UPDATED EVALUATION FOR THE WILLIAMSON, BURNET AND NORTHERN TRAVIS COUNTIES PRIORITY GROUNDWATER MANAGEMENT STUDY AREA

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Priority Groundwater Management Area File Report

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EXECUTIVE SUMMARY ✯✯✯

A 1990 study by the Texas Water Commission [Texas Commission on Environmental Quality (TCEQ) predecessor agency] and Texas Water Development Board (TWDB) determined that Williamson County and parts of Bastrop, Bell, Burnet, Milam, and Travis counties did not meet the criteria to be designated as a "critical area" primarily because of the availability of surface water supplies to meet projected needs. By statutory definition, the critical groundwater problem criteria include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawn, and contamination of groundwater supplies. The Texas Water Commission, however, recommended that progress toward the conversion from groundwater to surface water usage should be reinvestigated at a later date, and if conversion plans were not being implemented or if groundwater conservation districts were not being formed, designation consideration for the area may need to be reconsidered. Since the 1990 study, the residents of Bastrop and Lee counties, Bell County, and Milam and Burleson counties have confirmed the creation of groundwater conservation districts. During the final phases of completing this report, the citizens of Burnet County also confirmed creation of a groundwater conservation district.

This priority groundwater management area (PGMA) update study summarizes and evaluates data and information that has been developed in Williamson, Burnet and northern Travis counties over the past two decades to determine if the area is experiencing or is expected to experience, within the next 25-year period, critical water supply problems. This report relies primarily on the data and supporting information for the 2001 Brazos G and Lower Colorado Regional Water Plans and the 2002 State Water Plan. The report also evaluates and uses information provided by stakeholders, other TWDB publications and data, data from the groundwater availability modeling for the Northern Segment of Edwards aquifer and the Trinity/Woodbine aquifers, and natural resources issues identified by the Texas Parks and Wildlife Department. The report evaluates the authority and management practices of existing water management entities and purveyors within and adjacent to the study area, and makes recommendations on appropriate strategies needed to conserve and protect groundwater resources in the study area.

On July 26, 2004, TCEQ mailed a notice to approximately 280 water stakeholders in the study area to solicit comments and information about water supplies and groundwater availability, water level trends, water quality, and groundwater management. Most respondents from Williamson County stated that the study area should not have critical groundwater problems during next 25-years and should not be designated as a priority groundwater management area. The Burnet Water Council commented that even though localized groundwater problems exist in the study area, the study area should not be designated as a tri-county PGMA due to different water use practices among the three counties.

The three-county study area gets water from Colorado River and Brazos River Basin sources and groundwater. In 2000, 164,876 acre feet (acft) of water was used: surface water accounted for 83 percent (137,459 acft) of the water used, and groundwater accounted for 17 percent (27,417 acft). The primary sources of surface water supply in the study area are from the Highland Lakes, Colorado River, and water supplied through the Brazos River Authority. The Edwards and Trinity Group aquifers are the primary groundwater sources in Williamson and northern Travis counties, and the Ellenburger-San Saba, Hickory, and Marble Falls, and Trinity Group aquifers are the primary groundwater sources for Burnet County. Other aquifers also supply groundwater to the study area.

The total quantity of water available for supply in the study area was estimated to be 345,209 acft in 2000, and is projected to decrease by eight percent between 2000 and 2030. In 2000, municipal use accounted for 141,667 acft (86 percent) of the total amount of water used, up from 107,254 acft in 1995, and up from 93,541 acft in 1990. Of the amount of water used for municipal purposes in 2000, 22,646 acft (16 percent) was supplied by groundwater sources and 119,021 acft (84 percent) was supplied from surface water sources. Between the years 2000 and 2030, total population within the study area is projected to increase by approximately 91 percent. The total 2030 projected water demand for the three-county study area is anticipated to be 298,278 acre feet/year (acft/yr), an increase of 133,402 acft, or 81 percent over the 2000 water use. Municipal needs represent the largest demand for water in the study area and are projected to increase by approximately 124,667 acft over the 30-year planning period. Municipal needs account for 86 percent of the total water use in 2000 and increases to 89 percent of the total annual water demand for 2030, from 141,667 acft/yr to 266,334 acft/yr.

The water supply problems identified in the study area include lack of drought-reliable groundwater supplies, lack of firm supplies for some municipal use and most mining use, localized water level declines, potential groundwater supply impacts from new mining or industrial wells, and removal of groundwater from aquifer storage to meet future demands. Most water supply concerns in the study area are addressed with surface water contract renewal, on going and continued water supply infrastructure expansion, and Carrizo-Wilcox aquifer groundwater development for import - all management strategies adopted by the 2001 Brazos G and Lower Colorado Regional Water Plans. There are no significant changes to the management strategies identified in the two 2005 Initially Prepared Regional Water Plans for the study area. During the last 15 years, the study area water purveyors have secured and continue to secure additional surface water resources while not increasing the amount of groundwater use. Using the water demand projections developed by the Brazos G and Lower Colorado Regional Water Planning Groups, the TWDB groundwater availability predictive models for the northern Edwards and Trinity/Woodbine aquifers do not project future significant regional water-level decline to occur in the next 25-year period in the study area. Over the 50-year horizon, the model runs do predict that a gradual long-term water-level decline will occur in the Pflugerville-Round Rock-Georgetown area.

The groundwater quality in the Edwards aquifer is generally good, however, the aquifer is highly vulnerable to surface contamination. The quality of water in the aquifer is directly affected by the total environment of the water, from its origin as rainfall to its ultimate discharge from wells and springs in the aquifer. Most of the dissolved matter in the groundwater is from the solution of substances in the rocks that compose the aquifer. The groundwater quality of the Trinity group aquifer in the western portion of the study can be characterized as a calcium carbonate type water. Downdip to the eastern side of the study area, the water quality tends to decrease, becoming more saline. Water quality problems in the study area are best solved by coordinated efforts of state and local government, and water supply entities. The TCEQ Edwards Aquifer Protection Program rules address activities that could pose a threat to water quality in the Edwards aquifer and the surface streams that feed it in Williamson and northern Travis counties. Naturally occurring water quality problems in the Trinity Group aquifer, especially in the eastern side of the study area, are primarily addressed by blending this groundwater with surface water to achieve the drinking water standards.

Most of the identified water supply problems are localized and are not study area-wide problems. The available data indicates that study area water supplies are of sufficient quality to meet intended and projected uses. Further, study area water purveyors have secured adequate water resources or are presently working to secure adequate water resources to meet all water demands for the next 25-year period. Based on the presently available information, the study area is not experiencing and is not expected to experience within the next 25-year planning horizon, critical groundwater problems. Therefore, the report concludes and recommends the Williamson, Burnet and northern Travis counties study area should not be designated as a priority groundwater management area at this time.

The report evaluates the feasibility and practicability for groundwater management by a groundwater conservation district (GCD), and concludes that managing and protecting the aquifers within the study area could be effectively accomplished through the establishment of a groundwater conservation district. A GCD could benefit the study area by implementing Texas Water Code, Chapter 36 authorized monitoring, assessment, planning, permitting, and education programs, as well as through water well spacing and water-quality protection rules.

Groundwater management strategies to monitor, evaluate, and understand the aquifers sufficiently to establish programs to protect the riparian habitats fringing rivers, streams, and lakes, as well as protecting karst habitats, should be a priority in study area land-use planning processes. Implementing programs to minimize water level declines from concentrated pumping centers, and maintaining the existing spring flows in the study area and in counties adjacent to the study area would also facilitate the protection of natural resources. Cooperating and supporting existing multi-agency efforts such as the Balcones Canyonlands Preserve, Williamson County Karst Conservation Foundation, and TCEQ Edwards aquifer protection rule are also recommended to help conserve natural resources in the study area.

Because the study area's water supply concerns are mostly solved with implementation of water management strategies, PGMA designation is not recommended at this time and any GCD creation action would have to be locally initiated. The local leadership, landowners, and citizens must determine if they desire to manage their groundwater resources through a GCD. If their answer is yes, the citizens, on their own initiative, would need to consider the different methods and options available to create a groundwater conservation district.

Most study area stakeholders have made it clear they do not believe a multi-county GCD would be practicable based on both hydrological conditions and other factors such as study area population densities. Burnet County stakeholders commented that they greatly preferred a Burnet County-only GCD, and in fact legislatively created and voted to confirm the creation of the Central Texas Groundwater Conservation District during the preparation of this report. The new Central Texas Groundwater Conservation District is sufficiently authorized to manage and protect the groundwater resources in Burnet County. Groundwater monitoring, assessment, planning, education, and permitting programs, as well as water well spacing and well closure programs are recommended for the district to manage the Trinity and Paleozoic-aged aquifers for the present citizens of the county and for future generations. Implementation of these types of programs will allow the district to identify and address water-level declines in localized areas of heavy pumpage, provide safeguards from well interference from new groundwater users, and protect groundwater quality.

Nearly all of northern Travis and Williamson counties are within certificated water purveyor service areas. Through conservation programs and efforts to meet new demands with surface water sources, these entities can largely maintain their present groundwater systems. However, these types of entities do not have authority to control large-scale groundwater pumpage for private purposes that could potentially impact a shared groundwater supply. The Clearwater Underground Water Conservation District in Bell County noted the effectiveness of their groundwater management measures may be lessened if surrounding areas are not likewise managing the shared groundwater resource.

The Williamson County Water Visionary Committee does not support the creation of a GCD in Williamson County and noted that there is little public support in the county for such a district. TCEQ staff suggests that the most practicable method to achieve groundwater management for landowners who are concerned about groundwater quantity or quality impacts from the new users or demands may be to petition an adjacent GCD, either individually or collectively, to have their property added to the district.

In absence of a GCD, TCEQ staff suggest that the Commissioner Court of Williamson County should follow through with its intent to adopt a formal Williamson County master water supply plan to address the supply, treatment, and distribution of water throughout the county to insure both rural and urban areas are efficiently and adequately supplied with water. Lastly, TCEQ staff suggest that a GCD consisting of Williamson and northern Travis counties would be a feasible groundwater management entity only if there were public support for it to succeed.

INTRODUCTION ☆☆☆

To enable effective management of the state's groundwater resources in areas where critical groundwater problems exist or may exist in the future, the Legislature has authorized the Texas Commission on Environmental Quality (TCEQ), with assistance from other agencies, to study, identify, and delineate priority groundwater management areas (PGMAs), and to initiate the creation of groundwater conservation districts (GCDs) within those areas, if necessary.

In 1990 and 1991, the Texas Water Commission (TCEQ predecessor agency) completed 14 "critical area" studies (now PGMA studies) in various parts of the state to determine if these areas were experiencing critical water problems, or were expected to experience such problems in the next two decades. The Commission determined that four of these study areas had or were expected to have critical groundwater problems and designated them as such, and that five of the study areas did not have and were not expected to have critical groundwater problems and no further evaluation or action was needed.

The Commission determined that the other five study areas did not meet the criteria to be designated as having critical groundwater problems; however, the Commission requested that these five areas be reinvestigated at a later date when more data became available. The area including Williamson, Burnet and northern Travis counties overlying the Edwards and Trinity aquifers was one of these five study areas. Appendix 1 includes a reproduction of the technical summary for the original 1990 study and recommendations for the Williamson and adjacent counties study.

