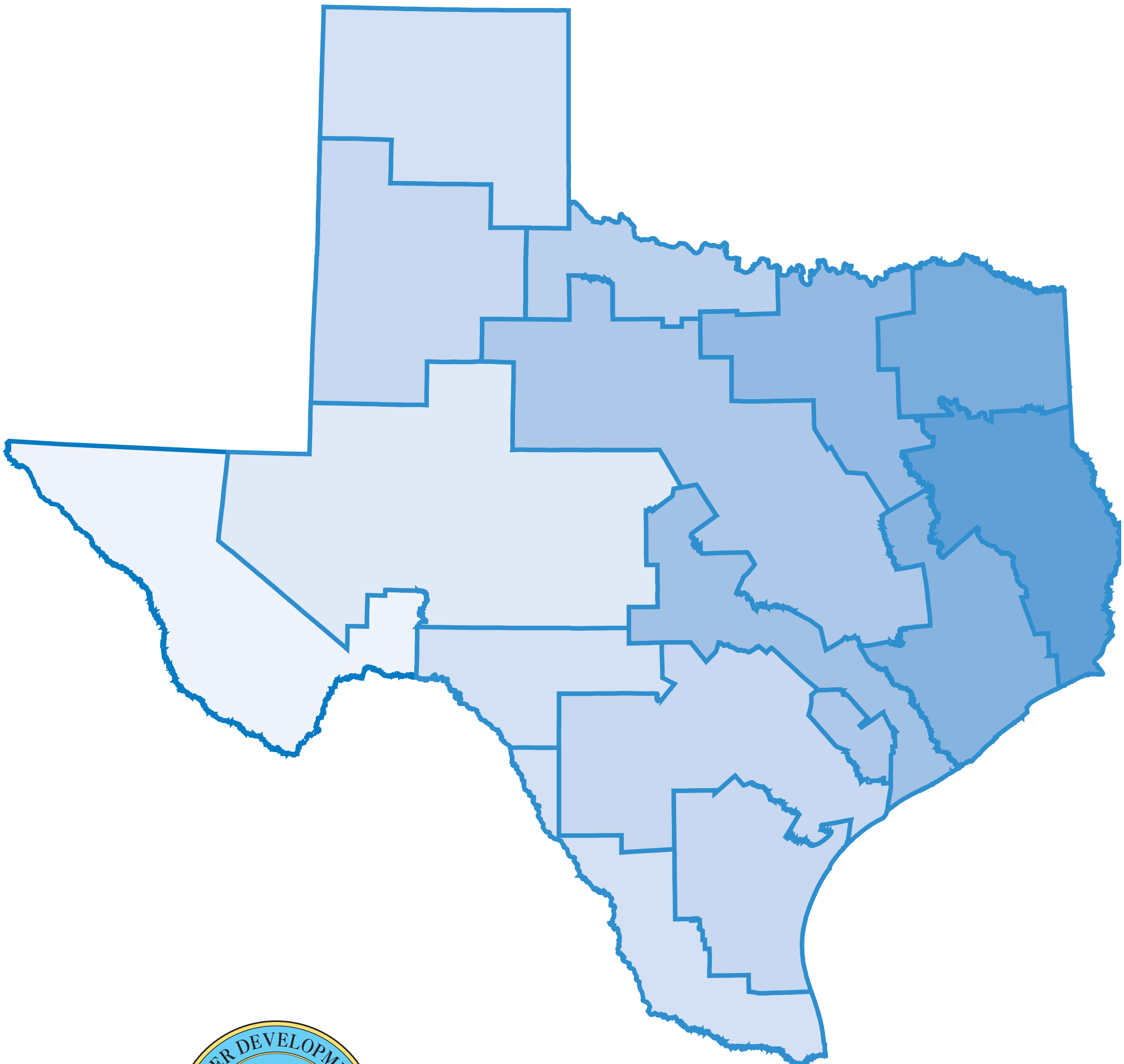
Water for Texas – 2002



Texas Water Development Board
January 2002

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December 31, 2001

To: The People of the State of Texas
The Honorable Rick Perry, Governor of Texas
The Honorable Bill Ratliff, Lieutenant Governor of Texas
The Honorable James E. "Pete" Laney, Speaker of the Texas House of Representatives
The Honorable J. E. "Buster" Brown, Chair, Natural Resources Committee, Texas Senate
The Honorable David Counts, Chair, Natural Resources Committee, Texas House of Representatives

Transmitted herewith is the first State Water Plan, Water for Texas – 2002, adopted pursuant to Senate Bill 1, 75th Texas Legislature. The Texas Water Development Board adopted this plan unanimously on December 12, 2001.

This plan realizes Senate Bill 1's vision for an open and participatory process with specific decisions made at the regional level. It identifies actions to be used to meet local water needs during a drought of record and over the next 50 years. By incorporating the 16 approved regional water plans, this plan reflects the combined penmanship of over 450 regional water planning group members. In addition to incorporating the approved regional water plans, the Board also sought the input of an advisory stakeholder group and the general public in preparing the policy recommendations contained in this plan.

Volume I contains statewide water resource information, results of the regional water planning process, lists of recommended unique reservoir sites and river and stream segments of unique ecological value for the Legislature to consider, and policy recommendations. Volume II provides detailed water supply strategies for each city, town and area in the State. Volume III includes electronic copies of the 16 approved regional water plans.

The regional and state water planning process is dynamic in nature. Already, the next round of regional water planning is underway. These plans will be subject to ongoing revisions as the Planning Groups respond to changed conditions and new information. In addition, the formally revised regional water plans will be submitted by January 5, 2006 with a revised State Water Plan following one year later.

This planning must recognize that rapid growth will continue to exert great pressure on the capabilities of many local governments to implement and finance the strategies included in the regional water plans. Without implementation, Texas will not be able to keep pace with this growth and related environmental, health, and public safety concerns.

William B. Madden
Chairman

Craig D. Pedersen
Executive Administrator

Our Mission
Provide leadership, technical services and financial assistance to support planning, conservation, and responsible development of water for Texas.

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Water for Texas – 2002

Volumes I - III

Section 16.051 of the Texas Water Code directs the Texas Water Development Board to prepare, develop, formulate, and adopt a comprehensive State Water Plan that incorporates the regional water plans approved under Section 16.053. The State Water Plan shall 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 the entire State.

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1.0 Highlights and Major Policy Recommendations of the 2002 State Water Plan

The Texas Water Development Board (TWDB) is proud to present *Water for Texas—2002,* the seventh State Water Plan adopted since the drought of the 1950's. As the title states, the goal of *Water for Texas—2002* is to provide a grassroots water plan that, if implemented, will meet the needs of all Texans, even during conditions of drought. While some needs may remain unmet, the degree to which this plan achieves that goal is unprecedented, both for the State of Texas and for any other water resource planning effort.

Water for Texas—2002 is the first State Water Plan to be adopted by the TWDB since the passage of Senate Bill 1 during the 1997 Texas Legislature. One of the primary elements of Senate Bill 1 changed the planning process to one based on public participation at each step of the process and local and regional decisions to produce regional water plans—plans that then form the basis of the State Water Plan. The process focused on local and regional decisions to help achieve the goal of increasing the chance of plan implementation over that of previous, more centralized plans. There is no question about the benefits resulting from local decision making and the increase in public participation, public education, and public awareness. The Planning Groups, initially appointed by the TWDB under the authority of Senate Bill 1, eventually included approximately 450 representatives having a broad array of interests, including 11 interest group categories specifically required by statute. They worked for more than 3 years to develop their 16 regional plans. Nearly 900 public meetings across the State were held by the Planning Groups as they developed the 16 regional water plans. The Planning Group members spent thousands of hours and traveled as many miles as they created these plans. Clearly, public education and understanding of water resource issues will continue to grow as a result of such efforts.

A great wealth of information has been provided by the Planning Groups on water demands, supplies, actions needed, and a host of other issues and policy recommendations. The Legislature enacted changes during the 77th Session on four of the six recommendations common to all of the regional plans (See Section 14.1). The changes were to continue the planning process, provide adequate funding for regional water planning, provide adequate funding for implementing water plan recommendations, and clarify Senate Bill 1 provisions on unique stream segments. The Legislature and TWDB also followed the Planning Groups' recommendation to make certain administrative activities eligible for funding. However, the Legislature did not enact changes to address the last common requirement that the Planning Groups wished to change—allowing alternative strategies rather than specific water management strategies for water user groups with needs.

To further maximize public input in the development of policy recommendations in the 2002 State Water Plan, TWDB drew on the input of a stakeholder advisory group. Eighty-three persons from across the State represented a broad array of those interested in water, including Planning Group members, cities and other political subdivisions, agriculture, environmental and other interest groups, and State agencies. This group met in a public forum 5 times as a large body and approximately 15 times in smaller roundtables with other persons interested in specific policy issues.[1]

[1] See Appendix I to Volume I for a discussion of the stakeholder process and a list of recommendations and Volume III for the complete text of the stakeholders' report to the TWDB.

The Texas Water Code §16.051 (b) states that the State Water Plan "*shall be a guide to State water policy*" in Texas. **The 2002 State Water Plan incorporates the approved regional water plans. But to meet this statutory charge of being a policy guide, the TWDB believes that it is necessary to highlight broad conclusions from the regional water plans, tie them together with some common threads, and link them to key policy issues. For the regional water plans and, by inference, the 2002 State Water Plan to be successfully implemented, these recommendations will require legislative or regulatory action.**

TWDB presents the following discussions and recommendations to meet these goals. **Data, water management strategies, key policy recommendations from regional water plans, key stakeholder-process policy recommendations (which have built on this earlier work), and ideas from the TWDB have been integrated into the narrative that follows.** The regional water plan recommendations and stakeholder policy recommendations are included in Section 14.1 and Appendix I, respectively, and should be reviewed for a more thorough exploration of the policy issues facing Texas. Owing to the wide diversity in Texas, not all of the recommendations, both from the Planning Groups and the stakeholder process, represent consensus. So many recommendations have been made that not all could be included in this section. Their absence should not be construed as a lack of support or appreciation of any of these recommendations.

Water: The Driving Influence

The regional planning process focused on identifying actions necessary to meet water needs during drought-of-record conditions. Droughts in Texas are a recurring phenomenon, and the regional water plans have identified ways for most, but not all, water users to address their water needs. However, it should be noted that future climatic conditions may induce droughts more severe than those experienced during the historical period of record. Thus, planning for drought-of-record should not be viewed as planning for the "worst-case scenario" because future droughts may be worse than those for which we have historical data. In some cases, drought will require painful choices because the Planning Groups were unable to identify solutions for all users to meet their needs. As a result, some needs during drought will be unmet and shortages will occur.

By 2050, almost 900 cities (representing 38 percent of the projected population) and other water users will need either to reduce demand (through conservation and/or drought management) or develop additional sources of water beyond those currently available to meet their needs during droughts. Total inability of current water sources to meet demands increases from 2.4 million acre-feet per year (AFY) in 2000 to 7.5 million AFY in 2050. This includes water users that cannot rely on current sources because contracts expire during the planning period. Twenty percent of irrigation demand cannot be met by existing sources were a drought-of-record to occur today. Seven percent of municipal demand would not be met by existing sources if a drought were to occur now. **However, if a drought occurs in 2050, almost half (43 percent) of the municipal demand could not be satisfied by current sources.** Similar percentages of manufacturing and steam-electric power generation demands could not be met in 2050. While the exact consequences are impossible to specify, failure to meet these demands would have an unacceptable impact on the people and economy of the State. **The best response to this situation is a thoughtful, feasible, long-term plan for water supply acquisition and demand reduction.**

The regional water plans developed over the past few years are an excellent first step in that process, but the work must continue. These plans, by law and by necessity, are works in progress. Many Planning Groups identified areas on which they wanted to refocus or add to even as they were finalizing the first regional water plans. It will be especially important for all interest groups to participate throughout the next round of planning to ensure that all aspects are considered. **This important planning and educational process must be allowed to continue its good work.**

The success of the regional water planning process is highlighted by the cooperative agreements that were reached. Growth throughout the State may occur in areas where water resources are not available, creating either conflict or the opportunity for regional cooperation. **One of the great successes of the Senate Bill 1 planning process has been the work of Planning Groups who have turned previous conflicts into opportunities for win-win outcomes.** An example of this regional cooperation occurred when Region C and the North East Texas Region together developed a proposal for a major project to benefit both regions. The Lower Colorado Region and South Central Texas Region also worked together on solving a major water supply need of the San Antonio area in a cooperative sharing of water resources. Entities in the Dallas-Fort Worth area are working together on possibly using water from Oklahoma. The South Central Planning Group created numerous water-sharing initiatives within their region. The planning process created a forum that fostered cooperation, which in turn encouraged solutions involving interbasin transfers of water. This forum reduced distrust and allowed creation of win-win solutions of problems that only a few years ago appeared to be intractable. More of this activity needs to occur.

TWDB makes the following major policy recommendations:

1. The regional water planning process should continue.
2. Planning Groups should continue exploring the potential for voluntary, cooperative agreements that can meet water supply, quality, management, and financing needs of all parties while protecting critical instream flows and freshwater inflows to our bays and estuaries. The Legislature should consider ways to encourage this process to continue, support the Planning Groups in their efforts, and find meaningful ways to back their proposed solutions, including passage of targeted legislation. Unless the Legislature encourages voluntary, cooperative agreements and provides the legal and regulatory flexibility for such agreements to continue to occur, this aspect of the planning process will likely fail.

Agricultural and Rural Water Issues

Texas is a growing State, with population expected almost to double by 2050. Rather than being uniformly distributed, growth will focus most heavily around urban centers. Although most rural communities and small cities are growing, they are not growing as fast as those near urban centers. This trend will create issues of resource sharing and competition between rural and urban areas.

The rural (nonmetropolitan) areas of Texas, based on Federal designations, contain 15 percent of the State's population. Five percent of rural income comes from farming. Geographically, rural areas cover approximately 80 percent of the State. Twelve of the State's counties are among the top 100 U.S. counties in farm product sales. In these counties, most of which are heavily dependent on irrigation, more than 30 percent of the income is from farming. In these and many more of the State's rural communities, the economy is heavily dependent on the continued viability of agriculture, from the farmers themselves to the businesses they patronize, to the businesses throughout the State that process and sell farm products.

Agriculture currently uses the majority of the freshwater in the State but will lose that distinction for the first time in the State's history before 2030. Two main factors will create major implications for rural Texas: decreased irrigation due to depletion of groundwater resources in some areas and increased use of all water resources by growing urban/suburban centers. This impact on water use will reverberate directly and indirectly through local institutions, from feed stores to banks, and through rural communities as a whole. The effects could be devastating to rural Texas.

TWDB makes the following major policy recommendations:

1. The Legislature should consider **protecting rural-community access to local water resources to ensure the continued economic viability of rural Texas.**
2. The Legislature should consider creating new financing mechanisms to support agricultural water conservation in general, but especially to support the voluntary conversion of a portion of the water saved to other uses when the water is not needed in the rural area.
3. The Legislature should consider requiring disclosure of information quantifying impacts on rural Texas. Applicants for surface water appropriations or groundwater withdrawal permits that remove water from rural areas could be required to provide the information to the regulatory body considering the application. Surface water aspects should be coordinated with the study recommended under Surface Water in this section.

Groundwater

Groundwater is and will continue to be a major source of water for Texas. Planning Groups estimate that 14.9 million AFY of groundwater is available, according to various management philosophies. For some aquifers, the management philosophy is driven by environmental constraints such as the Endangered Species Act. This philosophy has resulted in a plan based on a significant reduction in the withdrawals from the Edwards aquifer. However, 6.1 million AFY currently cannot be used because of the absence of infrastructure to connect to or treat the water. Many water management strategies focus on using this 6.1 million AFY and replacing the 1.5 million AFY of groundwater supply that is currently being used but that will not be available in 2050 because of depletion of aquifers. **Further, because of projected depletions of groundwater and because of water quality problems, due to naturally occurring constituents or as a result of man's activities, groundwater supplies will be insufficient to meet some irrigation needs and the needs of some small cities.** Another aspect of the plan is that there is a shift in some areas towards groundwater use, in part, due to new regulatory requirements on interbasin transfers of surface water. For many, the demand on groundwater has raised the question of management goals: **Should aquifers be managed on a sustainable basis or on the basis of eventual depletion?** Sustainability may be chosen as the appropriate management philosophy for some aquifers, but in all likelihood it will not be selected for areas such as El Paso and the High Plains where management at sustainable levels would have enormous economic dislocations.

TWDB makes the following major policy recommendations:

1. TWDB continues to maintain that **groundwater management in Texas is best accomplished through local groundwater conservation districts.** Further, **these districts should be constituted considering both hydrology and the availability of sufficient financial resources to accomplish**

key management tasks while recognizing existing local governmental entities and mutual local agreements.

2. Groundwater conservation districts and regional water planning groups in a common groundwater management area should strive to have **compatible groundwater management goals.**
3. The Legislature should consider requiring groundwater conservation districts to include in their groundwater management plans a **management goal quantifying the desired future condition of the aquifer.** The future condition could be described using water quantity and water quality parameters.
4. The goal of groundwater management in Texas should be to move toward sustainability, but, because aquifers and the social and economic needs of the State vary from place to place, **groundwater availability should be locally or regionally assessed**, balancing all interests. This is clearly a situation where one size does not fit all. **Groundwater conservation districts and regional water planning groups should determine whether sustainable management is appropriate for their area or whether another management scenario better fits the needs of their locality**. The TWDB, working cooperatively with groundwater conservation districts and regional water planning groups, should **evaluate, as data become available, the hydrologic, environmental, social, and economic impacts of withdrawal of groundwater at various rates on the basis of the identified management strategies, including the long-term sustainable level if appropriate, for the major and minor aquifers.**
5. The Legislature should consider both statutory provisions and financial incentives related to developing viable groundwater/surface water conjunctive use projects in order to use all water resources more efficiently and effectively.
6. Because safeguards for transporters included in Senate Bill 2 (77^{th} Legislature) negated the need for Texas Water Code §36.121 and because of the unintended consequences of that section of law, the Legislature should consider repealing Texas Water Code §36.121, which exempts certain existing and planned municipal wells in certain countries from regulation.
7. The Legislature should consider requiring groundwater conservation districts to include in their groundwater management plans provisions to promote and implement programs, such as **conservation, recharge enhancements, rainwater harvesting, or brush control,** where appropriate and cost effective.
8. Regulatory programs to address abandoned oil and gas wells should be strengthened to minimize the contamination of groundwater supplies.

Surface Water

Surface water is and will continue to be a major source of water for Texas, especially for municipal and industrial purposes. This supply, generally reliable for cities, is renewable. Although approximately 14.9 million AFY of surface water is currently available, only 8.6 million AFY of that water can currently be accessed because of the absence of infrastructure and water rights. Some water management strategies are meant to utilize this unconnected water supply more fully. The regional water plans call for only eight new major reservoirs, each with more than 5,000 acre-feet of storage capacity, to be added to Texas' existing 211 major reservoirs during the next 50 years. These new major reservoirs would increase surface water availability by 1.1 million AFY, supplying approximately 16 percent of the projected 7.5 million AFY shortage in 2050. New reservoir development is limited in this manner not only because existing reservoir capacity exceeds demands due to the investments made in earlier years but also because of increased reliance on groundwater. This shift to groundwater partly results from new regulatory requirements on interbasin transfers of surface water. This increased reliance on existing sources may also increase the possibility of conflicts between competing uses, such as between water supply and recreation.

The Planning Groups suggest voluntary redistribution of existing surface water resources as a significant solution. However, facilitating this and other surface water recommendations in the regional water plans requires a legal system and effective and efficient administration of water rights that addresses water marketing and sales, wastewater reuse, and interbasin transfers. Since the first statutory enactment of a water rights legal system beginning in the late 1800's, water rights law has developed and evolved in a somewhat piecemeal manner. A full examination of this legal system could strengthen the whole and allow a thorough balancing of issues, which have become more acute as the various needs for water put greater demands on the State's water resources and test the limits of the existing legal system. Water rights administration is the nexus that links these issues, and its effective implementation is essential to allowing the planned use of existing resources while protecting natural resources. The Legislature has provided a mechanism for increasing protection of surface water rights by watermasters. Where crucial local support exists, water rights holders may petition the Texas Natural Resource Conservation Commission (TNRCC) for creation of a watermaster. The effectiveness of water rights administration is based on closely linking appropriate laws, agency rules, and up-to-date analytical tools.

The TWDB makes the following major policy recommendation:

1. The Legislature, through an interim committee process or otherwise, should consider **continuing to examine the water resource regulatory structure of this State and look for opportunities to meet the water management needs of the 21st century.** TWDB recommends the following elements be included, at the minimum, in the Legislative study:
    a. Consider changes needed in law relating to allocation and administration of flows resulting from wastewater discharges.
    b. Consider any changes needed to continue crafting a policy that addresses the imbalance between the location of water resources and the location of water needs, while recognizing broad public interests and the need to weigh the interests of the basin of origin and the needs in the receiving basin.
    c. Consider whether to require the implementation of watermaster programs in each river basin of the State, where appropriate.
    d. Consider any changes needed to create more certainty in the water rights amendment process, thus facilitating water marketing transactions.
    e. Consider allowing the TNRCC and TWDB jointly to develop a process that would link surface water availability models and groundwater availability models in areas where there is significant groundwater and surface water interaction, including major springs, as well as to recommend funding and statutory changes necessary to facilitate this linkage. The agencies should develop this process with significant involvement from major stakeholders.

f. Consider, as part of the study, protection of environmental water needs, water rights, and broad public interests.

Conservation

Conservation is a very critical element to meeting the State's long-term water needs. Baseline conservation assumptions were used to develop water demand projections in the regional water plans. Some Planning Groups recommended additional conservation measures for selected water users. Conservation was an important factor in limiting total water demand in the State, with municipal demand increasing only 67 percent despite a projected 90 percent population increase by 2050. Although additional water conservation is possible and necessary, conservation alone will not meet all Texas' water needs, if Texans are to enjoy at least as good, if not better, standard of living than we enjoy today.

Water demands in cities are primarily a function of per capita water use. Conservation efforts can help reduce per capita uses at rates that are appropriate for each city. On a Statewide average, **baseline conservation assumptions (primarily more efficient plumbing fixture code requirements) are projected by 2050 to effect a 22-gallon per capita per day (GPCD) savings from current rates of municipal use.** This projection equates to **not having to supply an additional 976,000 AFY by 2050**, relative to current per capita demand projections. The Regional Plans further recommend water strategies that save more than 1 million AFY. A local approach to conservation allows local impacts of climate, economy, and availability of water supply to be considered. However, some areas of the State show high current and future projections for per capita use (see Table 5-4). Conservation should play a more aggressive part in future regional water planning, especially in areas with high per capita water use.

Conservation in irrigation also accounts for significant savings and should allow **declines of agricultural use that are slower** than would otherwise occur as groundwater resources are depleted. Because the **regional water plans contemplate very little "new" water being produced, a significant portion of the water currently used in agriculture will be voluntarily converted to municipal use.** Continued efforts to assure agricultural production using less water will help alleviate potential adverse effects of reduced water availability for agricultural use on rural areas that support agriculture. **Efforts to provide agricultural water savings generated through voluntary conservation can help provide new supplies to municipalities while simultaneously preserving agricultural production and mitigating negative impacts that a loss of production might produce.**

TWDB makes the following major policy recommendations:

1. The Legislature should support and finance increased educational and technical assistance to implement advanced conservation technologies.
2. Water suppliers at the local level should establish minimum levels of water conservation. TWDB should modify its rules to require that water conservation plans and TNRCC should modify their rules to require that drought contingency plans include locally set quantified goals, such as in GPCD. One goal should be a target amount for "unaccounted for" water. Goals set by specific entities should recognize past efforts and local circumstances. TNRCC and TWDB should jointly identify quantified target goals for water conservation and drought contingency results that water suppliers and other entities may use as guidelines in preparing water conservation or drought contingency

plans. These target goals should not be mandates. The Legislature should provide sufficient funding to assist entities in implementing plans that are consistent with quantified target goals.

3. TNRCC and TWDB should jointly develop model water conservation programs for different types of water suppliers that would suggest best management practices for achieving the highest practicable levels of water conservation and efficiency achievable for each specific type of water supplier.
4. TNRCC and TWDB should jointly develop model drought contingency programs for different types of water suppliers that would suggest best management practices for achieving the highest practicable levels of water use reductions achievable during drought situations for each specific type of water supplier.
5. The Legislature should consider creating new financing mechanisms to support agricultural water conservation in general, but especially to support the voluntary conversion of a portion of the water saved to provide water to other uses. (See discussion on Providing and Financing Water and Wastewater Service below).
6. The Legislature should encourage new public buildings to include alternative technologies such as rainwater harvesting systems and gray-water systems to provide water for secondary uses, such as cooling towers, toilets, and landscape irrigation.
7. The Legislature should support and finance implementation of efficient irrigation systems and research on crops and landscape plants that are drought and saline tolerant.

Innovative Strategies

The regional planning process helped Planning Groups recognize alternative methods of meeting needs besides building new lakes or drilling new wells. The Planning Groups evaluated and recommended many innovative water management strategies, including brush management, weather modification, desalination, reuse of wastewater flows, modification of existing projects, and changes in operational procedures. Although procedures such as weather modification and brush management were aimed at providing water during normal times and were not specifically used to meet drought needs, they were recognized as steps some regions should take.

Some of the innovative strategies will require continued research and improvements to be cost effective. Others will need research to determine their reliability during drought conditions.

A number of recommendations relating to innovative strategies will be made under other subheadings. In addition, TWDB makes the following major policy recommendations:

1. The Legislature should consider any recommendations from a TNRCC stakeholder process now examining disposal issues associated with desalination processes.
2. The Legislature should encourage research to evaluate potential impacts, including environmental impacts, and to quantify the availability of water resulting from brush control programs.

Environmental

Texas needs to ensure adequate freshwater flows in streams and rivers and into bays and estuaries. This need was recognized in two ways in the regional water plans: (1) new projects received preliminary evaluations so as to pass appropriate flows for the environment (instream flows and freshwater inflows to bays and estuaries) and to protect water quality and (2) one region (H) recommended that certain stream reaches be protected and that Galveston Bay inflow needs be met. One reason other regions did not consider the protections of unique stream reaches dealt with uncertainty as to impacts of that designation. The 77th Texas Legislature subsequently addressed this uncertainty by amending statutory language.

Current Texas water law requires an evaluation of new surface water management strategy impacts on instream flows, bays and estuaries, and those ecosystems**. Additional clarity on what is considered an adequate environmental flow is needed.** Because of the complexities of defining an environmental flow as such, which species to protect and how to balance protection with the effects on the public welfare, additional policy directives are needed. Additional clarity is needed to define adequate environment flows with respect to duration, frequency, and location. Also, the vast majority of Texas water rights were appropriated before the provision in law of these environmental assessments. Therefore, **many river reaches and estuaries may not be managed with due consideration of the impacts of water use on these ecosystems.** Where additional water rights are sought, the full burden of environmental protection may fall on the last applicants, while prior applicants have no requirements applied to them. These prior applicants have invested and made other decisions on the basis of the laws and rules in place at the time that they received their water rights. **This is the essence of the environmental flow debate in Texas: how to provide for current environmental needs while recognizing our past practices and current law.** This dilemma is exacerbated because data on what a healthy ecosystem needs in many specific locations have not yet been derived.

Another environmental issue is protection of critical habitats that often are in competition with water supply projects. The Legislature may designate ecologically unique stream reaches and unique sites for reservoir construction. A stream reach with significant bottomland hardwoods may be eligible for either designation. These designation processes could be linked to protect certain ecologically unique stream reaches as habitat mitigation areas associated with specific water supply projects, thus creating a balanced outcome.

The answers to these complex policy issues are not easy. No clear consensus exists on these issues beyond the recognition of a problem regarding the provision of environmental flows. This issue could benefit greatly from additional dialogue and focused discussion.

TWDB makes the following major policy recommendations:

1. Dialogue should focus on environmental issues among a broad range of interested and impacted parties before the 78th Texas Legislature. The goal would be to establish consensus recommendations, where possible, regarding major changes needed, including what evaluation criteria to use to measure a sound ecological environment and identification of potential methodologies to protect environmental flows. The Legislature should consider establishing such criteria by statute.
2. The Legislature should consider adequately funding instream flow studies to determine flow conditions necessary to support a sound ecological environment (Texas Water Code §16.059).

3. The Legislature should consider providing funding for a voluntary conservation program in which most water saved would be made available to meet environmental water needs.
4. The Legislature should consider directing TNRCC, in coordination with TWDB and the Texas Parks and Wildlife Department (TPWD), to evaluate the status of flows using statutory evaluation criteria to be established for measuring a sound ecological environment by river basin, assuming various scenarios, including the full exercise of existing rights.
5. The Legislature should consider establishing policies that will facilitate natural resource agencies and water rights holders to **voluntarily provide environmental flows** by using purchases, the Texas Water Trust, or some similar method or concept.
6. The Legislature should consider coordinated designation of ecologically unique stream segments to protect habitat for mitigation purposes and unique reservoir sites to protect future water supplies.

Providing and Financing Water and Wastewater Service

Addressing the issue of providing water and wastewater service requires not only access to adequate quantity and quality of water supplies but also the infrastructure to treat and distribute this water and to likewise collect and treat effluent. It also requires competent, cost-effective service providers who have the skills and resources to build, manage, and maintain such systems.

In Texas, **all service delivery and most financing are locally generated.** It will remain so in the future. But **without external assistance, some local governments cannot develop the necessary internal expertise to provide the quality of service necessary under current health and safety requirements. Others, which may have the expertise, are unable to finance such service without external assistance.** Further, some areas that have significant population densities without adequate water or sewer facilities have no service providers at all. In some areas, newly created service providers, such as districts or other entities, may be unable to provide adequate service.

Economies of scale are significant in the provision of water or wastewater service. **Voluntary creation of regional systems, or consolidation where service levels are inadequate or nonexistent, may be necessary to create the basis for cost-effective and fully functioning and sustainable systems.** This could also reduce the need for external financial assistance, such as from the State.

A consistent outcome of the regional water planning process is a desire to implement plans to ensure that the needs of Texans are met. Without implementation, Texans clearly will not have the ability to meet their water needs. And yet implementation will not be without a cost. The water supply acquisition projects included in the regional water plans will cost approximately $17.9 billion. Needs for water and wastewater treatment, flood control, and internal community infrastructure costs will raise the amount for this 50-year period to $108.6 billion. Although local utility customers will pay most of this, some communities will be unable to afford it alone. For those, including many rural areas and small towns and some major city/regional projects, more cost-effective financing alternatives will be necessary. **Every regional plan emphasizes the need for an expanded State role in financing these supply enhancements.** The 77th Texas Legislature started the process of addressing this issue and other issues with Senate Bill 2 and Senate Bill 312. Although all these steps are significant, **additional efforts need to focus on filling critical gaps in State assistance programs.**

To ensure that the State's role is more effective in the future, TWDB makes the following major policy recommendations:

1. The role of **State assistance programs needs to be expanded to ensure that problems are addressed and long-term State goals are achieved.** State assistance cannot meet all needs nor does it need to. (In fact, current State assistance programs require a local commitment to repayment in the vast majority of cases.) Rather, State assistance should **focus on key gaps where basic needs or cost-effective opportunities cannot be met by local funds.** These gaps include **funding cost-effective, regional projects** (including those serving rural areas); **supporting disadvantaged communities**; and **funding nontraditional water management strategies and agricultural and municipal water conservation.** TWDB should establish a priority system for projects receiving State assistance from programs that cannot fund all applicants. The priority system should consider the level of conservation achieved by the applicant.
2. In order to achieve State goals, **more flexibility than is available under current bond financial programs needs to be provided.** Some needed projects, such as certain conservation activities on farms or in homes, cannot be financed by using tax-exempt bonds. Use of appropriated funds also can eliminate some of the necessary overhead associated with bonds. Some needed work will require high levels of assistance that cannot be provided by self-supporting bond programs. Therefore, the Legislature should consider **dedicating specific funding sources to enhance the State's ability to assist local governments in implementing water infrastructure projects and meeting the needs of the State's growing population.**
3. In order to ensure that all Texas communities that require assistance are provided access to State financial assistance, the Legislature should consider providing funding specifically for **outreach assistance** and for **developing training programs in financial and technical management.**
4. The Legislature should **facilitate public–private partnerships** by making statutory changes that enable the State to provide financial assistance to local governments for use in developing water-related infrastructure through public–private partnerships.
5. As part of the expanded assistance mentioned above, the Legislature should **commit adequate funding to the Rural Water Assistance Fund.**
6. The Legislature should **target financial assistance for mitigating costs of compliance to new drinking water treatment standards.**
7. The Legislature should consider whether existing statutes or their enforcement needs to be modified to **assure that water and wastewater service is assigned and provided for all future development in Texas.** This review should include analysis of regional development of service, assignment of service responsibility, and ensuring appropriate provision of service once assigned.

Data

Planning for the water needs of all Texas communities is a data-intensive effort. The Planning Groups recognized this need. More than 2,200 cities and other water users exist for which population and water demand values, projections of supply from current water sources, and evaluations of alternative water sources must be determined, now and for 50 years into the future. **The current accuracy of data used in planning varies, although better information on groundwater availability, groundwater use for irrigation, and environmental water needs is particularly sought.**

Events of September 11, 2001 show that ready access to some natural resource data and infrastructure information may not be in the best interests of public safety and welfare. Some consideration of additional security for that information is warranted.

TWDB makes the following major policy recommendations:

1. The Legislature should consider funding studies to **better describe groundwater and surface water interaction.**
2. The Legislature should consider funding **comprehensive studies and data collection on agricultural water use.**
3. The Legislature should consider **funding basic groundwater research** that is necessary to generate and analyze basic data needed and to **continue the development of groundwater availability models for all major and minor aquifers.**
4. **TWDB, TNRCC, TPWD and other governmental entities** responsible for most water-related information in Texas **should enhance the compatibility of technical information by increasing communication with one another and by identifying opportunities for improving data integration and data transfer and decreasing information redundancy and by supporting the Strategic Mapping (StratMap) digital base map layers as a common geographic framework on which to efficiently build, standardize, and centrally disseminate water-related data sets via the Internet.**
5. The Legislature should consider **supporting and funding enhanced real-time and Internet-based electronic data collection, transmittal, and storage methods** for surface water flow, groundwater levels, groundwater pumpage, and water quality while maintaining appropriate levels of data accuracy. Both real-time and Internet-based methods could **substantially reduce the cost** of some types of data collection, while facilitating more timely and flexible analysis and dissemination of critical water data.
6. The Legislature should consider exempting certain selected and sensitive data relating to natural resources and infrastructure from public disclosure for public security purposes if that data could be used to threaten public safety or welfare.

2.0 Introduction

> *The State Water Plan shall 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 the entire State. Texas Water Code, §16.051*

Water is a finite resource that requires careful and proactive management, and the era of plentiful and inexpensive water is rapidly ending. Water conservation, sound water management strategies, and efficient and adequate investment in a range of solutions are all essential to the development of the additional water supplies required to meet Texas' growing population and economic needs, including agriculture, and to protect our natural resources.

The 1997 State Water Plan identified the difficulties of marshaling the public support needed to bring major new water development projects to fruition. Factors contributing to this situation were the scarcity of and competition for water, the high costs of new water supply development, and the environmental ramifications of water supply development projects.

In partial response to the problems identified in previous State Water Plans and the extensive drought of 1995-96, the Texas Legislature passed Senate Bill 1 in 1997, setting into motion an unprecedented, grassroots-based, regional water planning process. The goal of this process was to develop a water supply management plan that would meet long-term demands, particularly during times of drought.

Senate Bill 1 (and subsequent legislation) directed the TWDB to coordinate the regional water planning process and to develop a State Water Plan to incorporate the regional water plans, resolve interregional conflicts, provide additional analysis, and make policy recommendations. Over the 3-year planning process, more than 450 voting and nonvoting community and interest group leaders developed 16 regional water plans. The TWDB provided input into whether the regional water plans met the requirements of the Water Code and TWDB guidelines. If no interregional conflicts existed between the regional water plans, each region was to consider TWDB and public comments, prepare and adopt a final regional water plan, and submit it to TWDB for approval and inclusion in the 2002 State Water Plan. The TWDB found that all regional water plans met the legal requirements and planning guidelines and therefore were approved. Those 16 regional water plans are the basis of this document, *Water For Texas–2002*.

The 16 Regional Water Planning Groups (Planning Groups) identified more than 800 water user groups that will need additional water supplies sometime during the next 50 years and recommended feasible water management strategies to meet most of those needs. Solutions proposed by the Planning Groups include strategies such as the use of currently developed surface water and groundwater sources, conservation, reuse, new interbasin transfers, and development of additional groundwater and surface water resources. Eight major and ten minor new reservoirs were recommended by the Planning Groups to meet identified needs of the water user groups. The Planning Groups evaluated the environmental impacts of these water management strategies, with the goal of providing adequate water to maintain instream flows and freshwater inflows to bays and estuaries. The Planning Groups estimated total capital costs over the next 50 years to meet needs for additional water supplies at $17.87 billion, including $4.41 billion to implement strategies involving new reservoirs. Meeting these costs will require a long-term financial commitment from local political subdivisions, regional authorities, and the State of Texas. Meeting the State's future water needs will require a full range of management tools and strategies.

The 2002 State Water Plan is the culmination of a 3-year effort by local, regional, and State representatives. Clearly, the most significant difference in this planning effort as compared with previous efforts is the broad level of public involvement that occurred throughout the process. Nearly 900 public meetings and hearings, along with technical assistance and support from the State's natural resource agencies, (TWDB, TPWD, Texas Department of Agriculture [TDA], and TNRCC), demonstrate the broad commitment of Texas to ensuring adequate water supplies to meet future needs. To ensure that as many individuals and organizations as possible would have an opportunity to provide comments on the draft 2002 State Water Plan, during the month of October, 26 public meetings were held in 16 cities. In addition, for the first time, videoconferences were held in 10 cities to receive comments on the draft 2002 State Water Plan. Finally, in November, two public hearings were held in Austin. Throughout this effort, more than 600 individuals attended to provide comments on the draft 2002 State Water Plan.

This plan, providing detailed water management for the next 50 years, identifies all water user groups in the State, including cities having populations of 500 or more, and aggregate demands according to county for other water use sectors, such as manufacturing. It also records the projected water demand for each water user group over the 50-year planning period, indicates whether the water user group has a need for additional water in the future, and provides water management strategies to meet the projected need. The 2002 State Water Plan, developed with unprecedented extensive and intensive public involvement and decision making, is based principally on local and regional needs and solutions for meeting future water demand.

In addition to summarizing the planning process and synthesizing the information gathered from the Planning Groups, the TWDB held a series of stakeholder meetings to discuss policy issues related to water. For results of this process, see "Policy Recommendations from Stakeholders" in Appendix I. In addition, the TWDB also recommended a few alternative water management strategies for the Planning Groups to consider during the next round of planning.

2.1 Organization of the Plan

The 2002 State Water Plan comprises three volumes.

Volume I presents:

- statewide water resource information,
- a general discussion of the planning methodologies and results of the regional water planning process,
- a list of recommended unique reservoir sites,
- recommended river and stream segments of unique ecological value,
- a discussion of anticipated impacts of implementing water management strategies proposed by the State Water Plan, including environmental and economic impacts, and
- policy and legislative issues and recommendations.

Volume II presents the recommendations of the approved Regional Water Plans for every water user group and major water provider in the State. This volume is meant to be used as a reference document, allowing anyone interested in a specific community or other water user group or major water provider to learn about water supply and the strategies recommended to ensure future water supply. In addition, because the Planning Groups may amend regional water plans at any time, Volume II has been designed so that it too may be easily amended and updated in a timely manner to reflect changes in both local and regional conditions.

Volume III consists of an electronic copy of Volume I and the 16 approved regional water plans.

The TWDB published *Water For Texas—Summary of Regional Water Plans* in February 2001. Since then, the Planning Groups and TWDB staff have made numerous corrections and revisions to the information in the regional plans. Because of these changes, the numbers in the 2002 State Water Plan, *Water For Texas—2002* may be different from those in the summary published in February 2001. Furthermore, the Planning Groups may amend their plans at any time. Therefore, the 2002 State Water Plan should be considered an overview of water planning in Texas. TWDB's Web site (www.twdb.state.tx.us) should be considered the source of the latest information.

3.0 History of Water Planning in Texas

Texans have long recognized the importance of planning for the State's future water needs, primarily because of the frequency of droughts that have occurred and will continue to occur in Texas. However, a rapidly growing population and economy requiring reliable supplies and additional water to replace declines in the amount of water currently available, resulting from mining of aquifers and sedimentation in reservoirs, have also heightened our awareness of the need for good water planning. Texas began Statewide water planning nearly 45 years ago after the devastating drought of the 1950's. At the end of that drought in 1957, the Legislature created the TWDB and mandated Statewide water planning. The voters of Texas subsequently approved a constitutional amendment authorizing TWDB to administer a $200 million Water Development Fund to help communities develop reliable water supplies.

Including the current 2002 State Water Plan, the TWDB and the Texas Board of Water Engineers have prepared and adopted seven State Water Plans over the past 45 years. The 1961 plan was adopted by the Texas Board of Water Engineers and the 1968, 1984, 1990, 1992, 1997, and this plan, the 2002 State Water Plan, were adopted by the TWDB. The first two plans, adopted in 1961 and 1968, consisted of initial attempts to describe the State's water resources, to quantify future water needs, and to propose water supply projects to meet future needs. The 1968 State Water Plan included flood protection, hydropower generation, drainage, water quality, recreation, and fish and wildlife as part of a comprehensive water resource management. In addition to conventional water supply projects, the 1984 State Water Plan proposed significant new conservation and environmental and groundwater protection initiatives and identified long-term funding requirements for water-pollution control.

The 1990 State Water Plan continued the evolution of water planning in Texas by building on new directions established in the 1984 State Water Plan and by emphasizing improved overall management of the State's water infrastructure systems. In 1992, TWDB updated the 1990 State Water Plan, focusing on policy initiatives and making minor modifications to projects.

In 1992, TWDB began to broaden participation in developing the State Water Plan by including TPWD, TNRCC, and others interested in the water planning process. Key goals of this planning process included:

- promoting consistent planning, policy, regulation, management, and efficient use of the State's water resources;
- minimizing or avoiding any needless or unproductive conflict in the planning and management of such resources; and
- providing an ongoing, cooperative planning and policy process for orderly and responsible water conservation, development, and management.

The TWDB adopted and published the results of this consensus-based water planning process in the 1997 State Water Plan.

Significant shifts in the planning approach to conservation, reuse, reservoir development, and the environment were first evident in the 1990 State Water Plan. These changes emerged more prominently in the 1997 State Water Plan and are given even greater emphasis in the 2002 State Water Plan.

Conservation of water and reuse of wastewater are now commonly adopted water management strategies to meet future needs for additional water supplies. Previously these water management strategies were discussed but not recommended to meet specific water supply needs. Water conservation currently is projected to reduce future demands by about 13 percent, as compared with 2000 demands.

The deemphasis on building reservoirs is apparent in both historical reservoir development patterns and State Water Plans (Figure 3-1). Texas now has 211 major reservoirs with greater than 5,000 acre-ft of conservation storage capacity. However, only one of Texas' major reservoirs existed before 1900. By 1950, Texas had constructed approximately 62 major reservoirs. Major reservoir development was most prolific between 1950 and 1980, for the number grew by approximately 122 to a total of 184 in 1980. The pace of construction began to slow in the 1970's and has since slowed considerably as a result of environmental issues, increasing costs of reservoir development, and the reduced number of potential high quality reservoir sites.

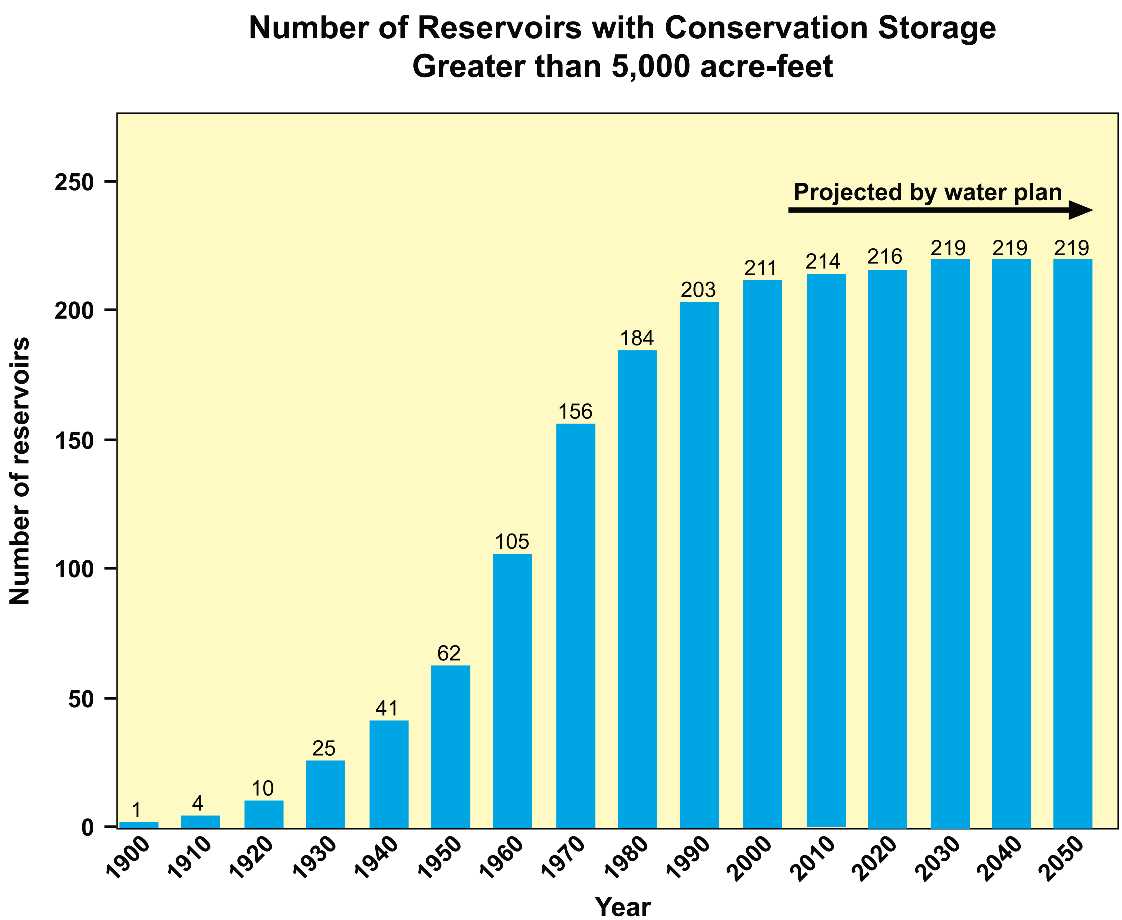


Figure 3-1. History and projected future of reservoir development in Texas.

Over time, State Water Plans have reflected this slowdown in reservoir development. The 1984 State Water Plan identified 65 major reservoir sites and allocated water from 44 of the new reservoirs to meet needs through 2030. In contrast, the 1997 and 2002 State Water Plans each recommended only eight major reservoirs to meet needs for additional water supplies through 2050 (Figure 3-1). Emphasis on conservation, reuse, and other alternative water management strategies lowers the State's reliance on new, large-scale reservoir projects. This trend is anticipated to continue in the future, with an increased use of desalination processes and other less conventional water management strategies.

Just as drought led to the creation of Statewide water planning, the TWDB, and the Water Development Fund, drought was also the impetus for the planning process in the 2002 State Water Plan. In 1996, Texas suffered an intense drought that caused significant economic losses and water shortages. Fortunately this drought was relatively short, but it lasted long enough to remind Texans of the importance of water planning and highlighted the need for more local and regional involvement in water planning.

4.0 Water Planning Process

Following passage of Senate Bill 1 in 1997, the TWDB initiated the regional water planning process by developing and publishing draft rules for regional and State water planning, along with related amendments to the TWDB Research and Planning Fund rules. After extensive consultation by the TWDB with other State agencies, stakeholders, and the public, the rules were revised and then adopted by the TWDB in February 1998. The rules describe the required elements in the regional and State plans, the composition of Planning Groups, and guidelines for financial assistance from the TWDB.

The regional water planning process involved defining the regional water planning areas, establishing the Planning Groups, and developing the regional water plans.

