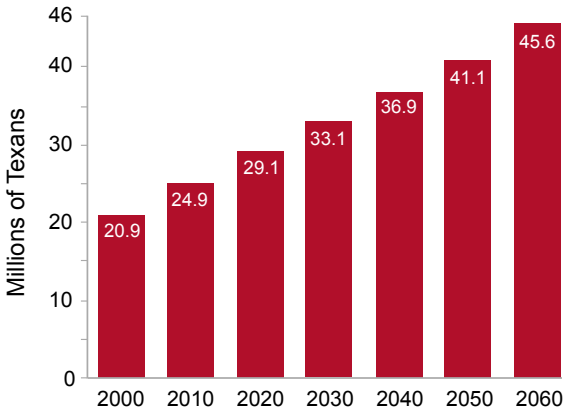



Figure 4.1. Texas state population projections for 2000-2060.

Table 4.1. Regional and state total population projections for 2000–2060

| Region | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| A | 355,832 | 388,104 | 423,380 | 453,354 | 484,954 | 516,729 | 541,035 |
| B | 201,970 | 210,642 | 218,918 | 223,251 | 224,165 | 223,215 | 221,734 |
| C | 5,254,722 | 6,625,282 | 7,966,389 | 9,093,847 | 10,246,795 | 11,559,990 | 13,087,849 |
| D | 704,171 | 772,163 | 843,027 | 908,748 | 978,298 | 1,073,570 | 1,213,095 |
| E | 705,399 | 855,466 | 1,018,479 | 1,161,232 | 1,283,725 | 1,405,966 | 1,527,713 |
| F | 578,814 | 618,889 | 656,480 | 682,132 | 700,806 | 714,045 | 724,094 |
| G | 1,621,961 | 1,882,896 | 2,168,682 | 2,458,075 | 2,739,717 | 3,034,798 | 3,332,100 |
| H | 4,848,918 | 5,775,097 | 6,707,045 | 7,679,397 | 8,653,377 | 9,739,109 | 10,897,526 |
| I | 1,011,317 | 1,090,382 | 1,166,057 | 1,232,138 | 1,294,976 | 1,377,760 | 1,482,448 |
| J | 114,742 | 135,723 | 158,645 | 178,342 | 190,551 | 198,594 | 205,910 |
| K | 1,132,228 | 1,359,677 | 1,657,025 | 1,936,324 | 2,181,851 | 2,447,058 | 2,713,905 |
| L | 2,042,221 | 2,460,599 | 2,892,933 | 3,292,970 | 3,644,661 | 3,984,258 | 4,297,786 |
| M | 1,236,246 | 1,581,207 | 1,973,188 | 2,401,223 | 2,854,613 | 3,337,618 | 3,826,001 |
| N | 541,184 | 617,143 | 693,940 | 758,427 | 810,650 | 853,964 | 885,665 |
| O | 453,997 | 492,627 | 521,930 | 540,908 | 552,188 | 553,691 | 551,758 |
| P | 48,068 | 49,491 | 51,419 | 52,138 | 51,940 | 51,044 | 49,663 |
| Texas | 20,851,790 | 24,915,388 | 29,117,537 | 33,052,506 | 36,893,267 | 41,071,409 | 45,558,282 |