Purpose and Scope

This report summarizes and evaluates data and information that has been developed in Williamson, Burnet and Northern Travis counties over the past dozen years to determine if the area is experiencing or is expected to experience, within the next 25-year planning horizon, critical groundwater problems. By statutory definition, these critical groundwater problems can include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies.

Further, since the end-purpose of PGMA designation is to ensure that GCDs are created in areas of the state with critical groundwater problems, PGMA evaluation is not necessary for areas that are presently within the boundaries of an existing GCD. The existing GCDs are authorized to adopt policies, management plans, and district rules that can address critical groundwater problems.

Methodology and Acknowledgments

This report evaluates the reasons and supporting information for or against designating the Williamson, Burnet and northern Travis counties study area as a PGMA. Based on this evaluation, the report provides conclusions and recommendations regarding PGMA designation, conservation of natural resources, and creation of GCDs and management of groundwater resources in the area.

This report relies primarily on the data and supporting information that was used to develop conclusions and recommendations in the Brazos G (HDR, 2001) and Region K (Turner, Collie and Braden Inc. et al., 2000) Regional Water Plans, and in the 2002 State Water Plan (TWDB, 2002). In addition, a cursory review of the Brazos G and Region K 2005 Initially Prepared Plans (IPPs) was conducted to identify new water supply strategies of significance. Much of the data used to support the regional and state water plans and this report is the result of other significant Texas Water Development Board (TWDB) efforts (Duffin and Musick, 1989; Ridgeway and Petrini, 1999; Jones, 2003; Harden and et al., 2004; and TWDB, 1997 and 2001). Special thanks are given to Craig Caldwell, Ian Jones, and Sanjeev Kalaswad for their assistance in various aspects of data compilation and interpretation (TWDB, 2003). Furthermore, this report considers natural resource issues identified in the Brazos G and K Regional Water Plans and by the Texas Parks and Wildlife Department (El-Hage and Moulton, 1999 and 2004).

On July 26, 2004, TCEQ mailed a stakeholder notice to solicit comments and to request data on water supply, groundwater availability, groundwater level trends, and groundwater quality. Several locally organized stakeholder meetings were also held in the study area and staff were invited to give an overview of the PGMA process and procedures, and an overview of the ongoing study. The writer acknowledges the stakeholders who participated in these meetings and the following stakeholders for providing written comments and data: Aqua Water Supply Corporation; the Honorable David Kithil, Burnet County Judge; the Burnet County Water Council; the Brazos River Authority (BRA); the Brushy Creek Municipal District; the City of Austin; the Clearwater Underground Water Conservation District (UWCD) and Turner Collie and Braden Inc. on behalf of the Clearwater UWCD; the City of Georgetown; the Lower Colorado River Authority (LCRA); the City of Round Rock; Sierra Club, Lone Star Chapter; and the Honorable John Doerfler, Williamson County Judge on behalf of the Commissions Court of Williamson County and the Williamson County Water Visionary Committee.

Location, Climate, and Topography

This study area is located in central Texas and covers approximately 2,685 square miles. For this evaluation, the study area includes all of Williamson and Burnet counties and Travis County north of the Colorado River (Figure 1). Parts of Bastrop, Milam and Bell counties have been removed from the study area as originally delineated in 1989 because local actions have been accomplished to create groundwater conservation districts.

The climate of the study area is characterized by long, hot summers and short, mild winters. The average minimum temperature for January, the coldest month, ranges from 37^0 F (3^0 C) in the northwest to 41^0 F (5^0 C) in the southeast. The average maximum temperature for July, the warmest month, is 96^0 F (39^0 C) throughout the study area. The average annual temperature for the period 1951-1980 ranged from 66^0 F (19^0 C) in the northwest to 68^0 F (20^0 C) in the east. The average annual precipitation ranges from 28 inches in the west to 35 inches in the east. These figures are based on National Weather Service records for the 30-year period, 1951-1980. Cyclic droughts occur in the region, most recently in 1996 and 1998 (Ridgeway and Petrini, 1999). The average annual gross lake-surface evaporation for the period 1940-1965 ranged from 60 inches in the east to 80 inches in the northwest (Duffin and Musick, 1991).

The study area is located in the Hill Country of central Texas. Most of the land surface expressions in the study area are the result of stream erosion of relatively flat or gently dipping rocks that are exposed on the surface. The soils in the study area are typically dark, gravelly, shallow to deep calcareous clays in the uplands, and reddish-brown to dark gray clay loams and clays in the bottomlands. The study area has moderately high relief with tabular divides, small limestone capped mesas, sharp-cut valleys, and a thorough dendritic drainage. Elevations range from slightly under 550 feet along the eastern part of the study area to slightly over 1,500 feet above the mean sea level in Burnet County in the northwest part of the study area. In northeastern Burnet County and Williamson County, drainage is to the east by the Lampasas, Little, and San Gabriel Rivers – tributaries to the Brazos River. Surface water drainage is to the south and southeast toward the Colorado River and its tributaries in southwestern Burnet County and Travis County.

The study area is relatively densely populated along the Interstate Highway 35 (I-35) corridor in Travis and Williamson counties. Population growth in the study area has been rapid since 1970, averaging 3.9 percent annually (Brazos G Regional Water Plan, HDR, 2001). In 2000, the total population in the study area was approximately 985,726 (TWDB, 2003). Burnet County had the lowest population in the study area with 33,874 inhabitants, and Travis County the highest with approximately 744,080 inhabitants. Austin (pop. 640,240), Georgetown (Pop. 33,357), Round Rock (Pop. 48,742), are some of the large towns in the study area, and Marble Falls, Burnet, Bertram, Cedar Park, Leander, Hutto, Taylor, and Pflugerville are some of the small towns (Figure 1).

Surface Water Resources

The study area is within two river basins–the Colorado River Basin and Brazos River Basin. The Lower Colorado River Authority (LCRA) in the Colorado River basin provides surface water to Burnet, Travis, and parts of Williamson counties. The Brazos River Authority (BRA) in the Brazos River basin is the primary provider of surface water to Williamson County. The BRA and LCRA have formed the Brazos-Colorado Water Alliance to identify water supply and treatment alternatives to meet the future needs of the Brazos G and Colorado River Basins (Brazos G Water Plan).

In the Colorado River Basin, major water storage reservoirs include Lake Buchanan and Lake Travis. These lakes, part of the Highland Lakes System, are owned and operated by the LCRA. The system also contains three intermediary lakes owned and operated by the LCRA–Inks Lake, Lake LBJ, and Lake Marble Falls. Lake Austin, the last in the Highland Lakes System, is owned by the City of Austin and is operated by the LCRA through an agreement. The LCRA operates these reservoirs to control floods and to provide a reliable source of water to downstream customers. The LCRA developed a Water Management Plan for the lower Colorado River Basin in response to requirements contained in a final report of adjudication of water rights to the LCRA. The firm yield of the Highland Lakes System was determined by modeling of the Colorado River (Region K Regional Water Plan, 2000). The resulting total yield for the Highland Lakes System is 445,766 acre feet per year (acft/yr).

Lake Walter E. Long (Decker Lake) is a minor reservoir in the study area, it is owned and operated by the City of Austin. The lake is formed by a dam on Decker Creek, which is a tributary to the Colorado River in Travis County. The lake is used to supply cooling water for an electrical generation plant by the City of Austin. The TWDB estimated that firm yield of this lake due to inflows along Decker Creek is 1,000 acft (acre feet).

Lake Granger and Lake Georgetown are reservoirs found in the Brazos River Basin in Williamson County. The total yield in 2000 for Lake Granger and Lake Georgetown was 19,220 acft and 14,711 acft, respectively. The other major Brazos River Basin reservoir that is important for study area water supplies is Lake Stillhouse Hollow. Water from Lake Stillhouse Hollow is delivered to Lake Georgetown through the Williamson County Raw Waterline. The total firm yield in 2000 for Lake Stillhouse Hollow was 71,044 acft. The water supplies from these major reservoirs are mainly used for municipal use.

The BRA manages the surface water resources of these three reservoirs and plays a major role in securing the surface water needs of Williamson County. Currently, BRA is implementing the Williamson County Raw Waterline, in agreement on a Highland Lakes water supply, and developing existing and future supplies to meet water needs in Williamson County.

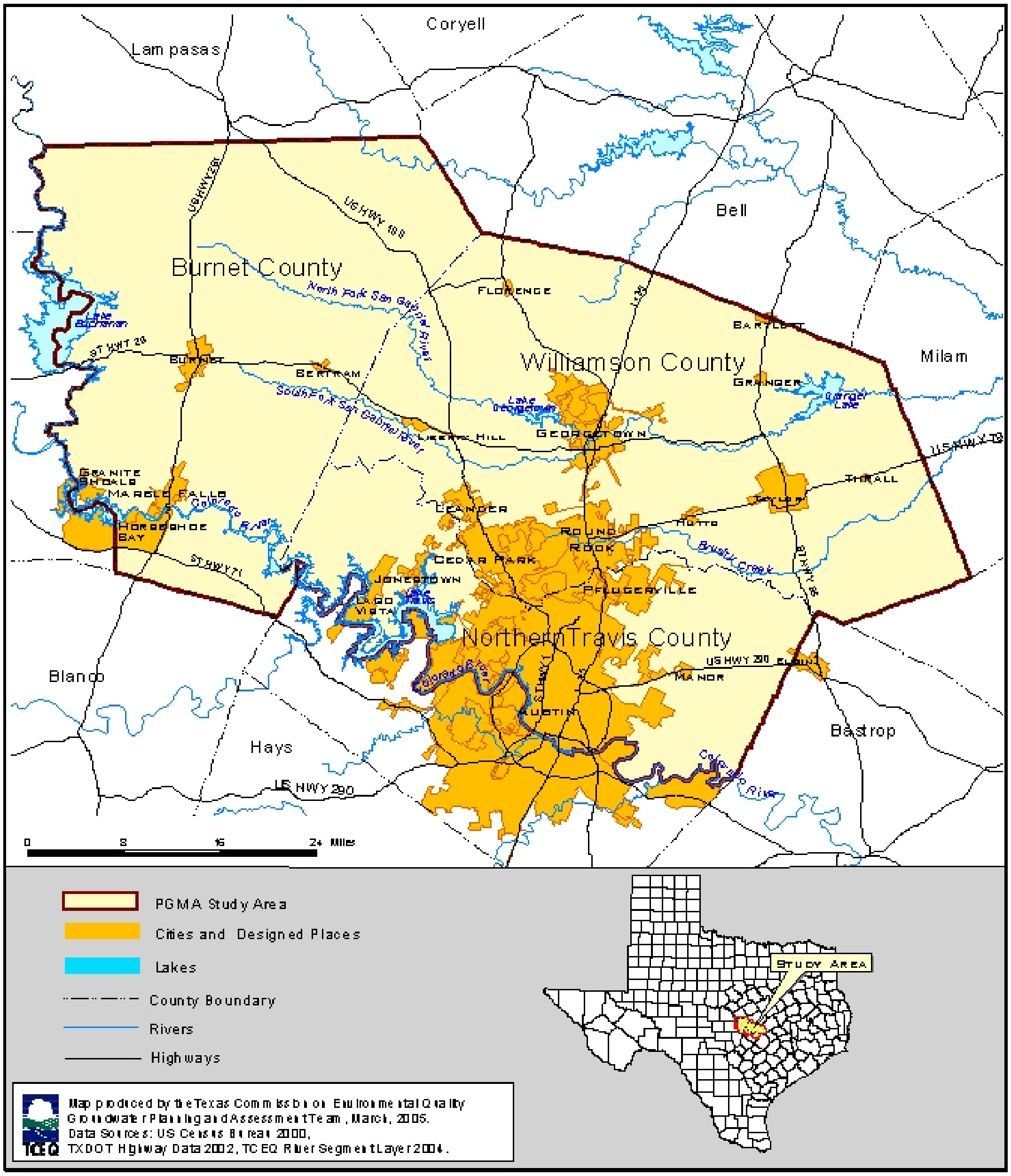

Figure 1. Williamson, Burnet and Northern Travis Counties Study Area Location Map

Stratigraphic units of the study area that contain water in usable portions range in age from the Cambrian Hickory Sandstone to Recent alluvium. Of these, the most important water-bearing units are of Cretaceous age. The structural features that most affect the Cretaceous and Tertiary Systems are the erosional surface upon which beds in these systems were deposited, the Bend Arch and Llano Uplift on the west, the McGregor High near the town of McGregor located southwest of Waco in McLennan County, and the Balcones and Luling-Mexia-Talco Fault Zones (Duffin and Musick, 1991).