4.1 Regional Water Planning Areas

Senate Bill 1 directed the TWDB to designate regional water planning areas, taking into consideration such factors as river basin and aquifer delineations, water utility development patterns, socioeconomic characteristics, existing regional water planning areas, political subdivision boundaries, public comment, and other factors that the TWDB deemed relevant. Regional water planning area boundaries were adjusted to include entire municipalities. Counties located on a boundary were contacted to determine preferences. Some counties opted to be part of two adjacent regional water planning areas. In other cases, regional water planning area boundaries were adjusted to encompass entire counties. One of the other relevant factors considered by the TWDB was the delineation of climatic zones. This process resulted in 16 regional water planning areas. The original designation simply used the nomenclature of Regions A-P. The Planning Groups were then given the option of adopting a new name based on the groups' preference or simply maintaining the original letter designation. For example, Region A chose the name Panhandle Water Planning Group (Table 4-1, Figure 4-1). The TWDB is required to review and update the planning area boundaries at least once every 5 years.

Table 4-1. List of Planning Groups.

TWDB Region	Planning Group Name
Region A	Panhandle
Region B	Region B
Region C	Region C
Region D	North East Texas
Region E	Far West Texas
Region F	Region F
Region G	Brazos G
Region H	Region H
Region I	East Texas
Region J	Plateau
Region K	Lower Colorado
Region L	South Central Texas
Region M	Rio Grande
Region N	Coastal Bend
Region O	Llano Estacado
Region P	Lavaca

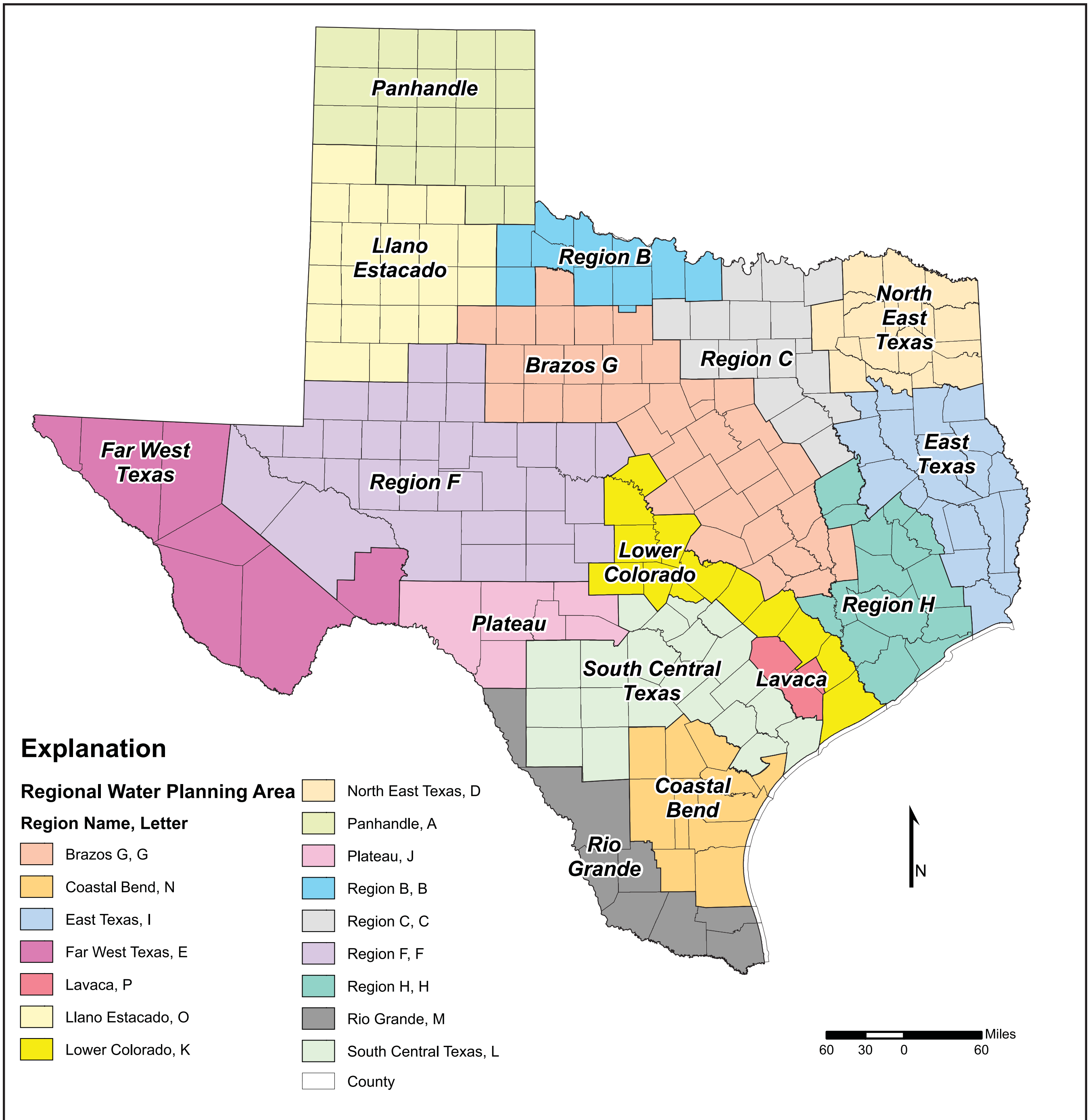


Figure 4-1. Location of the 16 regional water planning areas in Texas.

4.2 Regional Water Planning Groups (Planning Groups)

Each regional water planning area has its own Planning Group. Each Planning Group represents the interests of its regional water planning area and is responsible for the development of a regional water plan for its area.

As required by Senate Bill 1, the TWDB selected the initial members of the Planning Groups. These members, known as initial coordinating bodies, were selected from 11 interests identified in Senate Bill 1 and other relevant interests in the regional water planning areas. Senate Bill 1 required that interests including but not limited to public, counties, municipalities, industries, agricultural interests, environmental interests, small businesses, electric-generating utilities, river authorities, water districts, and water utilities be represented. The initial coordinating bodies then added other members as appropriate, as they transitioned into Planning Groups.

Each Planning Group approved bylaws to govern its methods of conducting business and designated a political subdivision, such as a river authority or groundwater conservation district, to administer the planning process and manage any contracts related to the development of regional water plans.

4.3 Regional Water Planning

The regional water planning process consisted of seven tasks:

1. describing the regional water planning area;
2. quantifying current and projected population and water demand;
3. evaluating and quantifying current water supplies;
4. identifying surpluses and needs;
5. evaluating water management strategies and preparing plans to meet the needs;
6. recommending regulatory, administrative, and legislative changes; and
7. adopting the plan, including the required level of public participation.

The Planning Groups first described their planning regions. These descriptions included information on the major water providers selected by the Planning Groups for inclusion in the plan, current water use, sources of groundwater and surface water, the area's agricultural and natural resources, the regional economy, summaries of local water plans, and other information deemed relevant by the Planning Groups.

The next task was to review population growth and water demand projections. The Planning Groups reviewed projections provided by the TWDB and proposed revisions resulting from changed conditions or new information. All 16 Planning Groups requested revisions to population and water demand projections for some of the water users in their regions. The TWDB, after consultation with the TPWD and the TNRCC, formally approved requests for revisions that met the criteria established for this process.

The Planning Groups then determined the water supplies that would be available from current sources during a repeat of the drought-of-record. Planning for a drought-of-record is required by Senate Bill 1 and is important for helping water users prepare for future droughts. In many cases, the Planning Groups used groundwater and surface water availability values developed for the 1997 State Water Plan. In other cases, the regions undertook new studies to update existing TWDB information. During the planning process, some regions experienced a new drought-of-record because of prolonged dry conditions occurring throughout the early 1990's to the present.

The Planning Groups then compared current water supplies with current and projected water demands to identify when and where additional water supplies were needed for each identified water user group and major water provider.

Senate Bill 1 required the Planning Groups to address the needs of *all* water users. If current supplies did not meet future demand, the Planning Groups recommended specific water management strategies to meet near-term needs (less than 30 years) and either strategies or options to meet long-term needs (30 to 50 years). In addition, the Planning Groups included the costs of implementing recommended water management strategies. Examples of recommended water management strategies include advanced conservation of existing water supplies, new reservoir development, new groundwater development, conveyance facilities to move existing or newly developed water supplies to areas of need, reuse of wastewater, water rights subordination agreements, and others. The Planning Groups, with assistance from the TWDB, also assessed the social and economic impact of not meeting those needs. If it was not feasible to meet a need, the Planning Groups noted and explained the conditions that led to their inability to fully meet the need.

The Planning Groups included regulatory, administrative and/or legislative recommendations as part of their plans. The Planning Groups conducted all functions at open meetings, and the planning process was conducted in an open and participatory manner. They held special public meetings when they developed their scopes of work and held hearings before adopting regional plans. This public involvement was intended to help direct the planning and determine the water management strategies to recommend. Consensus building within the Planning Groups was crucial to ensure support sufficient for adopting the plan. Plans were adopted at open meetings by vote of the Planning Group members in accordance with each group's respective bylaws.

4.4 Coordination between Planning Groups, States, and Mexico

Certain water management strategies, such as the development of a large reservoir, could satisfy needs in more than one region. As one form of coordination, the Planning Groups were allowed to form subregional water planning groups. Region C and the Northeast Texas Region, which are shown in Figure 4-1, formed the Sulphur River Task Group to plan for reservoir(s) in the Sulphur River Basin that could supply both planning areas. It was through joint meetings and other efforts that the Brazos G Region and Region H Planning Groups proposed and adopted the Little River Reservoir to serve needs in both regions. The Lower Colorado and South Central Texas Planning Groups used a series of joint meetings to discuss and eventually adopt the off-channel reservoir project in the Colorado River Basin to meet projected water needs in both regions.

Joint meetings between the Planning Groups served both to coordinate water management strategies and to circumvent later conflicts over the use of shared resources. Planning Groups along Texas borders also coordinated with neighboring states and the Republic of Mexico. Dialogue has begun with Oklahoma on potential water-sharing plans and with Mexico concerning water issues governed by international treaties. These discussions will potentially continue throughout future water planning cycles.

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**

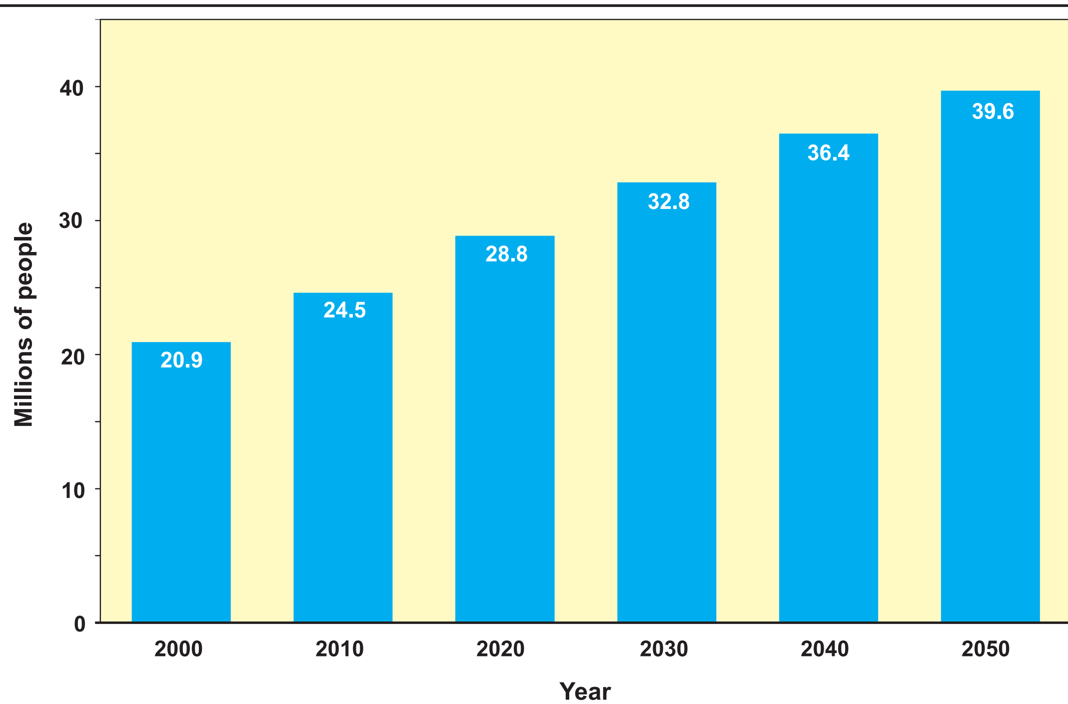


Figure 5-1. Projected population growth in Texas.

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).

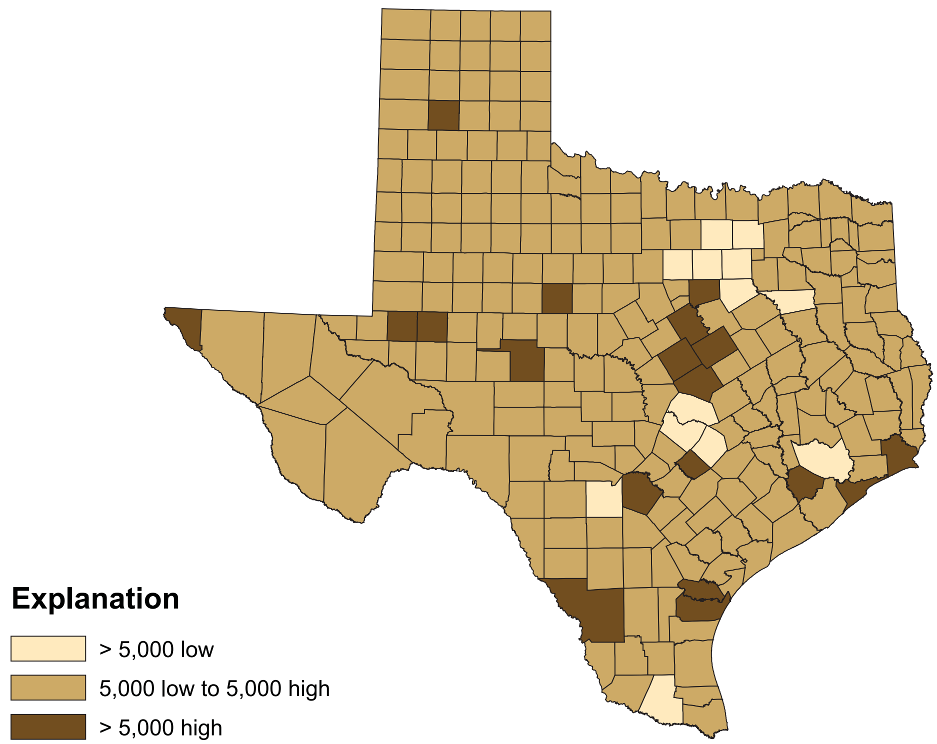


Figure 5-2. Numerical difference between TWDB's projection for 2000 and the 2000 Census.

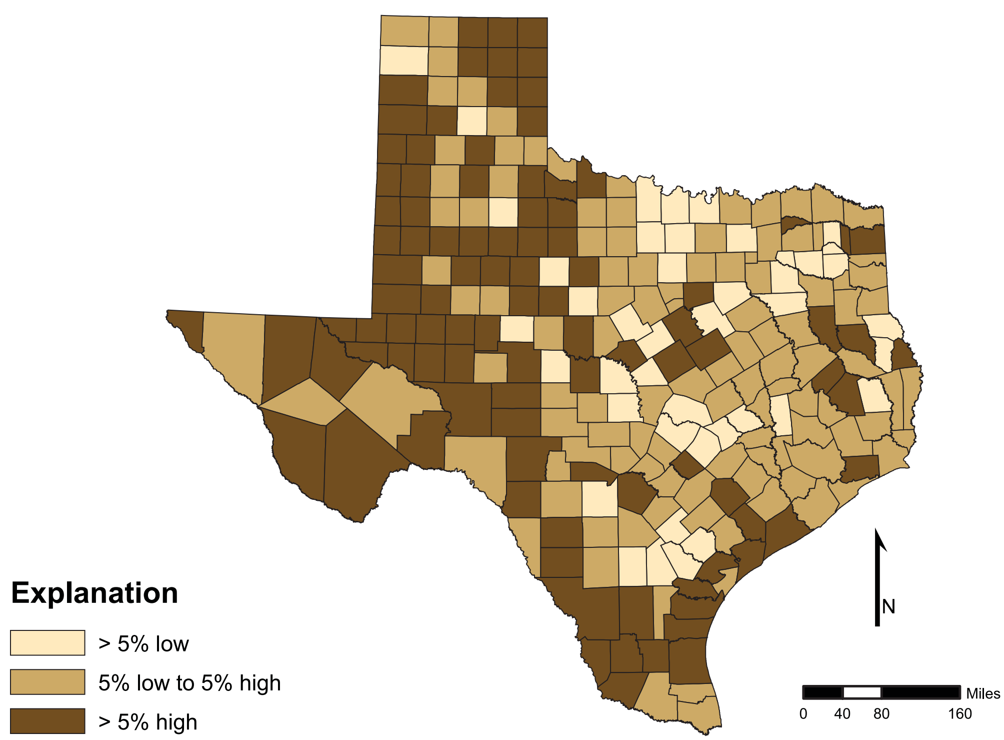


Figure 5-3. Percent difference between TWDB's projection for 2000 and the 2000 Census.

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**

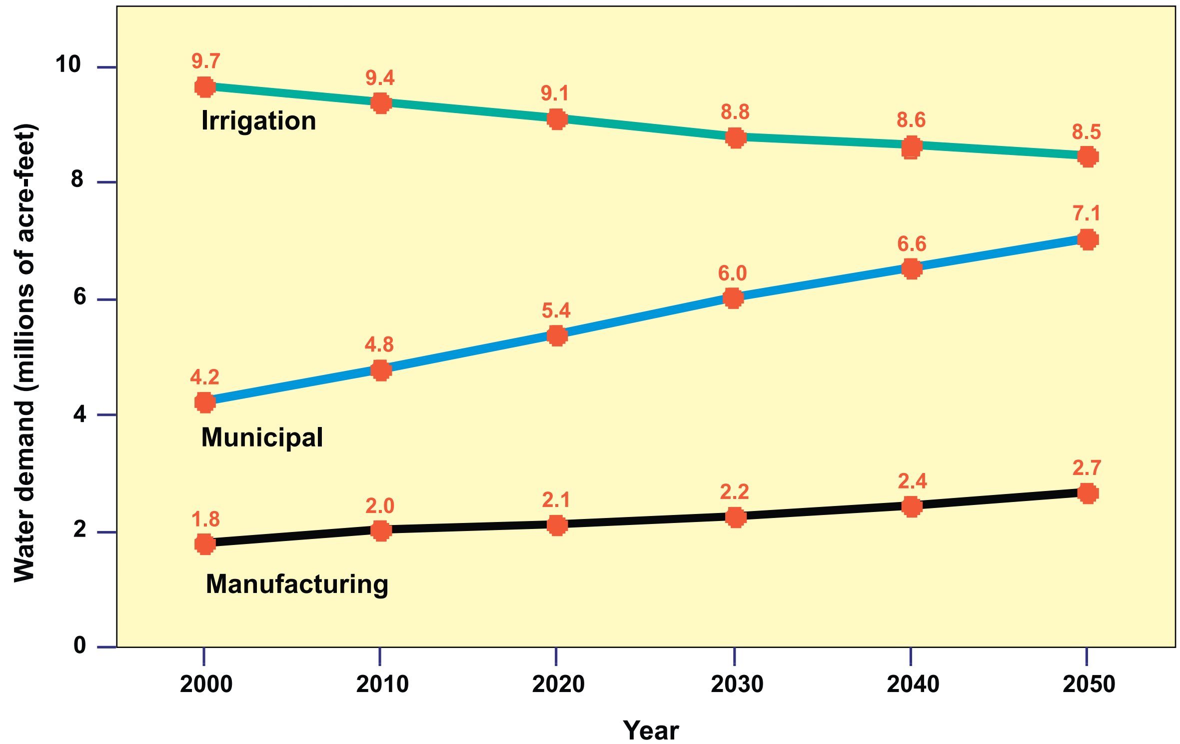


Figure 5-4. Projected water demand for irrigation, municipal, and manufacturing water uses during drought.

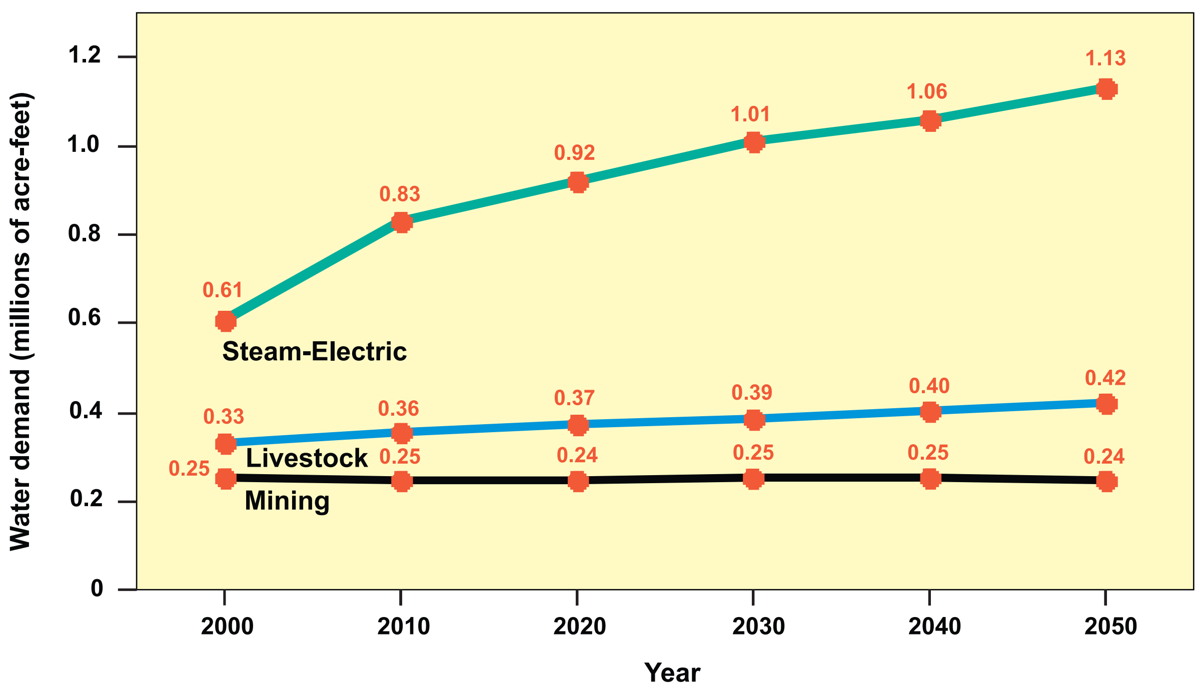


Figure 5-5. Projected water demand for steam-electric, livestock, and mining water users during drought.

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.

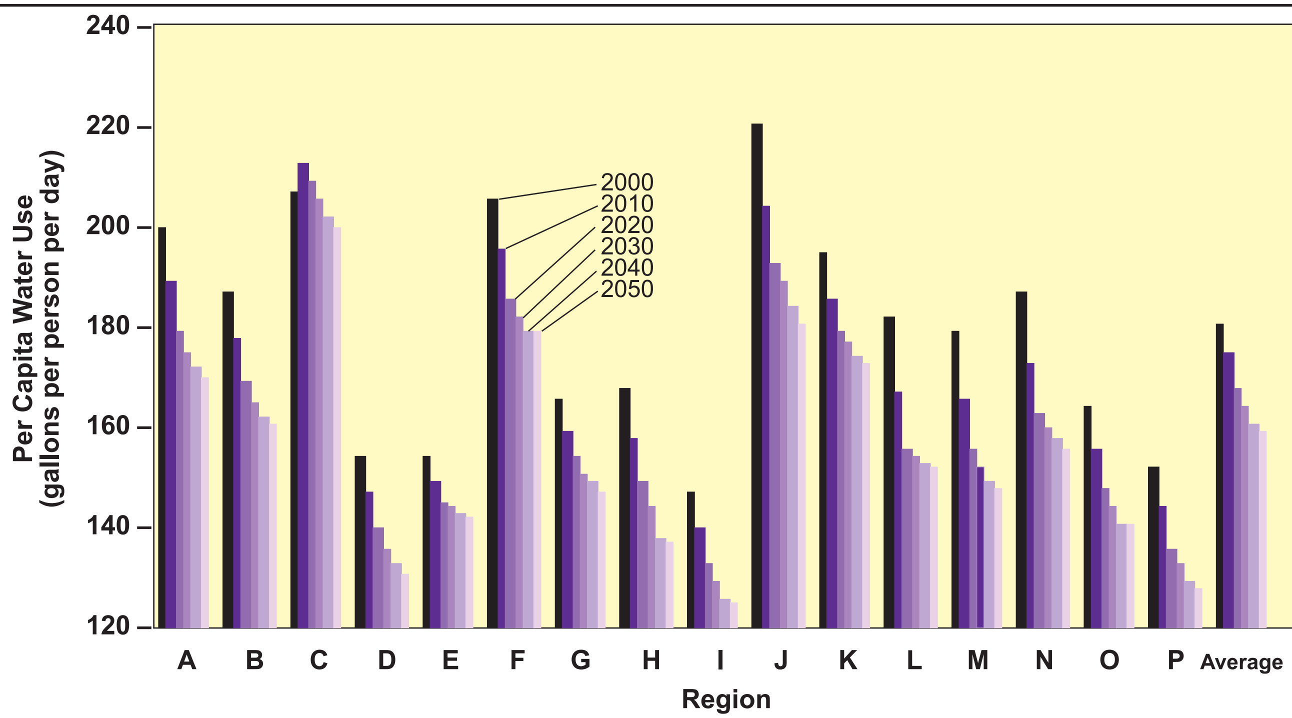


Figure 5-6. Regional per capita water demand projections for 2000-2050.

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.

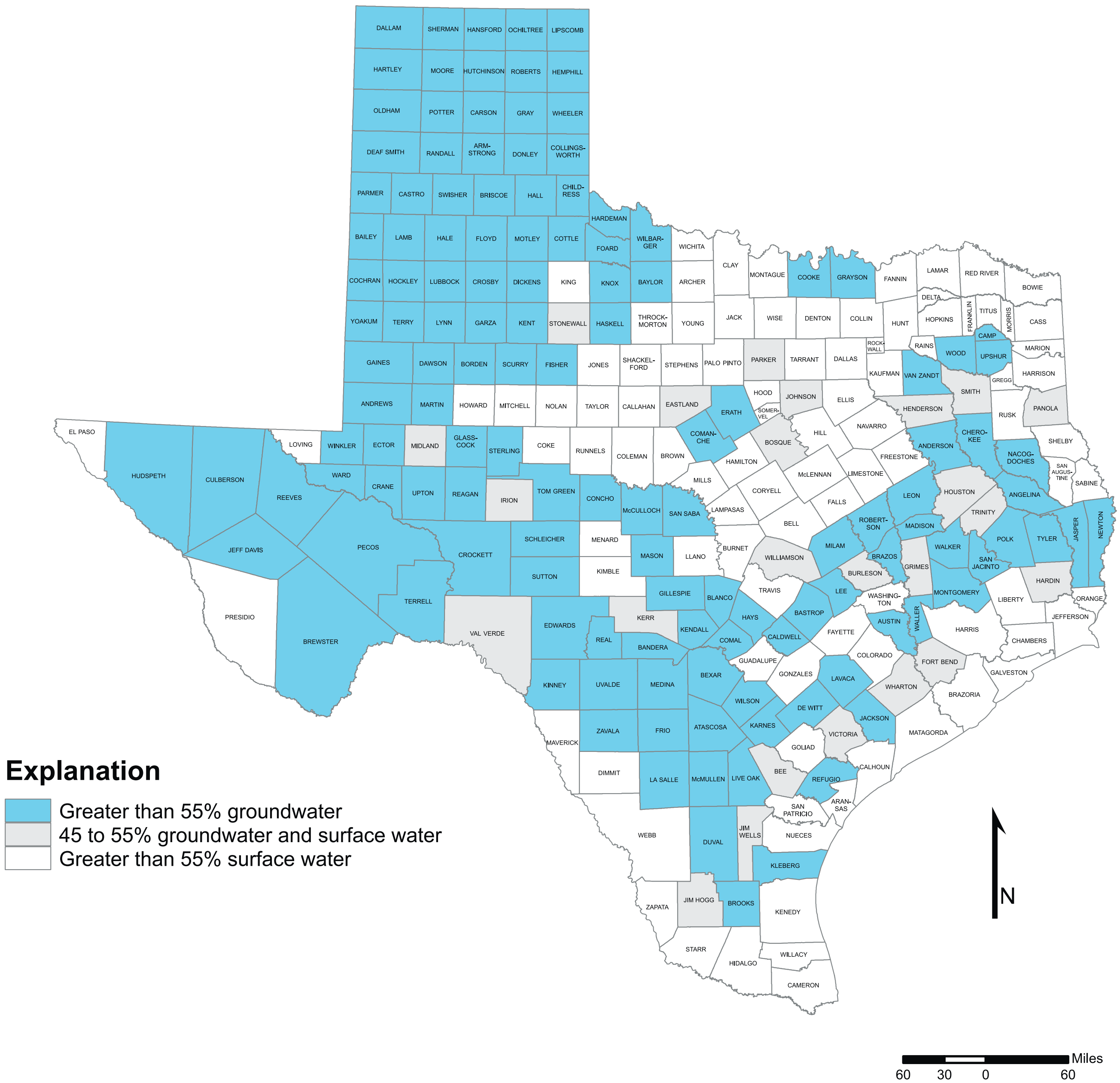


Figure 5-7. Analysis of total 1999 water use by county in Texas, illustrating dominant supply source. Analysis is based on TWDB Water Use Survey results and, although certain areas of the state did experience drought conditions during 1999, the water use patterns illustrated on this map do not uniformly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

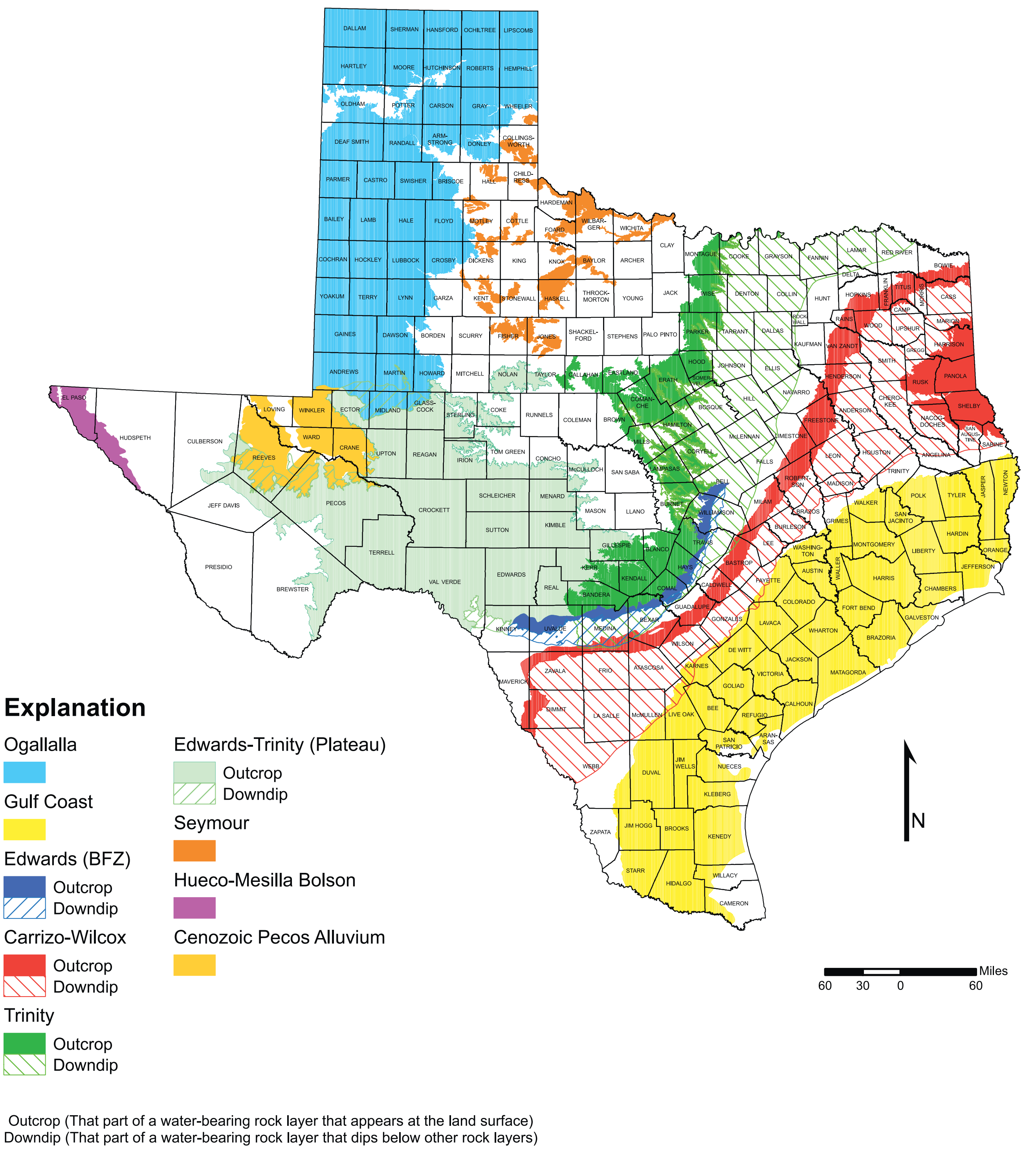


Figure 5-8. The major aquifers of Texas.

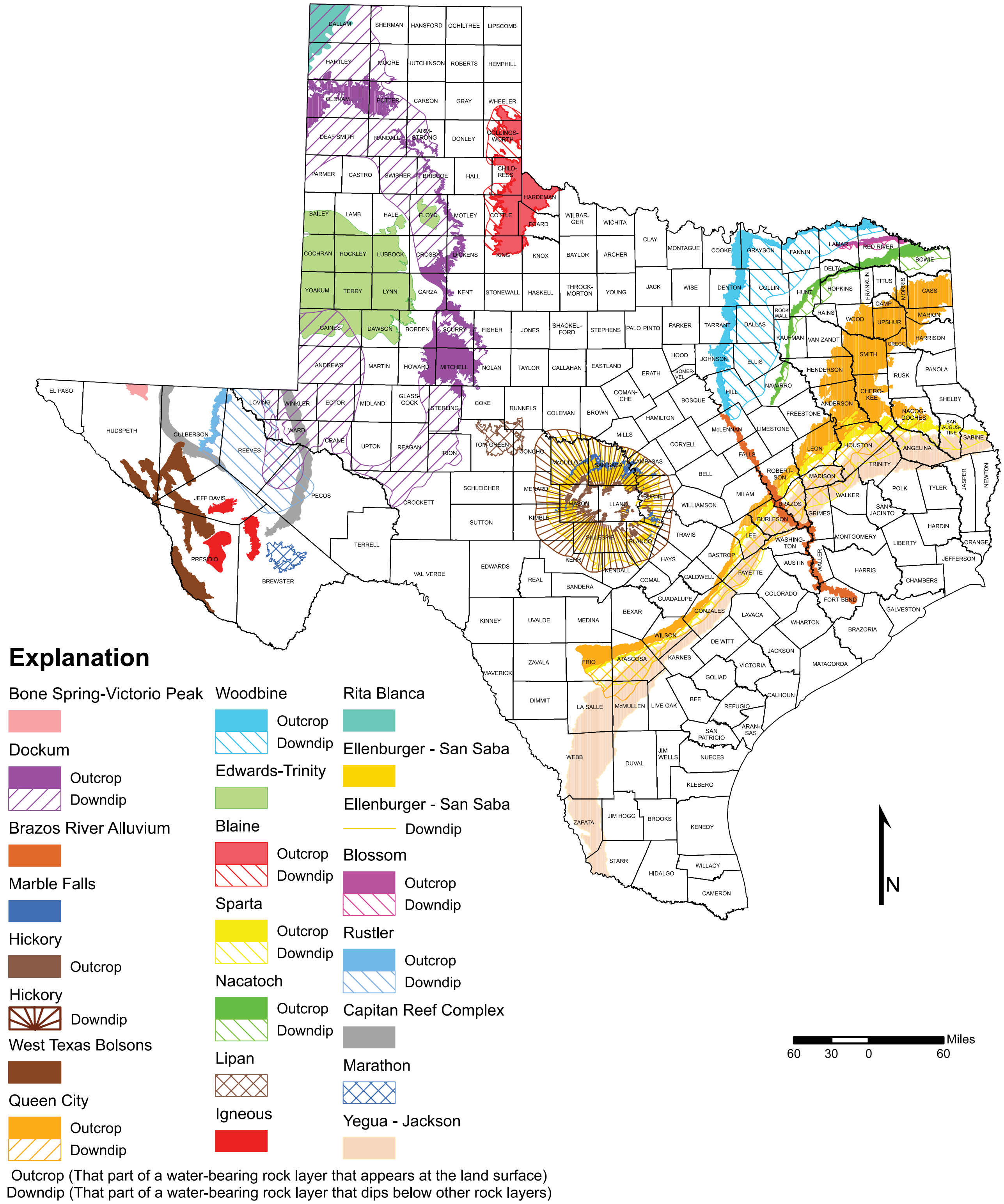


Figure 5-9. The minor aquifers of Texas.

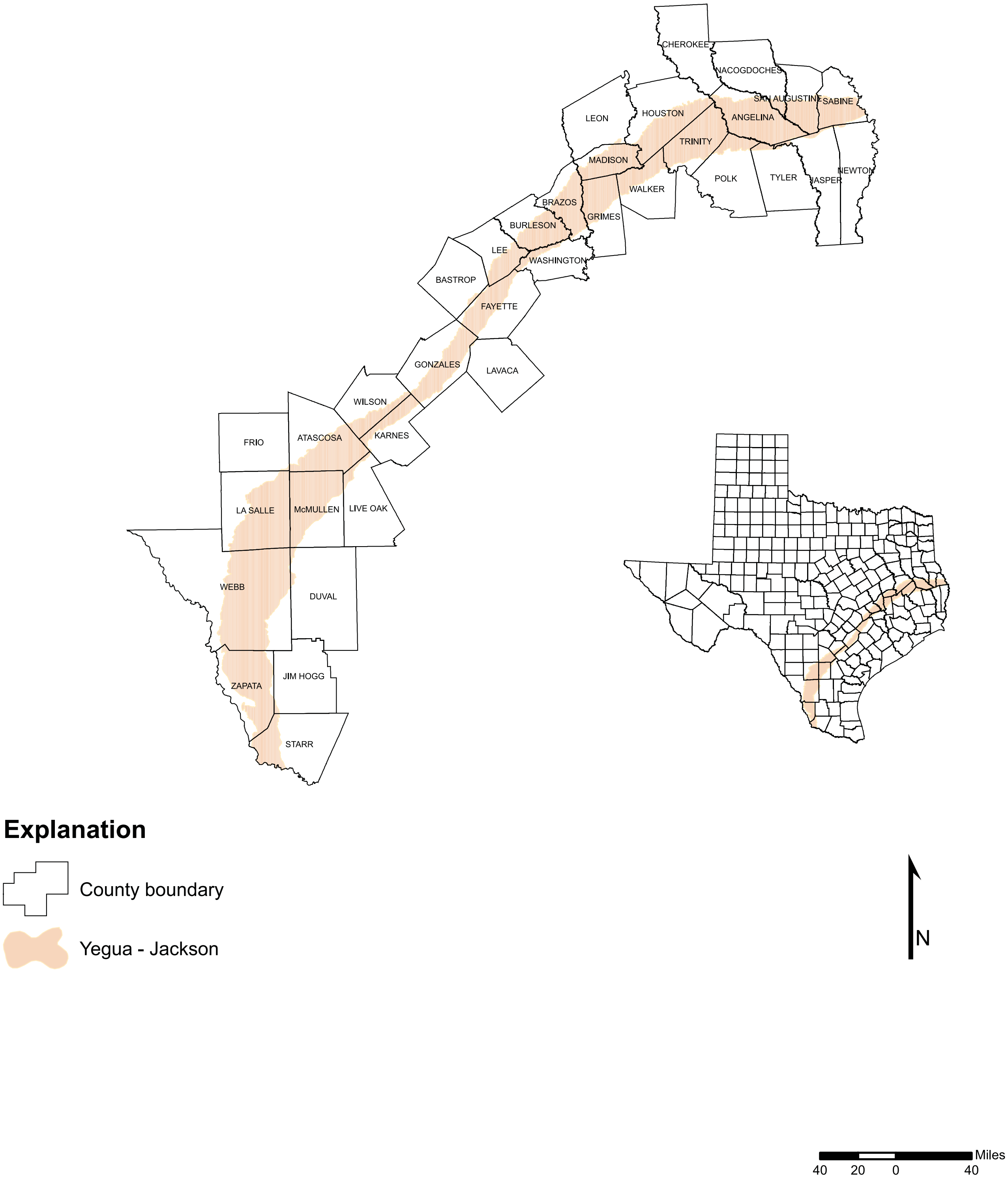


Figure 5-10. Location of the Yegua-Jackson aquifer in Texas.

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.

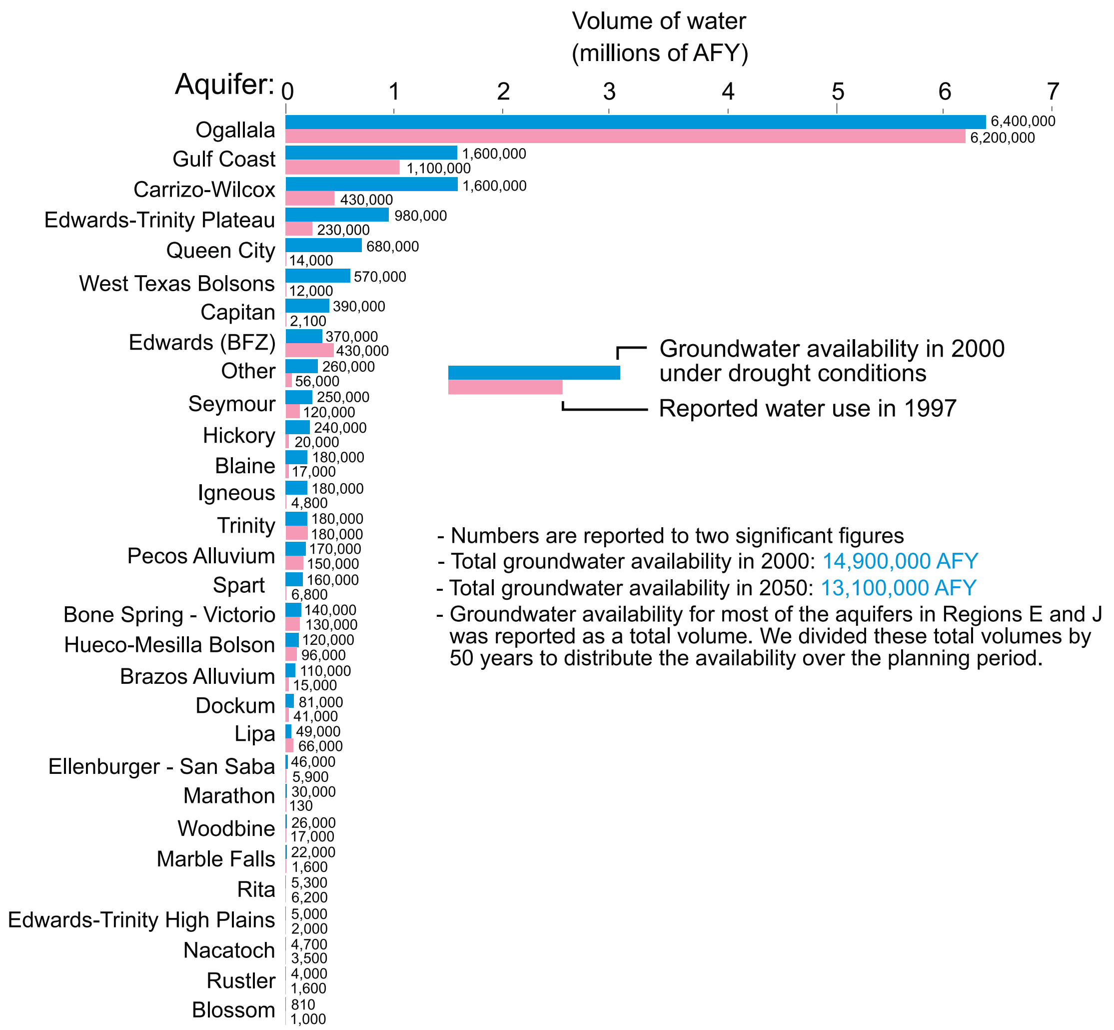


Figure 5-11. Groundwater availability for aquifers of Texas under drought conditions as reported by Planning groups.

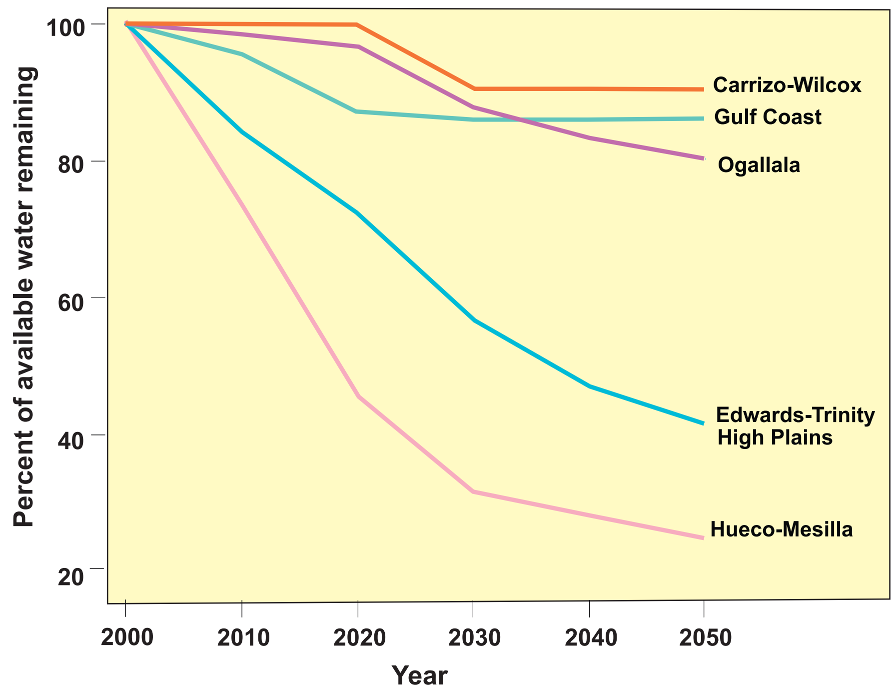


Figure 5-12. Percent of available groundwater remaining for the Carrizo-Wilcox, Gulf Coast, Ogallala, Edwards-Trinity High Plains, and Hueco-Mesilla Bolson aquifers through 2050. Major and minor aquifers not shown do not have appreciable declines of availability. Water availability in the Hueco-Mesilla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

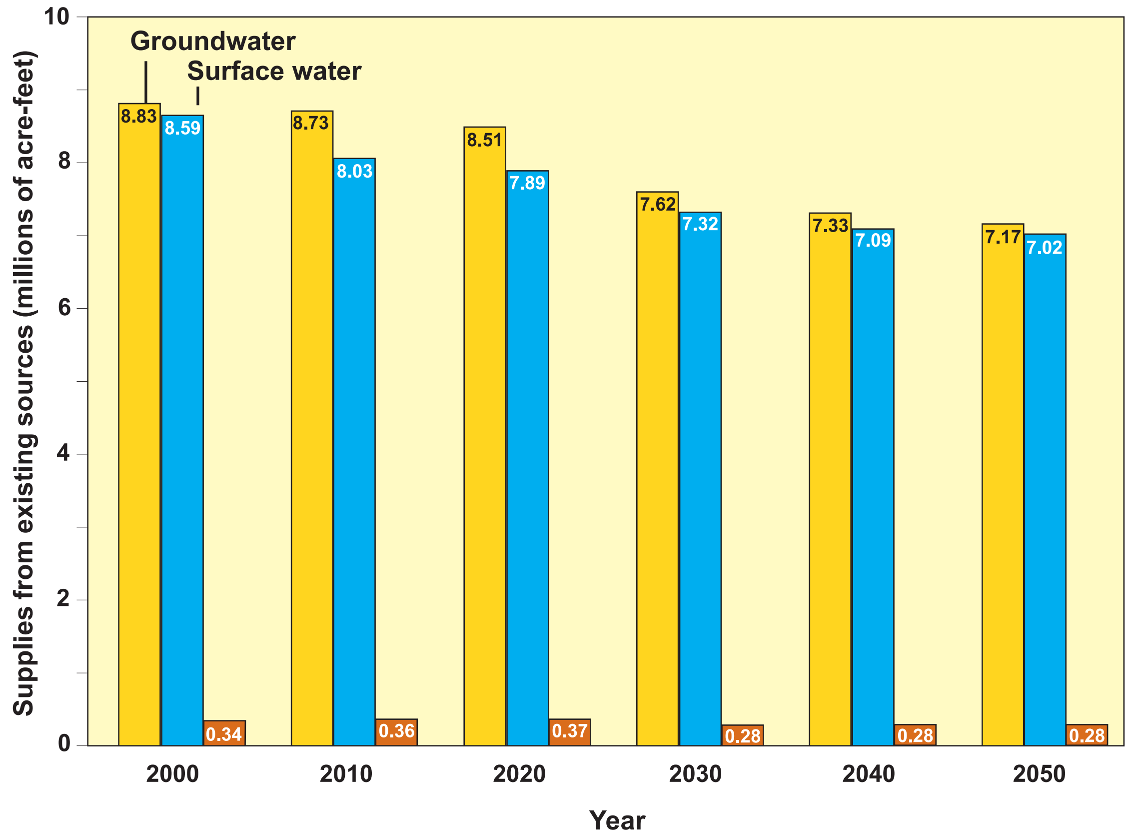


Figure 5-13. Current groundwater, surface water, and wastewater reuse supplies from existing sources through 2050 under drought conditions.