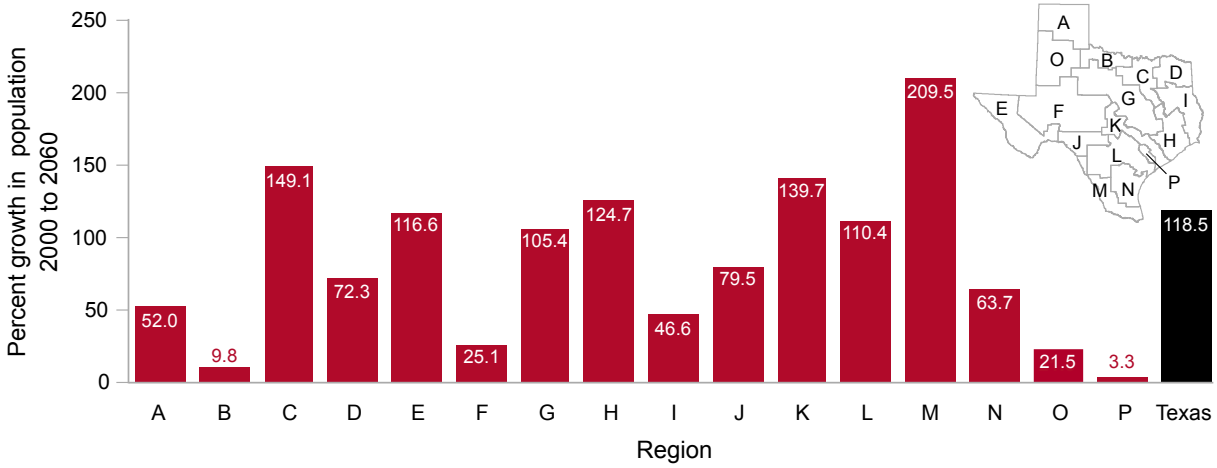



Figure 4.2. Projected population growth for planning regions.

Other regions, however, are expected to grow only slightly during the same period. These regions are generally in the more rural West Texas portions of the state (Regions B, F, and O) and the rural Lavaca area (Region P). Forty-five counties and 137 cities in Texas are expected to lose residents or have no growth (Figure 4.3).

## 4.2 Water Demand Projections

Although the population is projected to more than double between 2000 and 2060, water demand in Texas will increase by only 27 percent, from almost 17 million acre-feet of water in 2000 to a projected demand of 21.6 million acre-feet of water in 2060 (Table 4.2, Figure 4.4).

Table 4.2. Summary of water demand projections by category for 2000–2060 (acre-feet per year)

| Category | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| Municipal | 4,047,661 | 4,770,501 | 5,483,790 | 6,120,377 | 6,739,592 | 7,450,792 | 8,258,942 |
| Manufacturing | 1,559,912 | 1,825,686 | 2,004,666 | 2,163,421 | 2,319,913 | 2,452,107 | 2,578,582 |
| Mining | 278,624 | 270,845 | 280,815 | 285,964 | 276,054 | 276,931 | 285,573 |
| Steam-electric | 561,394 | 755,170 | 886,580 | 1,030,212 | 1,174,170 | 1,339,733 | 1,533,556 |
| Livestock | 300,441 | 344,495 | 374,724 | 381,241 | 388,243 | 395,945 | 404,397 |
| Irrigation | 10,228,528 | 10,345,131 | 9,980,301 | 9,585,833 | 9,206,620 | 8,843,094 | 8,556,224 |
| Texas | 16,976,560 | 18,311,828 | 19,010,876 | 19,567,048 | 20,104,592 | 20,758,602 | 21,617,274 |