The irregular erosional surface upon which Cretaceous formations were deposited generally slopes to the east and southeast. This surface consists of rocks belonging to the Permian, Pennsylvanian, and pre-Pennsylvanian Systems in the western part of the study area, the Pennsylvanian System in the west-central part, the Ouachita folded belt in the east-cental part, and Jurassic System in the eastern part. The ridges and valleys which make up the pre-Cretaceous surface had a direct effect upon the lower Cretaceous deposition in that thicker accumulations of sediments were laid down in the valleys and thinner accumulation on the ridges such as the McGregor High, where the Hosston Formation (lower Cretaceous) is absent or markedly thinner than in surrounding areas (Duffin and Musick, 1991).

On the west, the Llano Uplift and the Bend Arch also had an effect upon sediments containing the Cretaceous aquifers. The Llano Uplift, a structure dome with a core of igneous and metamorphic rocks, stood as an island during lower Cretaceous deposition. It acted as a source of sediments, and affected the depositional environment of the Cretaceous rocks immediately east of the Uplift area. Meanwhile, the Bend Arch area received marginal facies lower Cretaceous sediments of conglomerates, sands, and sandy shales, followed by limestones and marls as Cretaceous seas advanced (Duffin and Musick, 1991).

The Balcones Fault Zone extends from Travis County through Waco to Hill County. The Luling-Mexia-Talco Fault Zone approximately parallels the Balcones Fault Zone on the east and extends from Bastrop County northeasterly through central Limestone County. The Balcones Fault Zone has produced displacements of 400 feet or greater. The Luling-Mexia-Talco Fault Zone has produced displacements of 700 feet and more. These displacements may cause blockage or restriction of groundwater movement downdip, and also may contribute to contamination by allowing poor quality water to enter along fault planes. These undesirable conditions probably affect Cretaceous aquifers over a greater area than those in the Tertiary. The western boundary of the Luling, Mexia-Talco Fault Zone appears to be the controlling factor in the downdip limit of fresh to slightly saline water occurring in the lower Cretaceous aquifers (Duffin and Musick, 1991).

Cretaceous formations dip east-southeast at a rate of about 15 feet per mile in the northwest part of the study area. This dip rate increases to as much as 200 feet per mile east of the Balcones and Luling-Mexia-Talco Fault Zones.

Tertiary beds lie on an erosional surface sloping southeastward over rocks belonging to the Cretaceous age. Dip rates vary from 100-200 feet per mile toward the southeast except in fault blocks within the Luling-Mexia-Talco Fault Zone. The attitude of the fault blocks determines the rate and direction of the dip of the beds which in turn affects the rate and direction of movement of the groundwater. Also, the faulting may subject groundwater in these beds to contamination by providing a direct passageway along the fault planes for surface water runoff to enter the aquifers (Duffin and Musick, 1991).

The primary groundwater resources in the study area include the Edwards Balcones Fault Zone (BFZ), Trinity Group, Marble Falls, Ellenburger-San Saba, Hickory, and other aquifers (Figure 2).

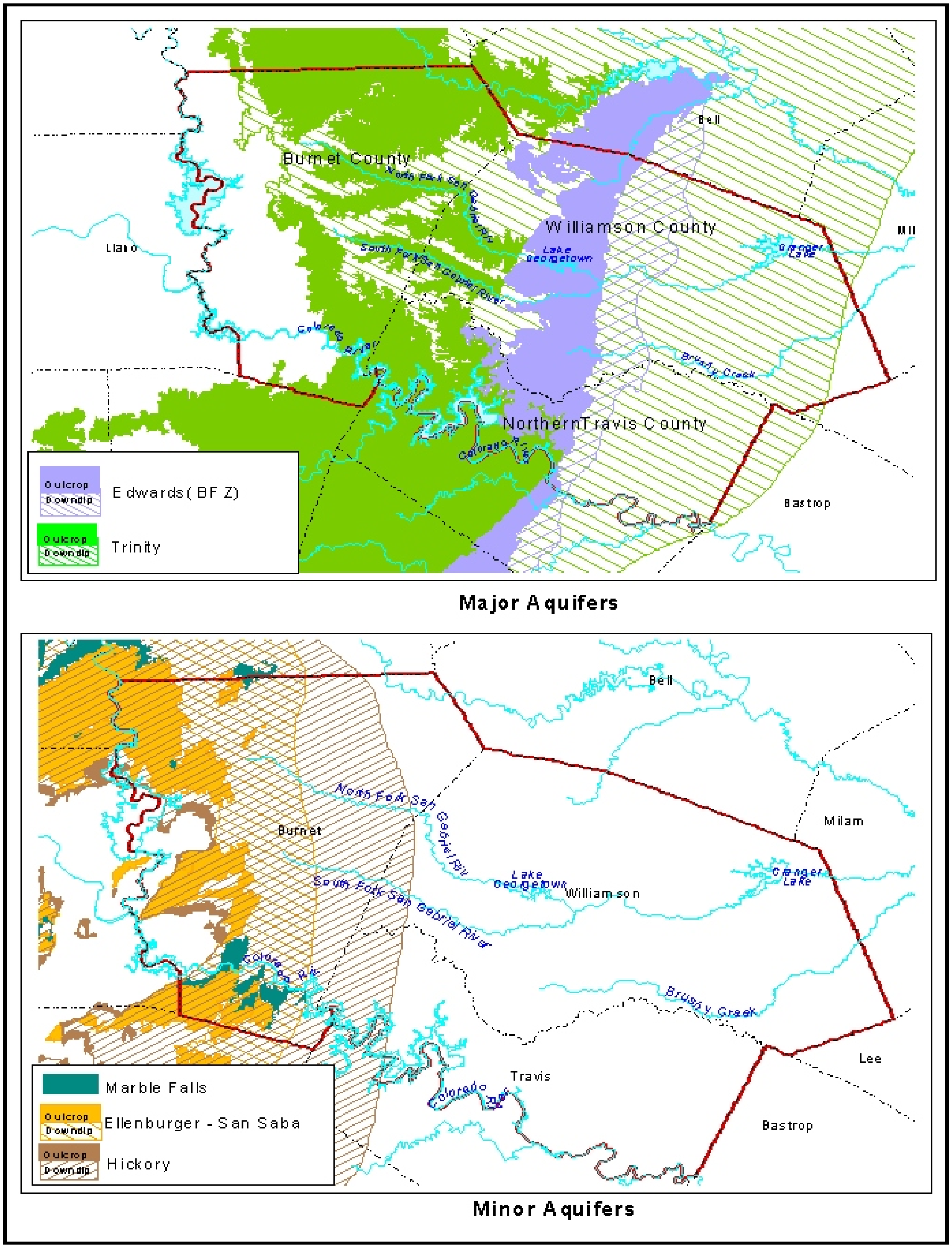

Figure 2. Major and Minor Aquifers, Williamson, Burnet and Northern Travis Counties PGMA Study Area.

Edwards Aquifer

The Edwards aquifer consists of the Cretaceous-aged Georgetown Formation, Edwards Group, and Comanche Peak Formation. The Edwards Group, composed of massive-to thin-bedded limestone and dolostones, contains most of the aquifer. Honeycomb textures, caverns, and voids in collapse breccias account for most of the significant aquifer porosity. The formation thins from about 300 feet in the Austin area to 100 feet in southern Bell County, outside the study area (Senger and others, 1990). The contacts between the Comanche Peak, Edwards, and Georgetown Formations do not reflect major lithologic changes. Even thought porosity is greater within the Edwards sequence, locally the porosity within the Comanche Peak and Georgetown limestones may also be high (Senger and others, 1990). Water-table conditions exists in the outcrop area and artesian conditions predominate under the confining Del Rio Clay (Ridgeway and Petrini, 1999).

The fresh-water section of the Edwards aquifer narrows toward the northern and southern boundary and expands in a west-east direction in the central part. The western boundary coincides with the westernmost outcrop of the Edwards Limestone, and the eastern boundary is represented by the “bad-water” line, which separates the aquifer from that area to the east where total dissolved solids exceed 1,000 milligrams/liter (mg/l) (Senger and others, 1990).

Recharge in the northern region of the Edwards occurs in tributaries, and infiltration from precipitation on the outcrop. It consists of mainly gently rolling terrain, whereas the Austin region is characterized by steeper and more highly dissected terrain. Surface runoff and precipitation infiltrates the aquifer through faults, fractures, sinkholes, and caves. These features have been dissolved out, which allows rapid infiltration as well as rapid movement of groundwater within the aquifer. Another complicating factor concerning the recharge and discharge measurement is the amount of subsurface recharge from the underlying Trinity Group aquifer (Duffin and Musick, 1991).

A study by Ashworth (1983) on the Lower Cretaceous formations in the Guadalupe River basin determined that approximately four percent of precipitation on the outcrop area can be considered as effective recharge to the aquifer. Klemt and others (1975) determined that an estimated three percent of the average annual precipitation is available as effective recharge. Their study was confined principally to the Brazos, Colorado, and Trinity River basins. Muller and Price (1979), reporting on the quantity of groundwater available in the state of Texas on an average annual basis through the year 2030, determined that approximately 1.5 percent of the average annual precipitation falling on the outcrop (effective recharge) can be transmitted through the Trinity Group aquifer.

The Edwards aquifer in the Austin area is slightly to moderately developed by wells, and springs are by far the greatest portion of the discharge from the aquifer. Barton Springs are considered to be a large spring, with an average annual flow of approximately 50 cubic feet per second (CFS) or 36,199 acre-feet for the period 1917-81, and ranked as the fourth largest springs in Texas. Although not as large as Barton Springs, there are numerous springs issuing from the northern part of the Edwards. Several small springs are located along the Colorado River and Mt. Bonnell Fault, with larger springs located near the eastern edge of the outcrop of the aquifer. Many smaller springs are found east in the outcrop in Williamson County, extending north into Bell County. The three main springs in the northern region are San Gabriel, Berry Creek, and Salado Springs.