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	Groundwater supplies from existing sources (AFY) 2000	2010	2020	2030	2040	2050		%
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.

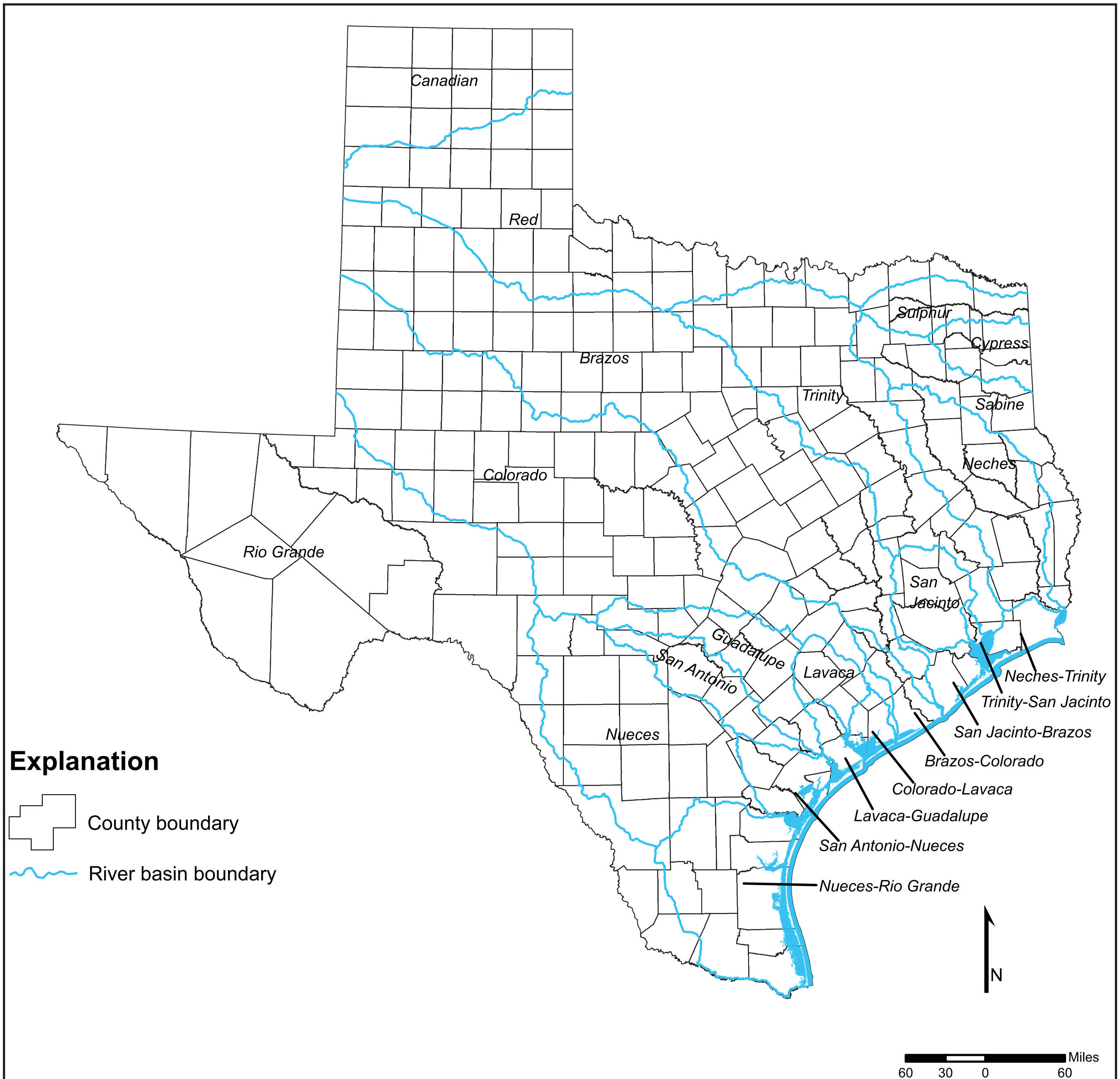


Figure 5-14. Major river basins of Texas.

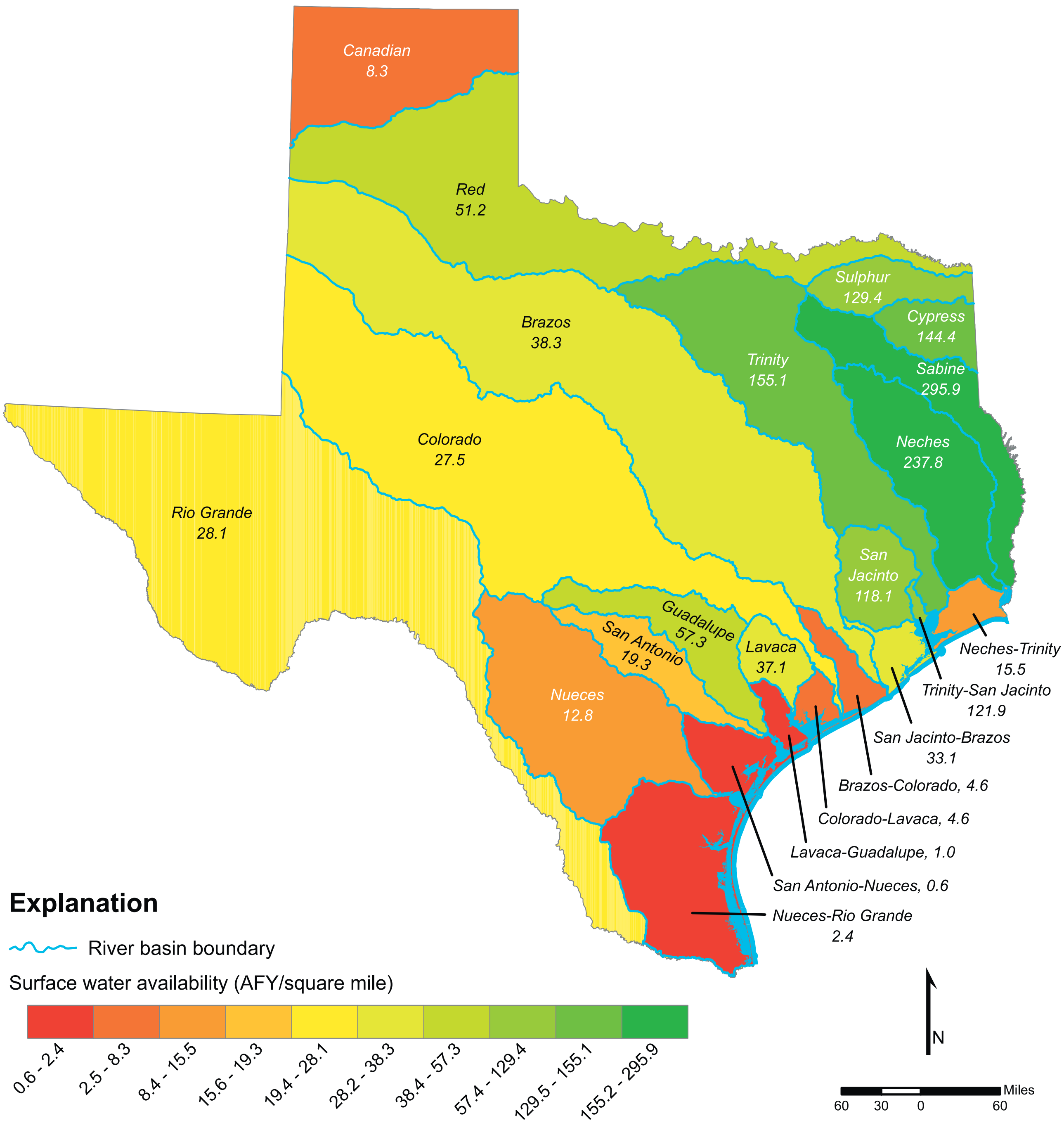


Figure 5-15. Surface water availability index.

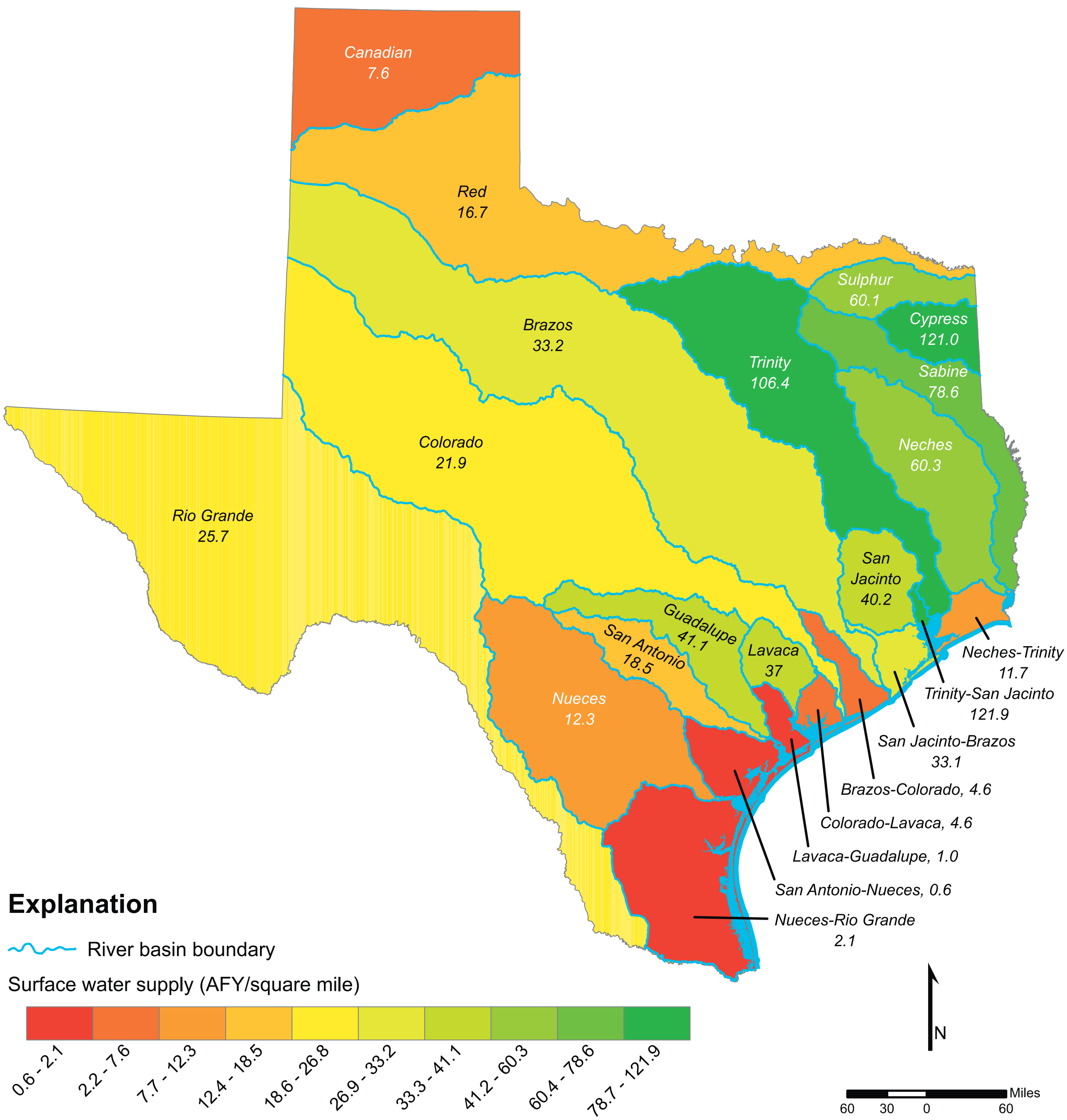


Figure 5-16. Surface water supply index.

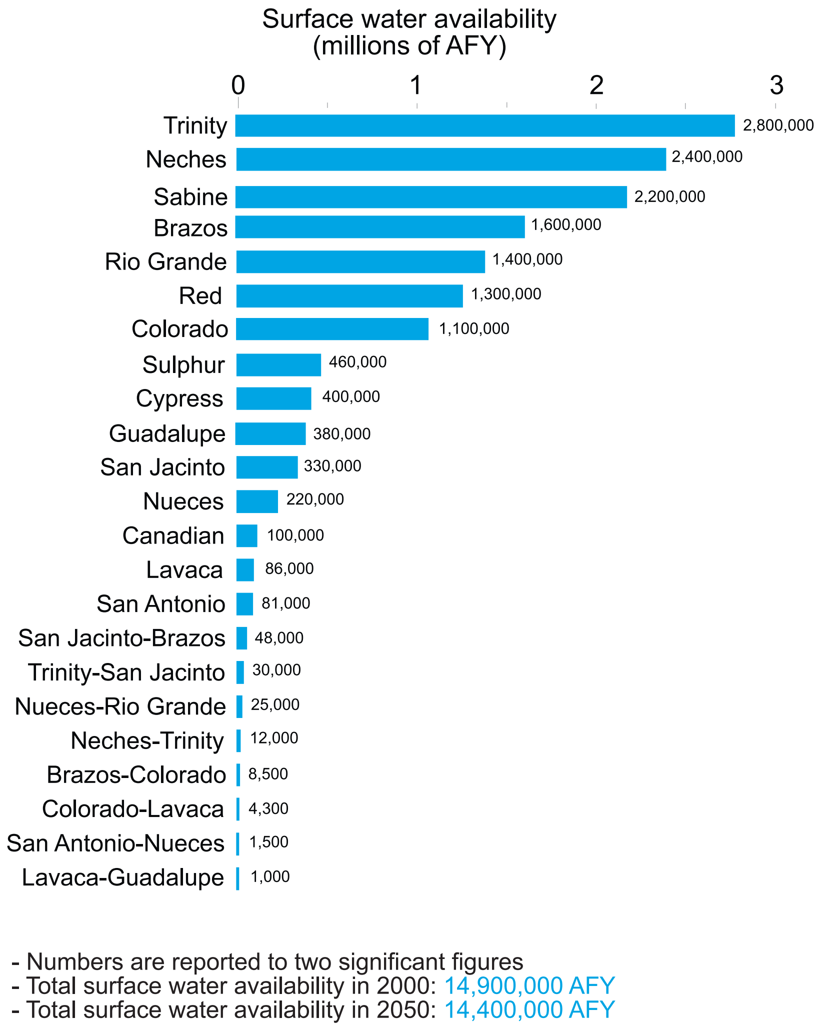


Figure 5-17. Surface water availability for the different river basins in 2000 under drought conditions.

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	2000	2010	2020	2030	2040	2050		%
	Surface water supplies from existing sources (AFY)							
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
76	Colorado River	Garwood rights to various recipients
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.

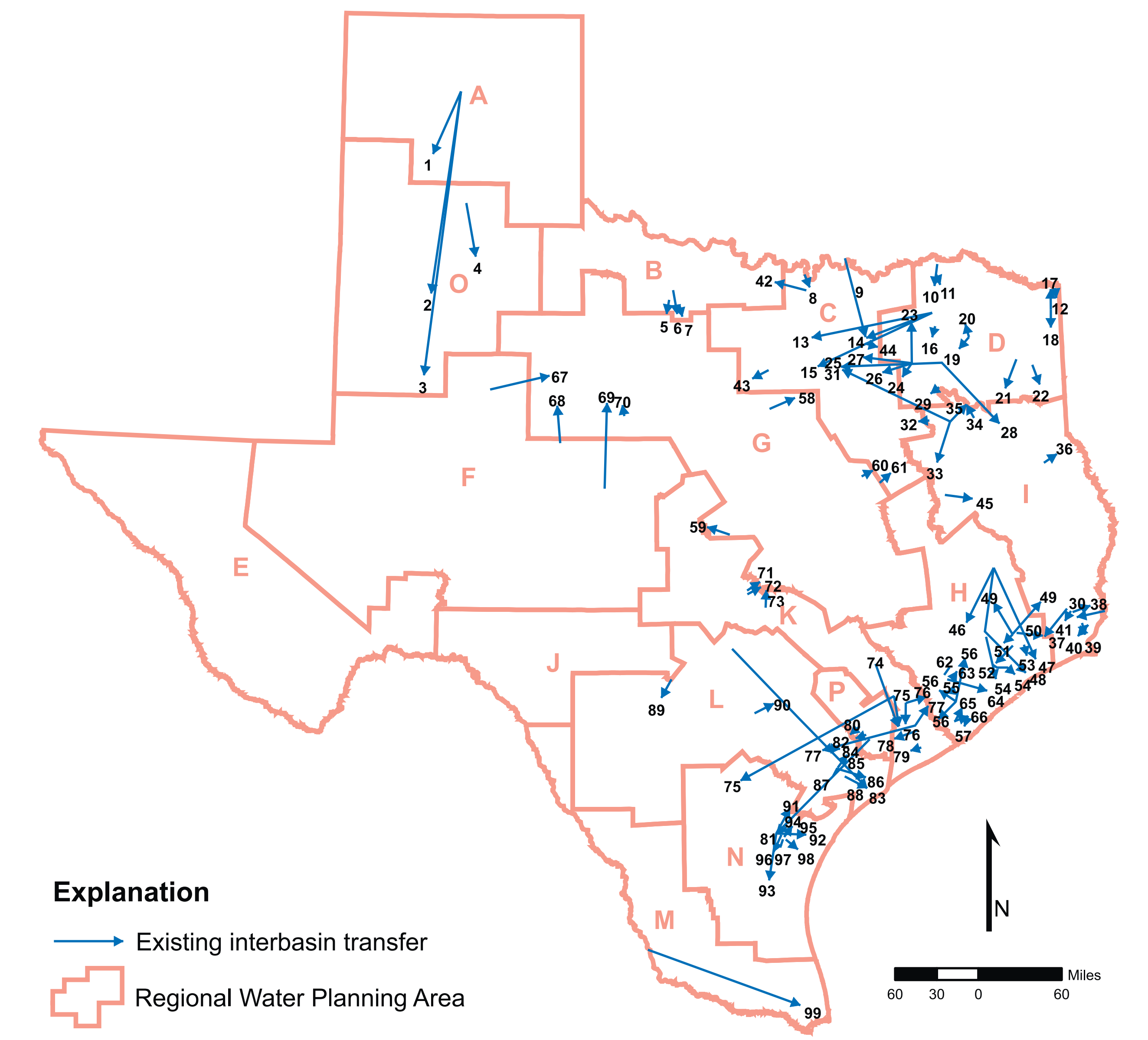


Figure 5-18. Existing interbasin transfers in the State. See Table 5-7 for descriptions of transfers (based on water rights information provided primarily by TNRCC).

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		Water supplies from existing sources (AFY) 2000	2010	2020	2030	2040	2050		%
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).

6.0 Environmental Planning

Key Finding The Planning Groups evaluated all new surface water management strategies for their impact on environmental flows.

Senate Bill 1 provided a new direction in water planning with a new set of environmental considerations. One highlight of this process was the provision that required that environmental interests be officially represented on each of the Planning Groups. However, significant involvement and input by environmental interests were not evident until very late in the planning effort.

The Planning Groups considered the environmental impacts of water management strategies with the goal of providing adequate water to maintain instream flows and freshwater inflows to bays and estuaries. One of the Planning Groups (Region H) also included a list of recommended river and stream segments of unique ecological value. The Planning Groups considered environmental impacts in varying detail. Some Planning Groups had comprehensive analyses, whereas others conducted more limited evaluations. The more comprehensive analyses addressed all items on the environmental checklist and described overall ecological impacts on habitats, fish and wildlife, water quality, instream flows, freshwater inflows to bays and estuaries, and cultural resources.

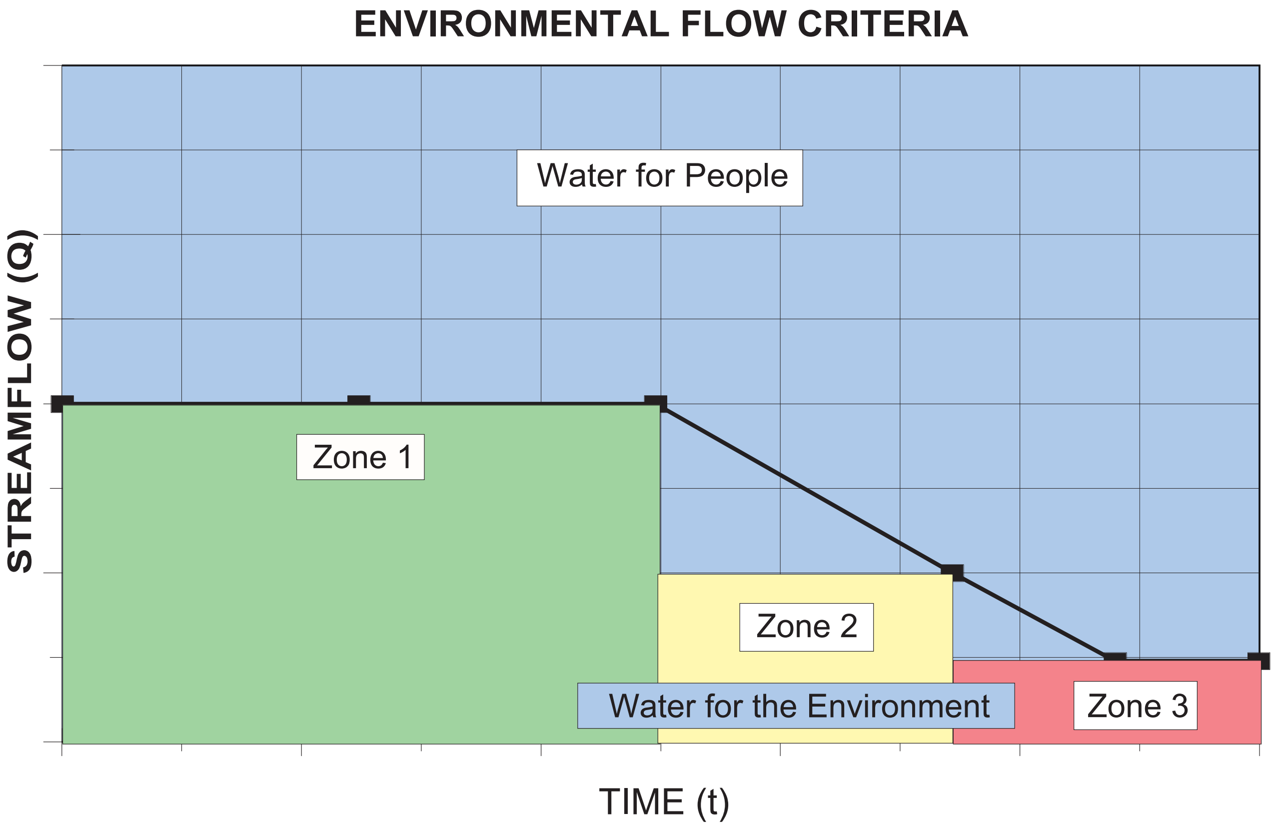
6.1 Environmental Flow Needs and Unique Stream Segments

Environmental issues that challenged Planning Groups the most were determining environmental flow needs for new diversions and reservoirs and recommending ecologically unique river and stream segments.

State and regional water planning requires use of consensus criteria to assess the environmental flow needs of all new water development strategies when site-specific field studies are not available or feasible during regional planning efforts. The criteria were developed through extensive collaboration among scientists and engineers from the State's natural resource agencies (TWDB, TPWD, and TNRCC), as well as academics, consultants, and informed citizens. The criteria are composed of multistage rules for environmentally safe operation of impoundments and diversions during above-normal streamflow conditions, below-normal conditions, and drought conditions (Figure 6-1). The criteria provide balance by sharing the adverse impacts of drought so that neither human nor environmental needs prevail over the other. However, it should be recognized that State and Federal permitting processes may require different environmental flow constraints based on the results of intensive field studies or other permitting considerations.

There are two distinct methods for determining environmental flow needs: statistical "desk-top" techniques and intensive field studies. The first method is used in water planning, particularly when several alternative water management strategies are being evaluated for meeting a water supply need. This method uses a statistical analysis of existing hydrological records for a potential water development site. The second method involves a field study and modeling assessment of the actual flow needed for environmental maintenance. The second method is generally recognized as more accurate than the statistical method and is generally required during the State and Federal permitting process.

Because many streams in Texas are fully or almost fully appropriated, opportunities are limited for making new water appropriations for the environment or for new water development projects that alone would provide flows sufficient to maintain a healthy ecosystem. In most cases, water rights issued before 1985 for development of water supply projects have no environmental requirements.



Zone 1=Above Normal Conditions: Pass-through 50th Percentile (Median) Flow.
Zone 2=Below Normal Conditions: Pass-through 25th Percentile Flow.
Zone 3=Extremely Low (Drought) Conditions: Pass-through 7Q2 Water Quality Flow.

Figure 6-1. Environmental flow criteria for regional and State water planning.

The TPWD proposed a list of ecologically unique river and stream segments for each regional water planning area for the Planning Groups to consider when developing their regional water plans. However, the Planning Groups were concerned about the legal implications on future use if a river or stream were designated as ecologically unique. All but one region (Region H) chose not to make any recommendations because there was no clear legal interpretation of what restrictions might be imposed on private landowners, municipalities, or agricultural and industrial interests. The Planning Groups unanimously agreed that the Legislature needed to better define the legal implications and limit any restrictions to the development of new reservoirs in a designated segment. Senate Bill 2 clarifies that a State agency or political subdivision of the State may not finance reservoir construction in a river or stream segment of unique ecological value (Texas Water Code 16.051(f)). This clarification is anticipated to help Planning Groups in their next round of planning.

6.2 New Environmental Assessment Tools

TWDB rules responded to Senate Bill 1 by requiring a range of environmental assessments, from environmental flow needs to wildlife habitats and cultural resources. To assist the Planning Groups as they made these assessments, the TWDB developed an environmental checklist of required and optional environmental issues to guide the regional water planning effort (Table 6-1).

Table 6-1 Environmental checklist.

Required assessments

- ❑ Description of Regional Planning Area
- ❑ Description of water sources, including major springs
- ❑ Description of natural resources
- ❑ Identification of water quality problems
- ❑ Identification of threats to natural resources

Evaluation of alternative management strategies for effects on

- ❑ Instream flows
- ❑ Bay and estuary inflows
- ❑ Wildlife habitat
- ❑ Wetlands
- ❑ Threatened and endangered species
- ❑ Cultural resources
- ❑ Evaluation of impacts of water management strategies on threats to natural resources
- ❑ Specific recommendations for water management strategies so that strategies that are environmentally sensitive are considered and pursued
- ❑ Use of environmental planning criteria or site-specific environmental information

Conditional considerations

- ❑ Recommendations for ecologically unique river and stream segments
- ❑ Recommendations that are needed and desirable to protect natural resources

Some of the Planning Groups developed new environmental assessment tools to evaluate the impacts of regional water supply projects on environmental and cultural resources. The South Central Texas Region developed a procedure to assess and compare the potential effects of 77 possible water supply options. For each category in the environmental checklist, they developed a protocol to consider regional context, relative value of resources, and the expected probability and magnitude of project-associated impacts. Within each resource category, impact scores for water management strategies were ranked, normalized, and then aggregated over the different categories to produce a total relative-impact score for each of the strategies. The East Texas Region developed a similar assessment tool on the basis of a score of the composite impacts for each strategy. The overall result is a tool that can be implemented, improved upon, and applied to future regional plans throughout the State.

7.0 Identification of Needs

When current water supply is less than projected demand, there is a need. The Planning Groups identified future needs by comparing current supplies with projected demands. Needs were identified for both individual water user groups and major water providers.

Water user groups are cities having populations of 500 or more and an aggregate of demand by county for other sectors, including manufacturing, irrigation, steam-electric power generation, mining, livestock, and county-other. Major water providers are entities that deliver and sell a significant amount of raw or treated water for municipal or manufacturing use on a wholesale or retail basis. Each region selected the quantity considered major for including entities in this category.

7.1 Water User Groups and Major Water Providers with Needs

Key Finding Total volume of needs increases from about 2.4 million AFY in 2000 to 7.5 million AFY in 2050.

Regionally, 438 water user groups and 18 major water providers had needs in 2000 (Figure 7-1 and Table 7-1, respectively). The number of water user groups nearly doubles by 2050, increasing to 883 (Figure 7-1), and major water providers with needs increases to 31 (Table 7-1). Region C and Brazos G Region identified the most water user groups with needs in 2050, closely followed by Region H and East Texas Region (Figure 7-2). East Texas Region, South Central Texas Region, and Region C identified the most major water providers with needs (Table 7-1).

The volume of needs for water user groups increases at varying rates over the 50-year planning horizon. In 2000, the largest volume of needs for water user groups by region was 652,441 AFY for the Rio Grande Region, followed by 494,873 AFY for the South Central Texas Region. By 2050, the largest volume of needs for water user groups moves to the most populous regions, with 1,203,947 AFY in Region C and 1,375,455 AFY in Region H (Figure 7-3). The volume of needs shown for the South Central Texas Region in this figure may be an underestimate because the final water availability value for the Edwards aquifer has yet to be finalized by the Edwards Aquifer Authority and the U.S. Fish and Wildlife Service. On a Statewide basis, the total volume of needs increases from about 2.437 million AFY in 2000 to 7.512 million AFY in 2050 (Figure 7-4). Throughout the 50-year planning horizon, irrigation and municipal are the categories with the greatest need (Table 7-2).

Table 7-1. Number of major water providers with projected needs in regional water planning areas.

Region	2000	2010	2020	2030	2040	2050
A	0	0	0	0	1	1
C	3	5	5	4	4	5
E	2	2	2	3	3	3
G	1	1	2	2	2	2
H	1	1	1	1	1	1
I	6	9	8	8	8	9
K	1	1	1	1	2	2
L	4	6	6	6	6	6
N	0	0	0	0	2	2
Total	**18**	**25**	**25**	**25**	**28**	**31**

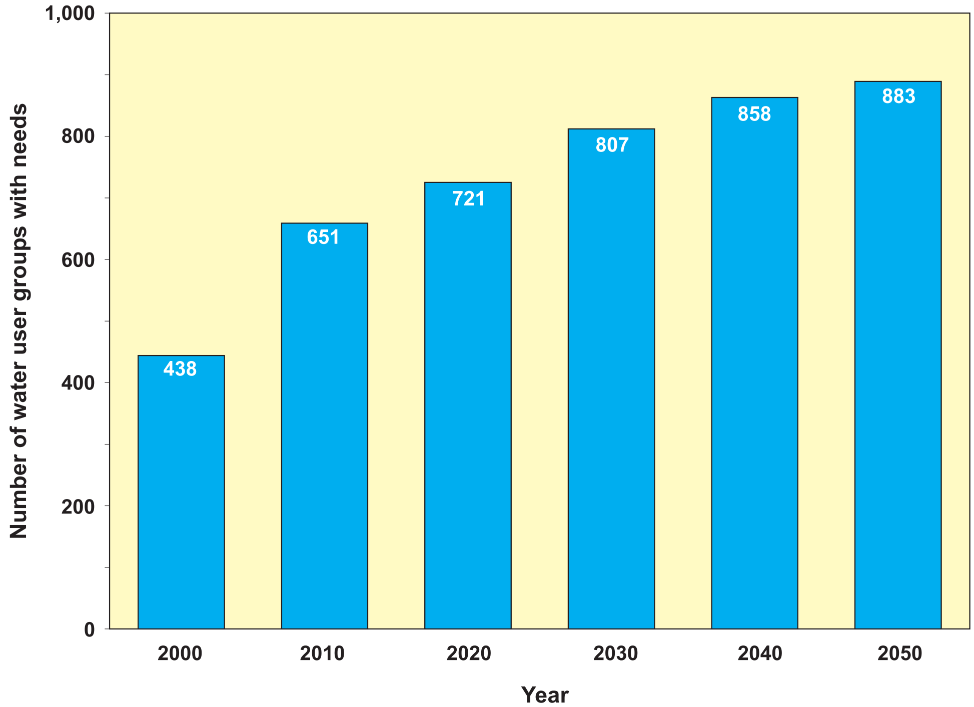


Figure 7-1. Number of water user groups with projected needs Statewide.

Table 7-2. Volume of needs for different water use categories (AFY).

Use	2000	2010	2020	2030	2040	2050
Municipal	310,094	710,612	1,280,291	2,080,184	2,574,946	3,037,646
Manufacturing	69,639	314,129	446,008	850,867	1,008,734	1,178,889
Steam-electric power	21,747	151,589	191,247	264,561	380,211	435,786
Mining	39,239	38,312	41,795	55,668	56,924	61,479
Irrigation	1,993,454	2,119,853	2,013,409	2,514,264	2,688,123	2,756,636
Livestock	2,847	3,956	5,386	14,677	35,174	41,731
Total	**2,437,020**	**3,338,451**	**3,978,136**	**5,780,221**	**6,744,112**	**7,512,167**

Not all identified needs were met, either in whole or in part, by the Planning Groups throughout the 50-year planning period. In 2050, 78 counties in Texas had at least one water user group with unmet needs (Figure 7-5).

7.2 Needs by River Basin

Out of the 23 basins, the Nueces and Nueces-Rio Grande Basins had the highest volume of needs for water user groups in 2000 (Table 7-3). The Trinity, Canadian, and San Jacinto Basins have the largest increases in needs between 2000 and 2050. By 2050, the Trinity, Nueces-Rio Grande, and Canadian Basins have the highest volume of needs for water user groups. Only four basins experience declining needs through 2050.

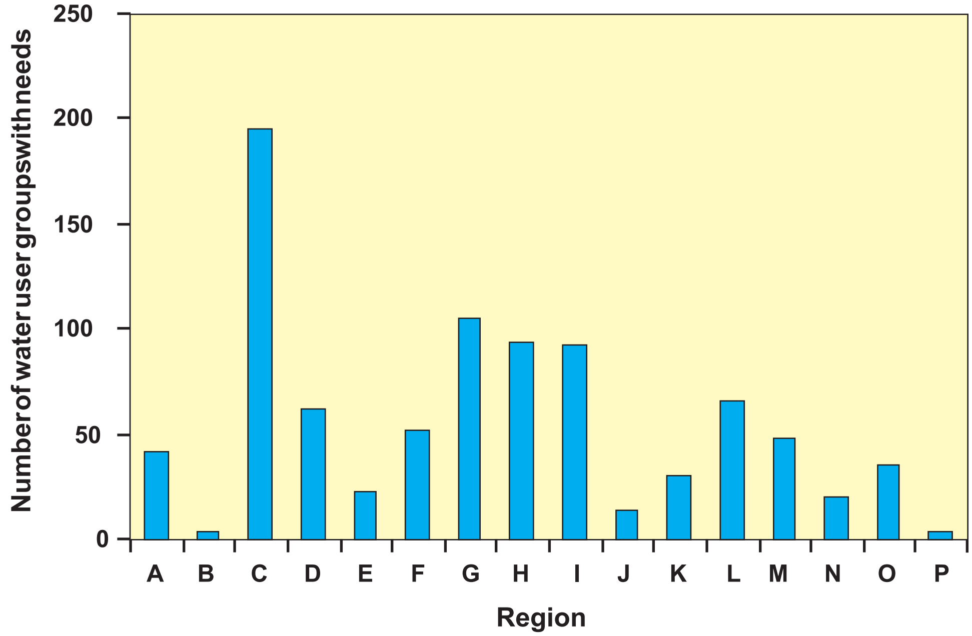


Figure 7-2. Number of water user groups with projected needs in regional water planning areas in 2050.

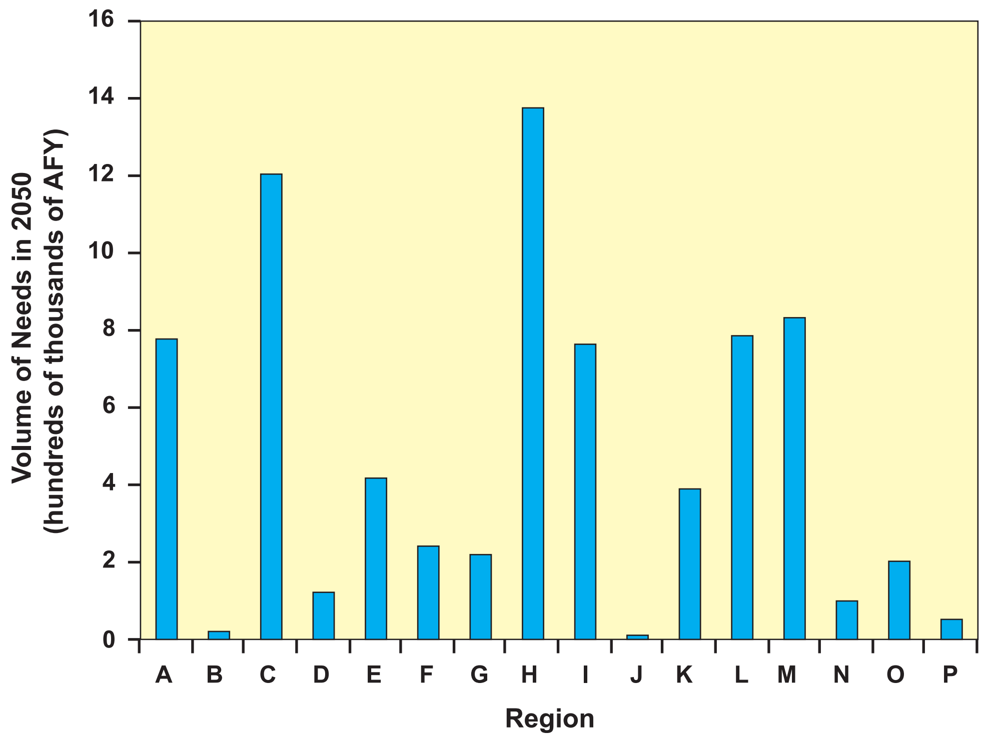


Figure 7-3. Volume of needs in regions in 2050.

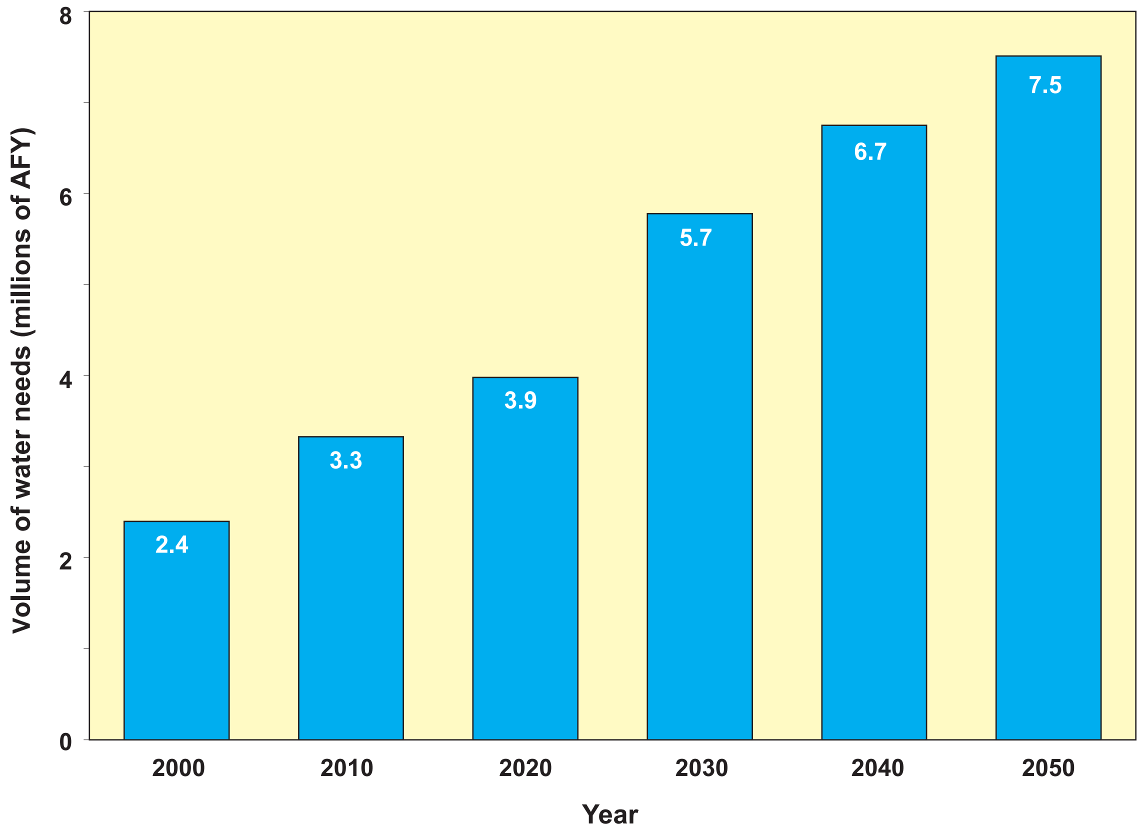


Figure 7-4. Volume of needs Statewide in 2050.

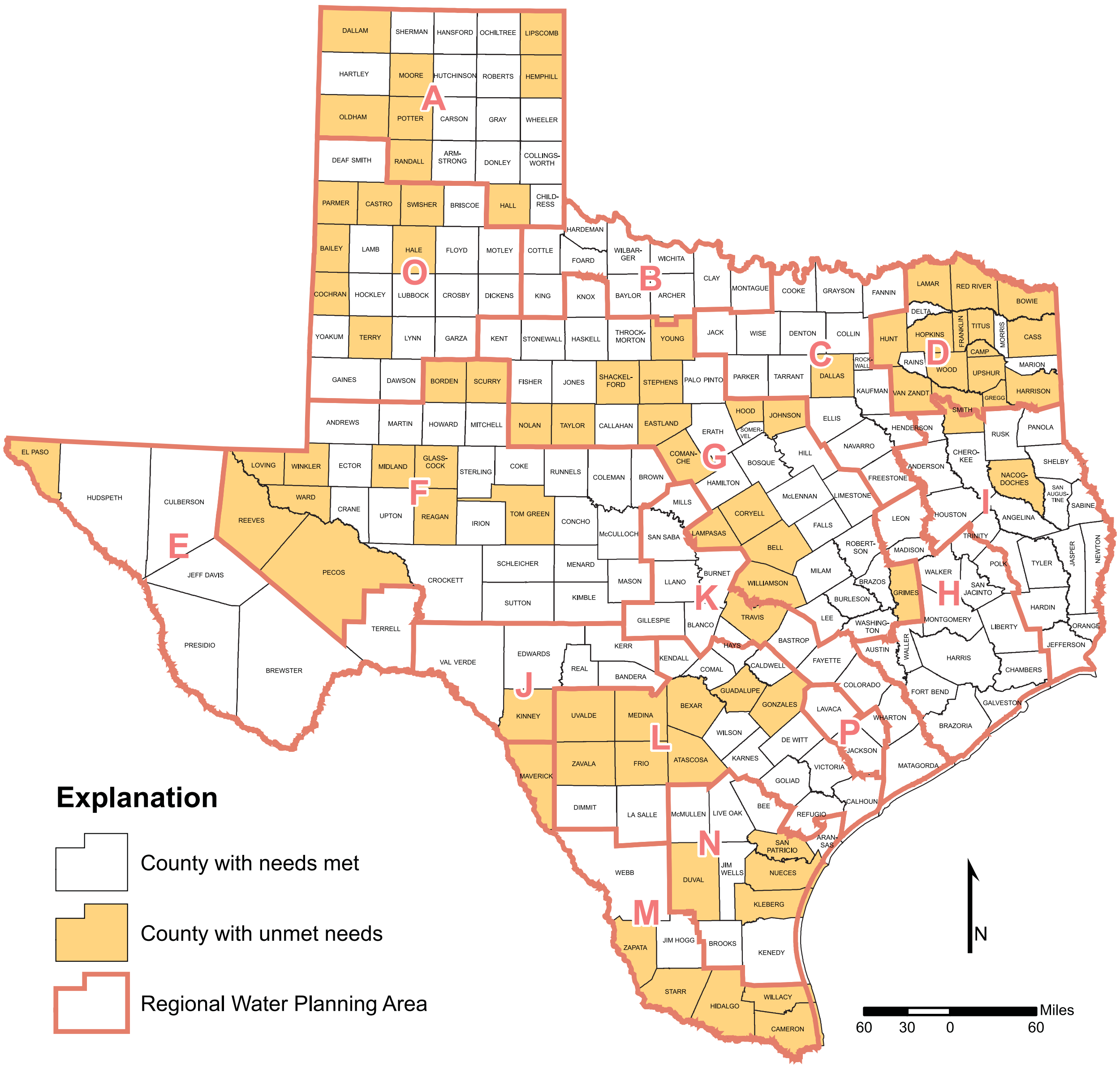


Figure 7-5. Counties in Texas with unmet needs in 2050.

Table 7-3. Volume of needs for water user groups in river basins (AFY).

Basin	2000	2010	2020	2030	2040	2050
Canadian	0	1,813	24,492	499,244	648,488	674,297
Red	7,884	9,083	11,198	21,888	98,150	140,043
Sulphur	4,009	6,840	8,599	14,563	15,830	16,709
Cypress	289	10,025	10,105	10,511	11,878	12,218
Sabine	23,051	57,498	84,512	113,879	144,000	198,468
Neches	37,116	143,716	165,062	193,377	217,117	247,723
Neches-Trinity	24,928	380,220	385,553	389,825	398,455	407,278
Trinity	91,862	340,267	600,766	847,496	1,052,349	1,221,249
Trinity-San Jacinto	0	6,755	89,671	111,773	121,295	131,404
San Jacinto	10,912	97,823	234,567	546,578	612,273	664,365
San Jacinto-Brazos	47,122	88,700	117,372	244,111	290,302	346,890
Brazos	233,556	285,794	350,734	428,408	537,411	602,935
Brazos-Colorado	189,308	184,469	178,797	173,018	169,522	168,276
Colorado	200,702	221,148	226,101	259,792	269,833	299,060
Colorado-Lavaca	138,374	132,918	128,791	124,876	121,084	117,450
Lavaca	86,216	82,965	79,196	75,718	72,450	69,443
Lavaca-Guadalupe	148	917	906	1,000	1,117	1,241
Guadalupe	16,913	30,391	40,029	53,721	66,972	88,655
San Antonio	166,722	198,112	239,817	309,418	368,976	413,885
San Antonio-Nueces	96	33	0	0	7,773	18,738
Nueces	324,739	305,723	286,202	322,753	309,026	301,435
Nueces-Rio Grande	574,129	513,268	477,441	478,815	613,884	727,422
Rio Grande	258,944	239,973	238,225	559,457	595,927	642,983
Total	**2,437,020**	**3,338,451**	**3,978,136**	**5,780,221**	**6,744,112**	**7,512,167**

8.0 Recommended Water Management Strategies

A water management strategy is a specific plan to increase water supply or maximize existing supply to meet a specific need. For example, if a Planning Group determines that a city has a need for additional water supplies in 2050, the Planning Group identifies, evaluates, and then recommends a strategy or strategies to meet that need. The Planning Groups evaluated and recommended strategies for cities, major water providers, and other water uses, including rural, manufacturing, irrigation, steam-electric power generation, mining, and livestock. Sometimes it was not possible to identify a strategy to meet a need or at least some portion of that need. In these cases, the Planning Groups were required to identify those needs for which no water management strategy was feasible.