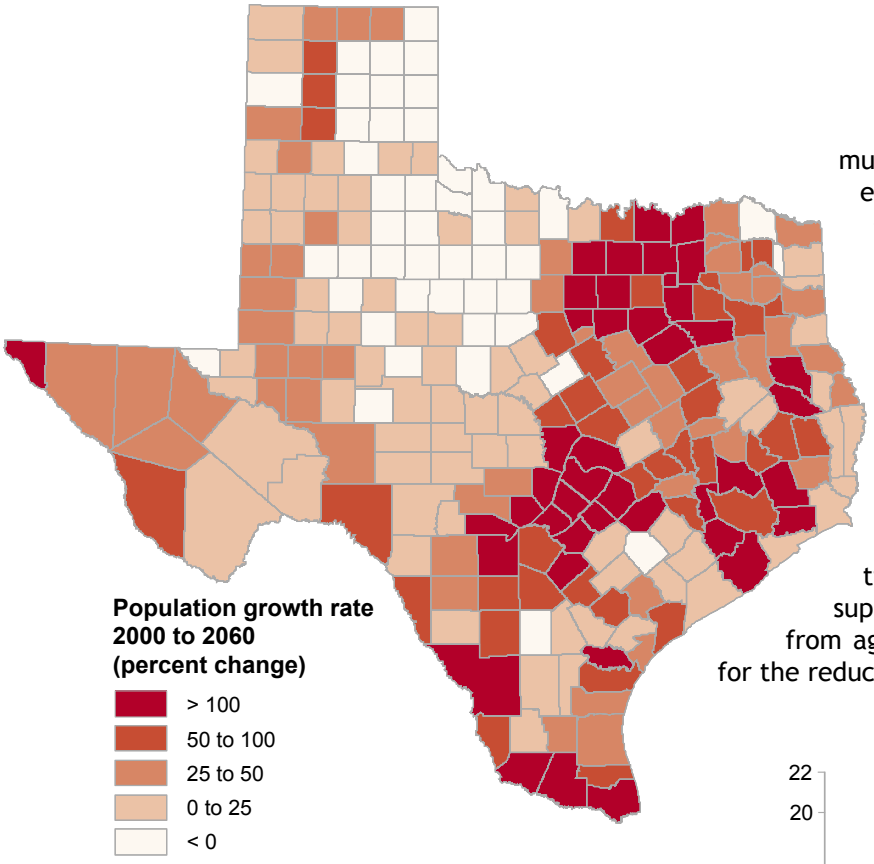



Figure 4.3. Projected population growth in Texas counties.

This smaller percent increase is primarily due to declining demand for agricultural irrigation water (10.2 million acre-feet per year to 8.6 million acre-feet per year), partially offsetting the increase in municipal water demand (4.0 million acre-feet to 8.3 million acre-feet).

Those categories that are most directly related to the increasing population of the state—municipal, manufacturing, and steam-electric power generation—show the greatest projected increase in water demand. The two smallest categories of water demand, mining and livestock, are projected to grow only slightly. However, the largest water demand category, irrigated agriculture, is expected to decrease, leaving its projected demand only slightly higher than the municipal category in 2060 (Figure 4.5). More efficient irrigation systems, reduced groundwater supplies, and the transfer of water rights from agriculture to municipal uses account for the reduced irrigation demand.

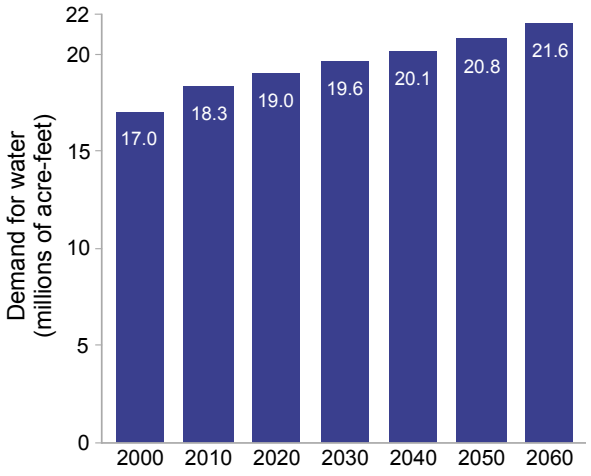



Figure 4.4. Texas water demand projections for 2000-2060.

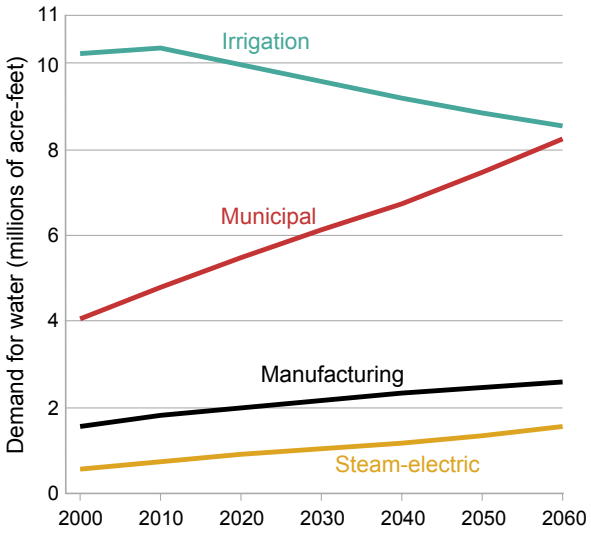



Figure 4.5. Projected demand for irrigation, municipal, manufacturing, and steam-electric uses.

As with the population projections, the total water demand varies significantly by planning area in the state (Table 4.3). Dramatic increases in water demands are projected in Region C, Region D, Region H, Region I, and Region N. Because of declining demand for irrigation, three regions show a projected decrease in total water demand over the planning period: Region A, Region O, and Region P (Figure 4.6).