Fluctuation of water levels in wells is an indicator of the effects of changes in pumpage and variations in precipitation over the years. Water levels in wells in the Edwards aquifer fluctuate over a wide range in most of the study area. Like spring flows, water levels have been low in years of low rainfall and have recovered during the wet years. The water levels in the mid-1950s were considered to be record lows, but with the increased pumpage during the late-1970s, the water levels have equaled or have been lower than those of the 1950s (Duffin and Musick, 1991). A noticeable decrease in water levels was observed during the severe droughts of 1983 to 1984 and 1996 (Ridgeway and Petrini, 1999).

Some wells near the recharge zone of the Edwards aquifer experienced the most significant water level declines (up to 120 feet) during the 1983-1984 drought. Some wells in this zone also reflect drawdown of up to 130 feet during the period of time culminating with the 1996 drought. The wells measured since 1996 exhibited a rise in water levels through 1997, indicating a relatively rapid rebound from drought conditions. Overall, the wells found near the recharge zone of the Edwards aquifer have current water levels equal to or only slightly below water levels measured in the 1960s (Ridgeway and Petrini, 1999).

The wells located downdip, near the Williamson-Travis county line, mostly in the artesian portion of the aquifer, show a decrease in water levels over time and are more affected by pumpage from nearby towns and cities. Some wells are also depicted with the most erratic historic water levels due to a wide fluctuations as a result of pressure changes created by nearby pumpage (Ridgeway and Petrini 1999).

Water-level data from the winter of 1997 indicates groundwater flow patterns have not changed significantly in the study area portion of the Edwards aquifers since the initial study. Ridgeway's and Petrini's 1999 potentiometric map (Figure 3) showed the predominant direction of the hydraulic gradient is to the east. From the north-central part of the City of Austin, a moderate southerly component dominates as groundwater generally flows toward the Colorado River.

A comparison of water-level elevations from the winter of 1987 to the winter of 1997 indicates an overall decrease in water levels in the middle to eastern portion of the aquifer (Figure 4) (Ridgeway and Petrini 1999). This water-level decline is due to the heavy groundwater pumpage around the Pflugerville area. In the late 1980s, water levels in the wells located in the eastern section were between 665 to 437 feet above mean sea level (msl). The average water elevation was 625 feet above the msl. The same wells were re-measured in 1997 to 1998 and found to have an average water-level elevation of 595 feet above msl (an average decrease of 30 feet), with water levels ranging from 671 to 437 feet above msl.

A single-layer groundwater availability model (GAM) for the northern segment of the Edwards aquifer (Jones, 2003) has been used to predict future water levels under average recharge and drought-of-record conditions. These predictive model runs used projected aquifer-pumpage rates developed by the Brazos G and Lower Colorado K Regional Water Planning Groups. The model predicts that in year 2030 water-levels in the northern segment of the aquifer will not change dramatically (less than 25 feet) under the conditions of average recharge (Figure 5). Under the conditions of drought-of-record, the model predicted water-level declines of greater than 25 feet to occur only along the western margin in the outcrop area of the aquifer (Figure 6). In the predictive scenario runs, higher water levels occur in the Round Rock-Georgetown area of the study area. These higher water levels are the result of projected municipal and industrial pumping rates in the Round Rock-Georgetown area that are much lower than historic pumping rates. Even though the model expected the pumping rates to rise over the 2001 through 2050 period, it will still be much lower than pre-2000 pumping rates. Jones (2003) outlined that the lower pumping rates will result from conversion from the use of Edwards aquifer groundwater to surface water to meet water demands. The southern part of the study area shows the most apparent rising pumping rates.

The model results indicate that no historic regional-scale-of-depression exist in the northern Edwards aquifer. As a result of relatively small pumping of the total water budget in the northern segment of the Edwards aquifer, regional-scale drawdown associated with increasing pumping has not been observed (Jones, 2003). However, pumping results in local drawdown. Gradual long-term water-level decline is occurring in the Pflugerville-Georgetown area.

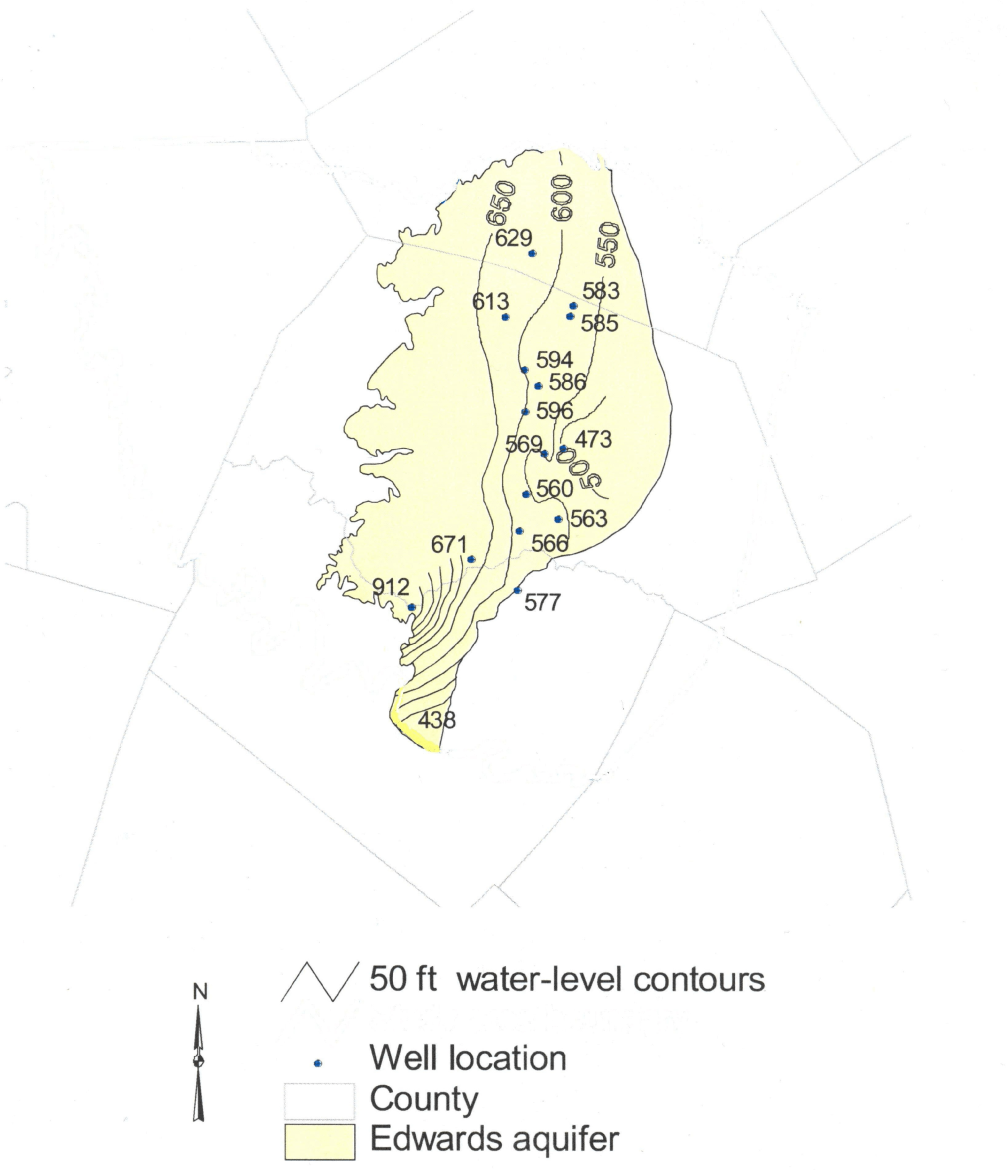

Figure 3. Potetiometric Surface Map, 1997 - 1998, Edwards Aquifer
(Ridgeway and Petrini 1999)

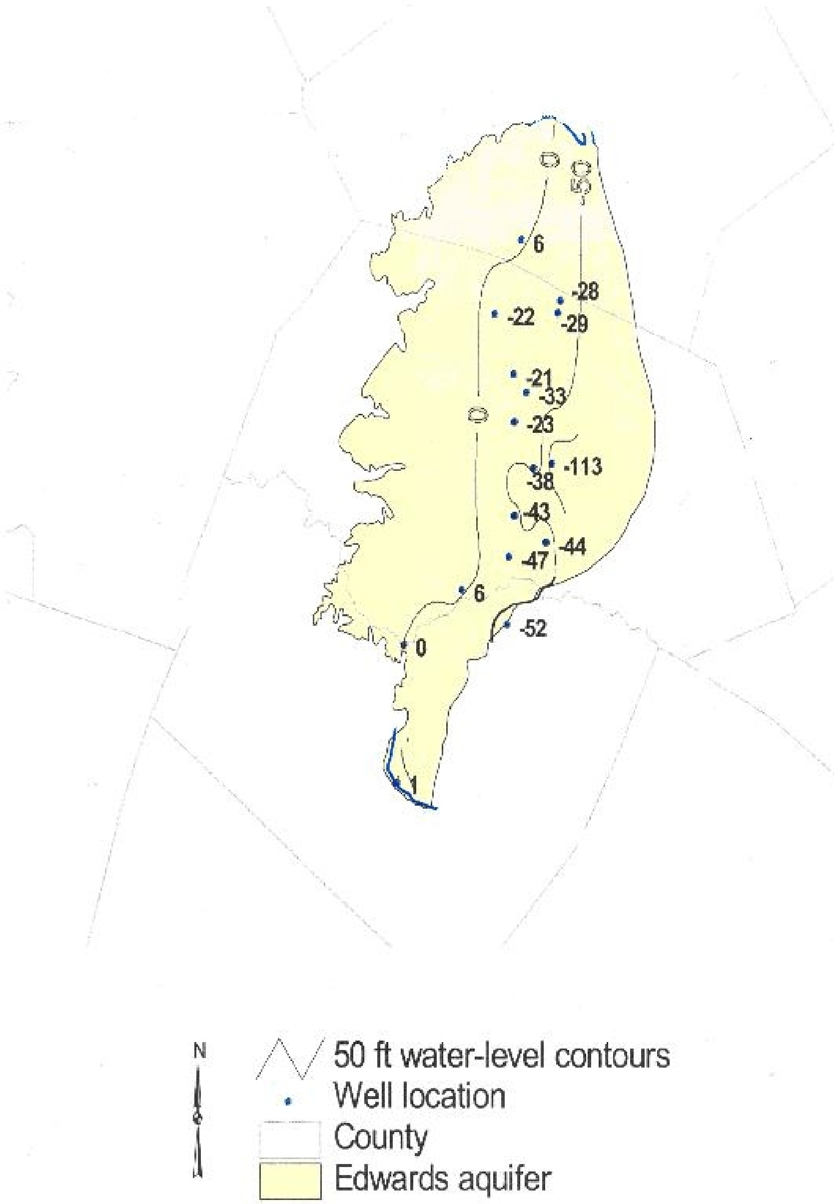

Figure 4.Water-level change in the Edwards Aquifer based on data collected 1987-1988 and data collected 1997-1998 (Ridgeway and Petrini 1999)