This section describes water management strategies recommended by the Planning Groups and also a few alternative strategies suggested for consideration by the TWDB. Recommended water management strategies are presented in two ways: a Statewide summary of strategies is presented in this chapter and a region-by-region summary of strategies adopted by the Planning Groups is included in Chapter 11.0. The region-by-region summaries include (1) information on the location of cities with needs; (2) a comparison of industrial, municipal, and agricultural demand with current supplies and supplies implementing water management strategies; (3) a comparison of water user groups with needs; (4) a comparison of types of water management strategies used to meet needs; and (5) a list of key elements included in the regional water plan. If all of the water management strategies recommended in the regional water plans are implemented, then at least on a volumetric basis, available supplies will be greater than projected demands in 2050 (Figure 8-1).

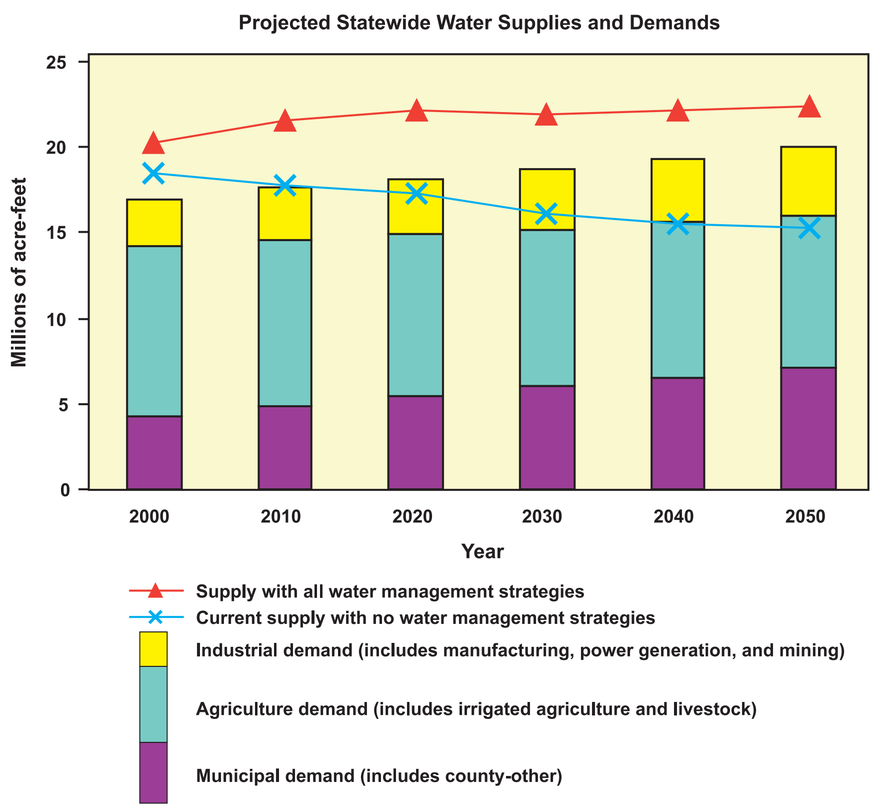


Figure 8-1. Statewide comparison of demands versus supplies with and without implementation of the regional water plans.

The Planning Groups evaluated the following water management strategies:

- water conservation,
- demand management,
- reuse of wastewater,
- expanded use of existing supplies (including systems optimization and conjunctive use of resources),
- reallocation of reservoir storage to new uses,
- subordination of existing water rights through voluntary agreements,
- enhancements of yields of existing sources,
- improvement of water quality (including control of naturally occurring chlorides),
- new supply development (including construction and improvement of surface water and groundwater resources),
- brush control,
- precipitation enhancement,
- desalination,
- aquifer storage and recovery,
- interbasin transfers, and
- other strategies.

The Planning Groups evaluated and compared all identified water management strategies on the basis of quantity, reliability, cost of water, and environmental impacts. These evaluations also included factors for calculating infrastructure debt payments, present costs, and discounted present-value costs. During the Planning Groups' evaluations, effects of strategies on environmental water needs were considered. Impacts on other water resources of the State, including other water management strategies and groundwater/surface water interactions, were also evaluated. In addition, the Planning Groups were required to consider provisions for interbasin transfers, including any social or economic impacts.

After evaluating different strategies, the Planning Groups then chose which strategies to recommend for meeting needs. As much as possible, the Planning Groups chose strategies that satisfied the directives and existing plans of water users in their region. This process implements the concept of Senate Bill 1 to have the water planning process conducted at the local/regional level and to improve local entities' participation in the implementation of recommended strategies.

Texas Water Code §11.134(b) includes a provision that the TNRCC grant a water rights application only if the proposed appropriation addresses a water supply need in a manner that is consistent with the State Water Plan and an approved regional water plan. Texas Water Code §16.053(j) includes a provision that the TWDB provide financial assistance to political subdivisions only if the proposed project addresses needs in a manner that is consistent with a regional water plan that has been approved by the TWDB. Both the TNRCC and the TWDB may determine that conditions warrant a waiver of these requirements. After the regional water plan is approved by the TWDB and the TWDB has adopted a State Water Plan, the projects included in the recommended water management strategies meet the criteria.

Summaries of the recommended water management strategies are included in the next section. Details of recommended strategies are included in Volume II and in the individual regional water plans included in Volume III.

8.1 Water Conservation

Regional water plans indicate that the current water supply will not be able to meet the demand for water over the next 50 years. The Planning Groups recommended that water conservation be utilized to meet the needs, at least partly, of 205 water user groups. Fifty-nine of these are irrigation water user groups. Thus, about 21 percent of the water user groups with needs recommend conservation as a water management strategy. The total projected savings from these conservation-based water management strategies are approximately 987,914 AFY by 2050. Based on a volumetric comparison, approximately 13.5 percent of the water to meet needs in the regional water plans will result from a variety of water conservation strategies (Figure 8-2).

In addition to the conservation-based water management strategies, the plans project that if conservation practices are improved on a continuing basis, Statewide municipal water demand will decrease by an average of 22 gallons per capita per day (GPCD), from 181 GPCD in 2000 to 159 GPCD in 2050. This 12 percent reduction in municipal demand, due in part to more efficient plumbing fixtures, is equivalent to 976,000 AFY by 2050. When combined, these recommended and required conservation efforts are projected to result in savings of 2.0 million AFY by 2050.

The decline in irrigation water demand from 57 percent of the State's total demand in 2000 to about 42 percent in 2050 is due to reductions in groundwater supplies, more water-efficient irrigation practices, and the voluntary transfer of surface water rights from agricultural users to municipal users. The Planning Groups recommended changing of crop varieties and types, utilizing genetic engineering, voluntarily converting irrigated acreage to dry-land production, utilizing conservation tillage methods, installing efficient irrigation equipment, and lining of irrigation canals to ensure efficiency of delivery systems for meeting future irrigation demands. Additional conservation techniques include laser leveling of fields and automated water delivery control systems.

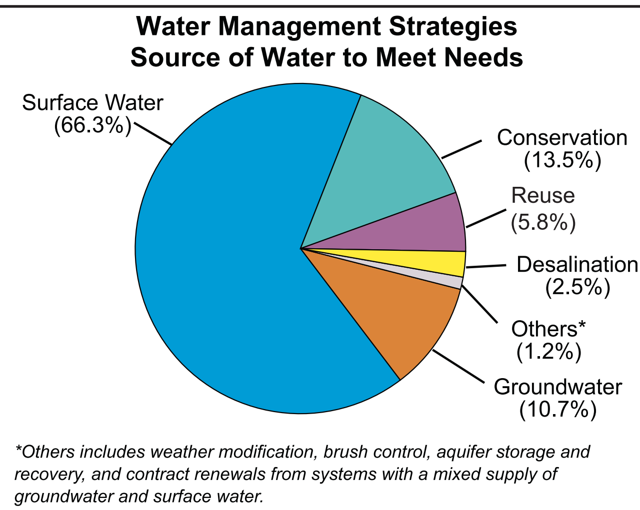


Figure 8-2. Volumetric comparison of the various sources of water utilized by recommended water management strategies to meet needs in the regional water plans.

Awareness and understanding of water conservation and water use efficiency have grown since the 1997 State Water Plan because drought conditions have impacted most regions of the State. So-called water-rich regions often could not meet demands because of rapid growth, and arid regions were pushed to extreme limits with hot, dry weather. This awareness can be a starting point in helping to meet future water demands in Texas.

Per capita demand projections vary greatly around the State. Although most regions of the State project a decrease in per capita use, some areas project an increase. Water demand can change because of population growth and changes in the socioeconomic characteristics of a community. Although water demand may increase, ensuring that water is being used as efficiently as possible is still prudent. Many communities around the State have taken great strides in ensuring wise water use and have found conservation programs to be a cost-effective method of meeting increased water demands while postponing expensive supply or capacity expansion. Austin, Corpus Christi, El Paso, Houston, and San Antonio all have active conservation programs that promote water use efficiency. Each of these cities has used water conservation for different reasons: Austin wants to lower demand to meet a growing customer base; Corpus Christi wants to postpone the need for additional supply; El Paso has a limited long-term supply; Houston needs to reduce its use of groundwater to reduce subsidence; and San Antonio has limited water availability, especially during drought conditions.

Water conservation is not limited to the larger cities. Many small and medium-size systems are committed to increasing water use efficiency. Programs such as bill explanation, plant tours, school programs, and working with local Cooperative Extension offices in educational and outreach activities have proven beneficial. Many smaller systems have partnered with neighboring water systems in public-awareness campaigns to increase exposure, limit confusion, and reduce costs by providing a unified conservation message.

Strategies identified for reaching levels of conservation needed to meet water demand in the 2002 State Water Plan include aggressive plumbing fixture replacement programs and water-efficient landscaping codes.

8.2 Groundwater

Groundwater management strategies recommended by the Planning Groups would result in an additional 779,000 AFY of water supply in 2050.

- The most common groundwater management strategy was installing new wells. These new wells would produce about 631,000 AFY by 2050.
- Regional plans recommended strategies for additional pumping of existing wells, which would produce approximately 122,000 AFY of additional supply.
- The Lower Colorado and South Central Texas Regions recommended artificial recharge strategies that would result in 26,000 AFY in 2050.
- Two Planning Groups proposed groundwater transfers (long distance transfers through pipelines) that would result in transfers of 173,000 AFY by 2050. This volume is included in other items in this list.

8.3 Surface Water

Surface water management strategies would result in approximately 4.8 million AFY of additional water supply in 2050. Some strategies may be included in more than one item in this list.

- Expanded use or acquisition of existing supplies, including systems optimization, and conjunctive use of surface water and groundwater, was recommended in 8 regions and will provide an additional 390,000 AFY of water supply.
- Five regions used reallocation of reservoir storage for new uses for an additional water supply of 107,000 AFY.
- 2,456,000 acre-feet of surface water supply comes from voluntary redistribution of existing water resources, including water marketing, sales, leases, and options in 12 regions.
- Two regions will utilize 151,000 acre-feet of water supply by enhancing yields of existing sources.
- Four regions recommended major interbasin transfer as water management strategy that will generate additional surface water supplies of 2,444,000 AFY by 2050.
- Seven regions included major reservoir development in their surface water management strategies that increase firm yield by approximately 1,116,000 AFY. Eight reservoirs having greater than 5,000 acre-feet of storage capacity are recommended as water management strategies to meet needs (Figure 8-3):
- Prairie Creek and Marvin Nichols I Reservoirs in the North East Texas Region,
- Lower Bois d'Arc Reservoir in Region C,
- Little River Reservoir in Brazos G Region,
- Allens Creek Reservoir and Bedias Reservoir in Region H,
- Brownsville Weir and Channel Dam in the Rio Grande Region, and
- Lake Eastex in the East Texas Region.

In addition, 10 reservoirs having less than 5,000 acre-feet of storage capacity are recommended as water management strategies to meet needs (Figure 8-3):

- Muenster Reservoir in Region C;
- New Throckmorton Reservoir, Meridian Off-Channel Reservoir, Groesbeck Off-Channel Reservoir, Somervell County Off-Channel Storage Reservoir, and Brushy Creek Reservoir in the Brazos G Region; and
- Llano Off-Channel Reservoir, Goldthwaite On-Channel Dam, Goldthwaite Off-Channel Dam, and Mills County Reservoir in the Lower Colorado Region.

The total capital costs for the 8 major and 10 minor reservoirs is estimated at approximately $3.05 billion.

8.4 Reuse

Reuse of wastewater was recommended as a water management strategy in 10 regions. These recommended strategies would result in 423,268 AFY of additional water supplies by 2050. This estimate compares with current (1999) reuse estimates from 190 utilities located in 115 counties reporting approximately 180,000 AFY of municipal reuse.

8.5 Desalination

Desalination was recommended as a water management strategy in four regions. In the Far West Texas Region and Coastal Bend Region, desalination of brackish groundwater was used as a strategy to provide 66,954 AFY in additional supplies. The desalination of coastal waters was recommended by the South Central Texas Region as a water management strategy to provide an additional 84,012 AFY. Region B included desalination in two recommended water management strategies for a total of 28,808 AFY. Currently in Texas, municipal desalination capacity is 25,750 AFY.

8.6 Brush Control

Brush control was utilized as a recommended strategy in only two regions (Brazos G Region and South Central Texas Region). Because this is a water management strategy that cannot be relied upon to produce reliable water supply during drought conditions, no capital costs or estimates of additional water supply were included in the regional water plans.

8.7 Major Conveyances

In order to deliver water supplies to the areas of need identified and addressed in the regional water plans, several new water conveyance systems will need to be constructed. Although precise determination of conveyance routes is beyond the level of detail required for regional water planning, the general location of the recommended conveyance structures illustrates that most of the water supplies will be conveyed to the larger urban areas of the State (Table 8-1, Figure 8-4).

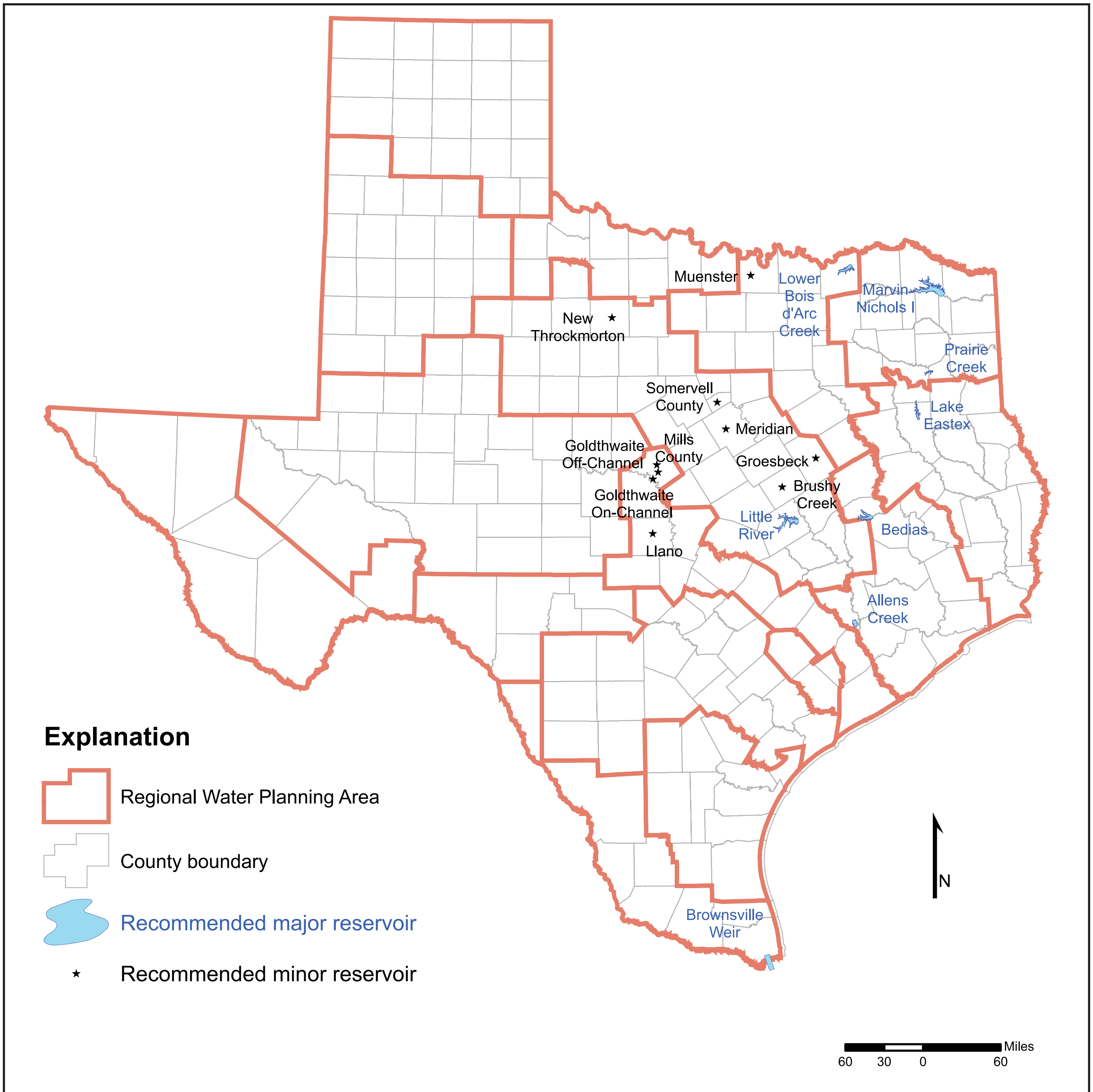


Figure 8-3. Major and minor reservoirs recommended in the regional water plans to meet needs.

Table 8-1. Major water conveyances proposed by Planning Groups.

ID	Conveyance from	To
1	Palo Duro Reservoir	Hansford, Hutchinson, and Moore Counties
2	Lake Diversion	Wichita Falls
3	Marvin Nichols I	Lavon Lake
4	Lavon Lake	Dallas County
5	Lavon Lake	Lewisville Lake
6	Lewisville Lake	Eagle Mountain Lake
7	Eagle Mountain Lake	Benbrook Lake
8	Oklahoma	Eagle Mountain Lake
9	Lower Bois d'Arc Reservoir	North Texas Municipal Water District
10	Lake Texoma	Grayson County Centroid
11	Benbrook Lake	Weatherford
12	Oklahoma	Chapman Lake
13	Lake Palestine	Dallas Water Utilities
14	Lake Fork Reservoir	Dallas Water Utilities
15	Moss Lake	Gainesville
16*	Jeff Davis and Presidio Counties	El Paso County
17*	Hudspeth County	El Paso
18*	Culberson County	Hudspeth County
19	Winkler County	Midland
20	McCulloch County	O.H. Ivie Reservoir
21	Winkler County	Colorado River Municipal Water District
22	Proctor Lake	Stephenville
23	Possum Kingdom Lake	Abilene
24	O.H. Ivie Reservoir	Abilene
25	Lake Graham	Throckmorton
26	Stillhouse Hollow Lake	Lake Georgetown
27	Lake Georgetown	Round Rock
28	Lake Travis	Round Rock
29	Houston	Gulf Coast Water Authority
30	Bedias Reservoir	San Jacinto River Authority
31	Luce Bayou: Trinity River	Lake Houston
32	Sam Rayburn Reservoir	Lufkin
33	Toledo Bend Reservoir	Rusk and Gregg Counties
34	Lake Eastex Reservoir	Cherokee County
35	Lake Eastex	Smith and Rusk Counties
36	Canyon Lake	Blanco, Wimberley, and Woodcreek
37	Lake Travis	Hays County
38	City of Austin	Hays County
39	Lower Guadalupe River	Bexar County
40	Lower Colorado River (Matagorda County)	Bexar County
41	Canyon Lake	Bexar and Comal Counties
42	Canyon Lake	Kendall County
43	Milam, Lee, and Bastrop Counties	Bexar County
44	Bastrop and Gonzales Counties	Comal and Guadalupe Counties
45	Gonzales and Wilson Counties	Bexar County
46	Gonzales County	Seguin and Schertz
47	Colorado River	Lake Texana
48	Canyon Lake	Hays County
49	Cedar Creek/Richland-Chambers System	Tarrant Regional Water District
50	City of Alice	Duval County
51	Lake Alan Henry	Lubbock
52	Lower Colorado River (Bastrop County)	Hays County
53	San Antonio Bay (Calhoun County)	Bexar County

* The Far West Texas Planning Group approved these strategies on the condition that they be studied further before they are fully implemented.

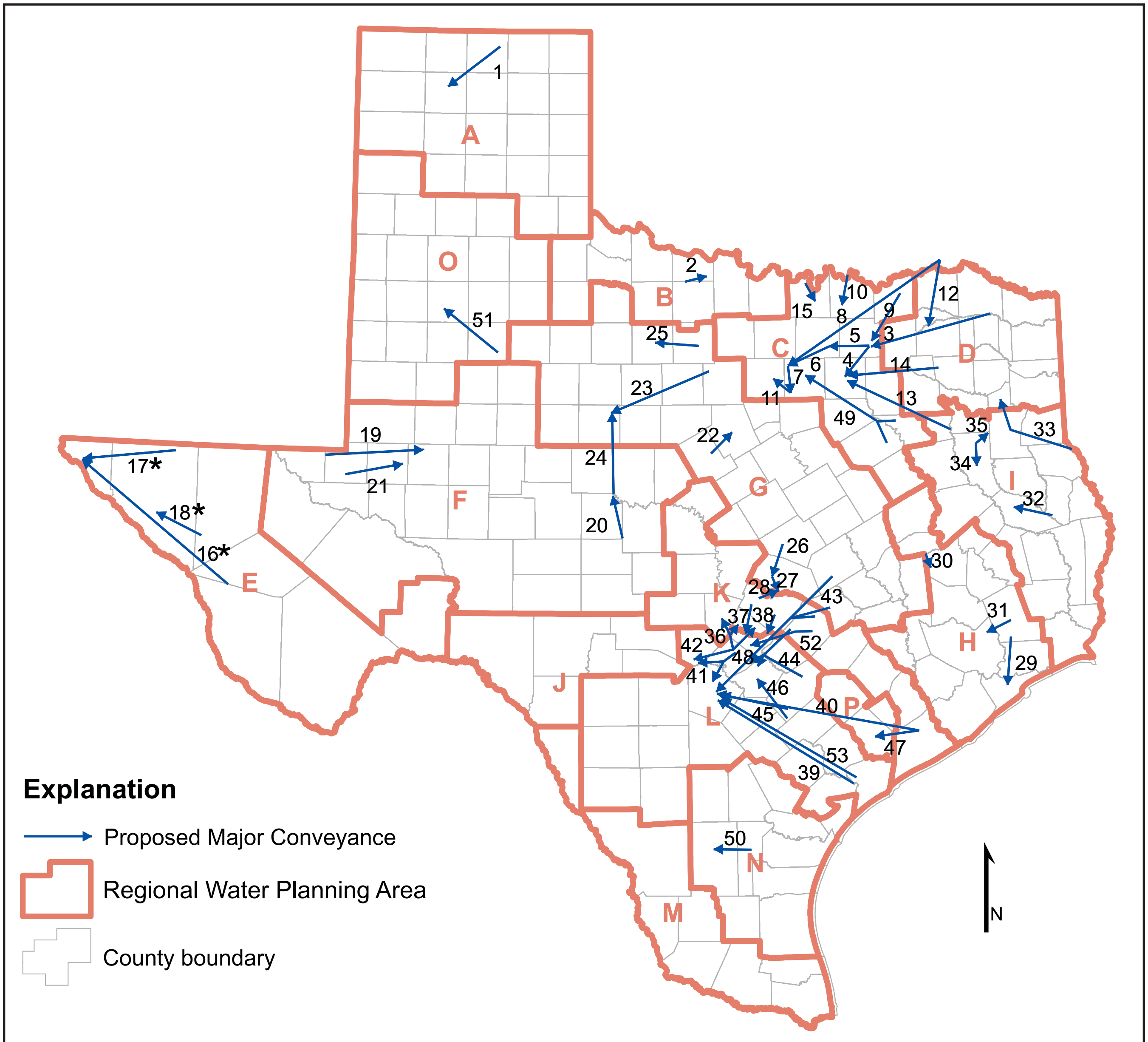


Figure 8-4. Major water conveyances proposed by Planning Groups.

9.0 Implementation Cost Estimates 2001–2050

Key Finding Total capital costs of implementing all of the water management strategies included in the 16 regional water plans are approximately $17.9 billion. Total capital costs of water supply, water infrastructure, wastewater treatment, and flood control through 2050 in Texas are now estimated at approximately $108.6 billion.

One of the most commonly asked questions regarding water planning efforts such as the regional water planning mandated by Senate Bill 1 is "How much is it going to cost to satisfy the various components for water required by all Texans as we move into the future?" Providing data related to the cost of water, both to policy makers and water utilities providers, in a timely and accurate manner is critical to ensuring future water supplies— especially in Texas, where growth rates are significant.

Because many of the major water projects could require as much as several decades to implement, those responsible for providing water-related services need as much time as possible to implement the plans. In Texas, efforts to develop estimates of the costs of water have been divided into four categories:

- water supply (including costs of major conveyances to points of distribution),
- water infrastructure (distribution within cities),
- wastewater treatment, and
- flood control.

The capital costs estimated for water supply projects are the total of capital costs included in the 16 regional water plans. The TWDB included specific guidelines regarding the process to be used during the development of these estimates.

Estimates of capital costs for water infrastructure are developed using the Drinking Water Needs Survey, a statistical sample of water systems in each state that is developed pursuant to the Safe Drinking Water Act. Identified water system needs are modeled, or extrapolated, from the sample survey to produce statewide estimates. The Drinking Water Needs Survey focuses on community water systems. Identified needs cover all aspects of water acquisition, storage, treatment, and distribution as they relate to the provisions and requirements of the Safe Drinking Water Act. Dams and reservoirs, water rights, and projects proposed purely for anticipated population growth are not included. Many projects that are ostensibly for growth have aspects that serve current population and are thus allowable. The latest survey (the 1999 Survey) was presented to Congress in February 2001.

Estimates of capital costs for wastewater facilities in Texas are developed using the Clean Water Needs Survey— a census of publicly owned wastewater treatment works that are usually termed *facilities*. Categories of need include treatment, collection-system rehabilitation, new collection systems, and major interceptor sewers. Many of the capital costs for wastewater facilities are for replacement, not just needs related to growth. The last survey was performed in 1996. The 2000 CWNS is under way, with results to be presented to Congress in 2002.

The 1997 State Water Plan estimated that total capital costs for meeting the needs of Texas through 2050 for water-related service needs were more than $65 billion. Of this total, $4.697 billion, or approximately 7 percent of the total capital costs, was estimated for major water supply projects through 2050 (Table 9-1).

Table 9-1. Capital costs of water-related services included in the 1997 State Water Plan.

Category	**1997 State Water Plan, total capital costs 2000-2050 (in billions)**
Water Supply	$ 4.697
Water Infrastructure	32.454
Wastewater	26.043
Flood Control	2.200
Total	$65.394

Current estimates of total capital costs to meet water-related service needs through 2050 have increased to $108.6 billion. Capital costs of water supply projects identified by the Planning Groups are estimated to be $17.9 billion, almost 16 percent of the total capital costs of all water-related service needs through 2050 (Table 9-2, Figure 9-1). Of the 16 Planning Groups, Region H, Region C, and the South Central Texas Region have the highest capital costs for all water-related service needs, accounting for approximately $66.0 billion of the $108.6 billion through 2050, almost 61 percent of the total for all water-related service projects Statewide (Figure 9-2). The South Central Texas Region has the highest capital costs per capita for water supply needs, estimated at just over $1,000 per capita in 2050 (Figure 9-3). However, because of the unique circumstances related to the current uncertainty regarding quantity of water supply available from the Edwards aquifer, direct comparison between capital costs per capita in the South Central Texas Region and other regions in the State may not be uniform.

Table 9-2. Capital costs of water-related services included in the 2002 State Water Plan.

Category	**2002 State Water Plan total capital costs 2000-2050 (in billions)**
Water Supply	$ 17.868
Water Infrastructure	41.672
Wastewater	46.983
Flood Control	2.100
Total	$108.623

The significant increase in capital costs for the categories listed is a function of several factors. The most important factor is better data resulting from both State (Senate Bill 1) and Federal initiatives. The identification and evaluation of all contributing factors will require in-depth analysis to fully understand the significant increase in capital costs of water supply projects included in the 2002 State Water Plan as compared with those in the 1997 State Water Plan.

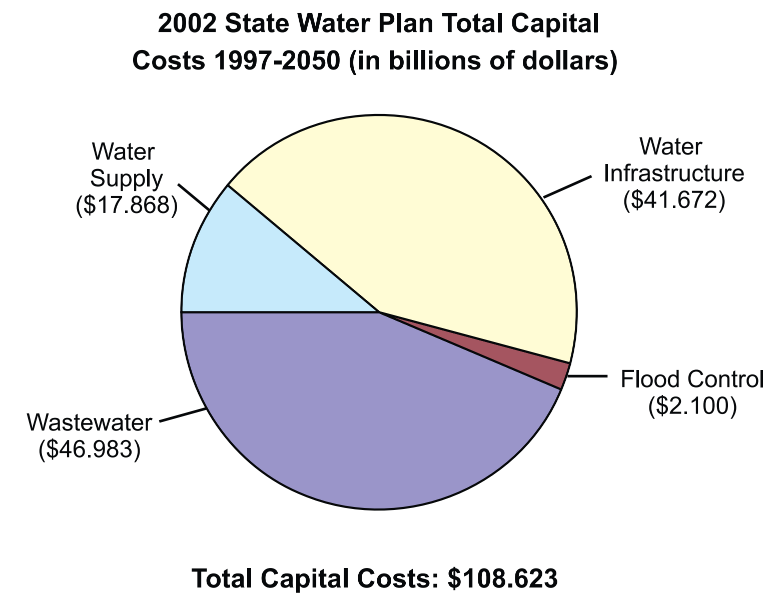


Figure 9-1. Relative proportion of estimated capital costs to meet water-related needs for Texas through 2050.

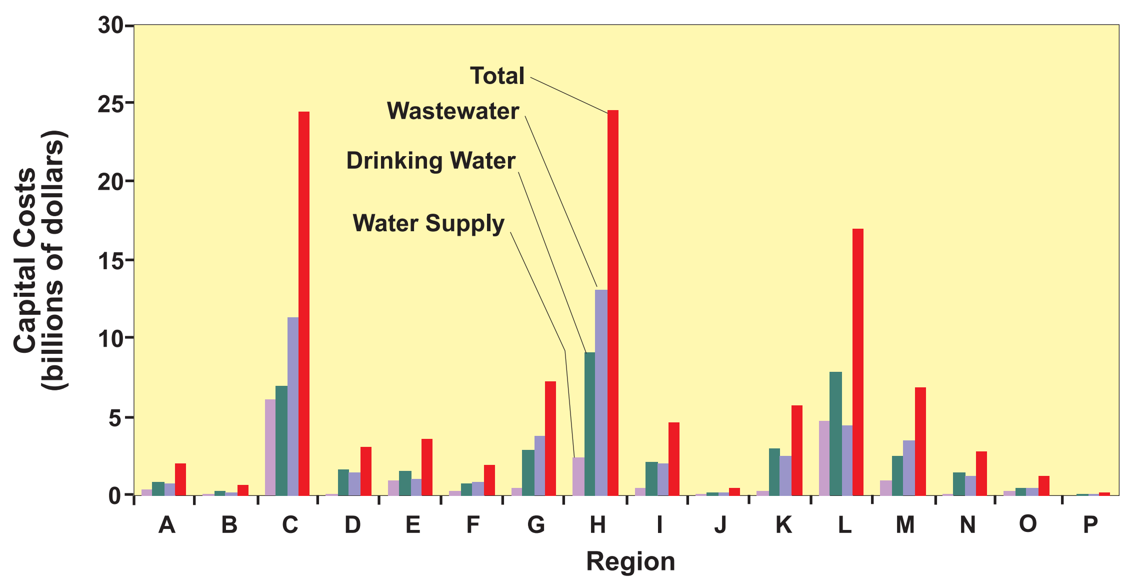


Figure 9-2. Through 2050, capital costs of (1) water supply, (2) drinking water (infrastructure), (3) wastewater, and (4) total capital costs, for the 16 planning areas.

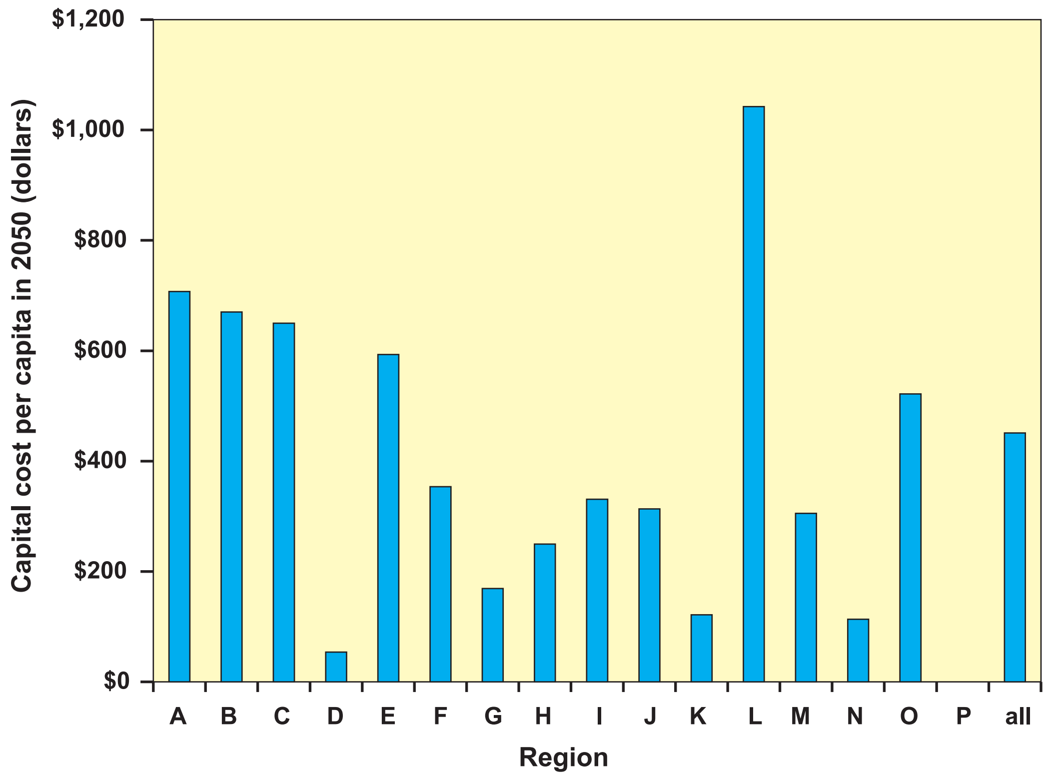


Figure 9-3. Capital costs on a per capita basis comparing projected population in 2050 and total capital costs through 2050.

10.0 Alternative Strategies

The following section is proposed in conformance with Texas Water Code §16.051(e) and with the goal of providing suggestions to the Planning Groups and the Legislature for further review.

The TWDB proposes a few alternative water management strategies for the Planning Groups to consider in the next round of planning. These alternative water management strategies include using water from East Texas, playa modification on the High Plains, and desalination in the Far West Texas Region. In addition to these three strategies, the TWDB encourages the Planning Groups to continue to explore opportunities for voluntary transfers of both surface water and groundwater to best meet the needs of Texas.

10.1 Voluntary East Texas Surface Water Transfers

By 2050, much of Region H, including the San Jacinto River Authority, the Gulf Coast Water Authority, and the Brazos River Authority, and parts of the Brazos G Region, primarily Williamson County and the Brazos River Authority, will need additional water supplies to meet needs. New reservoir development has been investigated as a strategy to meet the future needs of the Brazos G Region and Region H. However, as with most new reservoir development, opposition from various interest groups and landowners, as well as the need to procure State and Federal permits for construction and impoundment, may compel the Planning Groups to consider possible alternatives to new reservoir development to meet future water supply needs.

One alternative is to use part of the uncommitted water in the East Texas Region, which is beyond the amount needed to sustain the region's activities for the foreseeable future. Uncommitted water is defined as water that is not permitted by TNRCC, not committed by contract (including contracts that may reasonably be expected to be renewed), or not currently identified as necessary to meet a need as part of a strategy in a regional water plan. Possible sources of uncommitted water in the East Texas Region include the Lower Neches Valley Authority, the Sabine River Authority, the proposed Lake Eastex, and other sources that the Planning Groups may propose.

Any proposal should be crafted to benefit the East Texas Region economically. It should be designed to provide water to potential water user groups locally and within the region. It may be a more environmentally sound method of meeting growing demands.

The TWDB suggests that the Brazos G Region, Region H, and the East Texas Region jointly conduct additional studies to evaluate this strategy thoroughly to determine whether it is a viable option for meeting additional water supply needs. This evaluation should include appropriate methods for compensating the East Texas Region for any voluntary transfer of surface water.

The TWDB recommends that this water management strategy be considered as part of a voluntary negotiation between regions with the goal of creating positive outcomes for all. For example, the plans should ensure that East Texas' goals for the environment, timing of the transfer of water, and financing of important East Texas infrastructure needs are achieved.

10.2 Playa Modification

The Ogallala aquifer is recharged primarily through infiltration from playa lakes. Recharge characteristics of the approximately 20,000 playas located on the High Plains of Texas vary widely. Some playas, for example, do not hold water for significant periods of time after precipitation events illustrate features that naturally recharge the aquifer. Playas that hold water during both wet and dry periods produce very little, if any, recharge to the Ogallala aquifer. However, these playas often represent important wetland habitat. In between these two examples are playas that hold water only during wet periods but probably lose much of the surface water collected through evaporation. These are the playas that are likely candidates for modification to increase recharge to the Ogallala aquifer and extend the usefulness of this valuable natural resource.

Playa modification would supplement the benefits of precipitation enhancement and greatly increase recharge to the Ogallala aquifer. Experiments in the early 1970's showed that recharge rates from 0.5 to 4 feet per day were achievable in scenarios in which recharge basins were dug in or near playa lakes. In 2000, the TWDB completed a study that showed that an unmodified impoundment reservoir on Running Water Draw had a recharge rate of 0.5 inches per day. Because of an accumulation of silt and clay that seals the playa floor, not all playa lakes recharge the aquifer. Modifying the playa floor by removing the silt and clay can increase the leakage of ponded water into the aquifer. Playa modification increases the value of precipitation enhancement by allowing more of the increased rainfall to be recharged to the Ogallala aquifer.

With support from the 2001 Texas Legislature, the TWDB has started a project called the "High Plains Playa-Classification Initiative" to catalog playas in the High Plains area. Part of this work will be to delineate playas that may meet Federal wetland classification guidelines as wetland playas and to identify playas for possible modification. If these wetland playas can be clearly identified, greater efforts can then be made to maintain their viability in the High Plains ecosystem.

The TWDB recommends that the Panhandle and Llano Estacado Regions consider playa modification as a possible water management strategy during the next phase of regional water planning. Additional study is needed to develop more rigorous estimates of benefits and costs and to investigate how to minimize impacts to wetlands and the environment.

10.3 Additional Desalination

Whereas water management strategies in the Far West Texas Regional Water Plan evaluated the most feasible possibilities for additional supplies, including desalination of brackish water, the TWDB is recommending that the region consider additional desalination to meet needs not currently met in the plan. There are two sources of water for this additional desalination, the alluvium along the floodplain of the Rio Grande and brackish waters found in Hueco Bolson deposits. The alluvium, located between Interstate Highway 10 and the Rio Grande, contains large quantities of brackish groundwater (about 3,000 mg/L) at shallow depths. In fact, this groundwater is close enough to the land surface to seep into excavations for utility work and may cause problems. Although brackish water in the Hueco Bolson is less brackish (about 1,500 mg/L), it occurs much deeper below land surface.

The alluvial brackish-water resource could be tapped by a series of shallow wells and treated at reverse-osmosis plants sited in the Ysleta and Clint areas. Each of these plants would be able to produce more than 10 million gallons per day of freshwater from a series of wells arranged in such a way as to cause uniform lowering of the water table. As an added bonus, because of lower water tables in the area, utility work would no longer require that water be pumped from utility excavations. Water produced from the Hueco Bolson could also be treated at a series of reverse-osmosis plants sited to best address demand.

These scenarios are based, in part, on continued innovation by El Paso to meet needs for additional water supply. For example, work conducted by the Engineering Department at The University of Texas at El Paso at the Solar Pond research site is very promising for maximizing water production and brine disposal.

The TWDB believes that the Far West Texas Region, in addition to traditional groundwater development, should consider desalting of groundwater from the Rio Grande alluvium and Hueco Bolson aquifers. The TWDB also believes that solar pond technology should be further researched as a process to maximize water production and brine disposal.

11.0 Regional Summaries

Summary of Panhandle Region

The Planning Group identified water supply needs for 44 out of 128 water user groups in the region. The total needs by 2050 are about 777,400 AFY. There are 23 urban and rural municipalities that have needs in the planning area in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $390.4 million, including $307 million for municipal strategies. Irrigation strategies include precipitation enhancement, the North Plains evapotranspiration (NPET) network for scheduling irrigation, installation of low energy precision application (LEPA) equipment, changes in crop variety, implementation of conservation tillage methods, and conversion from irrigated agriculture to dry-land agriculture at a cost of $29.2 million. Livestock user groups propose to develop additional groundwater and to enhance precipitation to meet their needs at a cost of about $33.1 million. Manufacturing proposes to use additional Ogallala groundwater and the Palo Duro Reservoir at a total cost of $10.1 million. Mining will draw from the Dockum aquifer at a cost of about $1.4 million. Power generation proposes to use groundwater and effluent reuse at a cost of about $10 million.

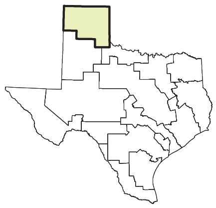
The plan proposes that all municipal needs occurring by 2050 will be met. The cities of Cactus, Dumas, and Sunray will share in building a transmission system from Palo Duro Reservoir to meet their future needs. All remaining municipal water user groups will depend on the Ogallala aquifer as a supply source for future water needs. Amarillo has selected a strategy to augment its supplies with Roberts County groundwater by 2025. Five of the water user groups will have unmet needs in 2050 of about 488,200 AFY for irrigation.

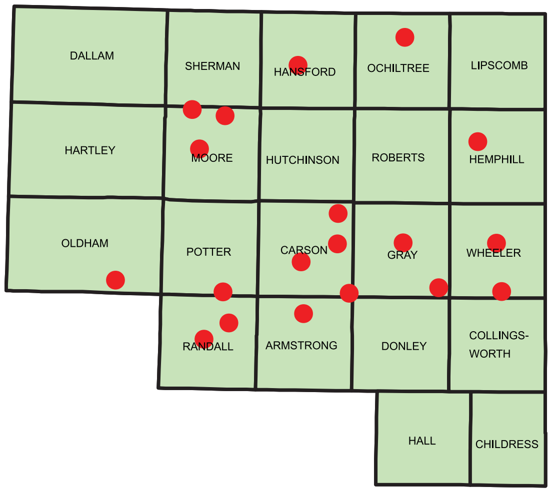
No new reservoirs are proposed for meeting future water needs in the planning area. The Planning Group has included a recommendation that a previously identified potential reservoir, Sweetwater Creek Reservoir, be eligible to receive funding to conduct feasibility studies for evaluating the potential yield.

A groundwater conservation goal (that 50 percent of the 1998 saturated thickness of the Ogallala aquifer would be remaining in 50 years) was adopted for the region. The Planning Group was firmly committed to ensuring that its activities were open and accessible to all interested parties. Several public information meetings featured the use of an interactive video-teleconferencing system that allowed interested parties to participate from their choice of as many as four locations.

The Planning Group received preliminary ideas on several water-transfer concepts. None of these transfer concepts was included in the regional plan because none was considered a preferred water management strategy. The Planning Group expects to study and evaluate several water-transfer concepts during the next planning cycle.

(A) Panhandle Region



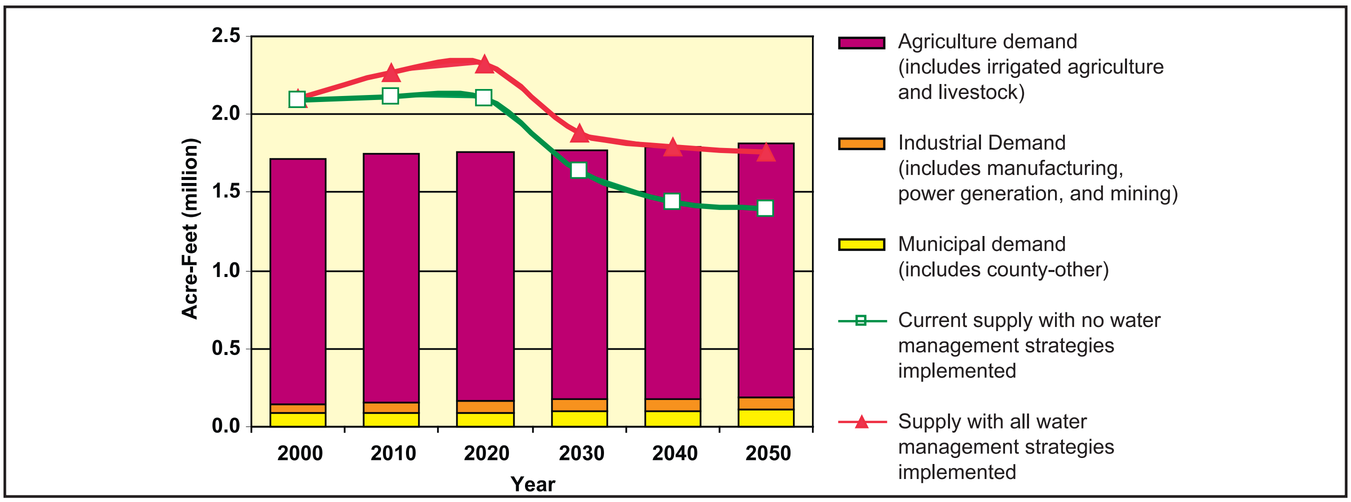


Cities with needs based on comparison of current water supplies with projected demands.

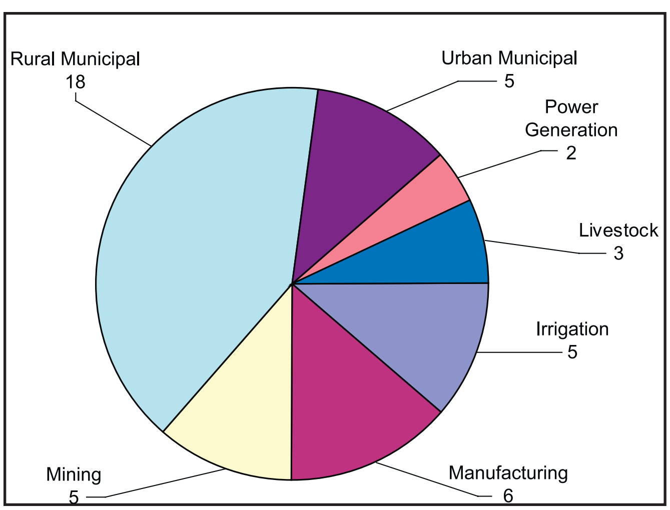
Key Points

- **Total capital cost: $390 million**
- No new reservoirs
- Strategies to meet all municipal needs occurring by 2050
- 44 water user groups with projected water needs by 2050
- Has goal of 50 percent of current groundwater supplies remaining in 50 years
- Significant public participation in planning process
- Potential water-transfer projects to be evaluated on individual basis as presented to the Planning Group

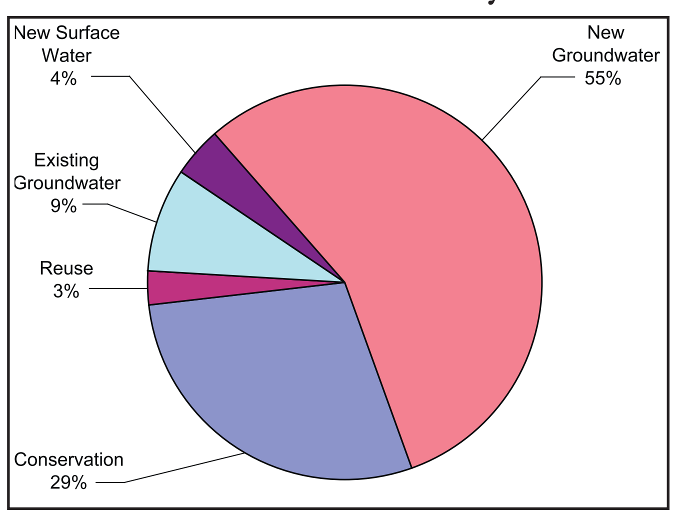
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Region B

The Planning Group identified water supply needs for 4 out of 68 water user groups in the region. The total needs by 2050 are about 20,669 AFY. There are 2 urban and rural municipalities with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $145.3 million. Major projects consist of treatment of water from Lake Kemp/Diversion Reservoirs ($60.6 million) for the City of Wichita Falls, groundwater from Round Timber Ranch Well Field ($3.8 million) for the City of Vernon and entities served by Vernon, the Hinds-Wildcat Pipeline ($648,000), an ion-exchange system for Lockett ($510,000), and the River Well Field for the City of Electra ($2.4 million). Although not used as a strategy to meet a specific need, the Chloride Control Project ($77.5 million) to improve water quality in Pease and Wichita Rivers before they reach Red River is recommended as a regional water supply management strategy.