Table 4.3. Regional and state total water demand projections for 2000–2060 (acre-feet per year)

| Region | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|
| A | 1,881,696 | 1,864,748 | 1,853,329 | 1,780,588 | 1,625,201 | 1,469,590 | 1,399,412 |
| B | 128,583 | 171,164 | 171,806 | 174,361 | 171,958 | 169,419 | 169,153 |
| C | 1,380,556 | 1,768,464 | 2,100,519 | 2,358,433 | 2,622,513 | 2,934,927 | 3,311,217 |
| D | 487,815 | 561,076 | 605,527 | 653,207 | 704,086 | 760,410 | 838,977 |
| E | 665,552 | 662,608 | 679,540 | 693,249 | 697,884 | 708,431 | 721,071 |
| F | 595,696 | 807,453 | 810,576 | 813,895 | 816,478 | 820,191 | 825,581 |
| G | 795,182 | 835,691 | 895,944 | 953,690 | 1,006,928 | 1,077,078 | 1,150,973 |
| H | 2,087,409 | 2,314,094 | 2,524,096 | 2,730,503 | 2,941,312 | 3,173,614 | 3,412,457 |
| I | 704,320 | 896,455 | 988,330 | 1,049,715 | 1,113,994 | 1,182,706 | 1,261,320 |
| J | 49,662 | 51,844 | 54,323 | 56,261 | 57,248 | 57,984 | 58,559 |
| K | 1,004,335 | 1,078,041 | 1,118,464 | 1,194,008 | 1,237,515 | 1,276,600 | 1,301,682 |
| L | 896,353 | 985,237 | 1,043,584 | 1,101,758 | 1,154,493 | 1,210,977 | 1,273,003 |
| M | 1,332,976 | 1,474,242 | 1,456,244 | 1,424,191 | 1,497,566 | 1,577,610 | 1,661,657 |
| N | 205,937 | 226,691 | 250,401 | 265,212 | 279,510 | 293,254 | 308,577 |
| O | 4,530,041 | 4,388,459 | 4,236,454 | 4,100,103 | 3,963,872 | 3,835,487 | 3,716,727 |
| P | 230,447 | 225,561 | 221,739 | 217,874 | 214,034 | 210,324 | 206,908 |
| Texas | 16,976,560 | 18,311,828 | 19,010,876 | 19,567,048 | 20,104,592 | 20,758,602 | 21,617,274 |

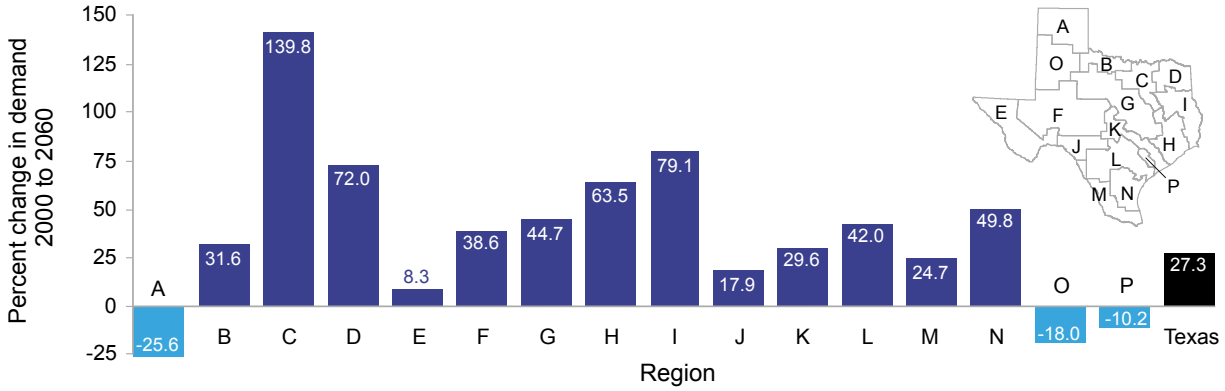



Figure 4.6. Percent change in projected demand by planning region for 2000–2060.

## 4.3 Methodology

### 4.3.1 Population Methodology

Determining the most appropriate set of population projections for each county was a lengthy process designed to develop consensus between state and local groups. Staff from TWDB, the Texas Commission on Environmental Quality, the Texas Department of Agriculture, and the Texas Parks and Wildlife Department, as well as representatives from the planning groups, all helped to develop initial projections. These draft projections were then sent on to the planning groups for review. As a result of planning group requests, TWDB made over 600 population projection revisions at the county and subcounty levels.