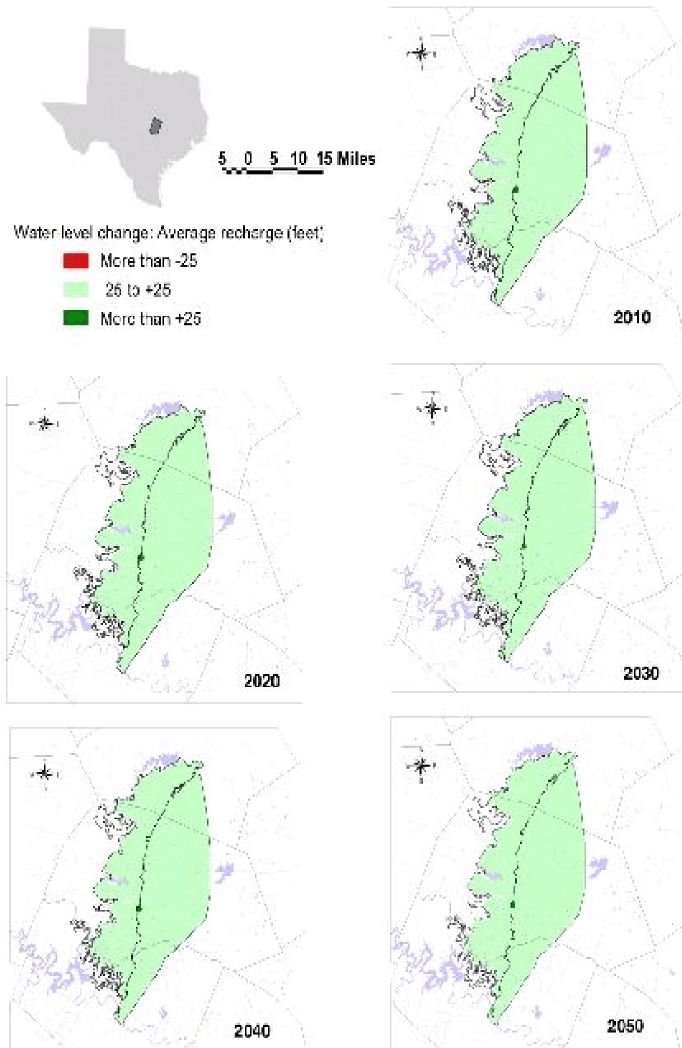

Figure 5. Simulated water-level changes 2010 through 2050, with average recharge.
(Jones 2003)

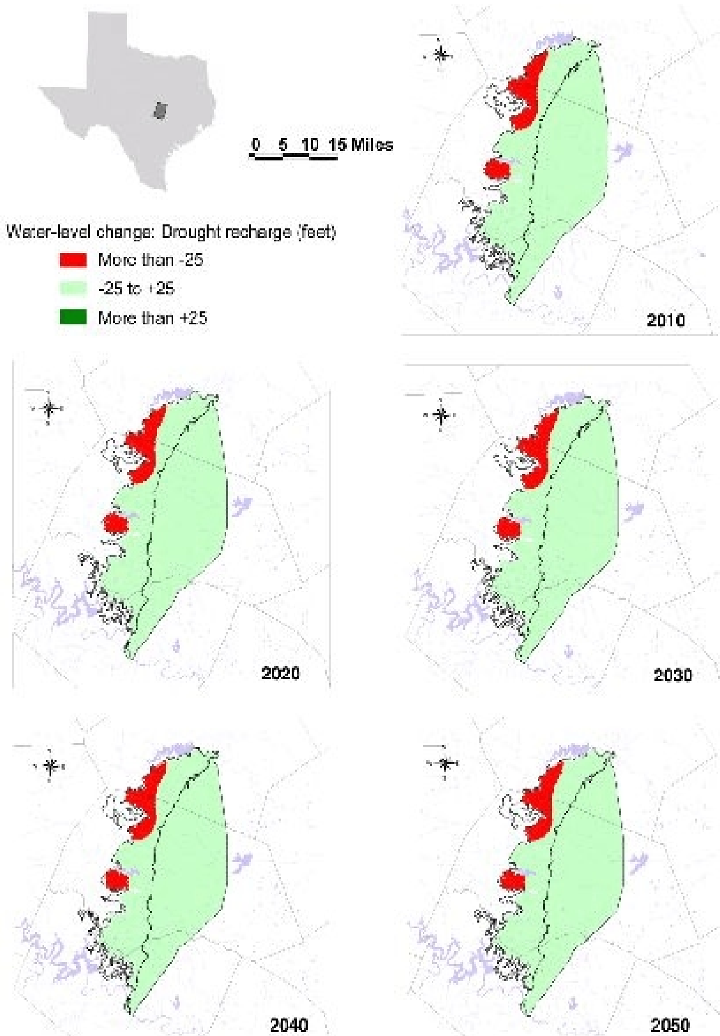

Figure 6. Simulated water-level changes 2010 through 2050, with drought-of-record recharge (Jones, 2003)

Trinity Group Aquifer

The Trinity Group aquifer consists of the lower Trinity hydrologic unit containing the Hosston and Sligo members of the Travis Peak Formation, the middle Trinity hydrologic unit containing the Cow Creek limestone and Hensel sand members of the Travis Peak Formation and the lower member of the Glen Rose Formation, and the upper Trinity hydrologic unit containing the upper member of the Glen Rose Formation and the Paluxy Formation (Duffin and Musick, 1991).

The lower Trinity hydrologic unit consists of a lower calcareous conglomeritic section, a middle calcareous section, and an upper calcareous clastic section. Regionally, the lower unit of the Trinity Group aquifer dips east to southeast. It ranges in thickness from 100 feet in the west to around 900 feet downdip in Milam County. Between the lower Trinity hydrologic unit and the middle Trinity hydrologic unit, the Hammett shale member of the Travis Peak Formation acts as a confining bed. The Hammett shale is a fossiliferous, calcareous, and dolomitic shale interbedded with thin limestone and sand layers. The middle Trinity hydrologic unit consists of a lower calcareous section with intermittent gypsum or anhydrite beds, a middle calcareous conglomerate section, and an upper calcareous section. The upper Trinity hydrologic unit consists of the upper Glen Rose Formation, containing alternating marl and limestone beds. Stair-step topography typifies the upper Glen Rose Formation in outcrop due to erosional characteristics of the lithology. Gypsum and anhydrite beds, which are present in some areas, have often been dissolved leaving solution channels (Duffin and Musick, 1991).

Recharge to the Trinity Group aquifer is derived primarily from rainfall on the outcrop, underflow, vertical leakage, and seepage from lakes and streams. The upper and lower members of the Glen Rose Formation and the Hensell Sand Member of the Travis Peak Formation outcrop over the western portions of the study area; therefore, these units receive the maximum amount of recharge. The Hosston Member of the Travis Peak Formation probably receives very little recharge from rainfall because of its limited surface outcrop and the type of soils (Duffin and Musick, 1991).

Groundwater in the Trinity Group aquifer moves slowly downdip to the south and east-southeast. The direction of the groundwater movement is perpendicular to water level contour lines and toward lower elevations. A potentiometric surface map for the Trinity Group aquifer is shown in Figure 7. Water level measurements indicate the hydraulic gradient of the potentiometric surface is about 10 to 100 feet per mile in most of the study area. In areas of continuous pumping, the direction of groundwater movement is toward these points of discharge from all directions. Because of low permeability and numerous confining beds, movement of groundwater in the upper member of the Glen Rose is generally in the same direction as the slope of the land surface (Duffin and Musick, 1991).

There are no known springs discharging from the lower Trinity aquifer in the study area. Most of the discharge occurs from flowing wells and pumpage. Discharge from the middle and upper Trinity aquifers are from pumping and flowing wells and springs.

Groundwater from the Trinity aquifer is used primarily in the west and east of the study area, where the Edwards Limestone is absent or too thin to produce significant amounts of groundwater. In the area of the Edwards aquifer, groundwater from the underlying Trinity aquifers is rarely used. Only in eastern Williamson County, where water quality of the Edwards aquifer deteriorates, groundwater from the lower Trinity aquifer (Hosston Formation) is used as the main water supply for several municipalities (Senger and others, 1990).

Abrupt changes in water-level elevations were not generally observed in the Trinity Group aquifer (Figure 8). The two main reasons for significant drawdown are normally associated with changes in annual rainfall and industrial or public-supply production (Duffin and Musick, 1991). In the unconfined recharge zone, water levels are primarily influenced by precipitation and to a lesser degree by public-supply production. In the confined portions of the aquifer however, drawdown is generally influenced more by public-supply production than by precipitation (Ridgeway and Petrini, 1999). Cones-of-depression have occurred in western Williamson County and north of the Colorado River in Travis County. The declining water levels are due to the low permeability of the water-producing sands and the groundwater pumpage by industrial and public supply users.

The Trinity/Woodbine aquifer GAM used the calibrated and verified transient models to predict future water lever response, artesian pressure declines/recovery in the downdip portion of the aquifer. The regional water planning groups estimated groundwater demands were used in the predictive simulations. (Harden et al., 2004).

Six scenarios were used in the GAM development to assess the water level and artesian pressure response from average rainfall and drought-of-record conditions. The model is comprised of seven layers, whose lateral extent is bounded by the outcrop zones to the north and west of the Trinity/Woodbine aquifer and by the Luling-Mexia-Talco Fault Zone in downdip areas (Harden et al., 2004). Of the seven model layers, two layers represent the primary aquifer interest to this study area. These are Hensel (layer 5) and Hosston (layer 7).

The predictive simulations showed that difference between drought-of-record and average rainfall water levels in downdip portions of the aquifer system were significantly less than one foot (Harden et al., 2004). This predictive water level response also showed a general water-level rise due to the planned reduction in pumpage assumed by the state and regional water plans in the study area. Water-level responses are most sensitive to pumpage and horizontal hydraulic conductivity in the Trinity aquifer.

Figures 9 and 10 present the simulated water-level changes from 2000 to 2030 for layer 5 (Hensen) for simulations assuming both average annual recharge and drought-of-record recharge distributions respectively. The predictive simulations showed that the pumping center in Williamson County had water-level recovery over 100 feet in 2030. Northern Travis has a similar prediction as Williamson County. Burnet County will remain without significant water-level changes for the next 25 years.

Figures 11 and 12 present the simulated water-level change from 2000 to 2030 for layer 7 (Hosston) for simulations assuming both average annual recharge and drought-of-record recharge distributions. According to the GAM modeling, the Hosston aquifer layer also showed significant water-level recovery in each of the predictive simulations. Eastern and western parts of Williamson and Travis Counties show water-level recoveries up to 100 ft. Water levels were not predicted to change appreciably for the next 25 years from present levels in Burnet County.