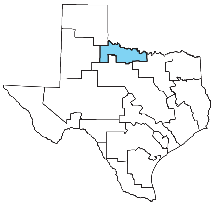
Unless water quality standards prevent use of some currently available supplies, all municipal water user groups are expected to have water supplies sufficient to meet drought-of-record conditions if one or a combination of recommended strategies is implemented. There are no unmet needs in 2050.

The City of Electra is projected to have a need of 51 to 65 AFY during the 2000 to 2050 period. The recommended strategy is to reopen River Well Field existing wells and install a reverse-osmosis treatment unit at the River plant. Round Timber Ranch Well Field is the recommended strategy for supplying the projected needs (91 AFY in 2050) of the City of Vernon and several small systems served by the City of Vernon. The water need for manufacturing in Wilbarger County is projected to be 521 AFY in 2050. Because the City of Vernon provides almost all of this water, the strategy for this need is included in Vernon's use of Round Timber Ranch Well Field.

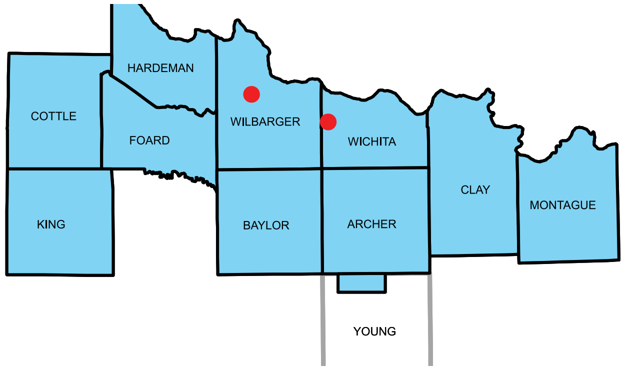
Although the firm yields of Kickapoo and Arrowhead Lakes are sufficient to meet the demands of the City of Wichita Falls, the city developed a safe yield estimate showing that the city could need about 20,000 AFY. To meet this potential need, the City of Wichita Falls has selected a preferred strategy of treating poor-quality water from Lake Kemp.

In the early 1980's the City of Wichita Falls identified a potential reservoir site near the Town of Ringgold. The Planning Group evaluated this strategy, which has a projected capital cost of $287 million; however, neither this strategy nor any other new reservoir was included as a recommended strategy.

Three major concerns that need to be addressed are (1) 13 groundwater-supplied water systems in Region B are not compliant with Primary Drinking Water Quality Standards, (2) Lake Arrowhead may contain arsenic levels above the allowed limit, and (3) salinity in Lake Kemp and Diversion Lake.



(B) Region B

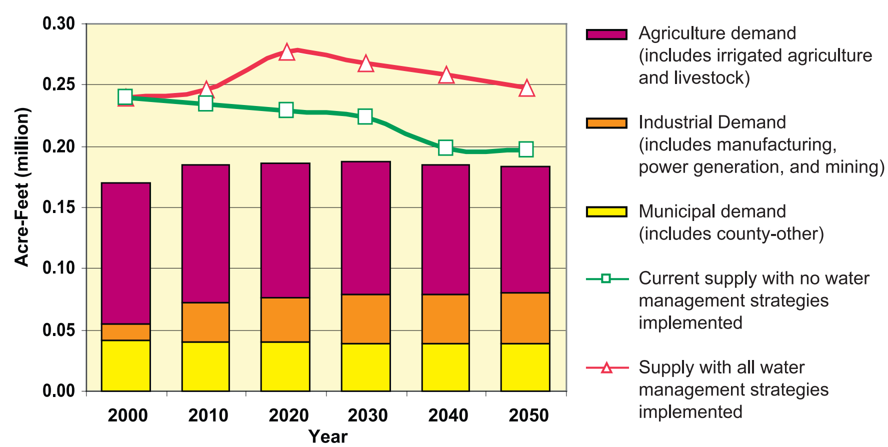


● Cities with needs based on comparison of current water supplies with projected demands.

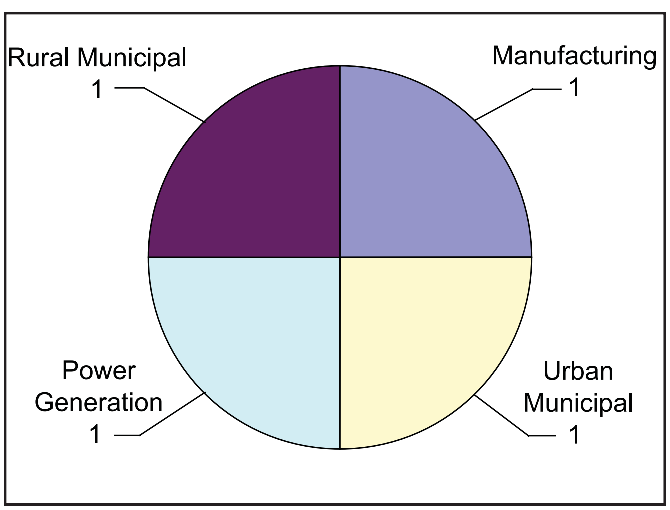
Key Points

- **Total capital cost: $145 million**
- No new reservoirs
- Strategies to meet all municipal needs occurring by 2050
- Four water user groups with projected water needs by 2050
- Chloride Control Project on the Wichita River is a regional priority
- Concern about cost of current and proposed requirements for mandatory treatment of water supplies, specifically nitrates

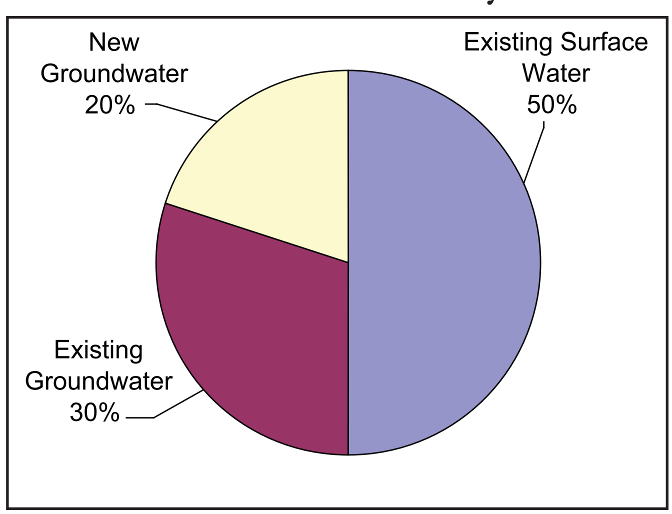
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Region C

The Planning Group identified water supply needs for 195 out of 270 water user groups in the region. The total needs by 2050 are about 1,203,947 AFY. There are 165 urban and rural municipalities and 4 irrigation and livestock user groups with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $6.16 billion. Selected examples of costs include Marvin Nichols I Reservoir ($1,625,190,000), Lake Fork Connection ($288,000,000), Trinity River reuse ($75,168,000), Lower Bois d'Arc Creek Lake/transmission system for North Texas Municipal Water District ($167,324,000), Ellis County water project ($65,945,000), Cooke County water supply project ($26,785,000), Denton County Water Treatment Plant expansions and related costs for Upper Trinity Regional Water District ($479,157,000), Fannin County water system ($52,358,000), Grayson County surface water supply system ($94,316,000), reuse of Garland wastewater in Kaufman County ($18,497,000), treated water delivery lines from Weatherford ($7,164,000), and new groundwater wells in Wise County ($544,000).

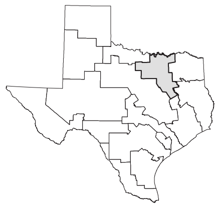
Most water supplied in Region C is provided by five major water providers in the region: Dallas Water Utilities, Tarrant Regional Water District, North Texas Municipal Water District, Fort Worth Utilities, and Trinity River Authority. Consequently, most municipal needs will be met by one of these providers. The only unmet needs in 2050 are about 6,300 AFY for municipal.

Within Region C, Lower Bois d'Arc Creek Reservoir is proposed in Fannin County, with an estimated yield of 123,000 AFY. Additionally, Muenster Reservoir is proposed in Cooke County. This proposal would be an impoundment of 4,700 AFY, with a diversion of 500 AFY.

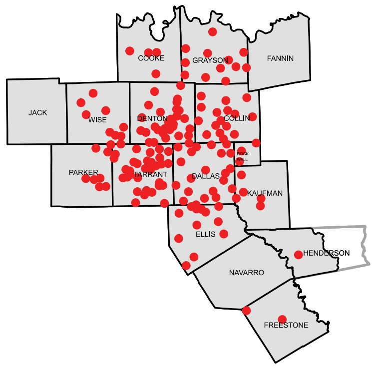
Significant regional needs result primarily from a large and expanding population base. In 1998, the region included 38 communities having 20,000 or more in population. The region has 12 of the 20 fastest growing communities in Texas. Judging from census figures released after plan adoption, regional population appears to be growing even more rapidly than anticipated.

Although some expansion of supply can occur within the region, the Planning Group also considered other areas for future supplies. Region C and the North East Texas Region formed the Sulphur River Task Group to address issues of importance to both regions. The Marvin Nichols I Reservoir was proposed, which will be located on the Sulphur River primarily in Red River and Titus Counties in the North East Texas Region. Eighty percent of the estimated yield of this reservoir would be conveyed to Region C.

Oklahoma water is recommended as a water management strategy for the North Texas Municipal Water District and Tarrant Regional Water District. Several entities in the region have been engaged in negotiations to purchase water from Oklahoma.



(C) Region C

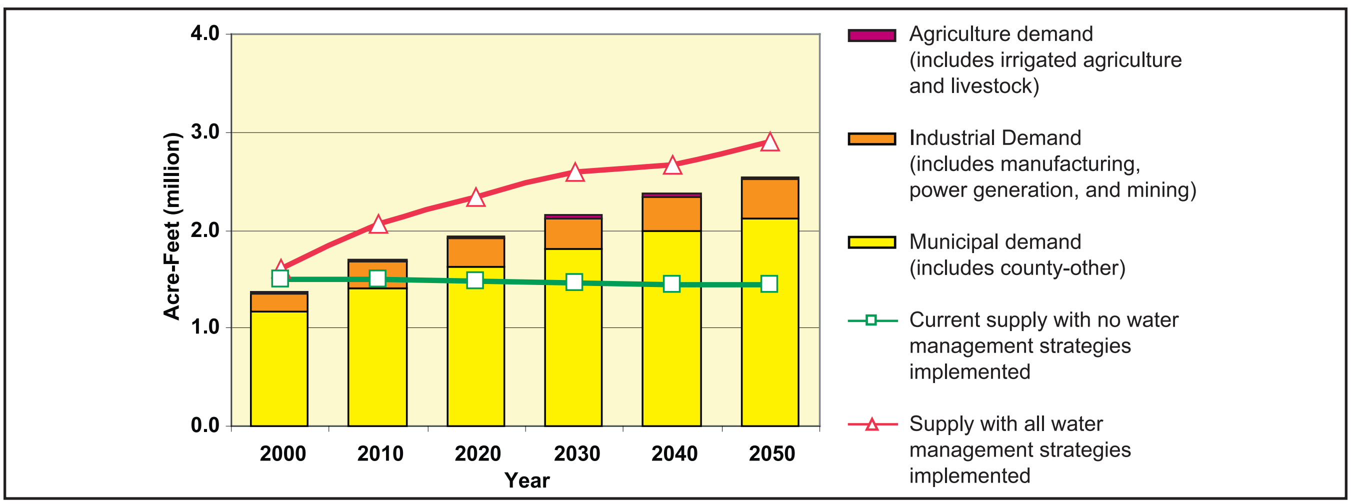


● Cities with needs based on comparison of current water supplies with projected demands.

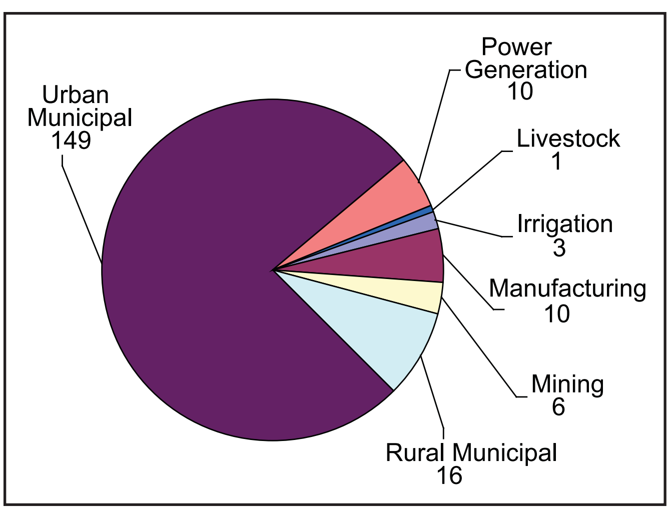
Key Points

- **Total capital cost: $6,161 million**
- One new major reservoir to meet needs
- 195 water user groups with projected water needs by 2050
- Includes 12 of the 20 fastest-growing communities in Texas
- Significant cooperation to obtain additional Region D water

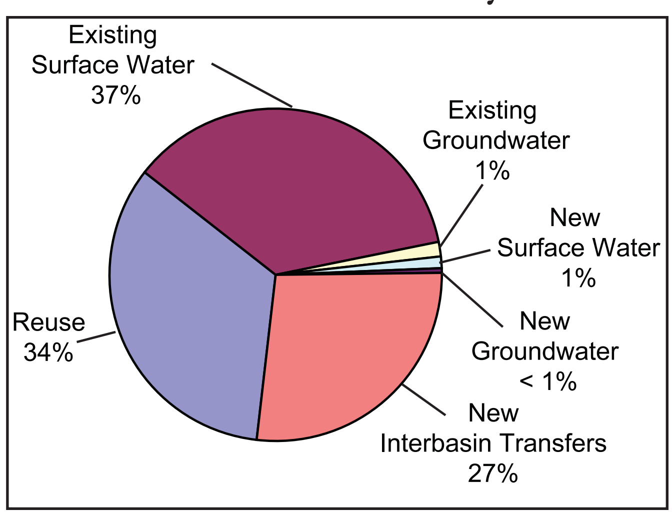
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of North East Texas Region

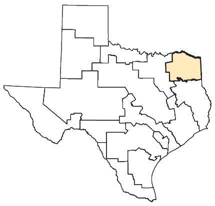
The Planning Group identified water supply needs for 66 out of 167 water user groups in the region. The total needs by 2050 are about 122,009 AFY. There are 59 urban and rural municipalities with needs in 2050.

The North East Texas Planning Group recommended that the Marvin Nichols I Reservoir site be developed to provide future water supply for water users within both the North East Texas Region and Region C. The Planning Group also recommended Prairie Creek Reservoir as a water management strategy, consistent with a recommendation, contained in the *Comprehensive Sabine Watershed Management Plan,* that the Sabine River Authority develop the reservoir. Prairie Creek Reservoir, as recommended, would yield an estimated 17,215 AFY. However, plans call for increasing the project yield by diversions from the Sabine River and/or a pipeline from Toledo Bend Reservoir.

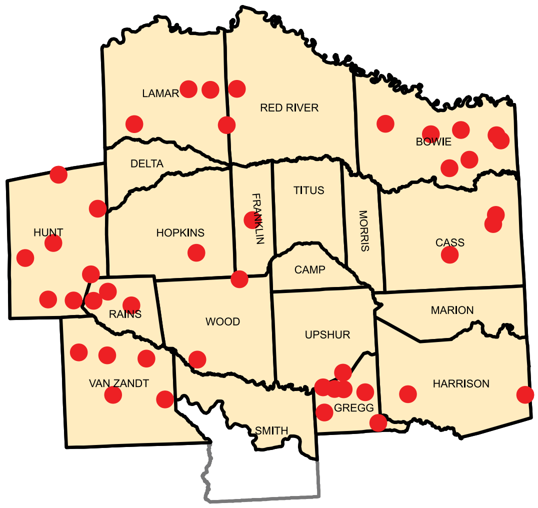
Estimated capital costs of recommended water management strategies to meet needs over the 50-year planning horizon are $55.0 million. Selected projects and costs include Prairie Creek Reservoir ($29,032,200), West Gregg Water Supply Corporation wells ($1,337,993), Harleton Water Supply Corporation surface water supply ($2,890,805), Star Mountain Water Supply Corporation wells ($2,192,735), and Lake Fork Water Supply Corporation wells ($1,504,665). To address many of the needs identified in the plan, no additional capital improvements will be required. Renewal of water supply contracts will be sufficient to ensure an adequate supply during the planning period. There are unmet needs in 2050 of about 26,100 AFY for manufacturing, 7,500 for steam-electric power, and 22,900 AFY for municipal.

The North East Texas Planning Group examined needs of smaller communities in detail because much of the regional population is rural. Within the region there are eight cities with populations of more than 10,000, whereas total regional population is about 687,000. The regional water plan addresses water supply needs of many districts, water supply corporations, and other communities that were too small to be defined as water user groups. One challenge now faced by the region is how to finance the improvements necessary to meet the needs of the rural population.

Region C and the North East Texas Region formed the Sulphur River Task Group to address issues of importance to both regions. The Task Group included representatives from each region.



(D) North East Texas Region

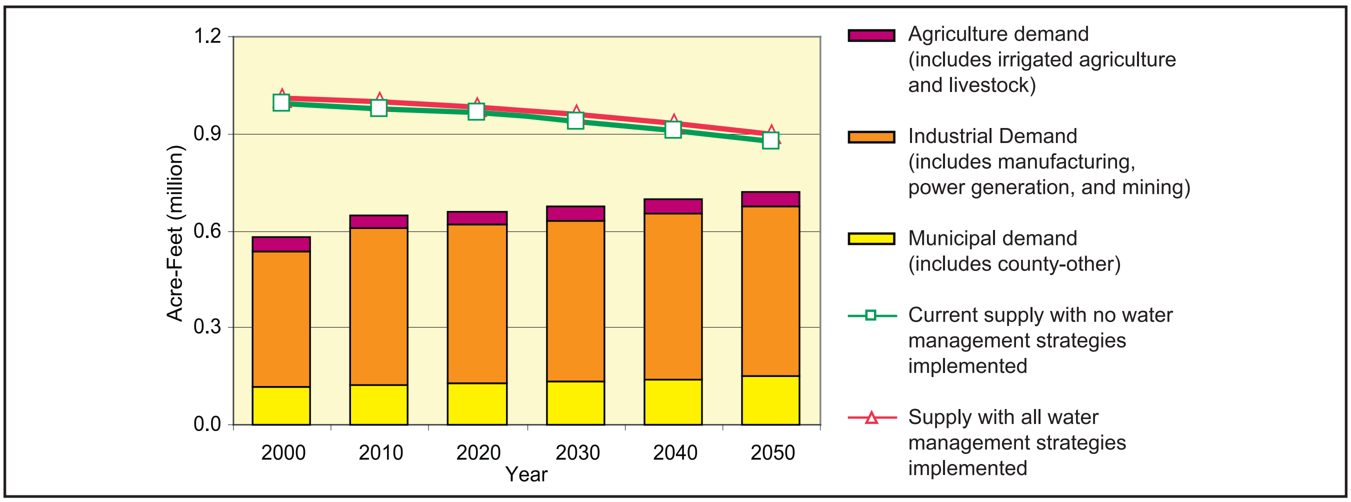


● Cities with needs based on comparison of current water supplies with projected demands.

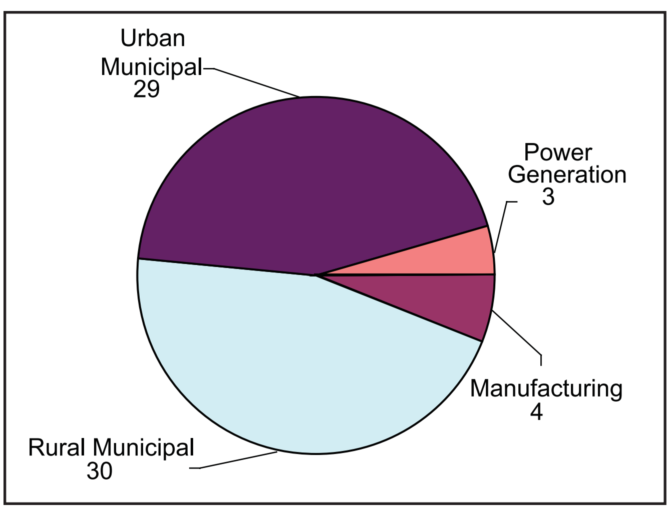
Key Points

- **Total capital cost: $55 million**
- Two new major reservoirs
- 66 water user groups with projected water needs by 2050
- Largely rural, creating a challenge to provide affordable water to many small communities
- Cooperating with and exporting water to Region C

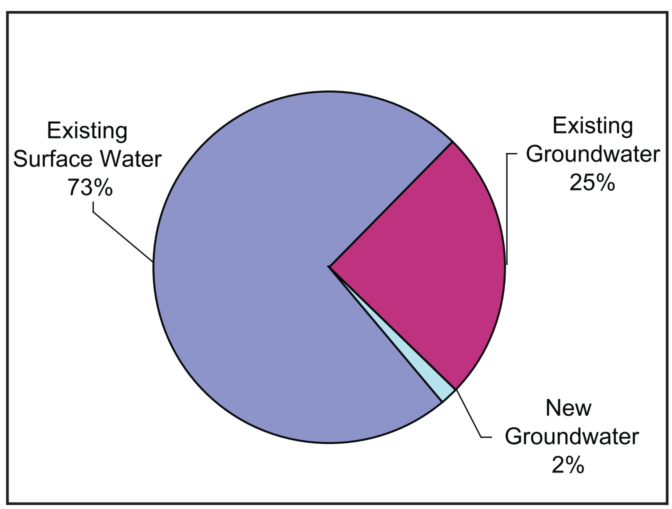
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Far West Texas Region

The Planning Group identified water supply needs for 23 out of 51 water user groups in the region. The total needs by 2050 are about 417,260 AFY. There are 16 urban and rural municipalities and 3 irrigation and livestock user groups with needs in 2050. The City of El Paso and entities supplied by El Paso are projected to have unmet needs after 2030.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $941.5 million. Major projects include $22 million for additional wells or increased use of groundwater, $83 million for wastewater reuse, $52 million for desalination, and $716 million for the long distance transport of groundwater from rural counties to El Paso.

County-other unmet needs (27,911 AFY in 2050) are projected for all counties except Culberson. Irrigation unmet needs of 146,361 AFY in 2050 arise from the limited availability of water in the Rio Grande during drought conditions. In El Paso County, unmet needs of 2,000 AFY in 2050 for steam-electric power generation, 20,332 AFY in 2050 for manufacturing, and 3 AFY in 2030 for mining are recommended to be met by purchases from the City of El Paso. Livestock unmet needs of 78 AFY in 2050 are projected in El Paso and Jeff Davis Counties.

The Planning Group recommended a combination of strategies, including additional surface water obtained from conservation savings in irrigation, purchase of irrigation rights, reuse, desalination, and purchase and use of groundwater from outside El Paso County. Expanded use of local groundwater is intended as a drought contingency supply. Even with these strategies, there is a projected total unmet need for municipal supplies of about 66,393 AFY in 2050. It is important to note that the Planning Group continues to evaluate water management strategies for the El Paso County area in an effort to meet all needs throughout the 50-year planning horizon.

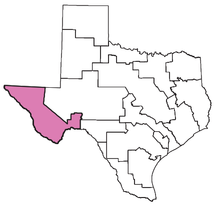
The Planning Group proposed no new reservoirs. The only potential location for a new reservoir would be on the Rio Grande, but the river's yield is fully committed and regulated by interstate and international treaties.

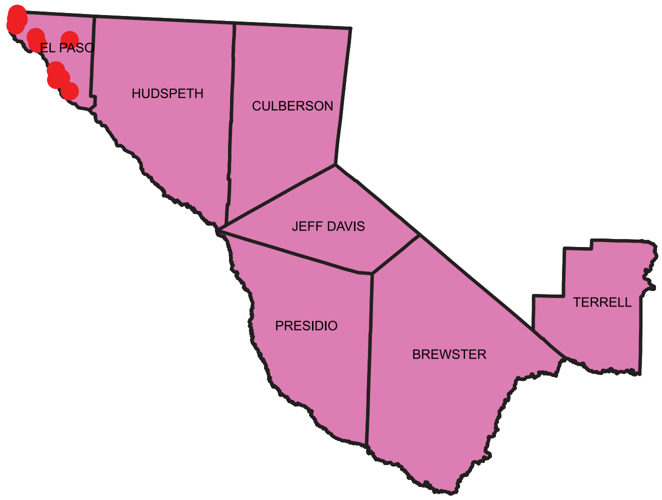
In El Paso County, reliance on local groundwater could cause the Hueco-Mesilla Bolson aquifer to become depleted of freshwater by 2030. If possible, the City of El Paso would like to reserve use of this aquifer to times of drought, when surface water is unavailable. In El Paso County during drought-of-record conditions, the Rio Grande is expected to have insufficient flow for demands.

Desalination of significant reserves of brackish groundwater was evaluated and is a potential future source of water supply if current technology issues are resolved.

Groundwater transfer from rural counties to El Paso is a potential strategy; however, the costs and impacts on local groundwater supplies will need to be examined in more detail.

(E) Far West Texas Region



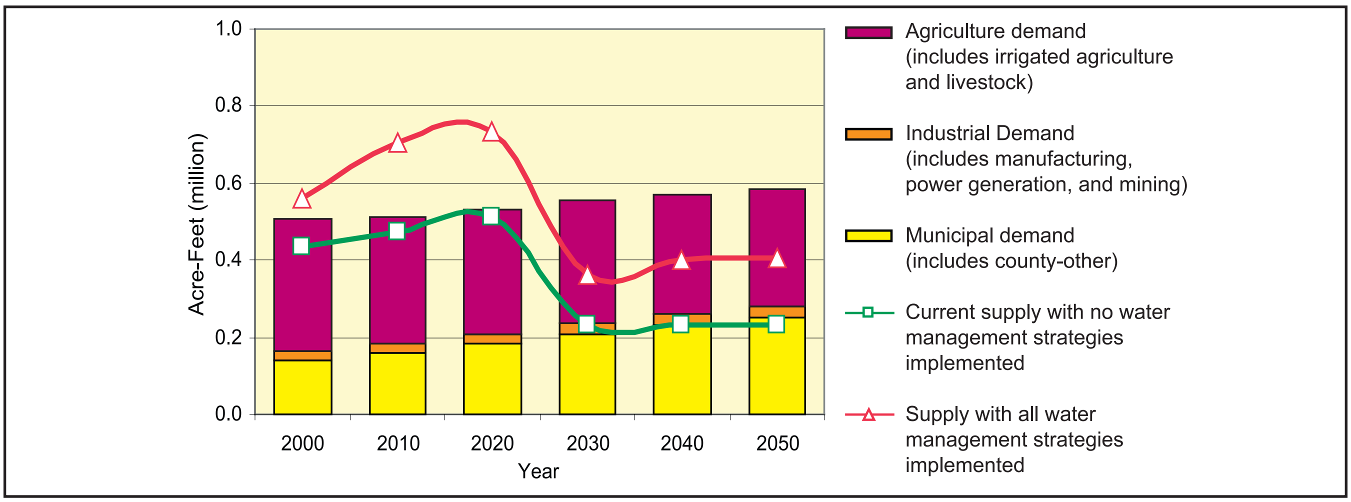


● Cities with needs based on comparison of current water supplies with projected demands.

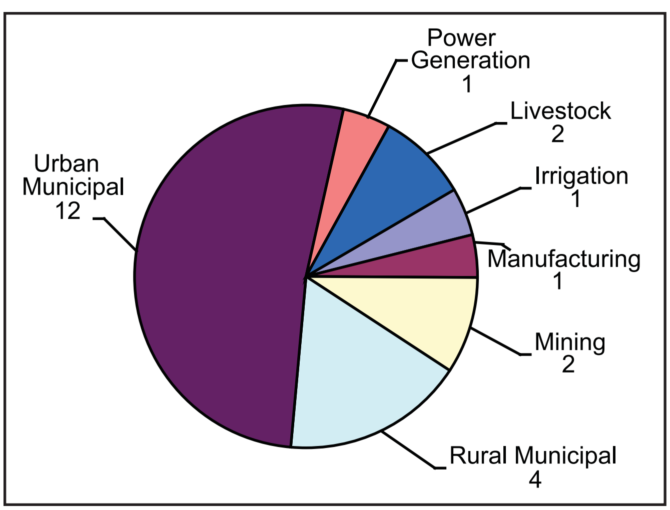
Key Points

- **Total capital cost: $942 million**
- No new reservoirs
- Eight cities with unmet needs by 2050
- 23 water user groups with projected water needs by 2050
- Fresh groundwater supplies available to El Paso probably depleted by 2030
- Rio Grande water unavailable during drought-of-record
- Desalination of groundwater increasingly important to El Paso
- Impacts of groundwater transfers from rural counties to be examined in more detail

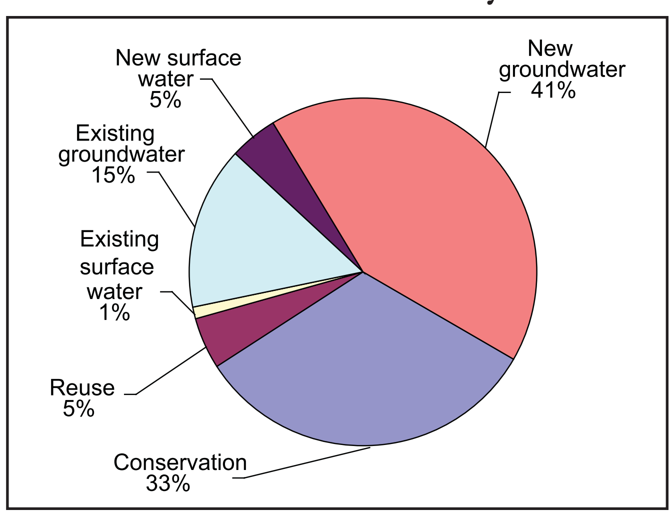
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Region F

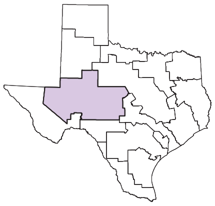
The Planning Group identified water supply needs for 51 out of 201 water user groups in the region. The total needs by 2050 are about 241,518 AFY. There are 19 urban and rural municipalities and 15 irrigation and livestock user groups with needs in 2050. There are unmet needs for irrigation in Glasscock, Midland, and Reeves Counties.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $326.0 million. Costs ranged from a low of $20 per acre-foot for advanced irrigation technologies to more than $1,700 per acre-foot for some municipal strategies. Estimated capital costs of municipal water management strategies total $195 million. Municipal needs include the cities of Midland and San Angelo and cities that rely on the Hickory aquifer. Recommended water management strategies for San Angelo and Midland include $65.8 million for development of groundwater supplies from T-Bar Well Field in Winkler and Loving Counties and $44.4 million to build a pipeline from McCulloch Well Field to Ivie Reservoir and improve deliveries from the Colorado River Municipal Water District. No new reservoirs are planned.

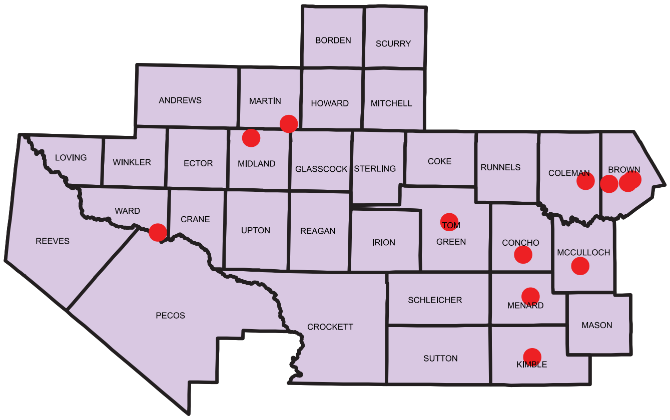
For many of the water user groups, existing supplies in the region could be developed further to meet needs. However, most of the municipal users of the Hickory aquifer have no alternative source of water. In addition, irrigation (the largest water user in the region) also lacks a readily expandable supply source to meet future needs. The largest unmet need in 2050 is about 82,000 AFY required for irrigation. This unmet need accounts for about 9 percent of the region's total demand in 2050. There are additional unmet needs in 2050 of 9 AFY for manufacturing and 40 AFY for livestock.

Remaining municipal demands rely on the Hickory aquifer, with no alternative. Additional concerns are the high cost of meeting current and proposed mandatory treatment standards for drinking water and for disposal of naturally occurring radionuclides, both of which may effectively eliminate the use of the Hickory aquifer as a primary drinking water source. Therefore, four different water management strategies are recommended: $17.4 and $13.8 million for building two water-treatment plants (Brady Creek and Lake Ivie, respectively) and $10 and $15.2 million for developing two well fields (New Ellenburger and New Hickory, respectively).

Estimated capital costs of irrigation water management strategies totaled $81 million. For most counties with irrigation needs, the development of additional supplies is not an option. Therefore, advanced water conservation irrigation technologies to reduce demands are recommended. These technologies include converting furrow irrigation to sprinkler or drip irrigation. Assuming 100-percent adoption of these technologies by 2020, the region could realize a 40- to 50-percent reduction in irrigation needs between 2020 and 2050. However, after full utilization of advanced irrigation technologies and available wastewater reuse, irrigation needs of Glasscock, Midland, and Reeves Counties are still unmet.



(F) Region F

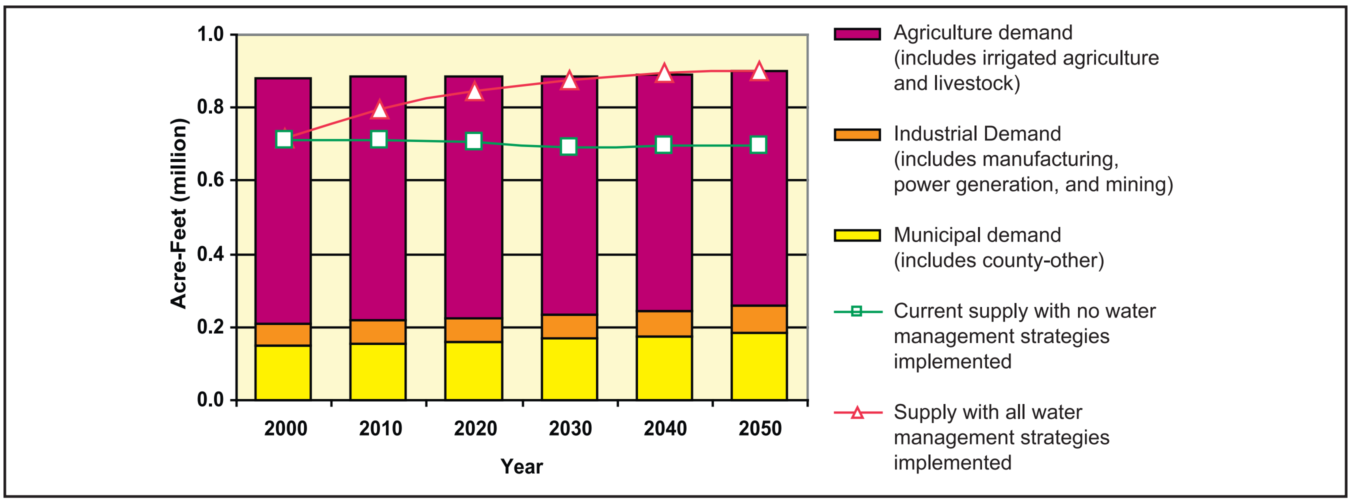


● Cities with needs based on comparison of current water supplies with projected demands.

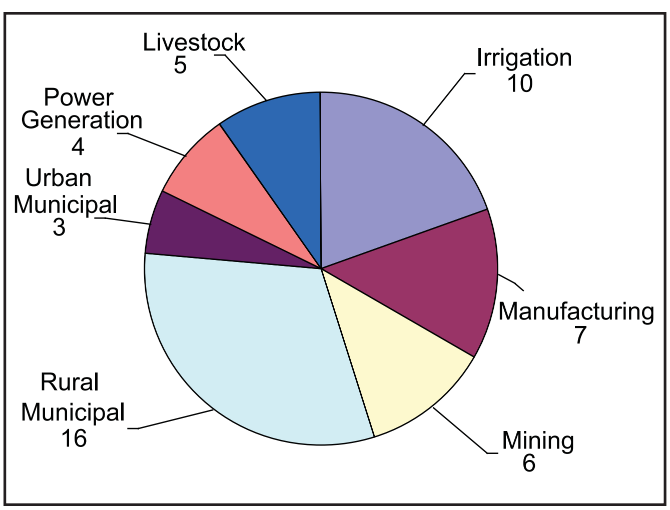
Key Points

- **Total capital cost: $326 million**
- No new reservoirs
- Strategies to meet all municipal needs occurring by 2050
- 51 water user groups with projected water needs by 2050
- Concern about high cost/low benefit of current mandatory treatment standards for drinking water
- Permit requirements for Spence and Ivie Reservoirs require constant releases regardless of inflow

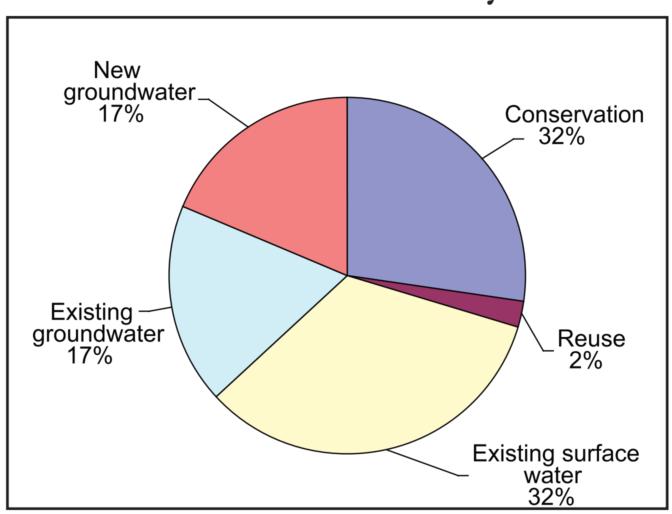
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Brazos G Region

The Planning Group identified water supply needs for 101 out of 319 water user groups in the region. The total needs by 2050 are about 216,357 AFY. There are 67 urban and rural municipalities and 7 irrigation user groups with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $523.5 million. This estimate includes about $80 million for the City of Abilene, $200 million for projects in Williamson County, and the remainder for funding strategies in the rest of the region.

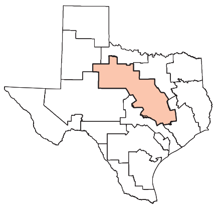
The Little River Reservoir site is the only major reservoir recommended. The yield and costs of this reservoir would be shared with Region H, with an estimated total capital cost of $361 million. Five minor reservoirs, New Throckmorton, Brushy Creek, Meridian Off-Channel, Somervell Off-Channel, and Groesbeck Off-Channel, were also included as strategies to meet needs at a total cost of about $48 million. There are unmet needs in 2050 of about 18,600 AFY for irrigation, 100 AFY for manufacturing, 1,700 AFY for mining, 3,300 AFY for steam-electric power generation, and 11,200 AFY for municipal.

In addition to the one major and five minor reservoirs recommended to meet needs, the region also recognized Breckenridge Reservoir, South Bend Reservoir, Paluxy Reservoir, Lake Bosque, and Millican Reservoir as potential reservoirs. However, these reservoirs were not recommended to meet identified needs in the region. Currently, the Planning Group and local interests are also involved in discussions related to the Double Mountain Fork reservoir site in Stonewall County, with the possible goal of inclusion in the next round of regional water planning. Also, pending the availability of additional information, the Legislature may want to evaluate this site as it considers designating unique reservoir sites.

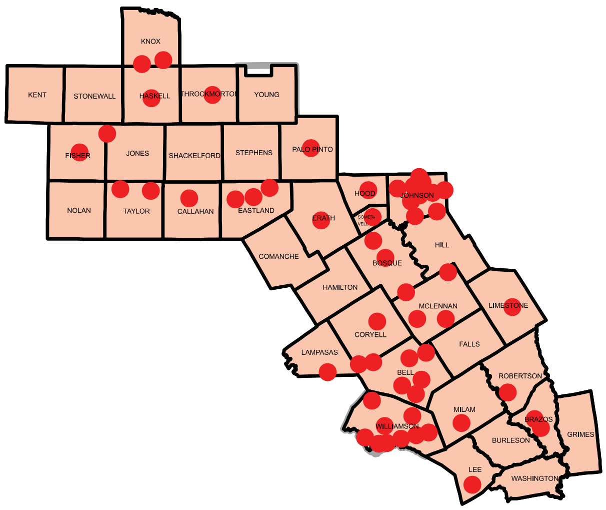
Historically every reservoir project built has had some measure of opposition from local landowners, especially those that have had to sell land that is in the impoundment area. The proposed Little River Reservoir is no exception, and many of the affected individuals have voiced their opposition at every opportunity. Much less opposition is involved with the minor reservoirs proposed in several areas of the planning region.

The largest water use in the Brazos G Region is municipal, accounting for 40 percent of the total demand. Municipal demand is projected to nearly double by 2050, and increases in steam-electric power generation, mining, and manufacturing demands are also expected. The demand for irrigated agriculture is projected to decline slightly over the planning horizon.

The development of groundwater in the Carrizo-Wilcox aquifer in areas such as Lee and Burleson Counties for use in Williamson County has met with opposition from landowners in the counties of origin. However, development of groundwater in these counties for export out of the region has met with even more opposition.



(G) Brazos G Region

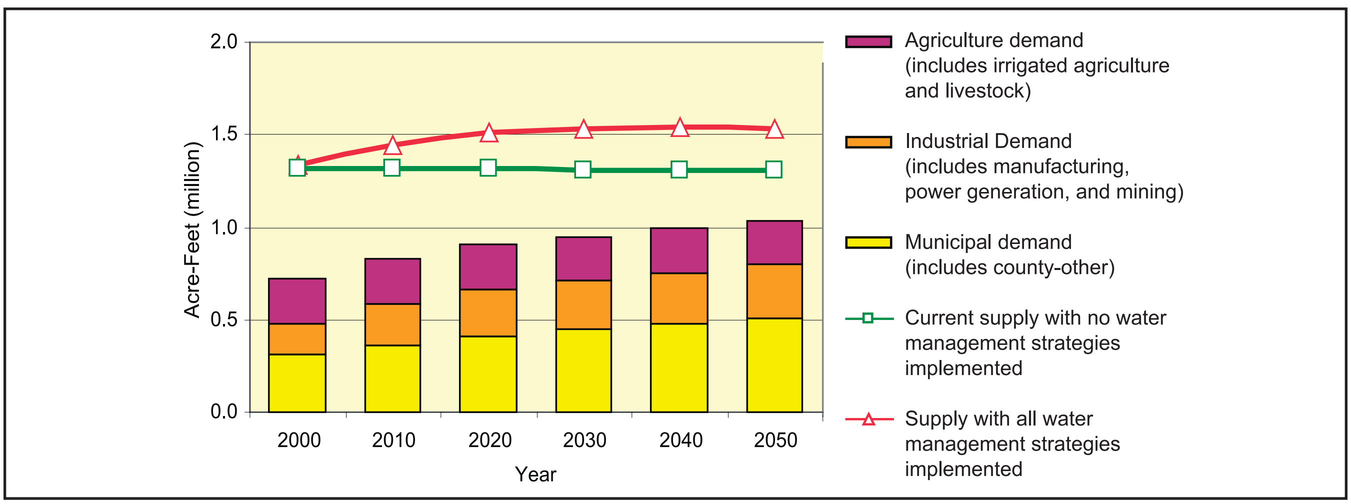


● Cities with needs based on comparison of current water supplies with projected demands.

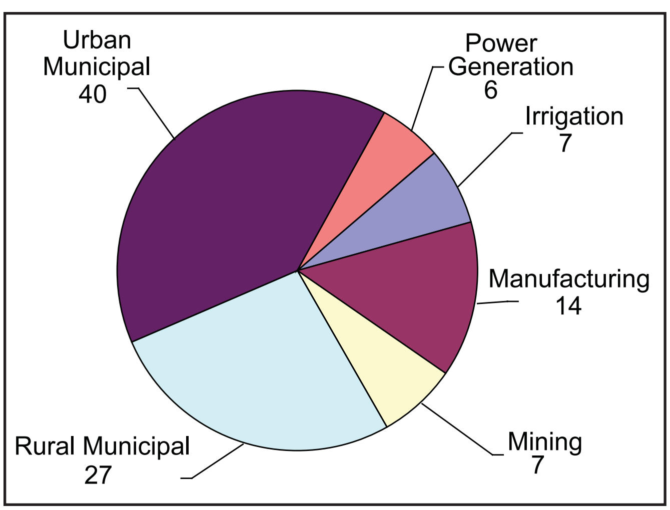
Key Points

- **Total capital cost: $524 million**
- One new major reservoir and five new minor reservoirs to meet needs
- Four cities with unmet needs by 2050
- 101 water user groups with projected water needs by 2050
- Opposition to groundwater exports
- Landowner opposition to reservoir development

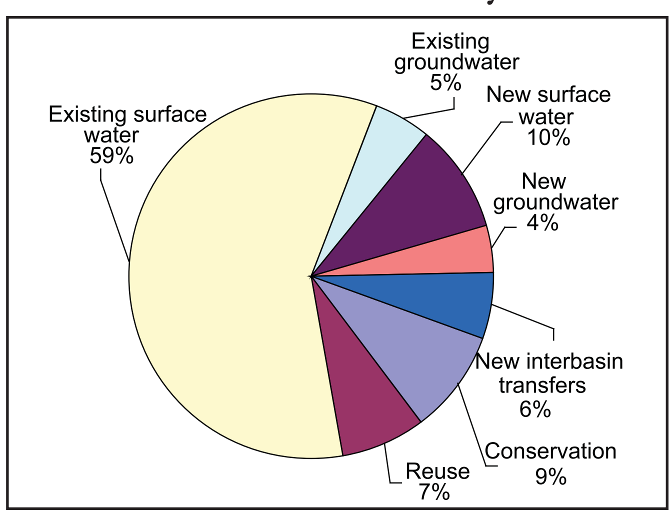
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Region H

The Planning Group identified water supply needs for 94 out of 202 water user groups in the region. The total needs by 2050 are about 1,375,455 AFY. There are 79 urban and rural municipalities and 3 irrigation user groups with needs in 2050.

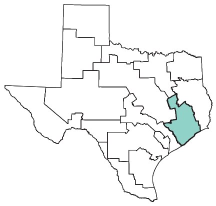
Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are $2.423 billion.

Region H designated five major water providers: the City of Houston, San Jacinto River Authority, Brazos River Authority, Trinity River Authority, and Gulf Coast Water Authority. These major water providers are responsible for the additional supply needed by most of the water user groups. There are no unmet needs for any water user groups in 2050.