Population projections for the 2007 State Water Plan used a standard demographic methodology known as a cohort-component procedure. This procedure uses separate cohorts (combinations of age, gender, and racial-ethnic groups) and components of cohort change (fertility, survival, and migration rates) to estimate future county populations.

The mathematical models and assumptions used for this process are, in essence, identical to those developed by the Texas State Data Center. TWDB varied these models only by expanding their scope to project over a 50-year time frame, adding to the 30-year projections of the Texas State Data Center (see Appendix 4.1).

Of the three components of future population change, migration rates, which calculate how many people move in and out of the counties, are the most critical. Fertility and survival rates can be assumed to closely follow observed rates of the recent past, but migration rates tend to be heavily influenced by the state of the economy, reflecting movement that takes advantage of economic opportunity. Migration can also be influenced by other unforeseen events, such as the catastrophic weather events of the recent past. Thus, three sets of projections were developed based on different assumptions regarding migration: one set projected zero migration; another assumed migration to equal one-half of the levels in the decade of the 1990s; and the third set assumed migration

to equal that of the 1990-2000 rates. The planning groups and state agency staff together determined the most appropriate migration projection for each region.

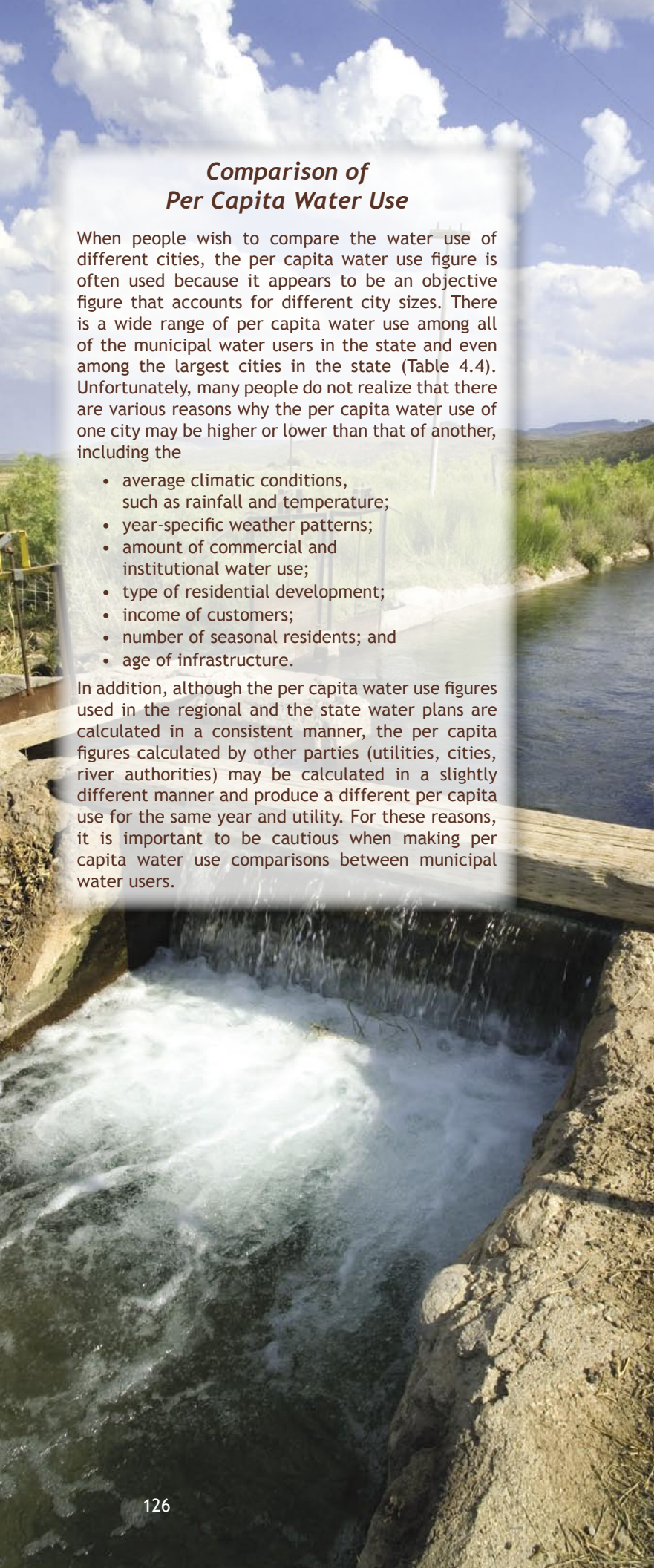
### *Subcounty Population Projections*

Because representatives from more of the state's unincorporated areas were involved in this planning process, the 2007 State Water Plan contains more detailed population projections than the 2002 State Water Plan. This plan projects population for 1,332 population centers, including cities with over 500 residents, utilities in unincorporated areas with water use in 2000 of 280 acre-feet or greater, and unincorporated population centers in sparsely populated counties. The 2002 State Water Plan included projections for 971 population centers; it did not include statistics on other utilities.

Because detailed cohort-component data is available only for county level population projections, TWDB used a different methodology to determine projections for cities, other utility service areas, and the remaining rural areas within each county. In general, the agency based initial projections on the estimated share each entity had of the 1990-2000 county growth. TWDB then applied that same percentage to the growth projections. However, when the growth trend for a county and a city went in opposite directions, other methods of projections more specific to the situation were used. Because census populations were not available for utility service areas, TWDB used the number of water connections and the populations served that were reported in TWDB's annual Water Use Survey to represent those baseline population figures.

## *4.3.2 Water Demand Methodology*

In a process similar to determining the population projections, staff from the four state agencies (TWDB, the Texas Commission on Environmental Quality, the Texas Department of Agriculture, and the Texas Parks and Wildlife Department) developed draft water demand projections. The plan-



### *Comparison of Per Capita Water Use*

When people wish to compare the water use of different cities, the per capita water use figure is often used because it appears to be an objective figure that accounts for different city sizes. There is a wide range of per capita water use among all of the municipal water users in the state and even among the largest cities in the state (Table 4.4). Unfortunately, many people do not realize that there are various reasons why the per capita water use of one city may be higher or lower than that of another, including the