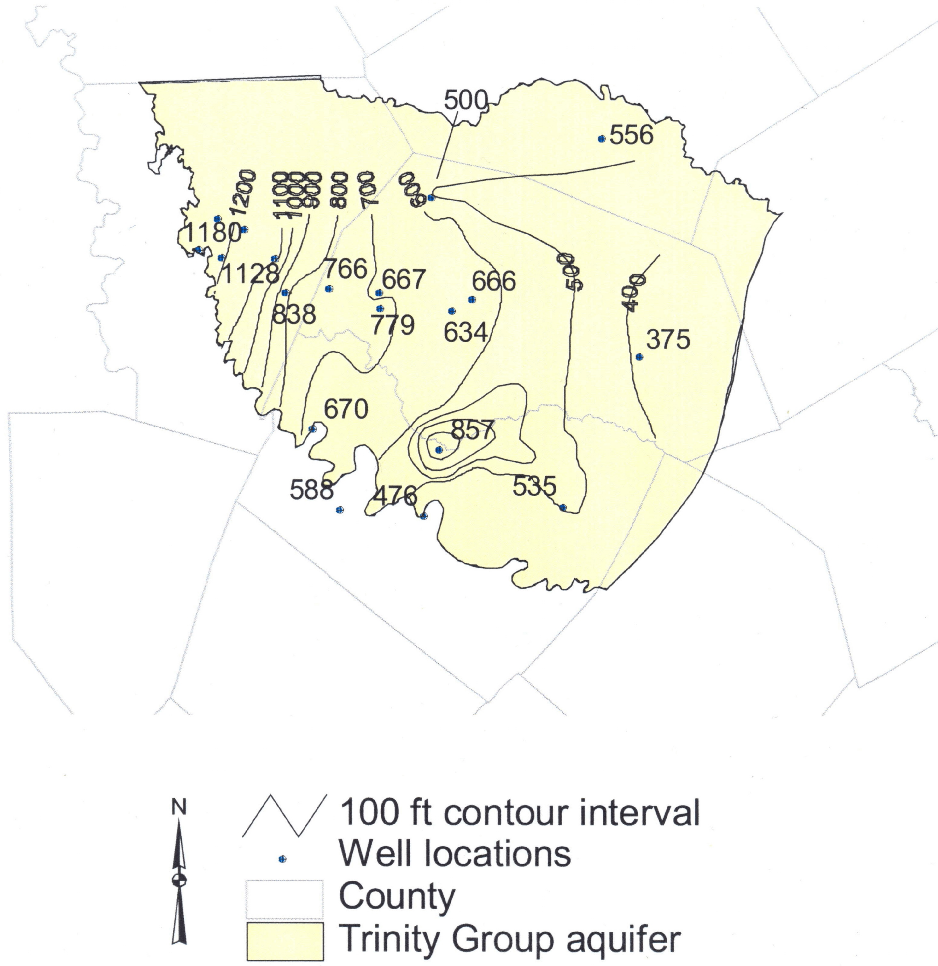

Figure 7. Potetiometric Surface Map, 1997 - 1998, Trinity Aquifer
(Ridgeway and Petrini, 1999)

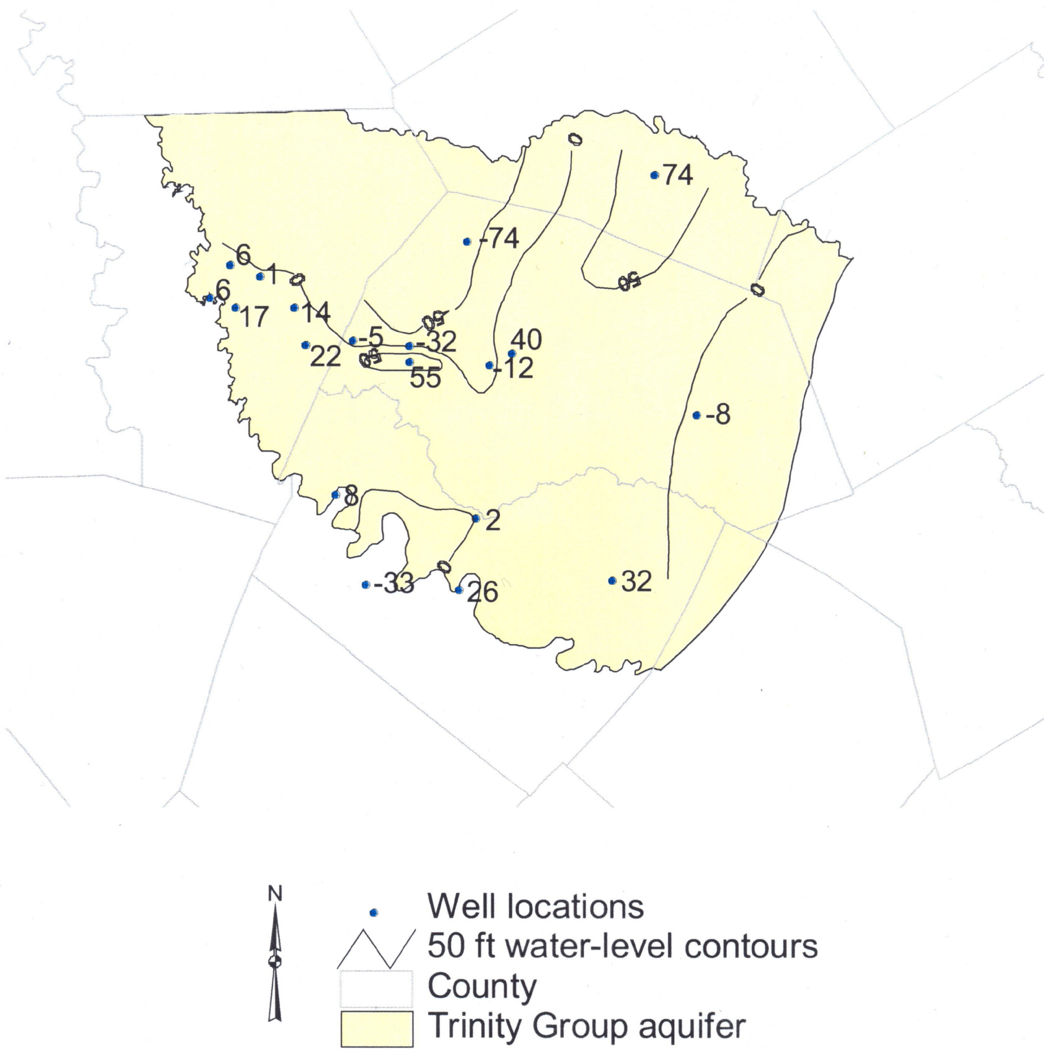

Figure 8. Water-level changes in the Trinity Group aquifers based on data collected 1987-1988 and data collected 1997-1998 (Ridgeway and Petrini, 1999)

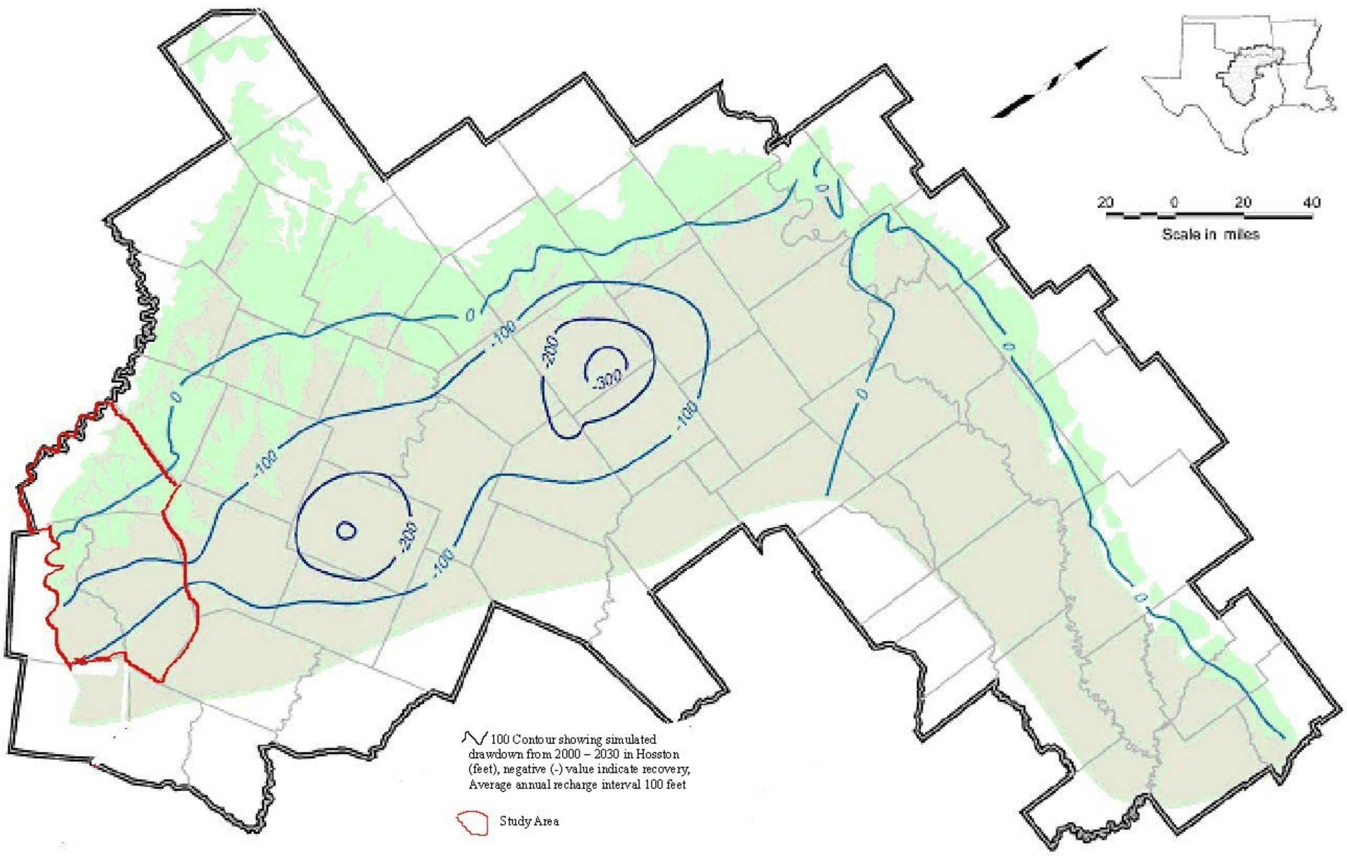

Figure 9. Simulated Water-level from 2000 to 2030 for layer 5 (Hensell), Assuming Average Recharge (Harden et al., 2004)