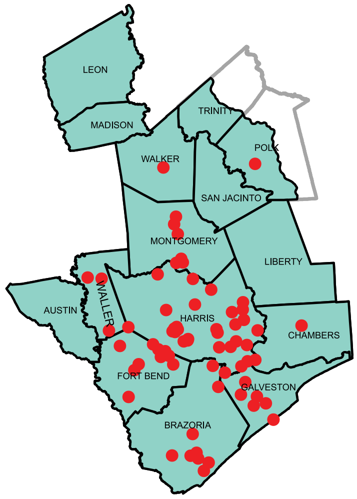
The Trinity River Authority will have a water supply surplus throughout the planning horizon, whereas the other major water providers must develop additional supply. To meet these needs, the Planning Group recommended three new reservoirs: Allens Creek Reservoir, Little River Reservoir, and Bedias Reservoir. The Allens Creek Reservoir would create 99,650 AFY of firm supplies for the City of Houston and for the Brazos River Authority. The Little River Reservoir would create 101,000 AFY for the Brazos River Authority, which includes 30,000 AFY for the Brazos G Region, and 28,000 AFY for the Gulf Coast Water Authority. Bedias Reservoir would create 90,700 AFY for the San Jacinto River Authority and the Trinity River Authority. Other significant water management strategies include a wastewater reclamation facility capable of treating 90,700 AFY, two water conveyances, two contractual transfers, and a voluntary redistribution of water supply. Some of the conveyances and transfers involve interbasin transfers. Region H cannot satisfy its future water needs without interbasin transfers.

Region H is second to Region C in population but it is anticipated that it will surpass Region C by 2050. Although the overall projected population growth is about 100 percent, certain counties adjacent to Harris County, such as Fort Bend, Waller and Montgomery Counties, are predicted to increase in population by as much as 400 percent by 2050. Present water use is second to that of the Llano Estacado Region, but by 2050, Region H is projected to have the greatest water demand of any region.

The Region H Planning Group adopted a regional water plan that includes aggressive municipal and irrigation conservation as water management strategies for all affected water user groups with needs. It was the only region to designate ecologically unique stream segments. It worked with the Galveston Bay Freshwater Inflows Group to adopt criteria, as part of its plan, for sustaining freshwater inflows to the Galveston Bay system.



(H) Region H

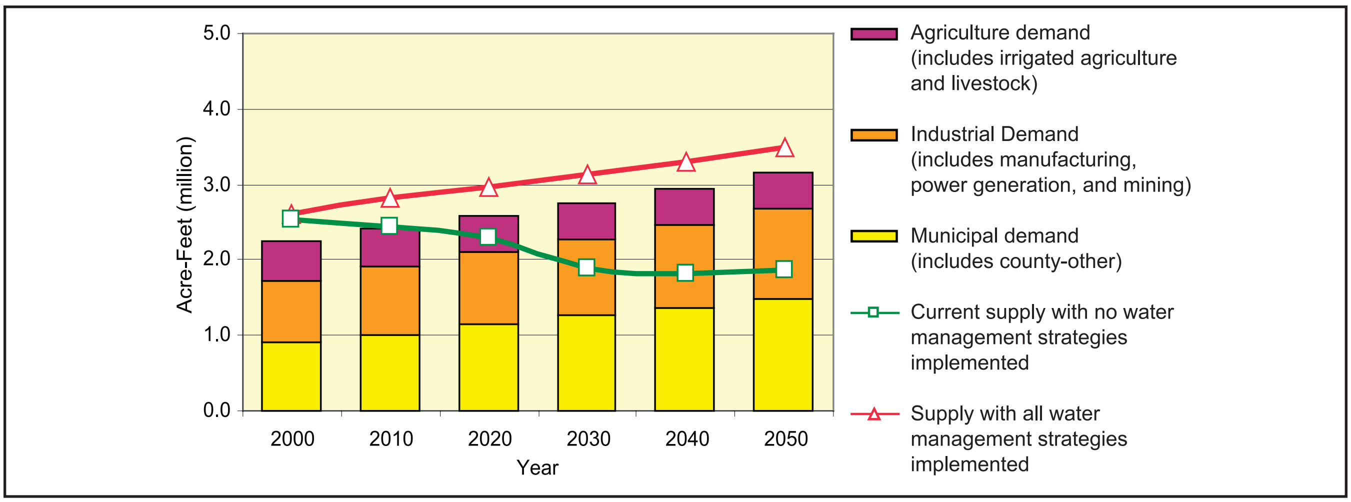


● Cities with needs based on comparison of current water supplies with projected demands.

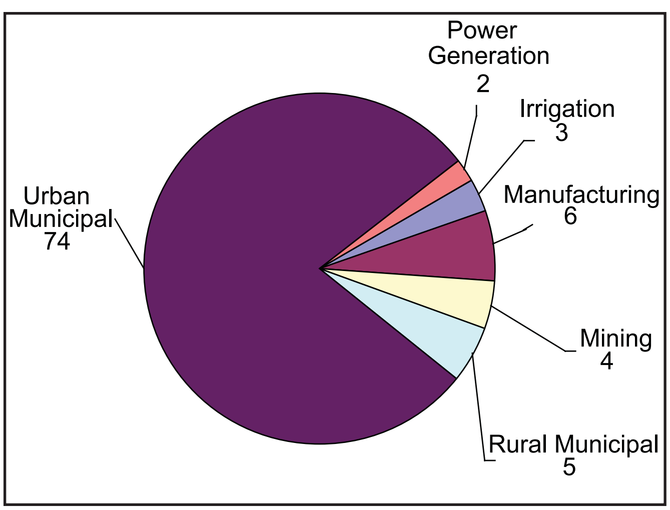
Key Points

- **Total capital cost: $2,423 million**
- Two new major reservoirs to meet needs
- Strategies to meet all municipal needs occurring by 2050
- 94 water user groups with projected water needs by 2050
- Greatest projected water use by any region by 2050
- Two-thirds of U.S. petrochemical production

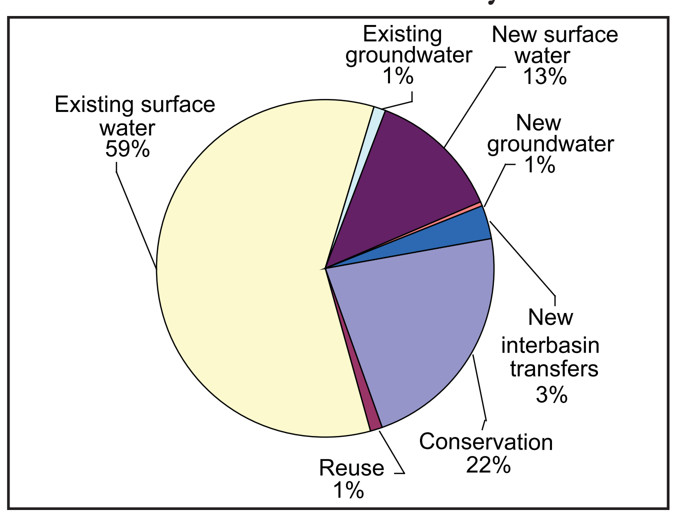
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of East Texas Region

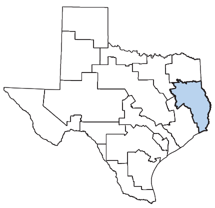
The Planning Group identified water supply needs for 92 out of 165 water user groups in the region. The total needs by 2050 are about 763,567 AFY. There are 47 urban and rural municipalities and 18 irrigation and livestock user groups with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $517 million. This includes approximately $200 million for new reservoirs, about $50 million for the City of Lufkin, and the remainder for funding strategies in the rest of the region. The one new reservoir recommended in the region is Lake Eastex, located on Mud Creek in Cherokee County. This reservoir has been permitted by the TNRCC and is in the process of obtaining Federal permits from the U.S. Army Corps of Engineers.

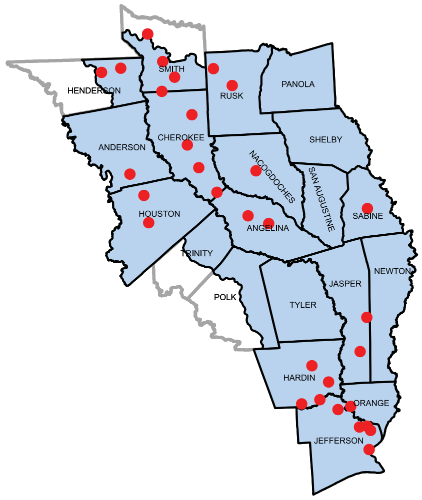
The largest water user in the East Texas Region is manufacturing, which accounts for 39 percent of the total demand of about 1.17 million AFY in 2050. Increases in steam-electric power generation, mining, and irrigation demands are also expected. Municipal water use for the region is projected to increase between 2000 and 2050, from about 171,000 AFY to 219,000 AFY. Five counties—Angelina, Jefferson, Nacogdoches, Orange, and Smith—account for most of the total municipal use for the region in 2050. The cities of Lufkin, Beaumont, Port Arthur, Nacogdoches, Orange, and Tyler are included in these counties. These cities will rely on increased groundwater and surface water production to meet their needs. The only unmet needs in 2050 are 3 AFY for mining and 17 AFY for municipal.

The region is very concerned about the environmental needs of instream flows and the bays and estuaries in the coastal area. Additional studies will be conducted in the next planning cycle to ensure that these needs are met.

The growing of houseplants in containers and the raising of poultry in large, confined growing houses are emerging as water use industries in the region. Tens of millions of gallons of water is needed each day in the region to supply these industries, and these demands are projected to continue increasing.



(I) East Texas Region

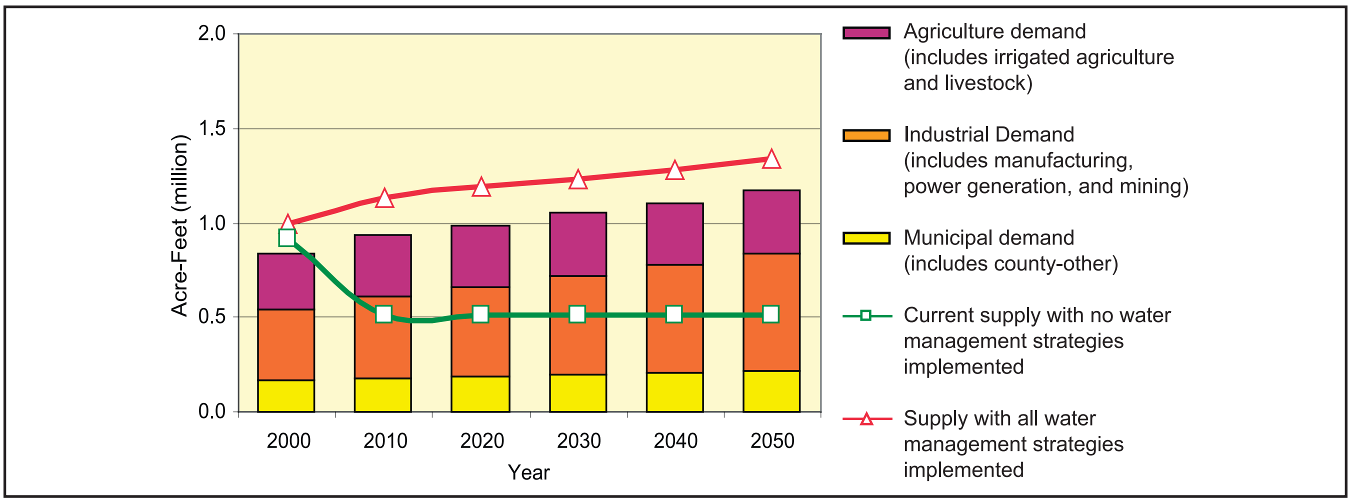


Cities with needs based on comparison of current water supplies with projected demands.

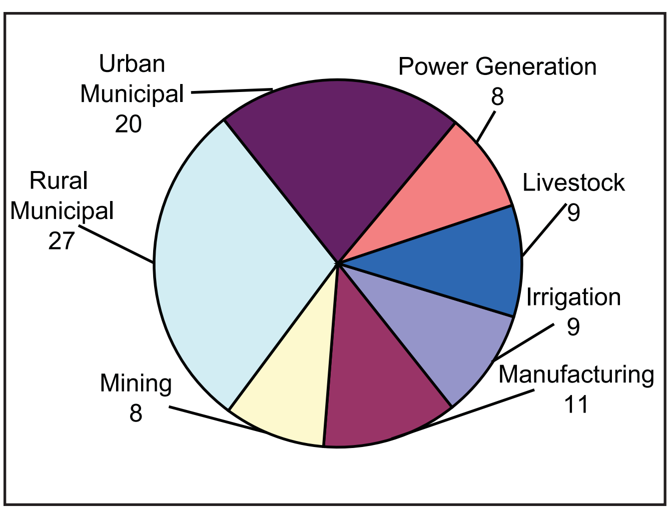
Key Points

- **Total capital cost: $517 million**
- One new major reservoir to meet needs
- 92 water user groups with projected water needs by 2050
- Concern about potential environmental impacts from water transfers on bays and estuaries
- Growing water-use industries, including poultry and plant nursery

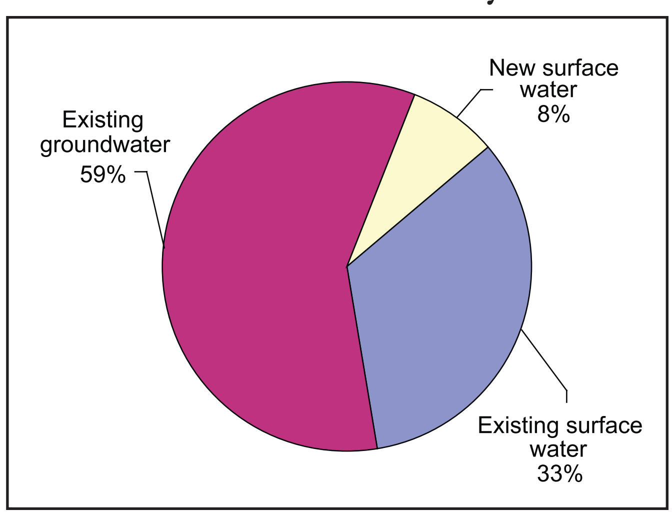
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Plateau Region

The Planning Group identified water supply needs for 12 out of 34 water user groups in the region. The total needs by 2050 are about 10,824 AFY. There are 4 rural municipalities and 6 irrigation and livestock user groups with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $65.8 million. Major projects include $34.0 million for new wells or expanded use of existing wells and $23.5 million for increased water-treatment-plant capacity.

The Planning Group projects that the Cities of Kerrville and Leakey will have needs under drought-of-record conditions. Kerrville has a need of 1,547 AFY that began in 2000. The Planning Group recommended a combination of strategies for Kerrville, including obtaining additional surface water rights, purchasing raw water from the Upper Guadalupe River Authority or Guadalupe-Blanco River Authority, developing additional groundwater supplies from a new remote well field, and expanding the current Aquifer Storage and Recovery System by adding two additional wells to provide a maximum of 5,450 AFY in 2050. The Planning Group projected that Leakey will have a need beginning in 2020 and recommended drilling wells to supply an additional 63 AFY by 2050. Beginning in 2000, rural needs are projected for Bandera and Kinney Counties. The Planning Group recommended that needs be met by drilling additional private wells to supply 4,528 AFY in 2050. The only unmet needs in 2050 are 72 AFY for municipal.

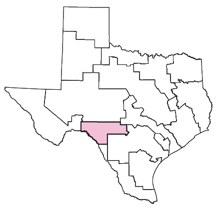
Irrigation needs are projected for Edwards and Kerr Counties beginning in 2000 and are 337 AFY in 2050. Expanded use of groundwater is recommended as the main supply source, with advanced conservation providing only minimal effects after implementation in 2030. Beginning in 2000, livestock needs of 342 AFY are projected by the Planning Group. These needs could be met by expanding use of existing groundwater. Water needs for mining are minimal at 179 AFY in 2050 and could be met by drilling of additional wells.

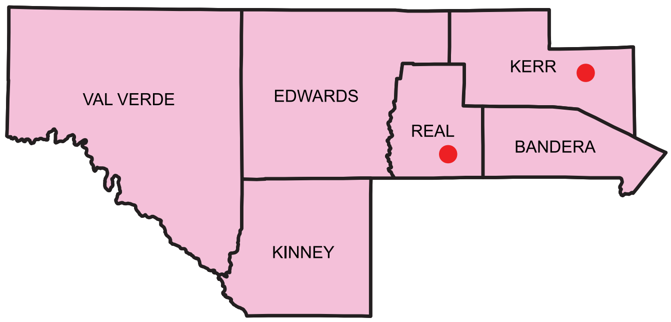
The Planning Group chose to evaluate the purchase of existing rights or water supply from entities having surface water supplies instead of proposing any new reservoir projects, even though construction of reservoirs in suitable areas may increase the amount of available surface water.

The Planning Group commented that environmental impacts on endangered and threatened species could limit future water development if that development were to affect springflows or streamflows critical to the existence of these species.

The Planning Group also commented that its members strongly believe that current knowledge of ground-water resources in the region is insufficient for them to recommend definitive quantitative strategies.

(J) Plateau Region



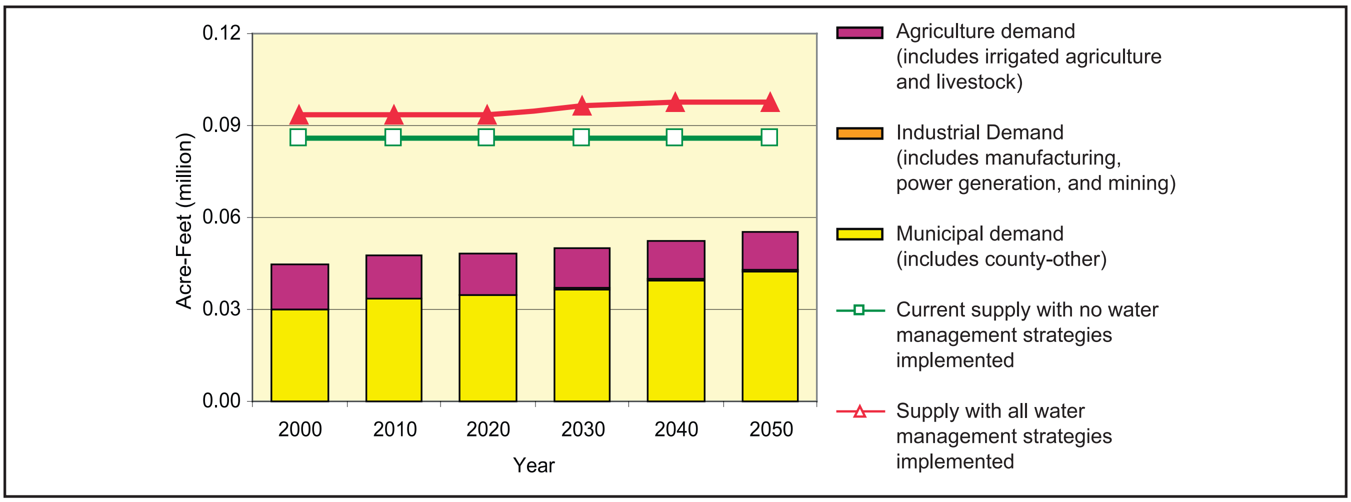


● Cities with needs based on comparison of current water supplies with projected demands.

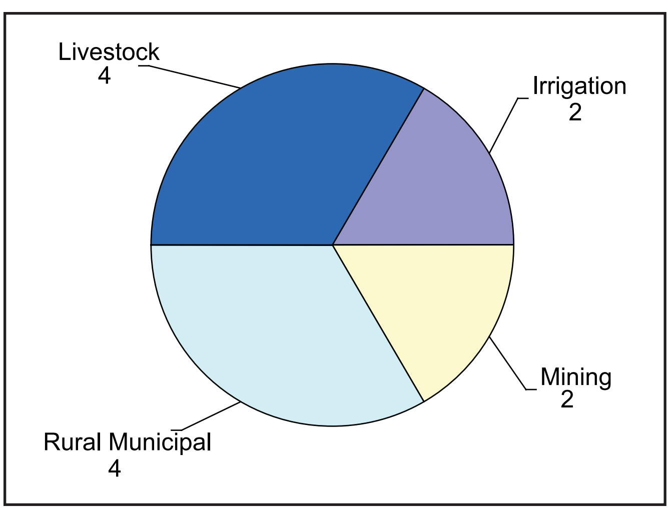
Key Points

- **Total capital cost: $66 million**
- No new reservoirs
- 12 water user groups with projected water needs by 2050
- Endangered and threatened species could limit future water development options
- Historical groundwater data insufficient for planning purposes

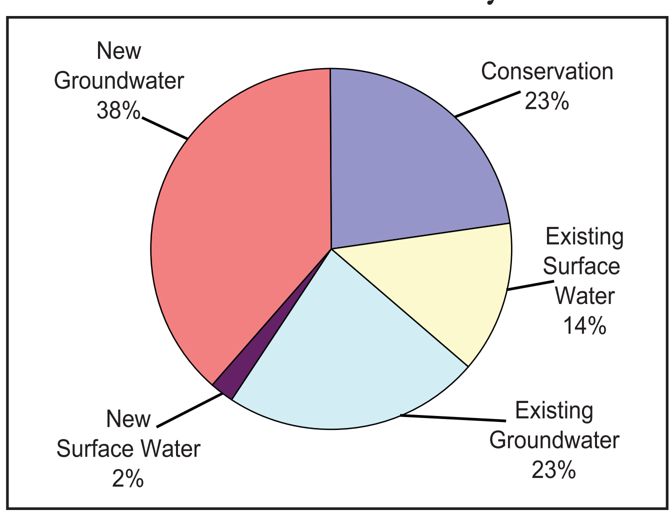
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



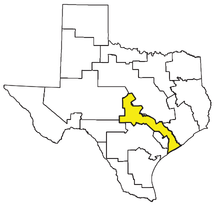
Summary of Lower Colorado Region

The Planning Group identified water supply needs for 30 out of 111 water user groups in the region. The total needs by 2050 are about 391,575 AFY. There are 24 urban and rural municipalities and 3 irrigation user groups with needs in 2050.

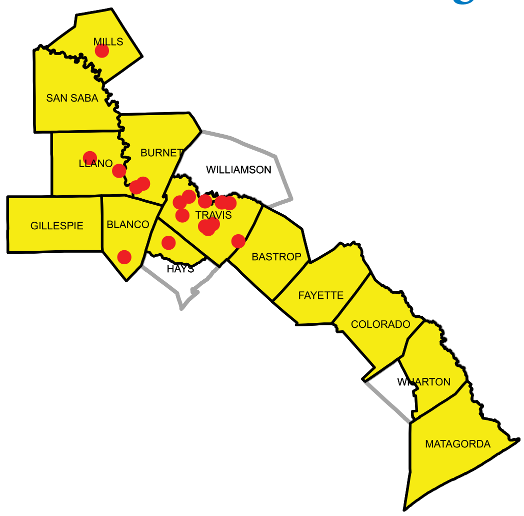
Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $256 million. The recommended water management strategies for the Lower Colorado Planning Region consist primarily of a series of off-channel reservoirs or “ring dikes,” proposed in the lower part of the region combined with the implementation of major irrigation conservation practices to meet irrigation needs. This project would also free water stored in upstream reservoirs currently used for irrigation to meet municipal needs in upper region counties. During drought, groundwater would be used as necessary to supplement surface water from the project. Highland lake levels would remain higher on average, owing to less-frequent irrigation demands from reservoir storage. Additional water from this project would be made available to entities outside the region (in the South Central Texas Region) to meet some of their projected municipal and industrial needs. Conceptually these entities would be responsible for project funding; however, such funding, as well as the assignment of new water generated by this project, will be determined through ongoing contractual negotiations between entities in the Lower Colorado Region and the South Central Texas Region. The off-channel reservoir project is expected to provide 300,000 to 330,000 AFY of additional water supply. The total capital cost is $800 million to $1 billion, with the portion of the cost to meet in-region needs estimated at $157 million.

Development of new wells adjacent to existing irrigation canals is needed to provide as much as 68,000 AFY during drought to supplement surface water produced by the off-channel reservoir project. New lines are recommended to transport 5,806 AFY of water to Dripping Springs, Buda, rural Hays County, and Blanco County and the City of Blanco at a capital cost of $52.3 million. Dredging existing reservoirs and building new channel dams in Llano and Goldthwaite are estimated to cost $7.8 million for the new storage portion only. New groundwater development and an aquifer storage and recovery project for Gillespie County are estimated to cost $8.3 million for a yield of 1,120 AFY. Advanced on-farm conservation, canal lining, and crop research are recommended to reduce irrigation demand by 118,000 AFY at a capital cost of $31.8 million.

Groundwater availability throughout the region is defined on the basis of local aquifer characteristics. In general, availability is defined on a sustainable basis (estimated aquifer recharge) instead of on the basis of the total volume of water in aquifer storage.



(K) Lower Colorado Region

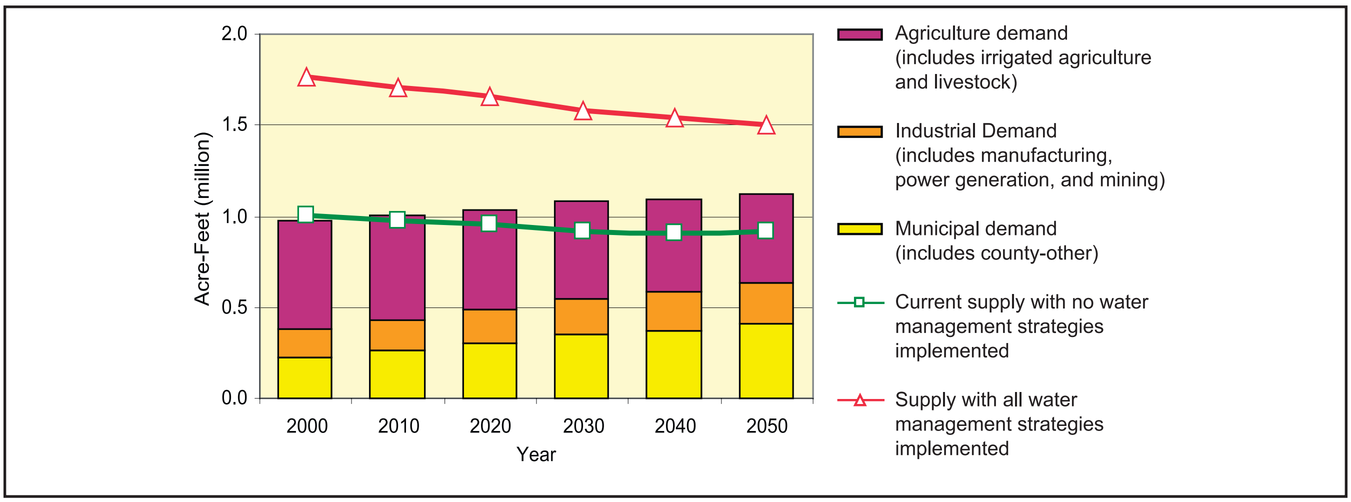


● Cities with needs based on comparison of current water supplies with projected demands.

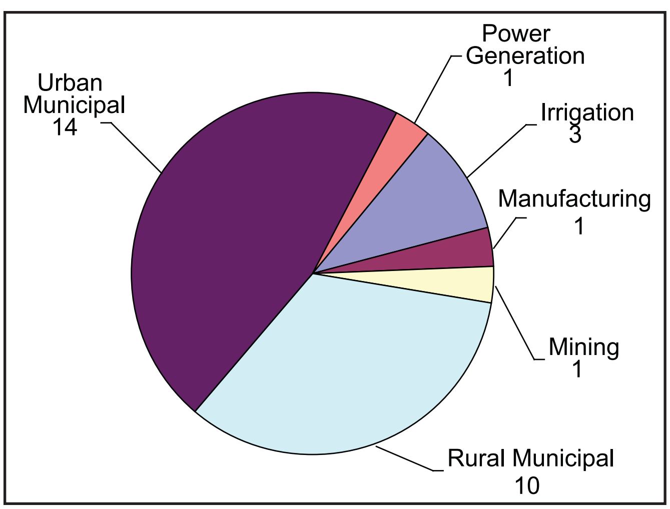
Key Points

- **Total capital cost: $256 million**
- Four minor reservoirs and four "ring dike" structures to meet needs
- 30 water user groups with projected water needs by 2050
- Groundwater availability defined on a sustainable basis rather than on a storage basis
- All irrigation shortages proposed to be met by sale of water to the South Central Texas Region and conservation

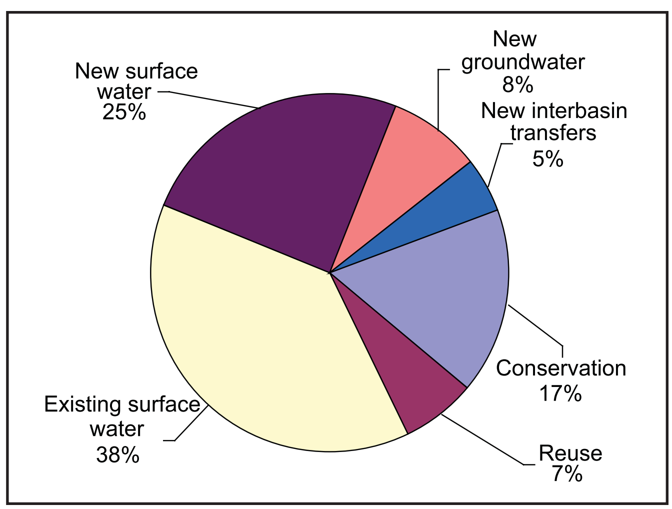
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of South Central Texas Region

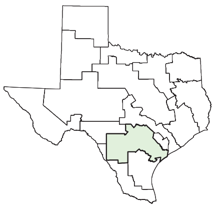
The Planning Group identified water supply needs for 70 out of 191 water user groups in the region. The total needs by 2050 are about 785,728 AFY. There are 50 urban and rural municipalities and 7 irrigation user groups with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $4.72 billion. The Planning Group adopted advanced water conservation as the basis for the projection of water demands in the region. The Planning Group estimated water supply needs for drought-of-record conditions of about 495,000 AFY in 2000 and 786,000 AFY by 2050. The projected needs in 2050 are estimated to be 505,000 AFY for municipal, industrial, steam electric, and mining and 280,000 AFY for irrigation. The plan shows 12 counties with municipal water user groups that have projected needs, 4 counties with projected industrial water needs, 2 counties with projected steam-electric power generation water needs, 7 counties with projected irrigation water needs, and 7 counties with projected mining water needs during the 50-year planning period.

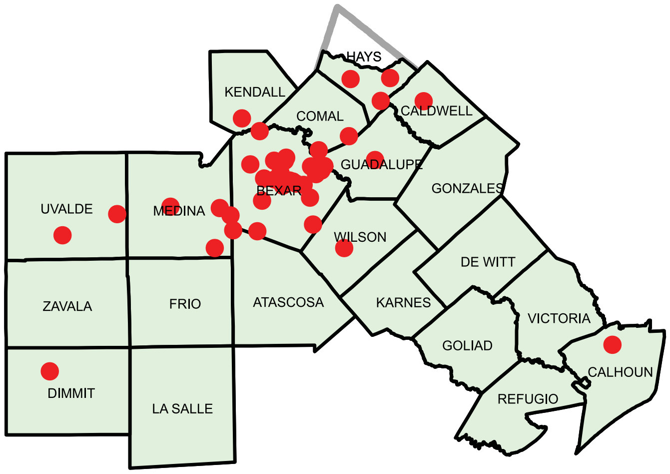
The plan includes water management strategies that could produce new supplies of as much as 744,053 AFY in 2050. These strategies include (1) municipal and irrigation water conservation; (2) water reuse; (3) purchase/lease and transfer of irrigation rights for municipal use; (4) aquifer storage and recovery; (5) increased use of Canyon Reservoir; (6) Lower Guadalupe River diversions (including 50,000 acre-feet of off-channel storage); (7) Colorado river diversion; (8) groundwater imports from the Simsboro aquifer in Bastrop, Lee, and Milam Counties; (9) desalination of seawater; (10) recharge of the Edwards aquifer; (11) enhanced use of the Carrizo-Wilcox aquifer from Wilson, Gonzales, and Bastrop Counties; and (12) expansion of existing well fields. The plan also includes brush management, weather modification, rainwater harvesting, and additional municipal water reuse. The Planning Group evaluated and then excluded large-scale development of new reservoirs and focused on smaller, off-channel balancing reservoirs for efficient operations and meeting peak seasonal water needs. The unmet needs in 2050 are 251,550 AFY for irrigation, 3 AFY for mining, and 98 AFY for municipal.

The South Central Texas Region is a complex area. It includes parts of six major river basins and overlies portions of four major and two minor aquifers. The water resources of the region include the Comal and San Marcos springs, which are reported to have the highest flow dependability and environmental stability of any spring system in the southwestern United States.

During the next decade, implementation of a number of water management strategies on an expedited basis will be necessary to avoid significant hardship, water rationing, and/or cessation of discharge from Comal Springs in the event of severe drought. Substantial water supply needs or shortages are also projected for irrigation use in the South Central Texas Region on the basis of present economic conditions for agriculture and there being no low-cost water supplies to be developed.



(L) South Central Texas Region

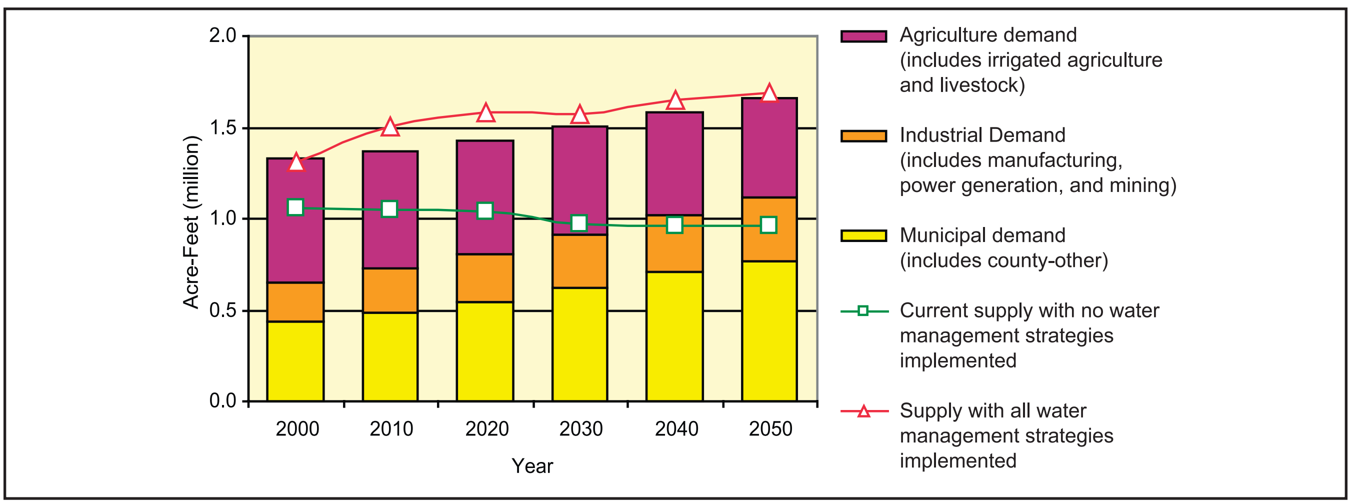


Cities with needs based on comparison of current water supplies with projected demands.

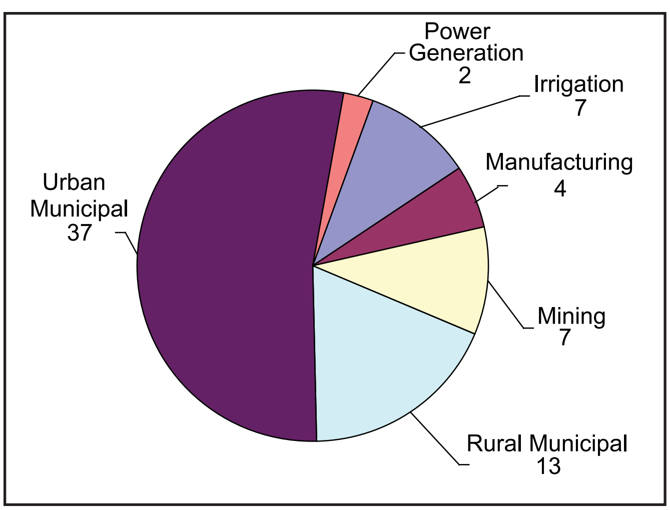
Key Points

- **Total capital cost: $4,720 million**
- No new major reservoirs
- 70 water user groups with projected water needs by 2050
- Development of new supply sources proposed, reducing reliance on Edwards aquifer
- Increased reliance on conservation, water imports, and transfer of groundwater irrigation rights to municipal use
- Advanced conservation

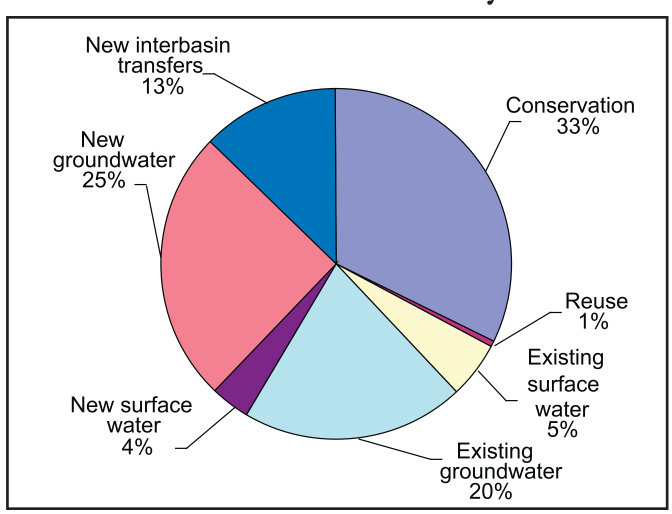
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Rio Grande Region

The Planning Group identified water supply needs for 48 out of 83 water user groups in the region. The total needs by 2050 are about 832,583 AFY. There are 39 urban and rural municipalities and 6 irrigation user groups with needs in 2050.

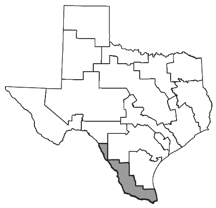
Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $930 million. Nonspecific strategies recommended to meet all municipal needs include additional or advanced conservation measures ($18 million), nonpotable water reuse ($140 million), and acquisition of additional Rio Grande water ($455 million). The third strategy refers to redistribution, by sale and purchase, of existing river supplies. The Planning Group also recommended local groundwater development ($32 million) and the construction of a weir and channel dam ($81 million) as specific strategies to meet the needs of Laredo and Brownsville, respectively. The weir would capture excess flows that currently go past Brownsville and discharge into the Gulf of Mexico; it would impound 6,000 acre-feet while diverting 40,000 acre-feet of water.

To address irrigation needs, the Planning Group recommended agricultural water conservation involving improvement of the conveyance and distribution system ($98 million); improving on-farm water use efficiency by metering, volumetric pricing and pipes ($106 million); and modification of TNRCC rules for operation of the reservoir system (no cost). The third recommendation was implemented by TNRCC in the spring of 2001. The only unmet needs in 2050 are about 346,000 AFY for irrigation and 9,000 AFY for municipal.

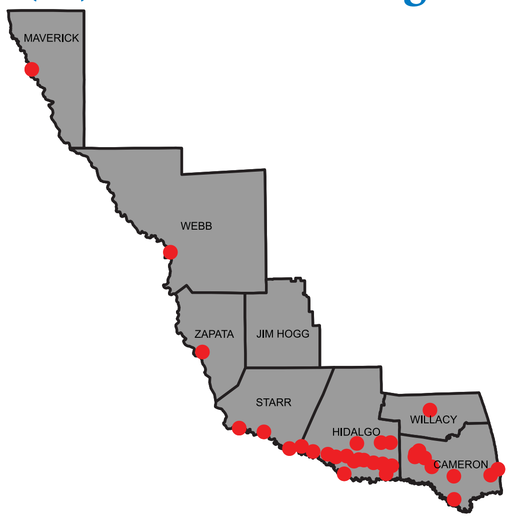
The Planning Group further recommended that the water supply from the Rio Grande be optimized by:

- improving real-time monitoring of the river and its major tributaries in order to minimize the conveyance losses and to maximize use of those waters not accounted for by treaty between the U.S. and Mexico ($1 million),
- controlling noxious weed vegetation on the Rio Grande (no costs available), and
- restoring the river's historic channel (rechanneling) between Fort Quitman and the City of Presidio to increase the flows reaching this planning area and thus firm up existing water rights ($10 million).

The Planning Group also suggested that a surface water model be made available for the Rio Grande to help determine impacts of environmental flow needs, and it strongly recommended that the U.S. Government take all necessary and appropriate actions to ensure Mexico's full compliance with the terms of the treaty allocating and governing water on the river.



(M) Rio Grande Region

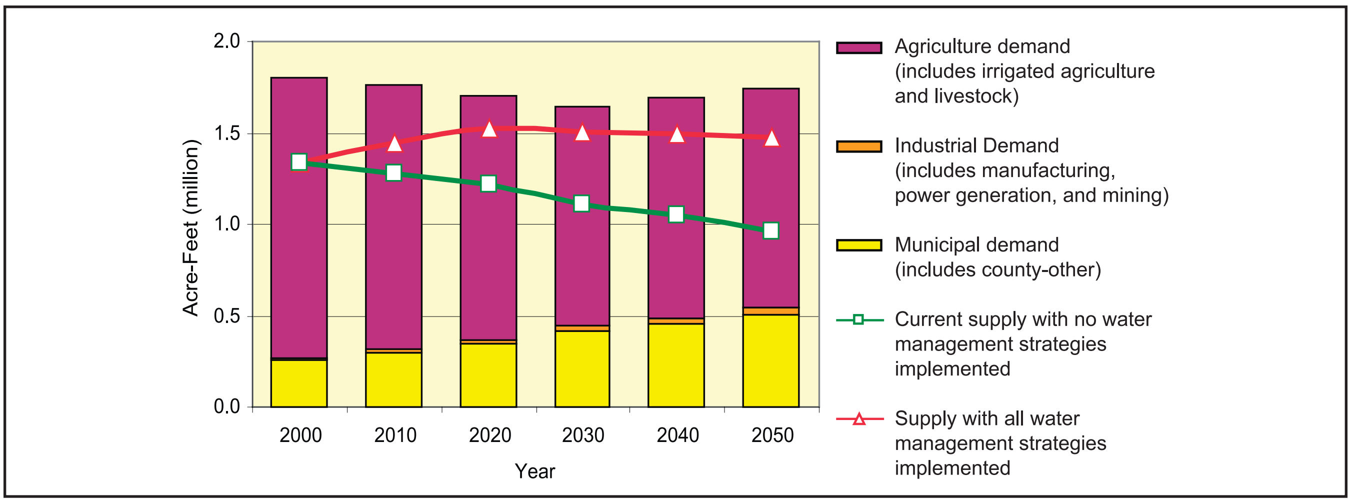


● Cities with needs based on comparison of current water supplies with projected demands.

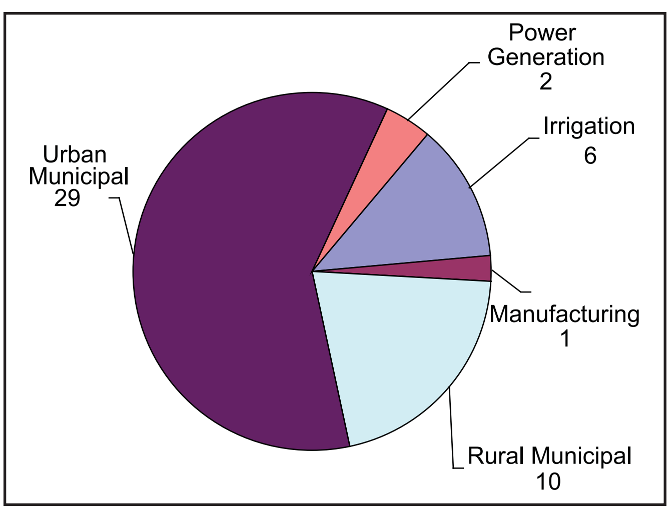
Key Points

- **Total capital cost: $930 million**
- One new major reservoir to meet needs
- 48 water user groups with projected water needs by 2050
- Water availability model needed for the Rio Grande to help determine impacts of environmental-flow needs
- Mexico's compliance with water apportionment treaty essential

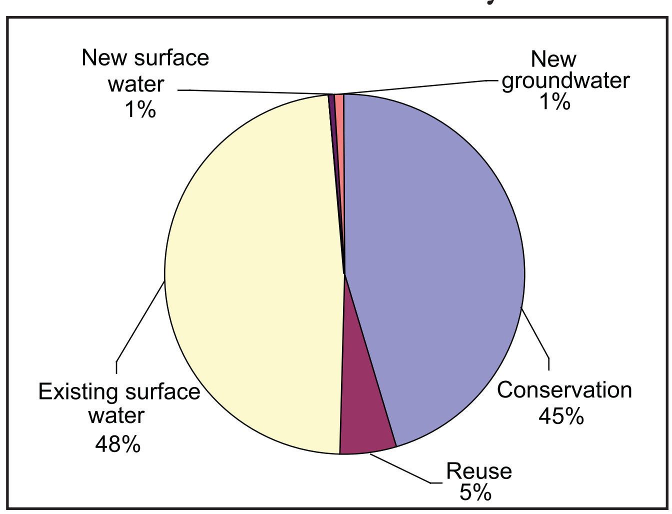
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Coastal Bend Region

The Planning Group identified water supply needs for 15 out of 78 water user groups in the region. The total needs by 2050 are about 99,220 AFY. There are 10 urban and rural municipalities and 2 irrigation user groups with needs in 2050.

Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $107 million.

Twelve strategies were recommended that involve both surface and groundwater supplies. None of the strategies involves the construction of any new reservoirs. Larger municipalities have recommended strategies to help fill their own needs, as well as those of interconnected communities:

- system interconnects involving a surface source ($3,364,000),
- additional (interruptible) Lake Texana water (no cost available),
- reallocation of surface water (no cost available),
- conservation from the manufacturing segment ($2,073,000),
- aquifer storage and recovery ($14,118,000), and
- use of surface water rights via the Garwood Pipeline ($83,250,000).

For smaller municipalities, which tend to be located in the groundwater-dependent western part of the region, the planning group recommended

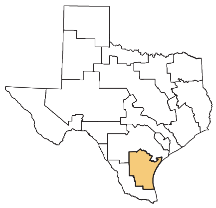
- short-term overdrafting of groundwater (no cost),
- voluntary reallocation of groundwater ($303,000), and
- utilizing of small desalination plants ($3,350,000).

The small municipal strategies also benefit local mining users. Mining strategies include both the use of nonpotable groundwater and the recycling/reuse of groundwater. Neither strategy has costs associated with it. Unmet needs in 2050 include about 1,200 AFY for manufacturing, 800 AFY for mining, and 3,400 AFY for municipal.

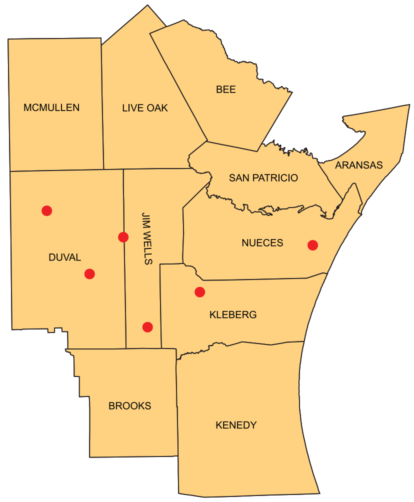
Irrigation needs are generally met through conservation. Those costs are estimated at $729,000. The Planning Group recognized that there will be some unmet irrigation needs.

The Planning Group will also continue to study the feasibility of large-scale desalination projects. A desalination project has the potential to meet needs in several regions. The Planning Group is exploring interregional cooperation on interbasin transfers and the exchange of surface water rights.

Finally, the Planning Group is actively involved in groundwater availability modeling (GAM) and has begun by recommending certain policy items for GAM consideration, such as pumping level cutoffs.