- average climatic conditions, such as rainfall and temperature;
- year-specific weather patterns;
- amount of commercial and institutional water use;
- type of residential development;
- income of customers;
- number of seasonal residents; and
- age of infrastructure.

In addition, although the per capita water use figures used in the regional and the state water plans are calculated in a consistent manner, the per capita figures calculated by other parties (utilities, cities, river authorities) may be calculated in a slightly different manner and produce a different per capita use for the same year and utility. For these reasons, it is important to be cautious when making per capita water use comparisons between municipal water users.

ning groups then made more than 900 subsequent revisions, all of which were incorporated into the final projections. The draft water demand projections were calculated using the historical water use from a base year and adjusting that figure for each future decade based on factors that influence the water demand for each water use category (population and economic growth, for instance). TWDB chose the year 2000 as the base year because it was very dry across nearly all the state, it matched with the availability of census population data, and it was recent enough to reflect current conservation and technological innovations. Water demand projections for all categories other than the municipal category were calculated on a countywide basis.

## *Municipal Water Demand*

Municipal water use is defined as residential *and* commercial water use. Residential use includes single and multifamily residential household water use. Commercial use includes water for business establishments, public offices, and institutions but does not include industrial water use. Residential and commercial water uses are categorized together because both use water similarly for drinking, cleaning, sanitation, cooling, and landscape watering.

This category includes demand projections for all the subcounty groups mentioned in the population methodology section—cities, other utilities, and aggregated rural populations. To determine demand for each group, TWDB first calculated per capita water use (often described as gallons per capita per day) by dividing each group's total water use in 2000 by its population. Those figures excluded sales to other utilities and industrial facilities. TWDB then multiplied the projected populations by the projected per capita water use.

The municipal water demand projections in most regions incorporated the anticipated future water savings from installing more water-efficient plumbing fixtures, as detailed in the State Water Saving Performance Standards for Plumbing Fixtures Act of 1991. All other future water savings from municipal conservation programs were incorporated only as adopted water management strategies by the planning groups.

## *Manufacturing and Mining Water Demands*

Draft projections for these two categories were based upon water use in 2000, as reported in TWDB's annual Water Use Survey. The base water use amount for each county was then projected into the future,

taking into consideration economic projections for the manufacturing and mining industries, as well as incorporated efficiency improvements from new technology. The projections also took into account the availability of accessible reserves and their effects on mining output.