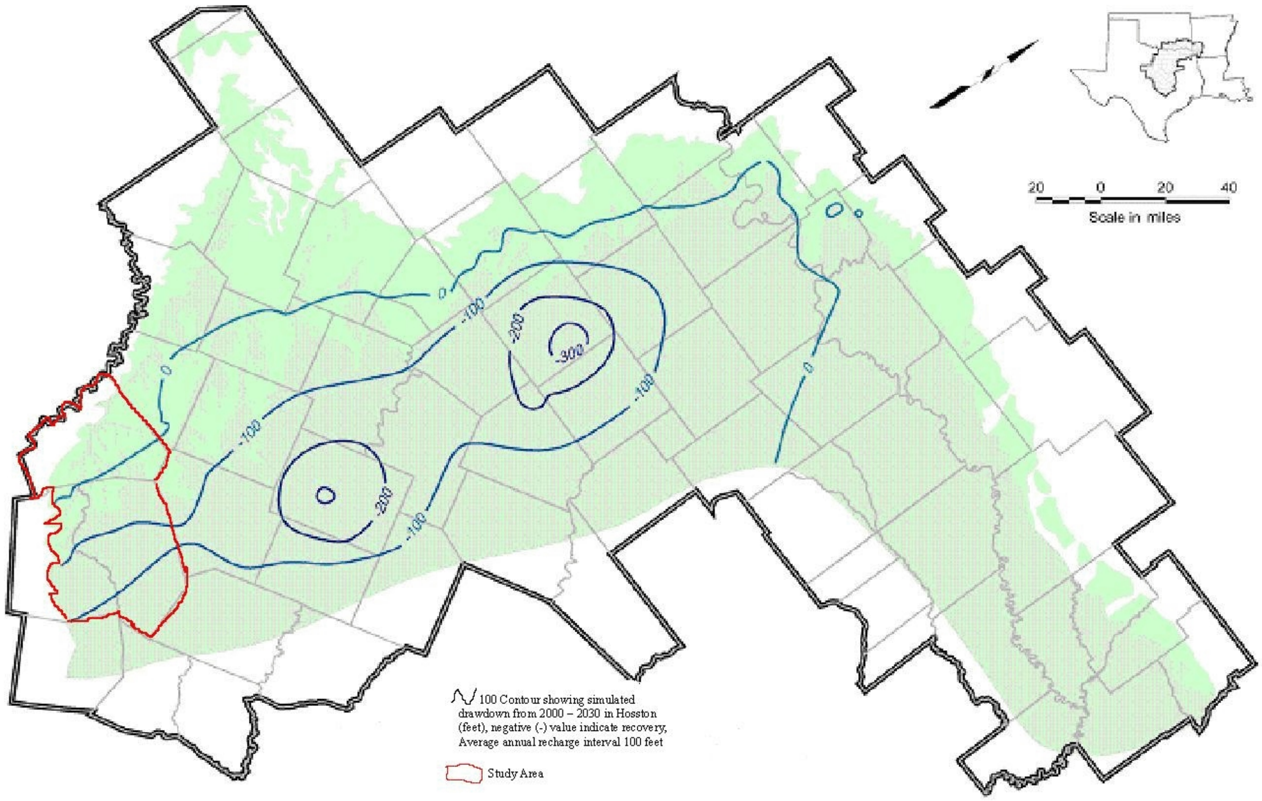

Figure 10. Simulated Water-level from 2000 to 2030 for layer 7 (Hensell), Assuming drought of record recharge distribution (Harden et al., 2004)

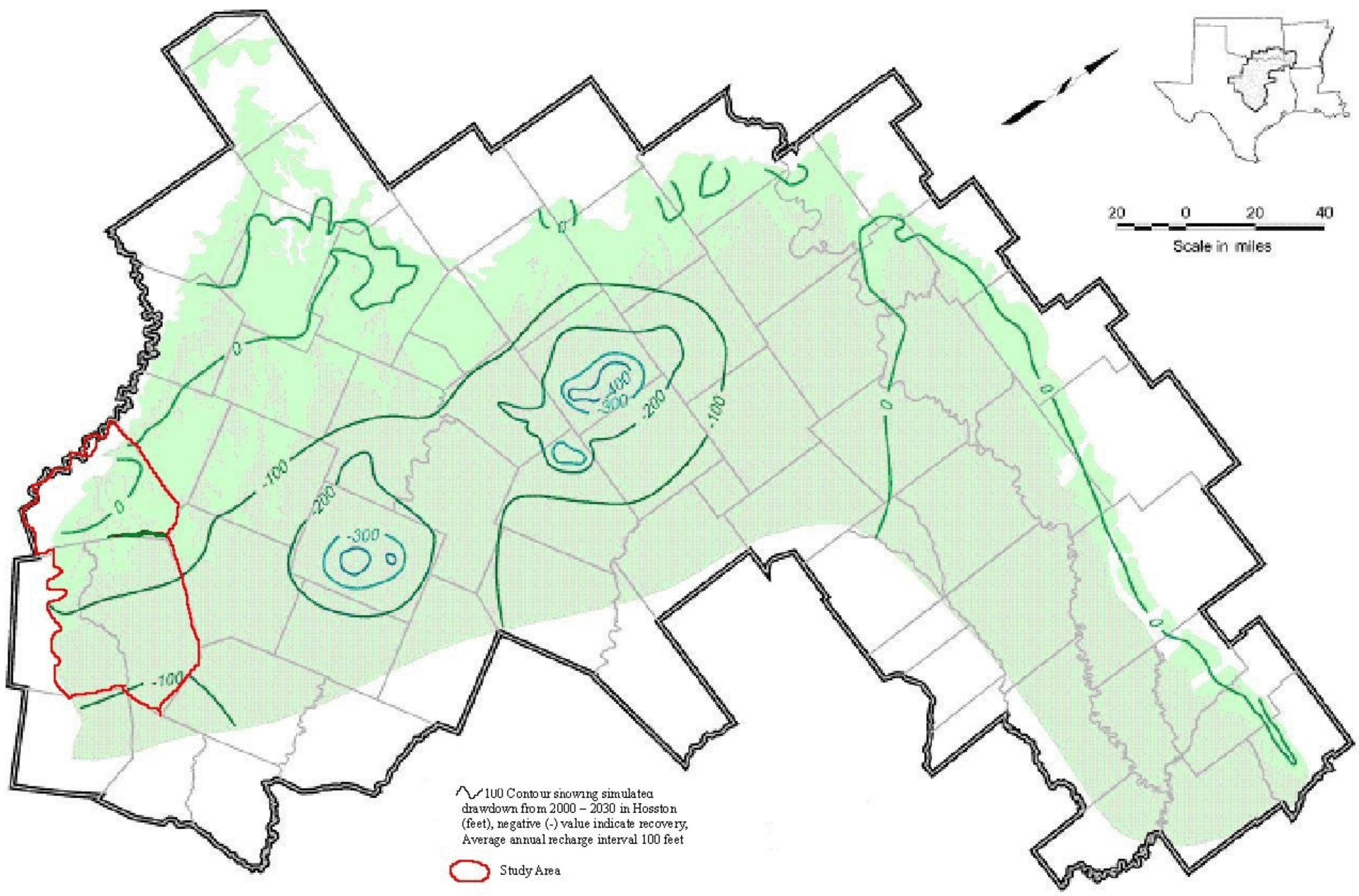

Figure 11. Simulated Water-level change from 2000 to 2030 for layer 7 (Hosston), Assuming Average Annual Recharge (Harden et al., 2004)

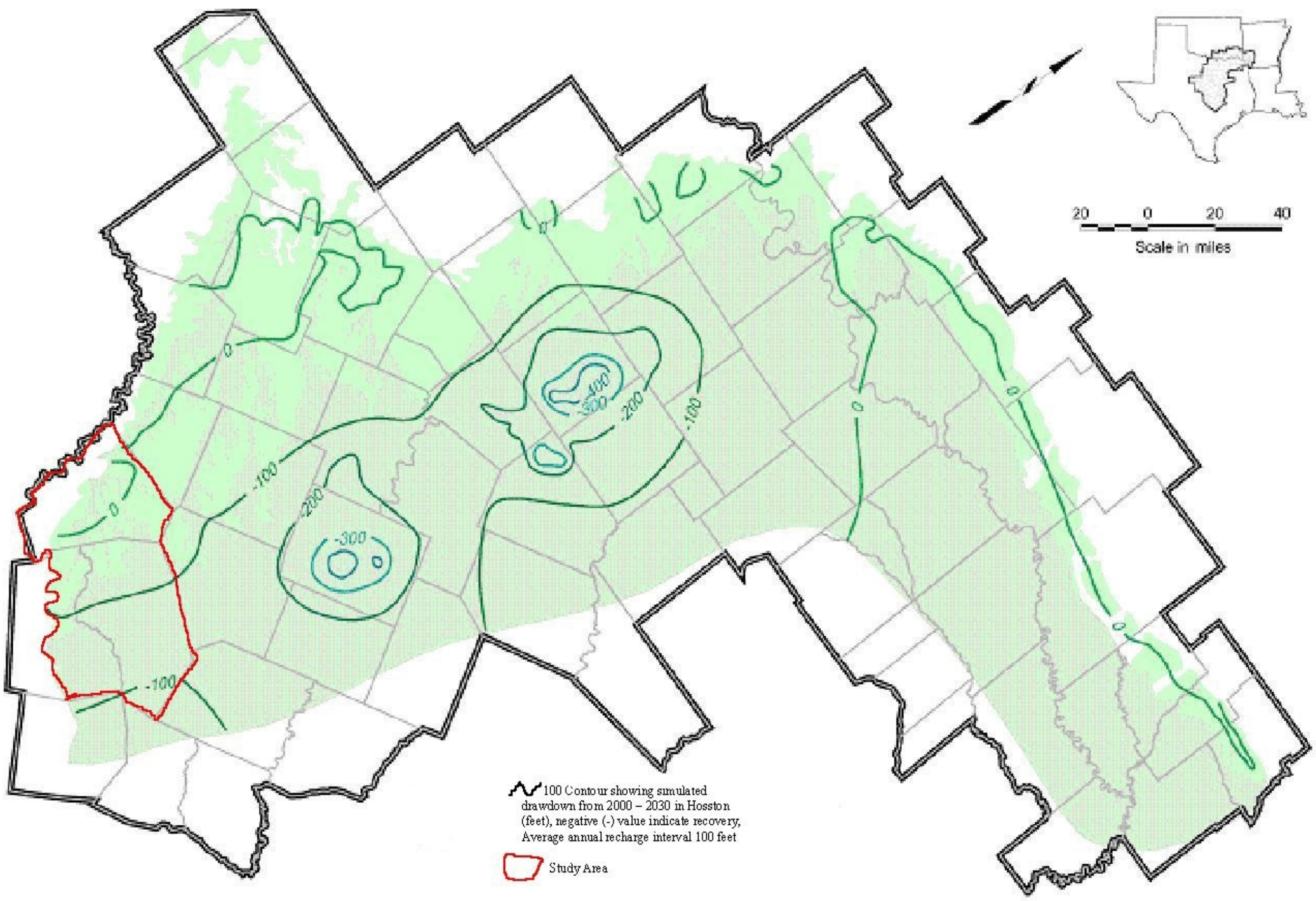

Figure 12. Simulated Water-level change from 2000 to 2030 for layer 7 (Hosston), Assuming Drought of record recharge distribution (Harden et al., 2004)

Minor Aquifers

Others aquifers which produce small to moderate amounts of groundwater in the study area are the Hickory, Marble Falls, and Ellenburger-San Saba (Figure 2). These aquifers mainly supply groundwater in Burnet County. Groundwater containing lower concentrations of total dissolved solids (less than 500 mg/l) in the Hickory aquifer are found in the western part of Burnet County surrounding the Llano Uplift. This lower concentration is indicative of recharge and active groundwater flow systems on and near the outcrop. A higher total dissolved solids in groundwater extend towards the central and eastern part of Burnet County, and may indicate restricted subsurface flow areas. Groundwater from the Ellenburger-San Saba aquifer yields fresh water (less than 500 mg/l total dissolved solids) in most parts of Burnet County except in the northern and southern tips of the county. Downdip, total dissolved solids increases with increased depth and may reflect restricted or stagnant flow. The quality of groundwater produced from the Marble Falls aquifer is generally suitable for most purposes.

Marble Falls Aquifer

The Marble Falls Limestone aquifer is exposed along the northern and eastern flanks of the Llano Uplift. The aquifer reaches a maximum thickness of 600 feet, with groundwater occurring in cavities and fractures in the Pennsylvanian-aged limestone (Muller and Price, 1979). The majority of the aquifer recharge is probably derived from inflow along cavities and fractures from the underlying strata (Brune, 1975), and infiltration of precipitation on the outcrop. Discharge occurs from large springs issuing from the limestone (Brune, 1975).