(N) Coastal Bend Region

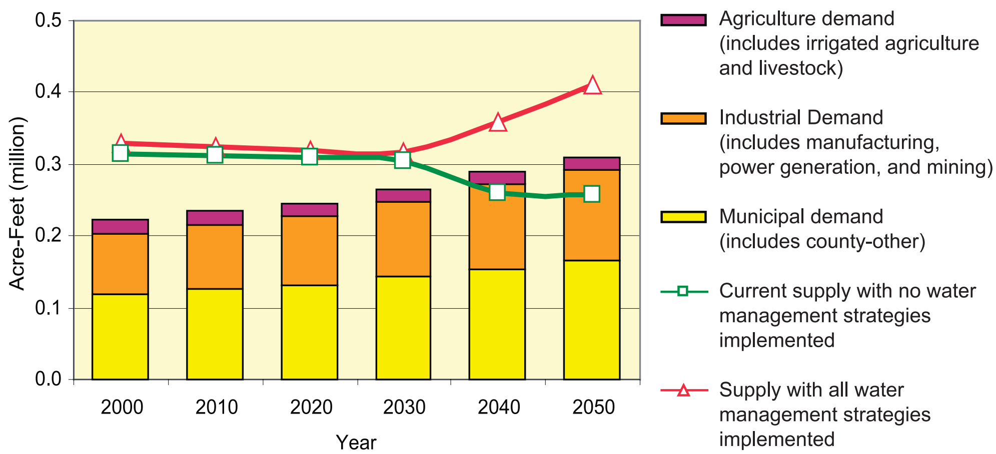


● Cities with needs based on comparison of current water supplies with projected demands.

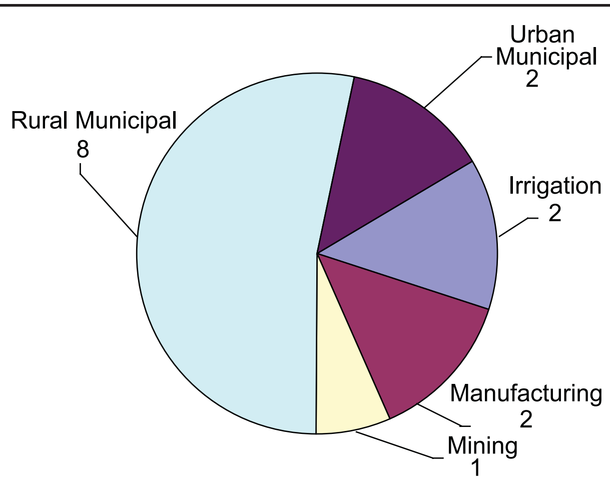
Key Points

- **Total capital cost: Over $107 million**
- No new reservoirs
- 15 water user groups with projected water needs by 2050
- Several small scale desalination projects proposed
- Interregional cooperation
- Control of groundwater development

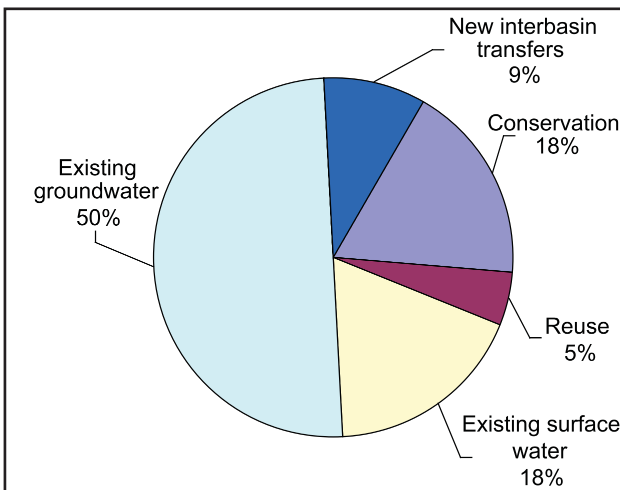
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Llano Estacado Region

The Planning Group identified water supply needs for 34 out of 149 water user groups in the region. The total needs by 2050 are about 202,204 AFY. There are 26 urban and rural municipalities and 8 irrigation user groups with needs in 2050.

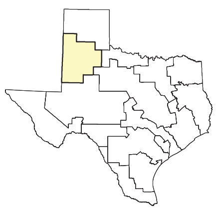
Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $306 million. These costs include $33.8 million for additional groundwater for municipalities, $123.9 million for a treatment plant and pipeline from Lake Alan Henry to the City of Lubbock, and $148.1 million for conservation for irrigation.

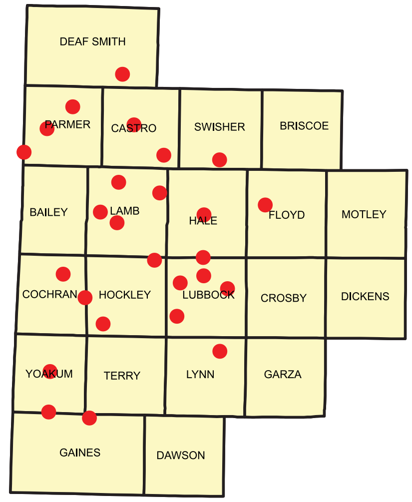
Recommended water management strategies focus on conservation, particularly as a strategy for irrigated agriculture. The Planning Group identified eight irrigation water user groups with needs, and six of these irrigation water user groups have an unmet need in 2050 of about 92,000 AFY. The Planning Group recommended the following water management strategies for reducing irrigation shortages:

- irrigation water conservation,
- agricultural water conservation practices on farms,
- precipitation enhancement,
- brush control,
- recovery of capillary water,
- research and development of drought-tolerant crops and new technology, and
- desalination of brackish groundwater.

The Planning Group also considered but did not recommend a water management strategy to construct a pipeline that would connect small municipalities and feedlots using groundwater from Hartley and Roberts Counties by means of a public/private partnership.

(O) Llano Estacado Region



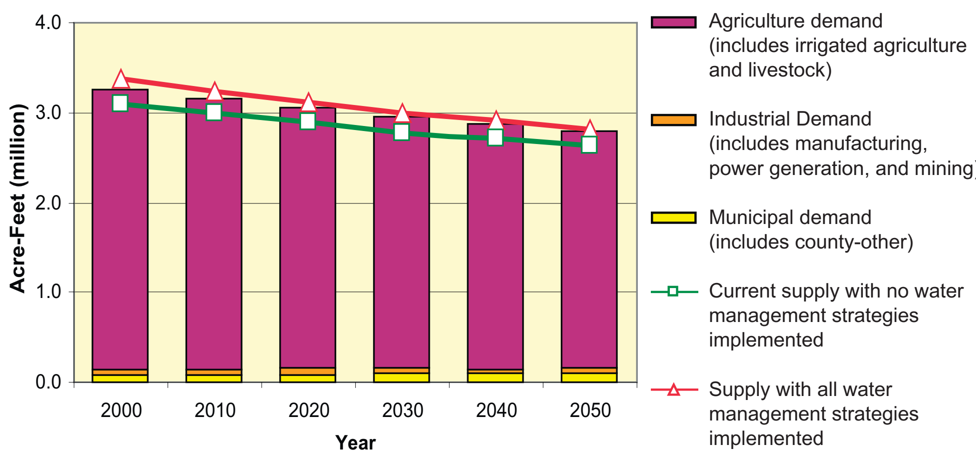


● Cities with needs based on comparison of current water supplies with projected demands.

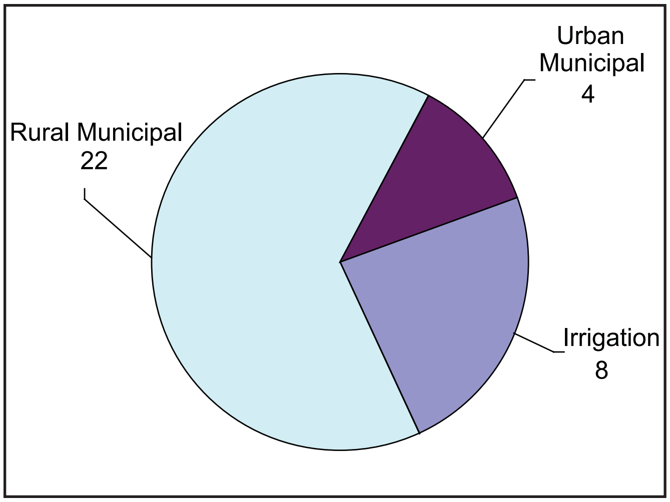
Key Points

- **Total capital cost: $306 million**
- Strategies to meet all municipal needs occurring by 2050
- 34 water user groups with projected water needs by 2050
- Variety of water transfer proposals being considered
- Focus on conservation, especially for irrigated agriculture

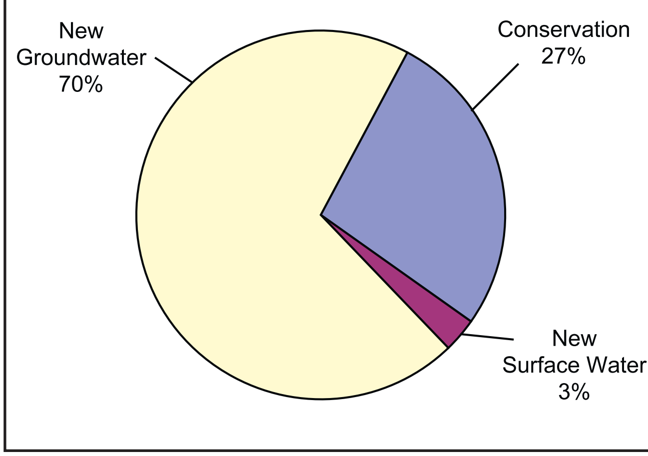
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



Summary of Lavaca Region

The Planning Group identified water supply needs for 4 out of 22 water user groups in the region. The total needs by 2050 are about 51,845 AFY. There are no urban or rural municipalities with needs, but 4 irrigation and livestock user groups will have needs in 2050. There are no capital costs for meeting the needs within the Lavaca Region.

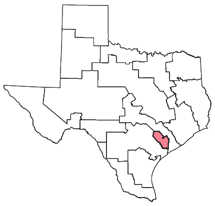
The recommended water management strategy for the Lavaca Planning Group is the temporary overdraft of the Gulf Coast aquifer during drought, allowing water levels to recover during normal conditions. The majority of demands in the region come from irrigated agriculture, which is a seasonal demand. Historical data indicate that water can be produced from aquifer storage during drought and that water levels will begin to recover between irrigation seasons. During normal rainfall years, water levels fully recover from recharge to the aquifer.

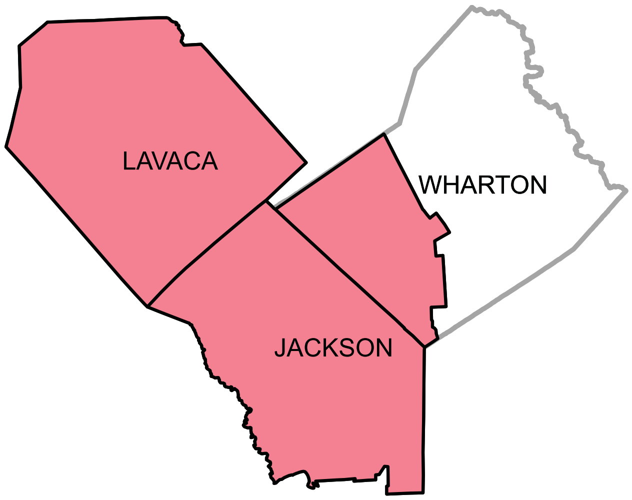
In order to meet municipal and industrial needs in other regions and to reduce any external pressure on local groundwater supplies, a large-scale desalination project on Lavaca Bay was recommended. This project involves a modular design that uses a multistage distillation or reverse-osmosis process. For additional water the project would most likely blend the high quality water from the desalination facility with water from other sources for transport to entities with needs. The capital cost of the desalination project is estimated to be $800 to $900 million, which would probably be borne by the entities receiving the water. Therefore, no capital costs are associated with the water management strategies to meet the needs within the Lavaca Region.

Groundwater availability throughout the region is defined on a sustainable basis (estimated recharge to the aquifer), as opposed to the total amount of water in aquifer storage. Water conservation was recommended for all user groups in the region.

New reservoirs are not recommended for meeting needs in the Lavaca Region. The Palmetto Bend II Reservoir site was recommended for designation as a unique reservoir site. This reservoir, which would be a companion project to the existing Lake Texana, already has a State permit.

(P) Lavaca Region



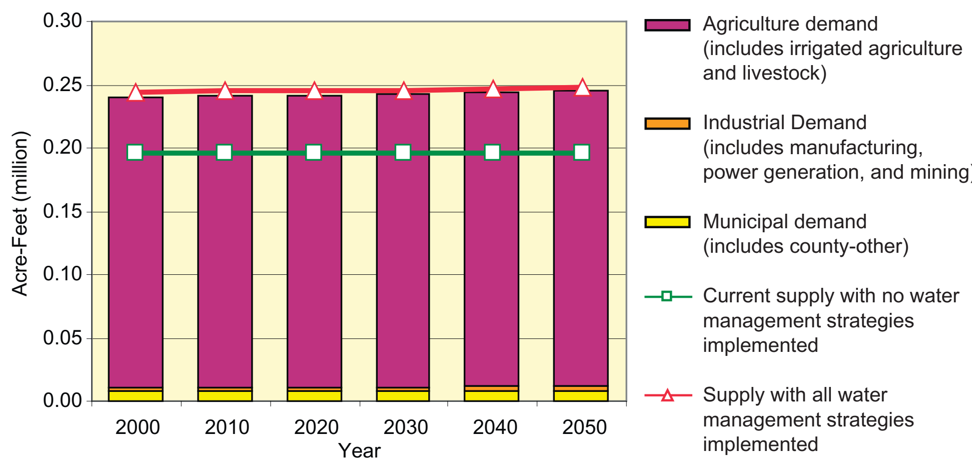


● Cities with needs based on comparison of current water supplies with projected demands.

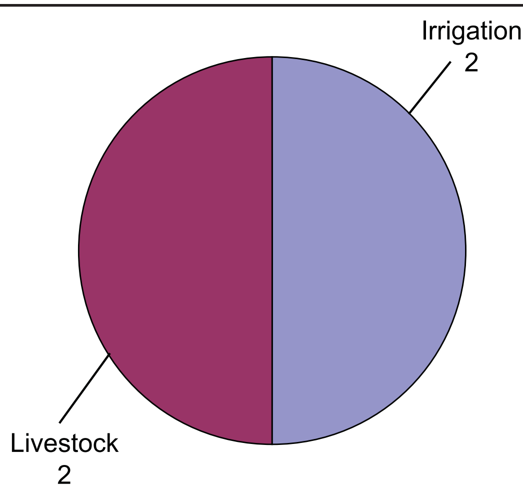
Key Points

- **Total capital cost: $0**
- No new reservoirs
- Strategies to meet all municipal needs occurring by 2050
- Four water user groups with projected water needs by 2050
- Desalination plant to meet water needs in neighboring regions recommended
- Groundwater availability defined on a sustainable basis rather than on a storage basis

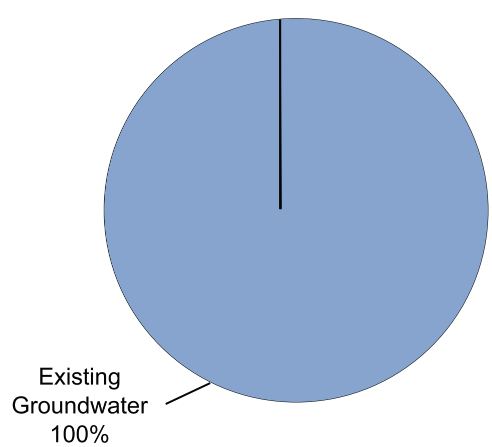
Projected Water Supplies and Demands



Water User Groups with Needs by 2050



Types of Water Management Strategies Used to Meet Needs by 2050



12.0 Socioeconomic Impacts

> **Key Finding If the State does not ensure that there is enough water to meet projected needs, models project that there will be 7.4 million fewer jobs, 13.8 million fewer people, and 38 percent less income Statewide in 2050.**

If a need for water is not met, there are social and economic impacts to a region and the State. For example, if a city does not have enough water to meet its needs, industry and people are not likely to move to that city. Existing industry may relocate to an area with more resources, taking employees and their dollars with them. If water for irrigation is insufficient, farmers may have to grow less profitable crops or stop farming altogether. These examples have direct impacts (fewer people, less industry, less farming) and indirect impacts (less spending, fewer needed services, fewer farm equipment purchases) on the local, regional, and State economy. Estimating these direct and indirect socioeconomic impacts is important for understanding the cost to the State when there is not enough water to meet needs.

12.1 Estimating Socioeconomic Impacts

The Planning Groups estimated the potential socioeconomic impacts of not meeting water needs in their regions. To do so, they used an analysis developed by the TWDB that estimates direct and indirect socioeconomic impacts of water. The TWDB used economic models to estimate direct and indirect economic benefits of water for residential, commercial, steam-electric power generation, mining, irrigation, livestock, and manufacturing uses for each region. The economic benefit of water was then used to calculate the economic loss when water could not be provided for a future use.

Direct impacts per acre-foot of water were estimated by taking the total economic benefit of a water use and dividing it by the amount of water used to attain that economic benefit. Economic benefit is measured in terms of product sales to final consumption, including exports, but excluding those sales that are used as inputs in the production of a different product in the region. For example, if a farmer sells his crop for $1,000,000 after using 10,000 acre-feet of water to grow that crop, and 75 percent of the region's crop sales go to final consumption, the direct economic benefit is $75 per acre-foot of water ($1,000,000 multiplied by 75 percent divided by 10,000 acre-feet). Direct economic benefit per acre-foot of water for each region was calculated for each water use except manufacturing (Table 12-1). For manufacturing, the direct economic benefit per acre-foot was calculated for different manufacturing uses at a Statewide level (Table 12-2) and then proportioned to each county according to the total manufacturing water use in the county.

The total economic impact of water is the sum of direct and indirect economic impacts. The indirect economic impact is considered in the economic multiplier (Table 12-3). The economic multiplier is the ratio of the direct and indirect economic impacts to the direct economic impact and depends on how much a region imports and exports. The total economic impact can be estimated when the economic multiplier is multiplied by the direct economic impact. For example, if the direct economic impact is $100 per acre-foot of water and the economic multiplier is 2.2, the total economic impact is $220 per acre-foot of water ($100 per acre-foot multiplied by 2.2).

Table 12-1. Direct economic benefit per acre-foot of water for different water uses in the regions (based on 1995 economic benefits and shown in 1999 dollars).

Region	Residential	Commercial	Steam-Electric	Mining	Irrigation	Livestock
A	34,946	122,096	65,348	12,698	298	33,748
B	55,738	160,682	7,650	14,919	338	10,913
C	47,900	148,779	35,012	21,029	467	1,950
D	50,653	176,674	8,867	35,447	111	16,503
E	25,228	218,148	61,636	12,144	161	1,627
F	34,437	193,356	15,459	10,643	187	16,734
G	41,856	240,578	11,358	9,109	317	11,907
H	46,852	246,079	36,670	24,352	115	2,009
I	47,079	162,198	16,407	44,021	116	1,737
J	41,308	141,557	0	9,613	186	13,379
K	41,328	207,736	1,456	8,311	160	1,927
L	39,514	335,305	6,501	5,786	121	13,356
M	28,414	153,365	28,535	3,666	283	8,839
N	51,988	123,361	64,854	10,673	90	1,109
O	34,771	208,509	11,744	18,792	169	31,986
P	54,258	188,221	0	33,665	179	9,268

Table 12-2. Direct economic benefit per acre-foot of water for different manufacturing water uses in the State (based on 1995 economic benefits and shown in 1999 dollars).

Water use	Economic benefit per acre-foot
Paper	13,838
Chemicals	44,154
Petroleum refining	83,692
Primary metals	46,855
Nondurable goods	127,139
Durable goods	397,629

The TWDB also calculated multipliers for income and employment. The income multiplier represents the fraction of the direct impact that ends up as wage and salary income and income to business owners (Table 12-3). The employment multiplier measures the number of jobs in full-time equivalents that result from using the water (Table 12-3). The impact from decreased employment on population was then estimated on the basis of the fundamental assumption of not meeting water needs.

Table 12-3. Economic output, income, and employment multipliers (based on 1995 economic benefits and shown in 1999 dollars).

Water use	Economic output multiplier (per dollar of direct impact)	Income multiplier (per dollar of direct impact)	FTE employment multiplier (per million dollars of output)
Livestock	2.256	0.534	26.990
Irrigation	2.118	0.538	36.688
Mining	1.711	0.416	9.881
Manufacturing	2.365	0.654	17.109
Steam-electric	1.624	0.452	8.692
Commercial	2.194	0.951	30.924
Residential	1.246	0.322	11.528

Economic output multiplier—the ratio of direct and indirect economic impacts to direct economic impacts
Income multiplier—the fraction of direct impact that ends up as wage and salary income and income to business owners
FTE (full-time equivalent) employment multiplier—the number of jobs in full-time equivalents that result from using the water

12.2 Impacts of Not Meeting Water Needs

Total water demand for the State under drought-of-record conditions is projected to increase from 16.9 million acre-feet in 2000 to 20 million acre-feet in 2050. Under the same conditions, water needs will increase from 2.4 million acre-feet in 2000 to 7.5 million acre-feet by 2050. This means that if no new supplies are developed, the State will be able to supply only 62.5 percent of projected water demands in time of drought in 2050. To assess the socioeconomic impacts of not meeting needs, the Planning Groups compared two scenarios: one where all water needs are met and another where water needs are not met.

If the State does not implement plans to ensure that there is enough water, model projections show that there will be 1.9 million fewer jobs in 2010, 4.8 million fewer jobs in 2030, and 7.4 million fewer jobs in 2050. Population growth would be affected by fewer jobs, with 3.8 million fewer people in 2010, 9.1 million fewer people in 2030, and 13.8 million fewer people in 2050. Income to the population is projected to be reduced by about 16 percent ($62 billion) in 2010, about 30 percent ($155 billion) in 2030, and about 38 percent ($238 billion) in 2050.

Agriculture accounts for more than 80 percent of total water needs in 2000 and slightly less than 40 percent in 2050. The economic impact of not meeting agricultural needs is small on the Statewide economy but large for local economies. Municipal needs increase from about 10 percent of total needs in 2000 to about 40 percent in 2050, and account for 60 to 70 percent of the total economic impact to the State.

13.0 Status of Water Availability Modeling

Key Finding Water availability models of the State's river basins are expected to be completed by December 2001, and groundwater availability models of the State's major aquifers are scheduled for completion in September 2004.

Texas is developing new, state-of-the-art computer models of surface water and groundwater resources. These new models are important tools for estimating the amount of water available to the citizens of Texas for the next 50 years. In 1997, the Legislature directed the TNRCC to develop water availability models for the major river basins except the Rio Grande Basin. In 1999, the Legislature provided initial funding for development of groundwater availability models for the major aquifers. The 2001 Texas Legislature directed the TWDB to develop groundwater availability models for the minor aquifers and the TNRCC to develop a water availability model for the Rio Grande. The status of these modeling efforts is described below.

13.1 Groundwater Availability Modeling

The TWDB, its contractors and cooperators, the Edwards Aquifer Authority, and the U.S. Geological Survey (USGS) are developing groundwater availability models of the major aquifers of the State. This effort will result in 17 models of the 9 major aquifers (Figure 13-1). Of these, 4 models have been completed, 10 models are currently under construction, and work on 3 models is planned to begin in 2002. Models of the Trinity aquifer in the Hill Country (developed by the TWDB), the north part of the Ogallala aquifer (developed by the Panhandle Planning Group), and the Barton Springs segment of the Edwards aquifer (developed by the Lower Colorado Planning Group) have been completed and are available at the TWDB Web site. The USGS expects to release the model and a final report of the Hueco Bolson aquifer at the end of 2001.

Models currently under development by the TWDB and its contractors include the south part of the Ogallala aquifer; the north, central, and south parts of the Carrizo-Wilcox aquifer; the north, central, and south parts of the Gulf Coast aquifer; the Edwards-Trinity Plateau aquifer; and the north segment of the Edwards aquifer. The model of the north part of the Gulf Coast aquifer is being developed by the USGS in cooperation with the TWDB, the Harris-Galveston and Fort Bend subsidence districts, and the City of Houston. The Edwards Aquifer Authority, in cooperation with the USGS, is developing a new model of the San Antonio segment of the Edwards aquifer. The TWDB plans to begin work on models of the Seymour, Cenozoic Pecos Alluvium, and the north part of the Trinity aquifers in fall 2002. All current and planned modeling of major aquifers are expected to be completed by September 2004.

A critical element of groundwater availability modeling is stakeholder participation. The TWDB assembled a technical advisory group of technical and policy experts to discuss the requirements and standards for modeling. External reviews of proposals and qualifications for contracted models were solicited from Planning Groups, groundwater conservation districts, and other State agencies. Each of the modeling projects has quarterly stakeholder advisory forums for the modeling teams to review progress and receive comments. Stakeholder advisory forums are open to anyone interested in the modeling process.

Planning Groups and groundwater conservation districts will use the models to assess availability of groundwater in the areas or regions. These assessments will be based on the socioeconomic needs of their areas and may be guided by groundwater management standards that describe the desired future condition of the aquifer, such as the quantity and quality of groundwater and the amount of springflow, baseflow, and subsidence.

Final reports, models, and aquifer information will be posted on the TWDB Web page (www.twdb.state.tx.us/gam).

13.2 Surface Water Availability Modeling

Senate Bill 1 required the TNRCC to develop water availability models for 22 of the 23 river basins in Texas. The TNRCC has hired contractors to develop modeling protocols, as well as the models, which were projected for completion by the end of 2001. These efforts have been coordinated with staff from the TPWD, TDA, and TWDB.

Regions C and North East Texas extracted monthly naturalized and regulated streamflows from the Sulphur River basin model and input the results into the TWDB daily reservoir operation model to calculate firm yields for the Marvin Nichols I proposed reservoir. The South Central Texas Region used the Guadalupe-San Antonio River basin model. The Coastal Bend Region used the Nueces model to calculate surface water availability for part of the region.

The Rio Grande basin was not included in Senate Bill 1 but was included in Senate Bill 76 of the 76th Legislative session, with a designated appropriation in the 77th Legislative session. The TNRCC will produce a model of the Rio Grande basin during the next planning cycle.

The water availability modeling program is used by the TNRCC for surface water rights permitting purposes and by the TWDB, TPWD, and planning groups for water planning purposes. Each water availability model includes basin water rights and hydrological data, GIS watershed graphic programs, a Water Rights Analysis Package (WRAP), and some supplementary programs.

WRAP, part of the water availability model, is a monthly water budget program. It allocates water availability for water rights according to the seniority of the rights. WRAP utilizes "naturalized" historical flow information as a basis for analysis. Naturalized flow means the estimated flow without any human interference. It can be estimated only from recorded river flows coupled with water use and return flow data.

Two major functions of WRAP are the calculation of the firm yield of a water supply reservoir and estimation of the reliability of water rights. Firm yield is defined as the maximum water volume a reservoir can provide each year under a repeat of the most severe historical drought condition. The WRAP tracks usable reservoir storage for the historical period and picks the lowest storage as the firm yield. Therefore, firm yield is more of a measure of water supply capability than a guarantee of availability.

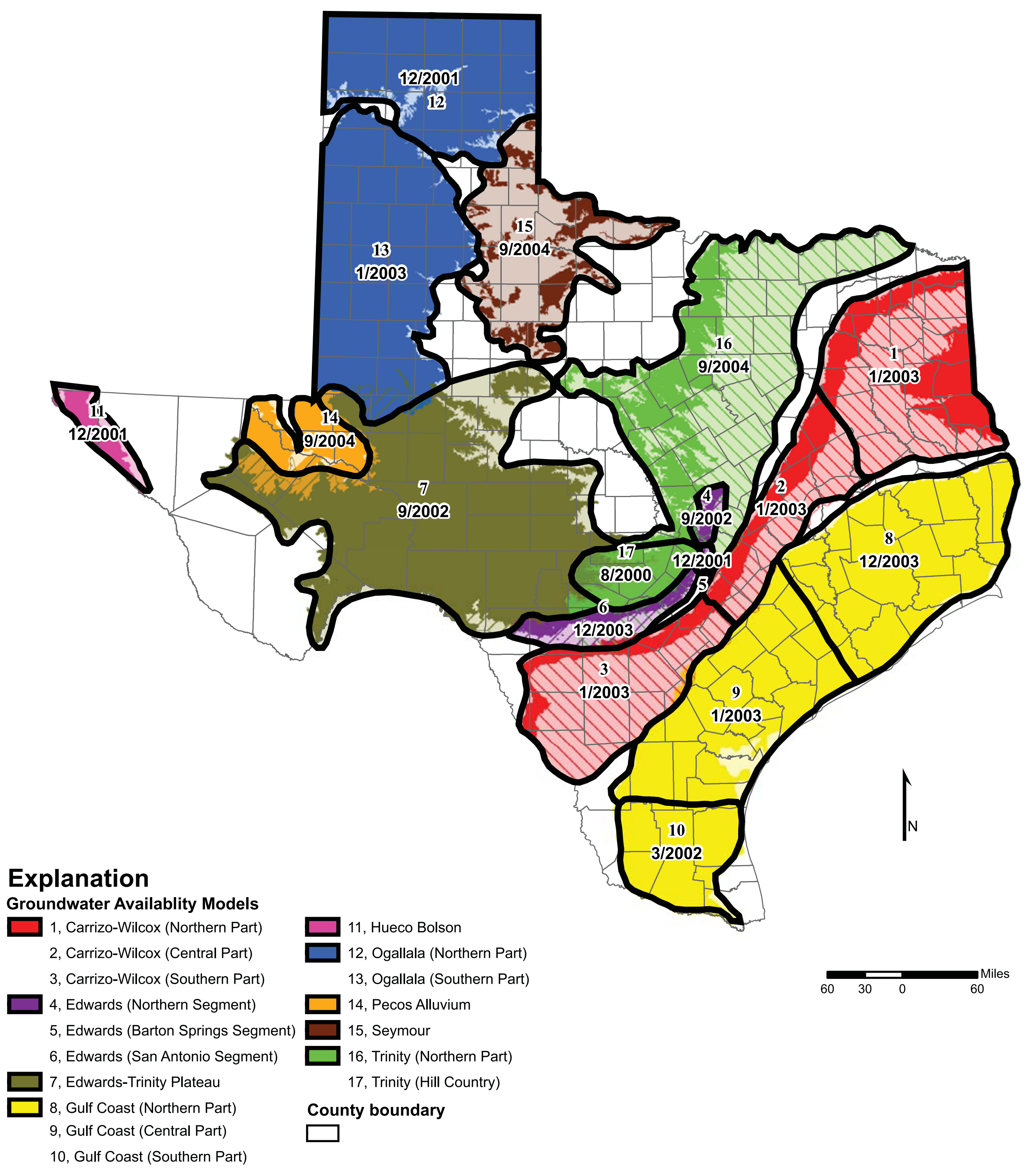


Figure 13-1. Locations and expected completion dates of groundwater availability models of the major aquifers of Texas.

14.0 Policy Recommendations

In Texas, decisions on water resource development, such as preferred water supply options, planning and design, and method of financing, occur at the local level. One goal of the State Water Plan is to bring together often disparate interests to identify policy issues and recommendations that improve the process of managing the State's water resources in order to meet near- and long-term needs.

Policy recommendations included in the 2002 State Water Plan are the result of a two-tiered process beginning in the fall of 2000 and ending in January 2002. The first set of recommendations is one provided by the Planning Groups to the Legislature and the TWDB at the end of the first round of regional water planning.

The second set of recommendations results from a consensus driven, policy development process conducted by the TWDB over a 5-month period by more than 80 stakeholders representing water-related interests throughout the State beginning in May 2001. These policy recommendations represent a collaborative effort to identify policy issues and recommend policy changes. The goal of this policy process was to achieve consensus on the recommendations. In situations where consensus was not reached, levels of agreement and alternative opinions were included in the policy.

14.1 Policy Recommendations from the Planning Groups

Key Finding The Planning Groups have six common recommendations for the Legislature: (1) to consider allowing the Planning Groups to select alternative water management strategies for water user groups with needs, (2) to continue the planning process, (3) to provide adequate funding for regional water planning, (4) to provide adequate funding for implementing water plan recommendations, (5) to clarify Senate Bill 1 provisions on unique stream segments, and (6) to consider making certain administrative activities eligible for funding.

Senate Bill 1 allowed the Planning Groups to make policy recommendations to the Legislature about their regional water plans. The recommendations represented regulatory, administrative, or legislative changes that the Planning Groups thought were needed to facilitate the development, management, and conservation of water resources and to prepare for drought.

The TWDB summarized the policy recommendations from the Planning Groups in the *Water for Texas Summary of Regional Water Plans* and presented them to the 2001 Texas Legislature. The common recommendations are again presented here.

Senate Bill 1 required the Planning Groups to develop a regional water plan that had specific provisions for water management strategies for handling a drought-of-record. Many Planning Groups believe that this requirement hampers their ability to make choices and meet the needs of their regions. They also believe that this requirement decreases local control and flexibility. They recommended the Planning Groups be allowed to select alternative water management strategies to meet needs. The TWDB has elected not to revise planning guidelines to address this recommendation. The 77th Texas Legislature also chose not to revise the statutory requirement related to planning in this regard.

The Planning Groups believe that the planning process has been worthwhile and strongly support the grassroots development of water policy for Texas. They believe that it should continue and recommend that the Legislature continue to support the process and the established regions. Continuity is important for the regions as they meet to address changing conditions, serve as communication liaisons with water users, and solve interregional water issues over the long term. The 2001 Texas Legislature, based largely on the broad support of the Planning Groups, continued funding for the regional water planning process.

Adequate funding is key to the success of the regional water planning process. The Planning Groups recommend adequate, continuous funding to improve the collection, monitoring, and dissemination of basic water data. Water data, including groundwater availability information, are critical for regions to accurately identify water needs and appropriate water management strategies. As with the previous recommendation, the 2001 Texas Legislature appropriated funds to make significant progress in addressing this recommendation.

The Planning Groups also recommend that the Legislature provide funds sufficient to implement water management strategies through a loan or grant program or other funding mechanism. During the first planning cycle, the Planning Groups identified a variety of water supply strategies to meet local and regional needs, and they feel that the strategies must now be implemented. Certain water management strategies, such as new reservoir projects, have greater capital costs and environmental challenges than those in the past. This was one of the primary points of focus during deliberations of Senate Bill 2 for the 77th Texas Legislature. Continued funding of the State Participation Program and the approval of a constitutional amendment to increase TWDB funding authorization for water projects in Texas both indicate the Legislature's commitment to addressing this recommendation. However, provisions of Senate Bill 2 require the Planning Groups to provide by 2003 to the Legislature more specific information on the local and regional funding needs and how the local political subdivisions plan to fund these projects.

In Senate Bill 1, the Legislature specifically asked the Planning Groups to consider identifying ecologically unique stream segments for potential designation by the Legislature. The Planning Groups recognize the ecological value of identifying and protecting unique stream segments. However, many found the implications of such a designation unclear. As such, they recommend that the Legislature clarify the definition, implications, and significance of identifying and designating these sites. A few Planning Groups specifically recommend that the Legislature consider the impact of a designation on private property owners and local governmental entities and consider limiting any impact. This issue was clarified in Senate Bill 2 passed by the 77th Texas Legislature.

Many of the Planning Groups believe the State should pay for some of the administrative activities of the regional water planning process, such as reasonable expenses of the Planning Group members, travel expenses of the voluntary Planning Group members, and public-notice requirements. In June of 2001, the TWDB revised funding guidelines to allow for reimbursement of certain administrative costs incurred during the planning efforts.

The Planning Groups provided a total of 340 recommendations on a variety of topics in the regional water plans, including legislative, TWDB rules, and funding suggestions. A detailed summary of the recommendations from the Planning Groups follows. For the complete text of all recommendations from the Planning Groups, see the 16 regional water plans in Volume III.

These recommendations represent the thoughts, needs, and wishes of each Planning Group and address specific legislative and funding recommendations. When grouped by topic, more than 23 different areas of concern were identified on topics ranging from agriculture, conjunctive use, data collection and research, the environment, groundwater availability, interregional water sharing, reuse, specific funding requests, sustainable population growth, and water quality. The listed policy recommendations represent summaries of specific recommendations. Every effort has been made to ensure the accuracy of the information presented here. The authoritative source of information on a specific region is its adopted regional water plan (Volume III).

Agriculture — Regions A, C, F, G, H, I, J, K, L, and M

A, F..........Gather information on water used for irrigating agriculture and watering livestock
A..............Create a water conservation reserve program for managing irrigated acreage
C ....Encourage the Texas Agricultural Statistics Service to include water supply questions on farm and ranch surveys
F ....Provide funding for local supply improvements, such as lining stock tanks
F, M ....Continue funding research on droughts and drought-tolerant crops
G, M.........Expand existing loan and grant programs to assist agriculture in conserving and developing water
H, M ....Fund research on more efficient irrigation practices
I ....Ensure that water is available for agriculture, even in the face of adverse economic conditions or competing demands
J ....Provide funding to landowners for management practices that best conserve water
K..............Study farmland preservation to explain how loss of rural and agricultural lands can affect the quantity and quality of State water supplies
L ....Establish and fund an Irrigation Technology Center as proposed by Texas A&M University
M.............Study the effect of any loss and establish an inventory of agricultural lands
M.............Encourage irrigation districts to review policies to facilitate water transfers among agricultural users

Brush Control and Land Management — Regions A, B, F, G, J, and K

A..............Evaluate legislative barriers to using playa lakes for recharge or other benefits
B..............Study brush management and water yields in the Wichita River watershed
F ....Fund brush control programs
F ....Fund groundwater recharge enhancement structures
G..............Focus programs assisting agricultural producers on intensive brush control
J ....Study the cost of brush removal and recharge benefits
K..............Study brush control projects; provide State and/or Federal funding

Conjunctive Use — Regions J, K, and N

J ....Encourage conjunctive use through tax relief or grants for those that claim riparian rights
K..............Support conjunctive use within Region K to promote conservation and to meet needs
N ....Declare that all water in the State should be managed on a conjunctive use basis

Conservation — Regions A, C, F, H, N, and P

A..............Direct that TNRCC should encourage utilities to monitor for unaccounted losses
C..............Increase State participation in water conservation efforts

F ....Fund implementation of conservation technologies through low-interest loans or incentives
H ....Address and improve water conservation activities in the State
N ....Manage water more efficiently by improving conservation and system operating policies
P ....Support existing efforts by agricultural producers to conserve groundwater and surface water

Data Collection and Research — Regions B, E, J, L, M, N, and O

B ....Fund data collection on agricultural water use and water management/conservation projects
E, M.........Fund data collection in rural areas, including groundwater availability modeling; allow Planning Groups to request funding
J ....Study relationship between groundwater and surface water to determine effects on spring-flows
L ....Provide funding to TWDB and TNRCC to facilitate access to water data
M.............Evaluate effects of groundwater withdrawal on surface water availability and streamflows
N ....Expand research on groundwater conditions and aquifers
N ....Encourage oil and gas drillers to provide information on groundwater formations to facilitate identification of aquifer characteristics
O ....Fund development and maintenance of basic-data network

Desalination — Regions B, H, J, M, N, and P

B ....Maintain the chloride control project on the Wichita River as a regional priority
H ....Fund research and development program for desalination
J ....Conduct a feasibility analysis to evaluate the viability of desalination
M.............Fund research and development of desalination; offer incentives for implementation
N ....Direct TNRCC to review and reclassify concentrate from desalination process
N ....Study environmental impacts of concentrate discharges
N ....Fund State participation program and direct funding to desalination plant construction
P ....Finance full-scale desalination project

Education — Regions C, J, L, N, and O

C..............Provide education to board members of water supply corporations, special utility districts, and municipal utility districts
J ....Develop education programs for public and private sectors
L ....Fund public education programs on water; coordinate with Texas A&M University Extension Service
N ....Fund education programs for citizens on groundwater issues
O ....Fund public education programs about the regional water planning process

Environment — Regions F, H, I, K, and P

F ....Limit releases from Spence and Ivie Reservoirs to inflow levels
H ....Continue State Bays and Estuaries programs; provide for additional monitoring and research
I ....Investigate a regional or Statewide environmental mitigation system
K..............Direct that the Lower Colorado River Authority release water to prevent degradation of water supplies and to protect the environment
P ....Investigate, evaluate, and mitigate impacts to environment from desalination and Palmetto Bend Reservoir Phase II

Groundwater Availability — Regions A, D, H, J, K, and O

A ....Place a high priority on funding groundwater availability modeling projects, including minor aquifers
D ....Support completion of groundwater availability modeling project
H ....Expand funding for groundwater availability modeling
J ....Study Trinity aquifer; develop system of observation wells
J ....Direct Regions J, K, and L to evaluate the Trinity aquifer model
J ....Characterize and delineate groundwater in the Austin Chalk
J ....Assess the ability of the Trinity aquifer to receive and release water
K..............Collect groundwater availability information
O ....Pay for development and maintenance of computer models to quantify aquifer resources

Groundwater Management — Regions A, F, G, H, I, J, K, L, O, and P

A, H, J,
K, O, P .....Support the creation of Groundwater Conservation Districts (GCD's)
A ....Evaluate and clarify authority for reasonable and equitable export fees for GCD's
F, O ....Support current policy that GCD's are the preferred method of managing groundwater
G..............Support coordinated management of groundwater based on resource (aquifer) boundaries
H ....Maintain Rule of Capture in all areas not part of a GCD
I, L............Support Texas Water Conservation Association's legislative recommendations regarding the management of groundwater
J ....Do not limit a GCD's ability to manage water resources
J ....Establish and enforce uniform well rules in all Trinity aquifer counties
J ....Encourage and enable counties to establish lot sizes and well-spacing regulations
J ....Standardize methodology for groundwater supply evaluation Statewide
K..............Oppose groundwater mining except during extreme drought
K..............Repeal well-permitting exemptions in the Texas Water Code and allow GCD's to adopt own exemptions
K..............Support efforts by Region K GCD's to control or limit groundwater mining
K..............Allow a GCD to charge a transport fee for water produced in the district
L ....Provide additional authority to counties to plan for land use and to regulate development
L ....Require GCD's and Planning Groups to use the same water demand projection data
O ....Support Rule of Capture; modify it to require spacing of wells from property lines
O ....Remove well-permitting and production limitations of water wells within a GCD
O ....Oppose a transport fee for groundwater
O ....Support creation of GCD's in designated priority groundwater or surface water areas
P ....Support Rule of Capture; exercise local control through GCD's
P ....Establish an export fee to help offset the impacts of transferring water out of a region

Interbasin Transfers (IBT) — Regions C, D, E, F, H, I, K, L, N, O, and P

C, H ....Remove barriers to IBT's of surface water
D ....Maintain current law for IBT's of surface water
E ....Study IBT's of surface water to encourage Planning Groups to coordinate
F ....Maintain junior rights provision until water availability modeling is completed
I ....Maintain junior water rights provision until State Water Plan is developed by TWDB

K..............Follow principles established by Region K for transporting water outside of regions
K..............Preserve junior water rights provision
K..............Clarify junior water rights provision so that it applies to water sale contracts and rights transfers
K..............Adjust surcharge on future water sales to users in Williamson County
L ....Clarify that water transferred from bays or the Gulf of Mexico for desalination projects is not part of an IBT
N ....Repeal the junior rights provision and additional application requirements for IBT's for surface water
N ....Exclude water originating from desalination facilities from requirements of IBT permits for surface water
N ....Amend IBT provisions in Senate Bill 1 regarding desalination
O ....Oppose a transport fee for surface water
P ....Maintain junior rights provisions; oppose modification or elimination

Interregional Water Sharing — Regions G, L, and O

G..............Develop guidelines to encourage voluntary redistribution of water
L, O ....Ensure that all Texans know that Planning Group boundaries are not intended to prevent water transport

Public Involvement — Regions A, E, H, and J

A..............Evaluate notification requirements for amending the regional water plans
E ....Amend the Open Records Act to exempt private water information from being released without landowner's consent; prohibit State agencies from sharing data without consent and require them to treat all water data as confidential
E ....Verify and clarify that all Planning Group committees, subcommittees, and subgroups are covered by the Open Meetings Act
H ....Limit notification requirements for amendments to regional water plans
J ....Exempt Planning Group committees and subgroups from the Open Meetings Act

Regional Water Plan Implementation — Regions E, G, M, and N

E ....Clarify that the role of Planning Groups is to monitor implementation of regional water plans
G..............Create incentives for industries to donate water treatment and distribution facilities to governmental water suppliers
M.............Regionalize water and wastewater utility systems
N ....Amend State procurement law in order to give greater flexibility to public agencies to build plants
N ....Encourage a regional approach to water management

Reuse — Regions A, C, G, and N

A..............Evaluate and change rules governing the reuse of wastewater effluent in order to provide incentives to municipalities, industries, and agriculture to use it
C..............Reduce regulatory and legislative obstacles to indirect reuse of treated wastewater

G..............Encourage wastewater reuse as a water management option
N ....Establish State policy to promote reuse

Rio Grande Management — Region M

M.............Create a regional water entity for helping to manage the Rio Grande, developing conservation and supply projects, and monitoring and planning for water quality
M.............Recognize that compliance by Mexico with the terms of the 1944 treaty is essential to the area

Senate Bill 1 — Regions A, B, E, J, M, N, and O

A..............Clarify the relationship between drought-contingency and regional water planning
B..............Clarify the goals of drought-contingency and regional water planning
E..............Lessen focus of Senate Bill 1 on drought-of-record; plans should not be drought-contingency plans
E..............Clarify how existing plans and funding interrelate in Senate Bill 1
J...............Require State agencies involved in the planning process to participate in the Planning Groups
M, N ....Amend Senate Bill 1 to allow State funding for ongoing regional data-collection activities

Specific Funding Requests — Regions A, C, D, F, H, J, K, L, M, and N

A, F, H .....Provide continuing and interim funding to the Planning Groups
A..............Provide funding for utilities to replace or repair aging infrastructure
A..............Fund expansion and integration of the North Plains Potential Evapotranspiration Network
A..............Fund feasibility studies for the Sweetwater Creek Reservoir project
C..............Increase funding for TWDB loans and the State Participation Program
C..............Encourage Federal funding for developing and upgrading Natural Resources Conservation Service small watershed structures
C..............Fund maintenance and construction of stock ponds
D ....Fund assessment of public water systems that have groundwater quality problems
F..............Fund the Railroad Commission of Texas (RRC) programs on drilling and cementing of oil and gas wells that penetrate aquifers
F..............Expand funding of weather modification projects
J...............Fund programs to identify appropriate locations for recharge structures
J...............Fund modernization of water and wastewater systems; educate cities on the need to modernize
J...............Fund weather modification and rainwater harvesting
J...............Fund preliminary study of unique reservoir sites
K..............Fund research on a new high yielding, low water using variety of rice
L..............Provide sufficient funding to TWDB and TNRCC for administering State Water Plan programs
L..............Fund demonstration projects on alternative water supply strategies, such as desalination
L..............Fund a Center for Water Research at The University of Texas at San Antonio
L..............Fund Edwards Aquifer Research and Data Center at Southwest Texas State University
M.............Seek Federal funding for an International Boundary Water Commission (IBWC) study on rechanneling a part of the Rio Grande
N ....Establish a regional resource center for groundwater management in the Coastal Bend area

N ....Establish and fund a Regional Water Resources Information Management System
N ....Fund irrigation efficiency programs and creation of water conservation revenue programs to make it economically feasible for producers to convert from irrigated to dry-land farming

Surface Water Availability — Regions A, F, H, J, and M

A ....Require coordination between Planning Groups and State agencies on development of groundwater and surface water availability modeling projects
F ....Place a high priority on the water availability modeling project
H ....Direct TNRCC to use more realistic assumptions in water availability modeling
J ....Incorporate Medina Lake diversion system in TNRCC's water availability model
M..............Fund development of water availability model for the Rio Grande

Surface Water Rights — Regions C, G, H, J, L, and M

C ....Make certain water rights exempt from cancellation for nonuse
G...............Oppose cancellation of existing water rights as a water management option
H ....Exempt from cancellation water rights that have not been used in 10 years
H ....Exempt from cancellation any water rights secured by a sponsor of a water supply project
J ....Change definitions of "beneficial use" and "waste" in the Texas Water Code to prevent wasteful uses
J ....Devise a survey method to estimate unpermitted riparian water withdrawn from rivers and tributaries
L ....Fund TNRCC to ensure legal and appropriate use of permitted surface water rights
M..............Encourage coordination on urbanization issues between municipalities and irrigation districts

Sustainable Population Growth — Regions K and L

K...............Develop growth-limit projections for Region K
L ....Focus on the consequences of growth; evaluate land use and health of ecosystems to prepare for the future and to support a sustainable quality of life

Water Quality — Regions B, C, D, F, G, K, and L

B ....Allow long-term use of bottled water programs or provide a waiver for small user groups that have no reasonable, cost-effective means of complying with current regulations
C...............Increase State participation in watershed-protection planning
D ....Expedite replacement of methyl tertiary-butyl ether in reformulated gasoline with additives that do not threaten water supplies
F ....Place a moratorium on enforcement of current radionuclide standards; adopt new standards after more research has been done
F ....Provide regulatory guidance for disposal of radionuclide waste products
F ....Allow development and use of water supplies that exceed secondary drinking water standards without mandatory treatment
F ....Increase funding for RRC programs to identify and plug improperly plugged wells
F ....Strengthen RRC rules on abandoned wells
F ....Develop RRC plans to clean up saltwater disposal pits
G...............Assist local entities in implementing sound water quality projects

K..............Request thorough scientific data from the U.S. Environmental Protection Agency to determine health risks present in areas served by Hickory and Marble Falls aquifers

L ....Require consistency between State agencies on Federal permitting processes; articulate requirements in State Water Plan

Other Regions D and J

D ....Encourage consistency between TWDB rules for regional water supply planning and TNRCC rules for public drinking water systems regarding minimum requirements for water supply

J………... .Establish one State water agency

14.2 Recommendations for Designation of Stream Segments of Unique Ecological Value

Key Finding Region H was the only region to recommend unique stream segments, and it recommended six segments in its area. The TWDB recommends that the Legislature consider protecting the six segments identified by Region H in its area as unique stream segments.