### *Steam-Electric Power Generation Water Demands*

Representatives of investor-owned Texas utilities, under contract with TWDB, prepared projections for this category. They based projections on the anticipated demand for electricity and the amount of water needed to produce each unit of electricity (kilowatt-hours). Demand for electricity was assumed to grow in direct proportion to the population and to commercial and manufacturing sectors. The projections also included savings in the first 20 years generated by more efficient production methods.

### *Irrigation Water Demands*

The rate of future change in irrigation water demand was based on previous TWDB research, which used mathematical optimization models. These models determined the most profitable crop combinations and overall rate of water use, also taking into account land availability, improved technology, and local acreage history. In rapidly urbanizing areas, projections also incorporated estimated figures on the amount of acreage and water rights being converted to municipal use.

### *Livestock Water Demands*

Livestock water use for each county was based on the estimated livestock inventory in 2000 and on estimated water use per animal unit. In most cases, it was assumed that livestock use would remain constant over the planning horizon.

## *4.3.3 Additional Information*

More complete descriptions of these methodologies, as well as those for population projections, can be found in the Exhibit B Guidelines for Regional Water Plan Development (http://www.twdb.state.tx.us/data/popwaterdemand/2003Projections/Methodology.asp).

Table 4.4. Per capita water use for the 40 largest cities of Texas for 2003-2060 (gallons per capita per day)

| City | 2003 | 2020 | 2040 | 2060 |
|---|---|---|---|---|
| **10 highest use** | | | | |
| Richardson | 275 | 278 | 274 | 272 |
| Amarillo | 241 | 201 | 201 | 201 |
| Dallas | 238 | 262 | 257 | 256 |
| Abilene | 232 | 161 | 155 | 154 |
| Plano | 225 | 253 | 250 | 249 |
| Longview | 226 | 120 | 115 | 115 |
| Beaumont | 223 | 209 | 203 | 201 |
| Midland | 219 | 254 | 248 | 247 |
| Brownsville | 214 | 221 | 217 | 216 |
| Irving | 212 | 223 | 218 | 217 |
| **20 intermediate use** | | | | |
| Odessa | 211 | 202 | 195 | 194 |
| College Station | 196 | 217 | 213 | 212 |
| Lubbock | 191 | 202 | 196 | 195 |
| Round Rock | 191 | 194 | 191 | 191 |
| Waco | 190 | 183 | 183 | 183 |
| McAllen | 186 | 197 | 193 | 192 |
| Tyler[a] | 185 | 255 | 249 | 248 |
| Wichita Falls | 184 | 172 | 170 | 168 |
| Carrollton | 181 | 188 | 184 | 183 |
| Laredo | 179 | 192 | 189 | 188 |
| Austin | 177 | 173 | 171 | 169 |
| Fort Worth | 177 | 207 | 203 | 202 |
| Arlington | 173 | 179 | 175 | 174 |
| Sugar Land | 173 | 214 | 211 | 211 |
| El Paso | 169 | 176 | 171 | 170 |
| Houston | 164 | 152 | 147 | 146 |
| Harlingen | 164 | 149 | 144 | 143 |
| Garland | 158 | 160 | 156 | 155 |
| McKinney | 153 | 244 | 242 | 242 |
| Lewisville | 152 | 173 | 171 | 170 |
| **10 lowest use** | | | | |
| Corpus Christi | 150 | 171 | 166 | 165 |
| Mesquite | 146 | 157 | 153 | 152 |
| Baytown | 146 | 140 | 134 | 133 |
| Denton | 144 | 179 | 176 | 176 |
| Bryan | 144 | 140 | 135 | 134 |
| San Angelo | 143 | 193 | 187 | 186 |
| San Antonio | 142 | 139 | 135 | 134 |
| Pasadena | 128 | 110 | 105 | 104 |
| Grand Prairie | 125 | 145 | 142 | 141 |
| Killeen | 125 | 179 | 174 | 167 |

*Note:* Water use in 2003 is based on data self reported by the city to TWDB and may vary from the trend of projected future values (2020, 2040, 2060) due to atypical 2003 weather conditions, reporting errors, or other variable factors.

[a]The city of Tyler did not submit a Water Use Survey for 2003. The data reported for 2002 has been substituted.