Addressing the need for recognizing and protecting some of the unique stream resources of the State, Senate Bill 1 directed the Planning Groups to consider identifying ecologically unique stream segments for potential designation by the Legislature. Under TWDB rules, a Planning Group may recommend that a river or stream segment be considered unique ecologically on the basis of the following criteria:

- **biological function—**stream segments that display significant overall habitat value, including both quantity and quality, according to the degree of biodiversity, age, and uniqueness observed, and including terrestrial, wetland, aquatic, or estuarine habitats;
- **hydrologic function—**stream segments that are fringed by habitats that perform valuable hydrologic functions relating to water quality, flood attenuation, flow stabilization, or groundwater recharge and discharge;
- **riparian conservation areas—**stream segments that are fringed by significant areas in public ownership (including State and Federal refuges for wildlife), management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations for conservation purposes; or the stream segments that are fringed by other areas managed for conservation purposes under a governmentally approved conservation plan;
- **high water quality/exceptional aquatic life/high aesthetic value—**stream segments and spring resources that are significant due to unique or critical habitats and exceptional aquatic life uses that depend on or are associated with high water quality; or
- **threatened or endangered species/unique communities—**sites along streams where water development projects would have significant detrimental effects on State or Federally listed threatened and endangered species; or the sites along a stream that is significant because of the presence of unique, exemplary, or unusually extensive natural communities.

According to State law (as amended by Senate Bill 2), the designation of a river or stream segment of unique ecological value means solely that a State agency or political subdivision of the State may not finance the actual construction of a reservoir in a specific river or stream segment designated by the Legislature.

The TPWD provided a list of candidate stream segments in each of the 16 regions that appeared to fit at least one criterion for being designated as ecologically unique. In many cases, the U.S. Fish and Wildlife Service and other stakeholders provided input to this process.

Only Region H chose to recommend unique stream segments, identifying six (Figure 14-1). Most of the Planning Groups asked the Legislature to clarify this issue and expressed interest in addressing this and other related issues more fully in the next round of planning, when the implications of such a designation may be better understood.

14.3 Recommendations for Unique Reservoir Sites

Key Finding: Five of the Planning Groups found 33 sites uniquely suited for reservoir development.

Senate Bill 1 allows sites to be designated by the Legislature as having unique value for reservoir construction. Once a site is designated, State agencies and political subdivisions are prohibited from obtaining a fee title or easement that would significantly prevent the construction of a reservoir at that site. Although a site may be recognized as having unique value for reservoir construction by a Planning Group or by the TWDB in the State Water Plan, designation must be provided by the Legislature for statutory protection to be provided.

To date, the Legislature has designated two such sites: Allens Creek and Post Reservoirs.

The TWDB directed the Planning Groups to describe the sites, give reasons for the unique designation, and define how the State would benefit from the reservoir. The Planning Group and the TWDB used two criteria to assess whether a site could be considered unique for reservoir construction:

- The site had site-specific reservoir development recommended as a specific water management strategy or it had been included in an alternative, long-term scenario in an adopted regional water plan.
- The location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics (or other pertinent factors) make the site uniquely suited for reservoir development to supply water for the current planning period or reservoir development to meet needs beyond the 50-year planning period.

Five of the Planning Groups recommended 33 sites uniquely suited for reservoir development (Figure 14-2). Region C recommended 4 sites, the North East Texas Region recommended 15 sites, Region H recommended 3 sites, the East Texas Region recommended 13 sites, and the Lavaca Region recommended 1 site. Three of the sites, Marvin Nichols I, Carthage, and Kilgore II, were identified by multiple regions.

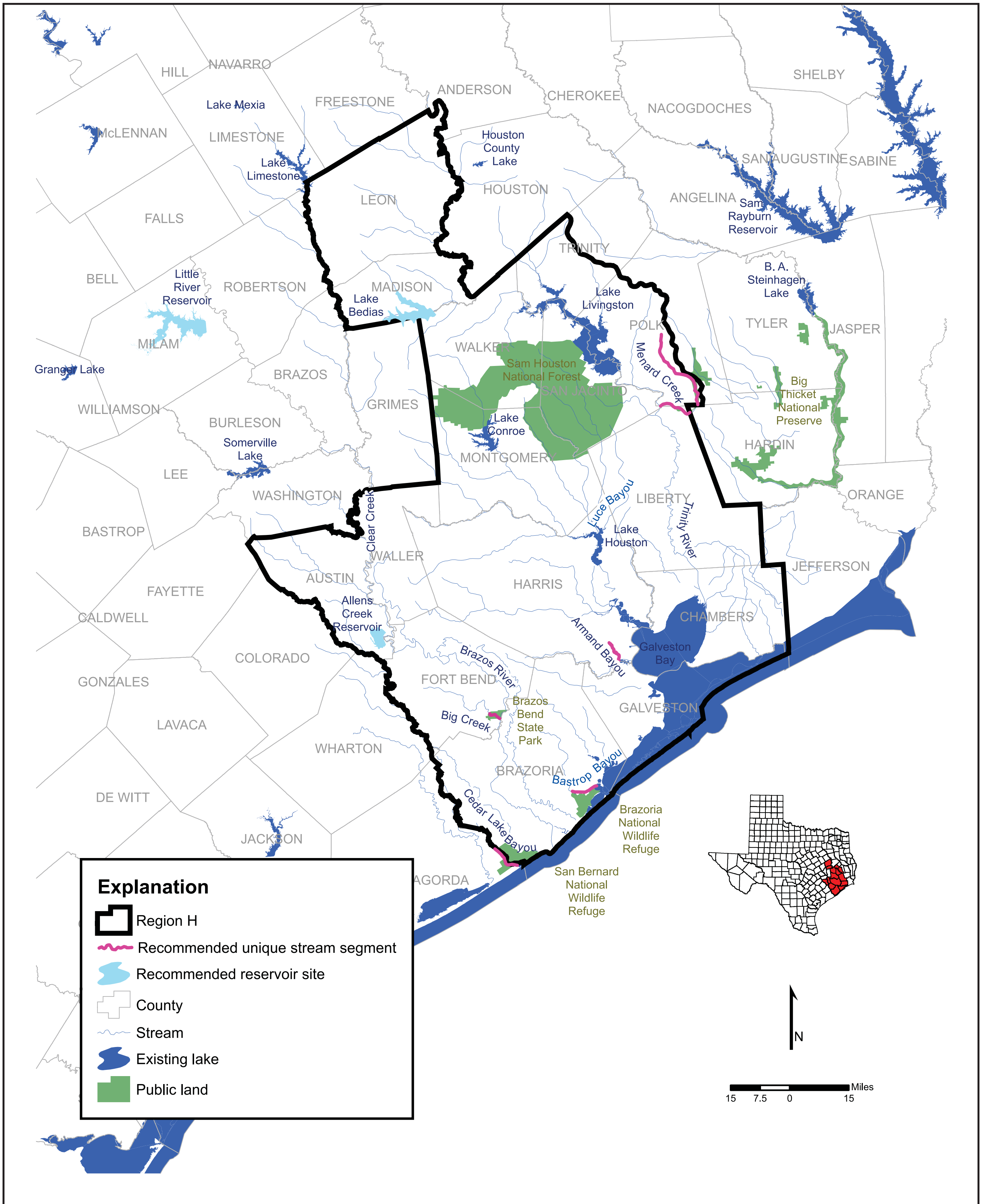


Figure 14-1. Reservoir sites and unique stream segments recommended by Region H.

Key Finding TWDB recommends that the Legislature consider 20 sites identified by the Planning Groups for protection as unique reservoir sites.

The TWDB reviewed the information in the approved regional water plans and recommends the following sites for protection:

- Red River Basin: Lower Bois d'Arc Creek, Big Pine, Pecan Bayou, and Muenster
- Sulphur River Basin: George Parkhouse I, George Parkhouse II, Marvin Nichols I, and Marvin Nichols II
- Cypress Creek Basin: Little Cypress
- Sabine River Basin: Prairie Creek, Big Sandy, Carl Estes, Rabbit Creek, and Carthage
- Neches River Basin: Eastex
- Trinity River Basin: Tehuacana and Bedias
- Brazos River Basin: Little River
- Lavaca River Basin: Palmetto Bend II

The following sites were reviewed but not recommended for designation and protection at this time, although they should remain under consideration as alternative unique reservoir sites.

- Barkman in the North East Texas Region because of lack of information in the regional water plan that justifies designation.
- Liberty Hills in the North East Texas Region because of lack of information in the regional water plan that justifies designation.
- Waters Bluff in the North East Texas Region because of significant wetland bank and conservation easement conflicts.
- Rockland in the East Texas Region because of lack of information in the regional water plan that justifies designation and potential environmental conflicts with a federally protected river reach.
- Big Cow Creek in the East Texas Region because of lack of information in the regional water plan that justifies designation and no identified needs that cannot be met by other sources.
- Bon Weir in the East Texas Region because of lack of information in the regional water plan that justifies designation and its location in the Lower Basin, which has a sufficient existing water supply for the planning period.
- State Highway 322 Stage I in the East Texas Region because of lack of information in the regional water plan that justifies designation and the existing lignite mine in the area conflicts with reservoir development.
- State Highway 322 Stage II in the East Texas Region because of lack of information in the regional water plan that justifies designation and the existing lignite mine in the area conflicts with reservoir development.

- Stateline in the East Texas Region because of lack of information in the regional water plan that justifies designation and no identified needs that cannot be met by other sources.
- Socogee in the East Texas Region because of lack of information in the regional water plan that justifies designation and no identified needs that cannot be met by other sources.
- Fastrill in the East Texas Region because of lack of information in the regional water plan that justifies designation and no identified needs that cannot be met by other sources.
- Ponta in the East Texas Region because of lack of information in the regional water plan that justifies designation and no identified needs that cannot be met by other sources.
- Double Mountain Fork in the Brazos G Region. Late in the planning process, the Brazos G Planning Group became aware of this reservoir site as a potential source of water supply. Currently both local and regional interests are evaluating this site for potential reservoir construction. Because of the severe water shortages that this region has experienced during drought conditions over the past several years, this site may be important in meeting the water supply needs of the region.

Additionally, the TWDB received many comments from concerned residents that construction of some reservoirs would inundate land that has been in their families for multiple generations. The TWDB recognizes that reservoir construction will inevitably create such impacts, which cannot be totally offset by monetary compensation.

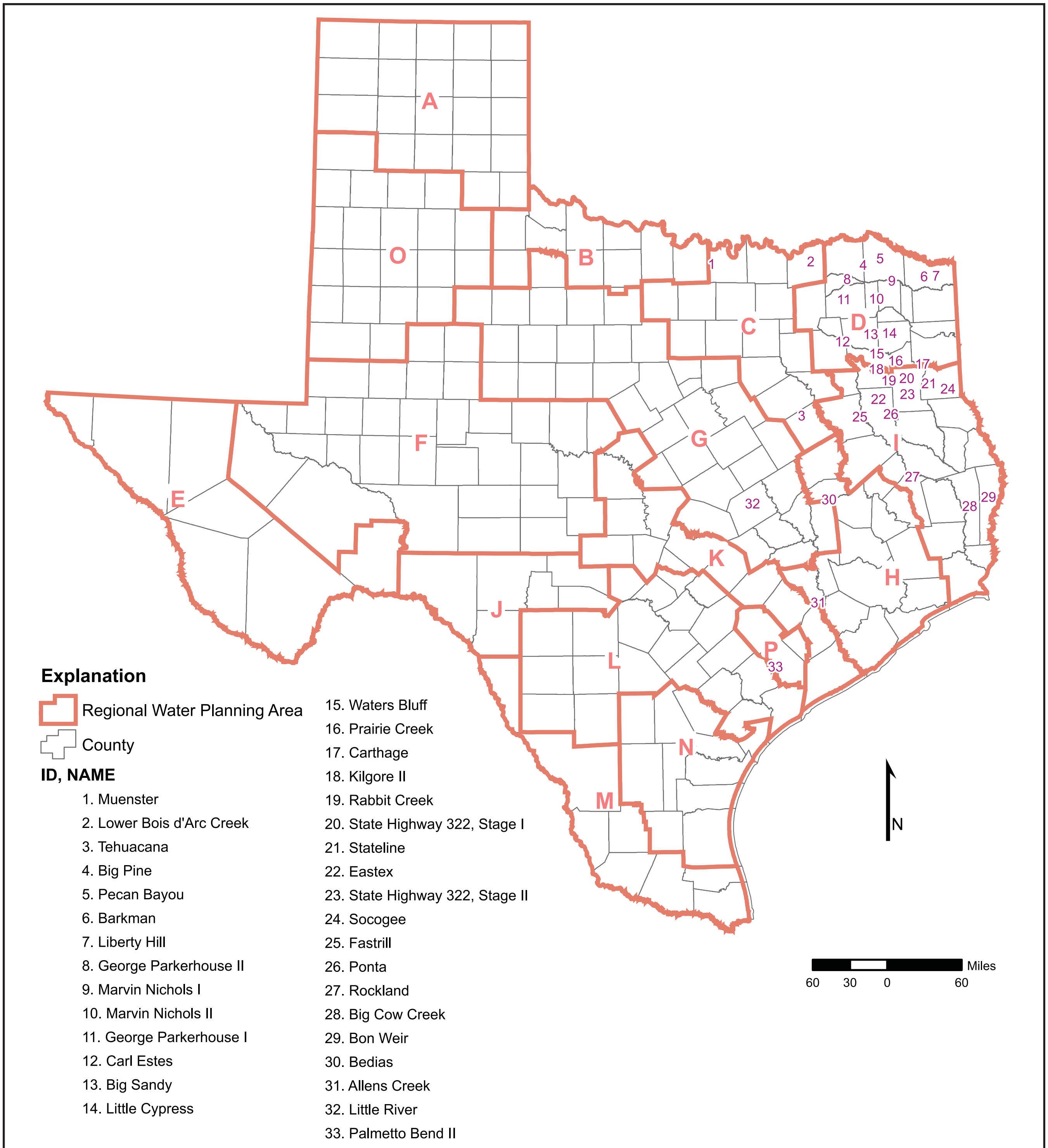


Figure 14-2. Unique reservoir sites proposed by Planning Groups.

Appendix I

Policy Recommendations from Stakeholders

Stakeholders included representatives of the Planning Groups, various State agencies, public interest, water and environmental associations, groundwater conservation districts, river authorities, cities, utilities, water-financing and legal representatives, and other members of the public actively involved in water supply planning and water policy issues. They were charged with identifying policy issues and recommending policy changes, if any, to improve the likelihood (including reducing impediments) of, and assist in implementing the regional water plans.

At the first of five stakeholder meetings, the group evaluated, refined, and ranked in order of importance 11 policy issues derived from input from Planning Groups, staff from State natural resource agencies, members of the Legislature and its staff, water interest groups, and the general public. The policy issues, in order of ranking, included surface water, water infrastructure financing, environmental protection/flow maintenance, agriculture/rural, groundwater, water marketing, conservation/drought management, water quality, nontraditional water management strategies, planning and implementation, and data collection and information.

At subsequent meetings, stakeholders and additional experts met in issue-specific subgroups (Roundtable Groups) to develop recommendations for each policy issue. Policy issues and recommendations were developed during face-to-face meetings and electronic discussions using an Internet discussion forum (similar to a chat room). Upon completion by a Roundtable Group, each policy paper containing recommendations was presented to the stakeholders for possible recommendation to the TWDB for inclusion in the 2002 State Water Plan.

The 2002 State Water Plan represents an expansion of efforts, started in 1992, in using consensus for developing the 1997 State Water Plan. The 1997 State Water Plan relied on consensus to improve cooperation in implementation and policy development with the TWDB, TNRCC, and TPWD, and, to a lesser extent, various other water interests and the general public. The 2002 State Water Plan expands the consensus development process to include a diverse set of water-related representatives from throughout the State.

Consensus support from the stakeholders and Roundtable Groups for each recommendation and policy issue was a goal of the stakeholder process. If consensus was not attained, the various positions were noted and the degree of support for each recommendation was indicated. If needed, alternative opinions were represented in each policy recommendation paper and were submitted to the TWDB for consideration in the 2002 State Water Plan. See Volume III for the complete text and voting results of the Stakeholders Report.

Surface Water Issues

A. Reuse

Recommendation

1. The natural resources agencies, with stakeholders, shall develop a report to examine benefits and impacts related to reuse for each river basin in the State and identify future information needs and policy options. (Approved at stakeholders meeting by majority.)

B. Subordination Agreement

Recommendation

1. TNRCC, TWDB, and TPWD should work with stakeholders to assess impacts of subordination on other water rights and environmental water needs.

C. Recreation

Recommendation

1. Reservoir owners should be encouraged to voluntarily provide an opportunity for discussion and public education concerning use of a reservoir for water supply and for recreational purposes.

D. Surface Water and Groundwater Model Interaction

Recommendation

1. The TNRCC and TWDB should jointly develop a process that would propose linking Water Availability Modeling (WAM) and Groundwater Availability Modeling (GAM) in areas where there is significant groundwater and surface water interaction, including recommendations for funding and statutory changes necessary to facilitate this linkage. The agencies should develop this process using significant involvement of major stakeholders.

E. Interbasin Transfer

Recommendation

1. The Legislature should direct natural resource agencies, with stakeholders, to develop a report with recommendations concerning interbasin transfers, which would include different needs and circumstances, with impacts, within each regional water planning area/basin of the State. (Approved at stakeholders meeting with one dissenting opinion.)

F. Encourage System Operation

Recommendation

1. TWDB should consider clarifying its rules to encourage system operations, where appropriate, including potential systems that cross planning area boundaries and groups in the regional water planning process.

G. Flood Management

Recommendations

The Legislature should consider

1. Encouraging groundwater conservation districts to cooperate with surface water entities and water rights holders to explore opportunities for enhancing groundwater recharge using stormwater runoff.
2. Taking all appropriate actions to ensure timely updates to FEMA maps where needed.
3. Legislating to require counties and cities to aggressively enforce floodplain regulations.

H. Permit Exemption

Recommendation

1. TNRCC should work with the Texas State Soil and Water Conservation Board and Natural Resources Conservation Service to develop and seek funding for a program to estimate the magnitude, distribution, and general location of exempt water storage facilities in priority areas.

I. Water Rights Administration and Enforcement

Recommendations

1. The Legislature should evaluate whether there is a need for a watermaster program in each river basin of the State. The Legislature should consider requiring the implementation of watermaster programs where appropriate.
2. The Legislature should consider providing additional funding to TNRCC to ensure effective water management, water education, and water rights enforcement for Texas.

Financing Water Infrastructure

A. State Assistance

Recommendations

1. The role of State assistance programs needs to be expanded to ensure that problems are addressed and long-term State goals are achieved. State assistance should be provided as required to supplement local efforts to
    a. achieve goals established by regional water planning groups for implementation of recommended water management strategies that the State decides merit assistance;
    b. support cost-effective regional projects, including, but not limited to, the current State Participation Program;
    c. support disadvantaged communities or communities with limited access to traditional capital markets with low-interest loans and grants, including consolidation subsidies to encourage cost-effective regional solutions; and
    d. support funding of nontraditional solutions.
2. Stakeholders were unable to agree on the introductory language to use for the following recommendation. Therefore, two introductory sentences are proposed.

Recommended at stakeholder meeting by majority: State priority-ranking criteria for projects receiving State assistance should include the following (not listed in priority order):

Recommended at the stakeholder meeting by minority: In programs where demand exceeds funding, the State should adopt priority-ranking criteria for projects receiving State assistance, which should consider the following (not listed in priority order):

a. Higher priority for projects to address urgent public health and safety needs.
b. Higher priority for creation of regional or multicommunity water and wastewater systems.
c. Higher priority for projects that meet the needs of small, rural, disadvantaged, or geographically isolated communities.
d. Lower priority for projects that cannot demonstrate managerial or technical expertise necessary to complete a project. A **minority at the stakeholders meeting** expressed concern about potentially penalizing small, rural, or disadvantaged communities because they may lack certain expertise; however, the recommendation was accepted by consensus.
e. Higher priority for water supply projects derived from reuse.
f. Higher priority for projects with environmental benefits.
g. **Recommended at the stakeholder meeting by minority:** Lower priority for projects with environmental damage. This recommendation generated a significant amount of discussion. Some alternative suggestions to item f were suggested as a compromise; however, stakeholders were unable to reach a consensus on any of the proposed suggestions.
h. Higher priority for projects with demineralization.
i. Higher priority for projects that produce more water with less total funding.

j. Higher priority for projects that maximize conservation, including agriculture.
k. Staff support to implement priority projects.

3. The following dedicated funding sources should be considered to enhance the State's ability to assist local government in implementing water infrastructure projects:
   a. Increased agricultural funding sources (Federal).
   b. Increased State Revolving Fund funding.
   c. **Recommended at the stakeholder meeting by majority:** Bottled water fee. A **minority at stakeholders meeting** suggested that this item be deleted because it will most likely be discussed by the Joint Committee on Water Resources (created by Senate Bill 2, 77th Texas Legislature, Regular Session) as part of the interim charges.
   d. General revenue.
   e. Statewide bond issue.
   f. **Recommended at the stakeholder meeting by majority:** Statewide sales tax on water and wastewater service. A **minority at the stakeholders meeting** suggested that this item be deleted because it will most likely be discussed by the Joint Committee on Water Resources (created by Senate Bill 2, 77th Texas Legislature, Regular Session) as part of the interim charges.
4. The stakeholders recommend that the following items from the Conservation/Drought Management section be included here:
   a. The Legislature should consider providing funds for loans to be made available for municipal conservation program activities, such as fixture replacement and other incentive programs.
   b. The Legislature should consider expanding tax exemptions for fixtures and equipment that are identified to lower water use and increase available supply.
5. The TWDB should remove unnecessary administrative burdens related to State Revolving Fund funding within the authority of TWDB.
6. Multiple purpose projects should be encouraged to take advantage of economies of scale and cost sharing.
7. A comprehensive financing package using State and Federal agency funding mechanisms should be developed.
8. Training programs in financial and technical management should be developed and outreach assistance provided to communities who lack these skills so that they can access financial assistance and implement water infrastructure projects.

B. Public-Private Partnerships

Recommendations

1. Encourage public-private partnerships in implementing solutions to water needs where appropriate.
2. Educational materials and programs should be developed and distributed on the Web site to assist water resource managers in becoming familiar with the benefits and risks of private investment in water infrastructure projects.
3. Statutory changes should be considered to ensure that State financial assistance could be made available to public-private partnerships.

Environmental Protection/Flow Maintenance

A. How to appropriately define and provide for instream flows and freshwater inflows to bays and estuaries?

Recommendations

1. In the absence of site-specific studies, the consensus criteria, as amended or modified by the natural resource agencies, should continue to be applied to water development projects for planning purposes.
2. A comprehensive instream flow study program should be implemented by the natural resource agencies as soon as possible in order to evaluate the ecological needs of priority stream segments in a timely manner, pursuant to recent statute directives (Senate Bill 2).
3. The existing interagency freshwater inflow study program previously established by the Legislature should continue to be adequately funded for the evaluation of inflow needs in the major and minor bays and estuaries, as conditions change along the coast and more data become available.
4. The Legislature should consider providing funding for voluntary conservation activities in which the majority of water saved would be made available to meet environmental water needs. (Approved at stakeholder meeting with one dissenting opinion.)
5. The natural resource agencies and institutions of higher learning should implement programs to educate the public about the need for instream flows and freshwater inflows to maintain the ecological health and productivity of the State's rivers, bays, and estuaries.
6. The Legislature should consider establishing policies that will facilitate the natural resource agencies and water rights holders in providing environmental flows by using the Texas Water Trust or some similar method or concept.
7. The Legislature should consider directing the natural resource agencies to establish a process or program, such as the Water Trust, to develop voluntary agreements with existing water rights holders for combined system operation of water supply systems to improve efficiency in such a way as to release water for the environment while not significantly reducing the availability of State water for diversion and beneficial use shared under the existing permits. The program should include proposed methods for financing any such agreements and the infrastructure necessary to implement them.
8. The Legislature should consider establishing criteria and directing the natural resource agencies to develop procedures for reserving water in the river basins as environmental flows to protect and maintain the living natural resources of the State. (Approved at stakeholder meeting with one dissenting opinion.)
9. The Legislature should evaluate whether there is a need for a watermaster program in each river basin of the State. The Legislature should consider requiring the implementation of watermaster programs where appropriate.
10. The Legislature should consider directing and funding TNRCC to implement its water rights cancellation authority. (Approved at stakeholder meeting with four dissenting opinions.)
11. The Legislature should consider directing TNRCC, in coordination with TWDB and TPWD, to evaluate the status of environmental flows on a river basin basis assuming various scenarios, including the full exercise of existing rights.
12. Existing property rights in water must be respected as Texas works to resolve the increasing competition for limited water supplies between consumptive use of water and environmental values. (Approved at stakeholder meeting with eight dissenting opinions.)

B. How to encourage voluntary transfers of existing rights to environmental purposes?

Recommendation

1. The natural resource agencies, in cooperation with stakeholders, should prepare a report to the Joint Legislative Committee and the Water Advisory Council identifying actions considered necessary and appropriate to increase the effectiveness of the Texas Water Trust.

C. What is an appropriate policy to ensure/protect needed springflows?

Recommendation

1. The Legislature should encourage groundwater conservation districts to include in their management plans an evaluation of the impacts of the plan on major springs and related surface water supplies.

D. What criteria should be used in determining which water bodies are monitored?

Recommendations

1. The Legislature should consider appropriating adequate State matching funds to complement all available Federal funds in order to complete the "core" network and add major springs to the State-Federal monitoring network.
2. The TWDB should seek more cooperators among industries, political subdivisions of the State (e.g., cities, river authorities, surface and groundwater conservation districts), Federal agencies, and other potential sponsors to fund the installation, operation, and maintenance of the new stream- and springflow gages that will be needed for the effective management of water resources in the future.
3. The natural resource agencies should continue and expand their State and Federally sponsored monitoring of Texas lakes, bays, and estuaries in cooperation with lake owners, local industries, hunting and fishing organizations, and conservation groups.
4. TWDB should change the monitoring criteria to include (a) stream gaging at potential future impoundment and diversion sites identified in the State and regional water plans, (b) stream gages at large governmentally funded brush control sites, (c) stream gages in river and coastal basins needed for tracking instream flows and freshwater inflows to bays and estuaries, (d) all stream gages used in the WAM's as permanent members of the "core" network, and (e) groundwater well gages that lie on flow paths between major pumping areas and major springs of interest.

Agricultural/Rural Water Issues

A. What are water-related threats to agriculture and what is the appropriate State policy to help ensure viability/sustainability/competitiveness of the industry and, at the least, address mitigation of these threats? How can impacts of the future shortages of water for agriculture be mitigated?

Recommendations

1. Regional Water Planning Groups should incorporate groundwater conservation district plans for water conservation programs to attempt to reduce overdraft or declining groundwater resources.
2. The Legislature should take actions that will facilitate funding of agricultural water conservation projects and make all or a part of those water savings available for nonagricultural purposes, while maintaining adequate supplies for agricultural use. Therefore, it should be State policy to provide mechanisms to facilitate or directly finance agricultural water conservation and transfer water savings through such mechanisms as the Texas Water Bank or other water markets. (Approved at stakeholders meeting with one dissenting opinion.)

3. The Legislature should fund a comprehensive agricultural water use database consisting of an inventory of agricultural lands and associated water demands. Additionally, the Legislature should require that the databases not contain site-specific landowner information.
4. The Legislature should evaluate whether the Rule of Capture properly addresses property rights; historical, cultural, and environmental values; and current and future water use requirements. (Approved at stakeholders meeting by substantial majority.)

B. What actions should be taken to address impacts of water supply changes on rural communities and their economy?

Recommendation

1. The Legislature should commit adequate funding to the Rural Water Assistance Fund.

C. What is the State's role in improving water conservation in agriculture?

Recommendations

1. Given the limitations under Federal tax law that restricts the uses of the existing TWDB bond programs, the Legislature should take other actions to facilitate alternative and flexible funding mechanisms for water conservation that address both conveyance system and on-farm efficiencies.
2. The Legislature should enact policies to encourage reuse of water for irrigation.
3. The Legislature should increase educational and technical assistance and expand funding through low-interest loans or other monetary incentives to implement advanced conservation technologies and Best Management Practices.
4. The Legislature should provide more support for research on saline and drought-tolerant plants and increase support for research on and adoption of efficient systems for delivery and application of irrigation water. Consistent and recognized methods should be utilized to evaluate and determine the cost and benefits associated with water conservation efforts.

Groundwater Issues

Texas Water Code (TWC) §36.0015 states "Groundwater conservation districts as provided by this chapter are the State's preferred method of groundwater management." The following issues and recommendations are offered solely for the purpose of supporting and strengthening the State's established position with regards to the management and conservation of groundwater resources in Texas.

A. Groundwater Management.
Discuss possible groundwater management goals, objectives, and strategies and the Groundwater Availability Modeling (GAM) results as illustrations of impacts of these goals, objectives, and strategies.

Recommendations

1. GCD's and RWPG's should work to identify possible goals and water management strategies for potential implementation, using the GAM's to evaluate and understand the impacts of these goals and strategies on the aquifer. GCD's and RWPG's over a common management area should strive to have compatible management goals. The TWDB should be available to assist in this effort, if requested. TWDB staff will provide any requested analysis on the basis of guidance from the GCD's and RWPG's. Results will be provided to the GCD's and RWPG's and also to the public over the Internet.
2. The Legislature should consider the addition of a management goal addressing the GCD's desired future condition for the aquifer for inclusion in the GCD's adopted groundwater management plan currently required in Texas Water Code §36.1071.

B. Discuss criteria to determine the validity and use of available studies other than State supported GAM's for evaluating groundwater management goals and strategies.

Recommendation

1. GCD's and RWPG's should meet and work with TWDB staff to discuss and establish the validity of alternative techniques. The criteria will be: Do the proposed studies (or evidence) evaluate aquifer impacts and do they result in better estimates than estimates resulting from GAM's? Along this line, it is clearly recognized that other studies and other hydrologic evidence may be used to supplement, enhance, or refine results obtained from the GAM's.

C. Describe impacts of operating water sources at sustainable levels.

Recommendation

1. The goal of groundwater management in Texas should be to move toward sustainability, but, because aquifers and the social and economic needs of the State vary from place to place, groundwater availability should be locally or regionally assessed, balancing all interests. This is clearly an example of where one size does not fit all.

D. Conjunctive Use.
Discuss success stories in Texas. Identify opportunities for more effective and efficient water management in Texas.

Recommendation

1. The State should consider both statutory provisions and financial incentives related to the development of viable conjunctive use projects in order to use all water resources in a more efficient and effective manner. TWDB, TNRCC, TPWD, TDA, GCD's, and RWPG's should work aggressively together to identify opportunities for conjunctive use and encourage its implementation.

E. Assessment of groundwater availability for minor aquifers.

Recommendations

1. The Legislature should appropriate sufficient funding for basic groundwater research necessary to generate and analyze basic data needed so that GAM's may be developed for all minor aquifers.
2. The Legislature should also consider encouraging GCD's to routinely collect basic groundwater data sufficient for groundwater availability modeling efforts and funding those efforts.

F. Rulemaking Powers of GCD's over wells in certain counties.

Recommendation

1. Because safeguards for transporters were included in Senate Bill 2, negating the need for TWC § 36.121, and given the unintended consequences, the Legislature should consider the repeal of TWC § 36.121.

Water Marketing

Water marketing is a mechanism by which existing water supplies may be voluntarily redirected to match supplies with new or different demands. Previous Texas Water Plans have recommended water marketing as a possible tool to meet water demands. Recently, as some river basins have become fully appropriated and certain groundwater sources strained, there has been heightened interest in water markets and increased interest in large surface and groundwater transactions.

A. What is the appropriate role of water marketing in the State's future?

Recommendation

1. Water marketing should play a significant role in future water supply planning and implementation. However, appropriate consideration must be given to potential third-party impacts of marketing. (Approved at stakeholder meeting with one dissenting opinion.)

B. What level of government should regulate water market transactions?

Recommendations

1. TNRCC should continue to be the agency regulating surface water rights.
2. Groundwater conservation districts should continue to be the State's preferred method of groundwater management.

C. What legal, institutional, and water management system changes are needed to provide for water marketing?

Recommendations

The Legislature should consider

Legal -

1. Requiring natural resource agencies, with stakeholders, to develop a report to look at benefits and impacts related to reuse for each river basin in the State and identify future information needs and policy options.
2. Clarifying the legal control of conserved water.
3. Determining how to identify and measure impacts from market transactions.
4. Clarifying protections for all interests, including the environment, to facilitate the efficient operation of the market.

Institutional -

5. Evaluating the need for a watermaster program in each river basin of the State.
6. Clarifying public welfare review terminology and criteria to be used for compensating areas of origin in surface water permitting.
7. Requiring that clear guidelines be developed concerning what information will be required during the TNRCC application process, including what information is required to get a declaration of administrative completeness.

Water Management –

8. Creating a publicly accessible database of water and water rights pricing information. All information will be posted solely on a voluntary basis.
9. Clarifying groundwater conservation districts' authority to prohibit the excessive drawdown and resulting permanent loss of groundwater supplies. (Approved at stakeholders meeting with one dissenting opinion.)

D. How would local water supplies be protected?

Recommendation

The Legislature should consider:

1. Forming additional Chapter 36 groundwater conservation districts or expanding existing districts to manage groundwater resources under clear management guidelines.

E. How would appropriate consideration of potential third-party impacts, such as those to agriculture and the environment, be ensured?

Recommendations

The Legislature should consider:

1. Developing procedures to better address third-party impacts, if any, from groundwater and surface water transactions. Processes may include the identification and quantification of mitigation measures.
2. Protecting rural communities' access to local water resources.

Conservation/Drought Management

This policy issue does not discuss agricultural water conservation as that is to be addressed in the Agricultural/Rural Issue.

A. What is the appropriate role of conservation and drought management in supplying Texas' water needs?

Recommendation

1. All water system operators should include conservation and drought management as integral parts of their water system operation. Recommendations for implementation are provided below.

B. Should minimum levels for water conservation and drought management be established? If so, how and by whom?

Recommendations

1. Minimum levels of water conservation should continue to be established by water suppliers at the local level. However, the TNRCC and TWDB should modify their rules to require that the water conservation and drought contingency plans include locally set quantified goals, such as in gallons per capita per day (GCPD). Goals set by specific entities should recognize their past efforts and local circumstances. (Approved at stakeholders meeting with four dissenting opinions.)
2. The Legislature should consider directing the TNRCC and TWDB to jointly identify quantified target goals for water conservation and drought contingency planning that may be used as guidance by water suppliers and other entities in preparing water conservation or drought contingency plans, and the Legislature should provide sufficient funding to assist entities in implementing plans that are consistent with quantified target goals.
3. The TNRCC and TWDB should jointly develop model water conservation programs for different types of water suppliers that would suggest best management practices for achieving the highest practicable levels of water conservation and efficiency achievable by a specific type of water supplier. (Approved at stakeholder meeting by substantial majority.)
4. The TNRCC and TWDB should jointly develop model drought contingency programs for different types of water suppliers that would suggest best management practices for achieving the highest practicable levels of water use reductions achievable during drought situations by a specific type of water supplier. (Approved at stakeholder meeting by substantial majority.)

C. How to facilitate achieving enhanced water conservation in all water use categories?

Recommendations

1. The Legislature should consider providing funds for loans to be made available for municipal conservation program activities, such as fixture replacement and other incentive programs.
2. The Legislature should also consider expanding tax exemptions for fixtures and equipment that are identified to lower water use and increase available supply.

D. How do we enhance water conservation and drought management public awareness and education?

Recommendation

1. A "Water Smart" or like program should be established as a permanent, year-round public awareness campaign. The outreach should be a coordinated marketing campaign utilizing private/public partnerships, all available media and include information on water supplies, water use, and water planning, as well as water conservation.

E. Leak detection.

Recommendation

1. The TWDB should review options for funding improvements of water system efficiencies, especially for reducing system losses. This subissue was approved at the stakeholder meeting with three dissenting opinions.

Water Quality

A. Identification of emerging water quality issues, their impact on water supply, and suggestions for solutions. These include revisions to radionuclide and arsenic rules, protection of brackish groundwater supplies, and protection of surface water from intrusion of saline sources.

Recommendations

1. State regulatory and financial agencies should coordinate with their Federal counterparts to suggest regulatory and financial assistance programs to address the impacts associated with the implementation of new radionuclide and arsenic standards. When new standards are implemented, the Legislature should consider the cost of these standards on local water suppliers and assess the adequacy of current financial assistance to mitigate costs.
2. State agencies are encouraged to use their existing authorities to protect brackish groundwater with the reasonable potential of becoming usable water supplies.
3. The State should support efforts to protect water supply sources from saltwater intrusion.
4. The State agencies should coordinate with their Federal counterparts to develop financial assistance and regulatory programs to address brine disposal from brackish groundwater.

B. What policy changes need to be made to provide a high-quality drinking water supply at an affordable cost?

Recommendation

1. State regulatory and financial agencies should coordinate together and with their Federal counterparts to assess the cost of implementing new standards and how available financial programs can meet those needs.

C. How can we effectively address point and nonpoint source water quality issues, including abandoned wells?

Recommendations

The Legislature should consider

1. Increasing financial assistance to soil and water conservation districts in Texas to develop watershed-based NPS management plans and to clarify that development of management plans is eligible for TWDB funding.
2. Authorizing natural resource agencies to assess the adequacy of current programs and financial capability to implement comprehensive watershed management.
3. Assisting GCD's in locating and plugging abandoned wells.
4. Enhancing funding for counties and other entities to address nonagricultural NPS and point source pollution.

Nontraditional Water Management Strategies

A. What is the appropriate role of desalination in providing water supplies and how to provide flexibility and incentives for desalination, the increased use of brackish water, and research on improving desalination technology?

Recommendations

The Legislature should consider

1. Supporting research on various desalination issues, including identifying suitable sites for new desalination plants in consultation with RWPG's,
2. Encouraging local and regional entities to consider providing additional incentives for desalination plants, and
3. Encouraging agencies to evaluate their permitting processes associated with desalination, in a timely manner, to eliminate inappropriate requirements.

B. What is the appropriate role of groundwater banking, recharge projects, and aquifer storage and recovery (ASR) in providing water supply and how to provide flexibility and incentives?

Recommendations

The Legislature should consider

1. Requiring groundwater conservation districts (GCD's) to consider including in their management plans a provision to promote and/or implement groundwater banking, recharge projects, and aquifer storage and recovery projects, where appropriate and cost-effective, to address areas with declining groundwater levels.
2. Encouraging agencies to evaluate their permitting processes associated with groundwater banking, in a timely manner, to eliminate inappropriate requirements.

C. What is the appropriate role of weather modification in providing water supply and how to provide flexibility and incentives?

Recommendation

1. The Legislature should consider providing funds to conduct research on the efficiency and impact of weather modification and on refining the techniques for cloud seeding/precipitation enhancement and to continue funding for current weather modification programs designed to enhance the availability of water.

D. What is the appropriate role of brush control in providing water supply and how to provide flexibility and incentives?

Recommendation

1. The Legislature should consider continuing State support for brush control projects, as appropriate.

E. What is the appropriate role of rainwater harvesting (RWH) in providing water supply, and how to provide flexibility and incentives?

Recommendations

1. In areas where such systems could reduce overdrafts on declining groundwater resources, GCD's and/or RWPG's should consider including RWH in their management plans.
2. The TNRCC should evaluate allowing the use of harvested rainwater as a raw water source so that it could be used to supplement the public drinking water supply.
3. Local and regional entities should consider providing additional incentives in their jurisdictions for those who wish to install RWH systems.

Planning and Implementation Issues

A. How to improve implementation of projects by enhancing State and State-Federal regulatory agency coordination?

Recommendations

1. In the regional planning process, the TWDB should coordinate participation of appropriate State and Federal agencies, such as BOR, U.S. Army Corps of Engineers, FWS, USDA-NRCS, and EPA, to resolve implementation issues. Regional and local agencies should be involved in the planning process at the regional level.
2. TWDB should change the regional water plan guidance rules to include a mandatory coordination meeting of regulatory agencies to identify impediments and fatal flaws to project implementation, once a water management strategy is identified as a feasible solution for a water shortage.
3. The State natural resource agencies should meet biannually to prevent compartmentalization of agency stewardships and prevent conflict or duplication between agencies.

B. How to enhance public involvement in the planning and implementation process?

Recommendations

1. TWDB, TNRCC, TDA, and TPWD should promote education of planning group members and offer the same information to the public on their important role within the regional planning process and implementation of water management strategies.
2. TWDB should provide clear guidance and communication to potential applicants and the public on the process of prioritizing projects for funding. This process should include education on regulatory issues affecting implementation.
3. RWPG's should work with TWDB to provide draft documents and more timely information as to the time and place of upcoming public meetings on the TWDB Web site to improve public participation.
4. TWDB will encourage public involvement by exploring ways to improve accessibility to the planning documents, such as developing an index of the contents of the regional water plans.

C. How to enhance nonstructural options?

Recommendation

1. TWDB, TNRCC, TPWD, and TDA should provide a technical report on implementation feasibility of such options. This report should include information on legal and regulatory obstacles, regional appropriateness, environmental requirements and protections, and funding opportunities.

D. How to enhance macro-planning?

Recommendations

1. TWDB and RWPG's should work together to conceptually address strategies beyond the planning horizon.
2. TWDB should consider developing a framework for regular meetings of regional water planning group chairs to discuss macro-planning and interregional cooperation issues in order to establish dialogue and education on issues involved in planning beyond regional boundaries and 50 years.

Data Collection and Information

A. Encourage compatibility of technical data and information across State agencies and other sources of data for the State's and all citizens' benefit.

Recommendations

1. The TWDB, TNRCC, TPWD, and other government entities should encourage compatibility of technical information by maintaining and increasing communication among these entities responsible for most water-related information in Texas. Such communication should focus on identifying opportunities and processes for enhancing efforts to integrate data and facilitate transfer of information between agencies (beyond the basic information already provided through the WIIC), and on evaluating possibilities to reduce redundancy in the information collected and maintained by the different agencies. The outcome of such increased communication and resulting initiatives should be reflected in each agency's internal operation work plans.
2. The TWDB, TNRCC, TPWD, and other government entities should encourage the inclusion of metadata (information about the data of a given data set) with all relevant sources of water-related data residing at different entities. Metadata facilitate the understanding of complicated data sets by providing historical, technical, and explanatory information regarding the associated data set, and they can therefore ease use and integration of different data sets.

3. State agencies and other government entities should identify and use common elements within water-related data sets residing in different entities to the highest extent possible, so that these databases can be more easily and directly related. At a basic level, at least a geographic (locational) reference or link should exist between many of these data sets because these data represent water-related characteristics associated with specific places. Therefore, geography can become a common link to some, if not many, of these to-date unrelated data sets. This item is further expanded in the discussion of the following issue.
4. The Water Information Integration and Dissemination (WIID) initiative illustrates the spirit of the above recommendations. A general recommendation is the formation of a task force, with dedicated resources, of the TWDB, TNRCC, and TPWD, with strong links to other State agencies and binational, Federal, State, regional, and local water data collection and management entities to develop an action plan to address these recommendations.

B. Enhance water management by encouraging use of StratMap data and Internet availability of data.

Recommendations

1. In response to these challenges, the TWDB, TNRCC, and TPWD should establish the Strategic Mapping (StratMap) digital base map as a common framework to be used to build, standardize, and display geographic locations of water-related data collected throughout the State to the highest extent possible and should invite other government entities to participate. The obvious benefit of this effort would be that data collected by different entities could then be seamlessly integrated on the basis of their location and on a common and approved set of base maps.
2. StratMap digital base map layers and other critical water-related data should be easily accessible via the Internet, utilizing the latest in technological advances. These technologies should continue to be used as a means of efficiently and centrally disseminating large amounts of water-related information from multiple sources. Furthermore, ongoing initiatives related to intra- and interagency data integration and dissemination should continue to be expanded to allow data from TWDB, TNRCC, and TPWD to be accessed simultaneously through a common Web-based interface. For example, in this fashion, critical information regarding streamflow discharge, water rights, and ecological information might eventually become available to the citizens of the State via the use of an Internet browser through a single information portal.
3. Water-related data holding entities should continue to expand other ongoing Web-based cooperative data networks, such as the Water Information Network through its Network Optimization Program, to bring other non-State agency governmental entities together to share important water-related information.

C. Enhance collection of information describing water resources, including real-time data collection, and funding needed for expansions of data programs and studies.

Recommendations

1. To solve these challenges, several efforts are already under way and should be provided continued support. Efforts to increase surface water and groundwater data collection in support of ongoing modeling initiatives (such as TWDB's GAM and TNRCC's WAM programs) should be continued. In addition, recommendations presented in individual regional water plans submitted to TWDB outlining specific requests for data collection and/or water resource studies in certain geographic areas of the state should be considered.
2. Efforts to enhance electronic data collection, transmittal, and storage methods regarding public- and private-sector, water-related activities should continue. Internet-based surveys are being used to collect data previously collected using only paper-based surveys, such as water use and ground-

water information. In addition, ongoing electronic real-time data-collecting methods used for surface water flow, groundwater levels, groundwater pumpage, and water quality should be greatly expanded to enhance the ability of the State and other governmental entities to make timely and efficient water management decisions, particularly regarding groundwater/surface water interactions. Real-time collection and storage of long-term hydrologic data improves drought and flood prediction efforts, water availability determinations, critical surface water and groundwater area evaluations, permit enforcement, and spill detection and response. Both real-time and Internet-based methods could substantially reduce the cost of some types of data collection, while facilitating more timely and flexible analysis and dissemination of critical water data.

3. The Legislature should consider allowing private landowners to keep their groundwater use data exempt from open records requests when submitted to applicable entities.

D. Issue: Enhance consistency of analytical techniques.

Recommendation

1. Increased efforts should be made by TWDB, TNRCC, TPWD, and other governmental entities toward ensuring that water analytical techniques are standardized among these entities and are made easily available to interested parties in the private and public sectors of the water management community, especially with respect to water modeling and related data analysis requirements. A specific and appropriate group may need to be identified and charged with developing strategies to address water data analysis consistency.

Conclusion

Issues of data collection and data dissemination are important to the State's efforts supporting the regional water planning process and should be considered for continued and increasing attention from the Legislature and the Texas public. Local efforts to collect data should be encouraged and coordinated with State efforts to maximize cost value and minimize duplication. Key data gaps should be identified and evaluated to insure that there are adequate water data in all areas of the State. Data that are high quality and easily available are critical to good water management decision making.