Ellenburger-San Saba Aquifer

This aquifer is composed of marine limestone and dolomite deposits of the San Saba Member of the Wilberns Formation of Cambrian age and the Ellenburger Group of Cambrian and Ordovician age. The Ellenburger-San Saba aquifer yields small to moderate supplies of water. The San-Saba Member and the Ellenburger Group are considered to be one aquifer due to their hydrologic interconnection and the difficulty in distinguishing the two stratigraphic units in the subsurface (Walker, 1979). The Ellenburger-San Saba aquifer is exposed at the surface in the circular shape which surrounds the Llano Uplift and dips into the subsurface away from the uplift. The aquifer is highly faulted in the surface and subsurface and was eroded prior to being covered by Cretaceous sediments, causing a large variation in aquifer thickness (Walker, 1979).

Hickory Aquifer

The Hickory Sandstone aquifer crops out and dips into the subsurface in a radial pattern around the Llano Uplift. The aquifer is principally composed of sand and sandstone of the Hickory Sandstone Member of the Riley Formation of Cambrian age (Muller and Price, 1979) and is the oldest aquifer in the study area. Extensively faulted in the outcrop and subsurface, the aquifer strata dip steeply away from the Llano Uplift. The Hickory was deposited upon an unevenly eroded metamorphic and igneous rock surface with a topographic relief in excess of 300 feet, which resulted in a wide variability in the accumulated thickness (Walker 1979; Black, 1988). Although recharge from precipitation on the circular outcrop with groundwater movement down gradient in a radial direction in to the aquifer does occur, the groundwater flow direction into and within the aquifer is modified by intense faulting as indicated in a study by Black (1988). He postulated that faults may either enhance recharge or discharge through overlying confining strata; may impede flow, causing groundwater to stagnate down dip of a fault; or redirect flow around a fault.

Other Groundwater Sources

The study area also gets groundwater supplies from other widely scattered sources. The Austin Chalk and Navarro and Taylor Groups, alluvium and terrace deposits and Wilcox Group produce small to moderate amounts of groundwater in the study area (Duffin and Musick, 1991). The alluvium and terrace deposits along the Colorado River are the larger producers of groundwater when compared to the Austin Chalk or Navarro and Taylor Groups in the study area. The alluvium and terrace deposits are found along the Colorado River. These deposits consists of gravel, sand, silt, and clay, sometimes cemented with calcium carbonate, with the coarser materials concentrated at the base. They occur at higher elevations than the more recent floodplain deposits.

In the Austin Chalk, groundwater usually occurs in the upper, weathered outcrop portion of the units, which is the most permeable. The unit contains numerous fractures and joints throughout the unit. It consists of a light gray chalk, limey marl, and chalky limestone. Some bentonite, glauconite, and pyrite nodules are also present in the unit. It has an extensive outcrop across Texas from northeast to southeast along the eastern portion of the study area. Water can also be present in the softer marls which occur throughout the unit. Groundwater occurs primarily under water-table conditions in the unit.

In the Navarro and Taylor Groups groundwater usually occurs in the upper, weathered outcrop portion of the units, which is the most permeable. Groundwater occurs primarily under water-table conditions. Lithologically, the Taylor Group and overlying Navarro Group are very similar and are treated as a single hydrologic unit. They consist of massive beds of shale, siltstone, marl, and chalk with clay. They also include beds of sands and some nodular and phosphatic zones. The unit is found along the eastern portion of the study area from eastern Williamson County to eastern Travis County.

The Wilcox Group crops out in the southeastern parts of Williamson County. It mainly consists of fine to coarse sand and lesser amounts of clay, sandy clay, sandstone, and silty shale with a few lenses of limestone and lignite. It yields small to moderate quantities of fresh to slightly saline water outside the study area.

NATURAL RESOURCES ☆☆☆

As requested by the TCEQ, an evaluation of selected natural resources in the study area was conducted by the Texas Parks and Wildlife Department (TPWD) in 1999 and updated in 2004. Most information presented in this section was obtained from TPWD's 2004 report prepared by El-Hage and Moulton. The remaining information has been obtained from the Brazos G and Lower Colorado Regional Water Plans or other sources as noted.

Texas Parks and Wildlife Department Regional Facilities

Within the study area, TPWD operates one state park, Bright Leaf State Park (SP), and one wildlife management area (WMA), Granger WMA. Granger WMA surrounds Granger Reservoir, which is owned and operated by the U.S. Army Corps of Engineers. The reservoir itself provides water based recreational activities, and in conjunction with the WMA, a rich habitat for waterfowl.

Springs, Wetlands, and Fishes

Most springs in the study area emanate from the Northern Edwards (Balcones Fault Zone) aquifer. Major springs in the study include Leon, Salado, and Berry Springs. The distribution and size, as of 1980, of those springs and seeps that are of some importance within the study area are listed in Table 3 (Brune 1981). Most springs emanate from the top of the groundwater reservoir, so changes in the water table elevation generally have immediate impact upon springs discharge rates.

In Travis and Williamson counties, the springs issue from the Edwards and associated limestones along the Balcones Fault Zone. Most of the spring waters in Williamson County pass through underground caves. These caves and associated springs are the home of several species of unusual invertebrates. "As they can live nowhere else, it is important to preserve the springs in order not to destroy the species (Brune 1981)." El-Hage and Moulton suggest the implementation of a PGMA in this region could regulate groundwater resources. In general, a flowing spring indicates the fact that groundwater supplies are not depleted.

The U.S. Army Corps of Engineers defines wetlands as areas that, due to a combination of hydrologic and soil conditions, are capable of supporting hydophytic vegetation. In the study area, wetlands are found primarily in narrow strips along rivers and streams.

As natural resource, wetlands are especially valued because of their location on the landscape, the wide variety of ecological functions they perform, and the uniqueness of their plant animal communities. Many wetlands are also valued for their aesthetic qualities, as sites for educational research, as sites of historic and archaeological importance, and as locations for conveying floodwaters. Wetlands provide high-quality habitats for wildlife, including foraging and nesting areas for birds and spawning and nursery areas for fish.

The rivers and streams within the study area have a variety of fish species common to the Brazos and Colorado River drainages. The reservoirs in the study area support many fish species that are not native. This results from stocking and "bait bucket" transplants.

Birds and Waterfowl

Many species of neotropical songbirds, wintering shorebirds, and a large number of waterflow stopover in the study area to feed and rest along the river banks and creek bottoms. The trees and shrubs that grow along the rivers, streams, and lakes are of importance to migrating songbirds and raptors, such as the yellow warbler and the swallow-tailed kite.

The Bald eagle (*Haliaeetus leucocephalus*), although rare in the study area, is a federally and state threatened species that is found primarily near rivers and large lakes in the study area. Bald eagles nest in tall trees or on cliffs near water.

The snow goose (*Chen caerulescens*), mallard (*Anas platyrhynchos*), lesser scaup (Aythya affinis), bufflehead (*Bucephala albeola*), and ruddy duck (*Oxyura jamaicensis*) are but some of a large population of waterfowl that stopover on reservoirs and rivers in the area at different times of the year to forage, nest, and roost.

The mountain plover (*charadrius montanus*), peregrine falcon (*Falco peregrinus*), and the interior least tern (*Sterna antillarum athalassos*) are on the special list of the TPWD Wildlife Diversity Program. The special species list includes those species that are considered threatened, endangered, rare or extirpated.

Amphibians, Reptiles, and Mammals

There are 1,100 vertebrate species in Texas, 60 of which are endemic (Texas Audubon, 1997). In the study area there are at least 44 species of reptiles, mammals, and amphibians that are either aquatic, semi-aquatic, or in some way wetland-dependent.

Bats typically drink water from rivers and other riparian habitats, as well as use rivers and streams as travel corridors. The cave myotis (*Myotis velifer*) is a good example. It is the most abundant bat of the Edwards Plateau and hibernates in central Texas caves in winter. Cave myotis are opportunistic insectivores that feed on a wide variety of insects depending upon what is most available on a given night. Small moths make up the largest portion of the diet although small beetles and weevils are also taken. The cave myotis is closely associated with water. When the bats leave their diurnal roots late in the evening, they fly to nearby ponds and streams over which they forage and from which they drink (Davis and Schmidly, 1994).

Most toads and frogs require an aquatic habitat in order to reproduce. For example, the red-spotted toad thrives in dry habitats, but requires a constant source of moisture, such as springs, seepages, pools along streams, and stock tanks (Garrett and Barker, 1987). The Jollyville Plaeau salamander is known from springs and caves of Travis and Williamson counties north of the Colorado River.

In the study area, most of the snakes, lizards, and turtles are restricted to riparian habitat adjacent to the local rivers, springs, ponds and wetlands. A good example is the Texas garter snake, which is usually found in riparian meadowland and juniper-wooded canyons along the eastern edge of the Edwards Plateau.

Vegetation and Soil

The natural regions of Texas were delineated largely on the basis of soil type (Godfrey et al. 1973) and major vegetation types (McMahan et al. 1984). The study area soils vary from dark calcareous clays, sandy loams in the uplands, to dark gray to reddish-brown calcareous clay loams and clays in the bottomlands.

Different crop types are found as the major land cover in the study area, followed by Oak-Mesquite-Juniper-Parks/Woods, Live Oak-Ashe Juniper Parks, and Live Oak-Mesquite-Ashe Jiniper Parks. Commonly associated plants with the Crops type are: cultivated cover crops or row crops providing food and/or fiber for either man or domestic animals. This type may also portray grassland associated with crop rotations.

The Oak-Mesquite-Juniper-Parks/Woods occurs centrally and north in the study area. Commonly associated plants include: post oak, Ashe juniper, shin oak, Texas oak, blackjack oak, live oak, cedar elm, agarito, soapberry, sumac, hackberry, Texas pricklypear, Mexican persimmon, purple three-awn, hairly grama, Texas grama, sideaots grama, curly mesquite, Texas wintergrass.

Live Oak-Ashe Juniper Parks and Live Oak-Mesquite-Ashe Juniper Parks types occur extensively in the western part of the study area. Commonly associated plants (Edwards Plateau) include: Texas oak, shin oak, cedar elm, netleaf hackberry, flameleaf sumac, agarito, Mexican persimmon, Texas pricklypear, kidneywood, saw greenbriar, Texas wintergrass, little bluestem, curly mesquite, Texas grama, Halls panicum, purple three-awn, hairly tridens, cedar sedge, two-leaved senna, mat euphorbia, rabbit tobacco.

Conservation Lands

The Williamson County Karst Conservation Foundation was formed in December 2002, for the purpose of providing a mechanism for conservation and the eventual recovery of endangered cave-dwelling invertebrates in the Williamson County area. Karst preserves will be acquired and managed by a non-profit corporation formed by the county. The initial preserve area includes caves located in the county's new Southwest Regional Park, and are targeted for conservation of the endangered Bone Cave Harvestman Spider (*Texella reyesi*) found primarily in the Williamson County area. Two preserve areas have been set aside: Mellinium Preserve of approximately 130 acres, and the Wilco Preserve of approximately 90 acres (http://www.wilcokarst.org/facts.html accessed in December 2004).

The Foundation is authorized to accept private and public funds to be used for the conservation and recovery of the karst species though the direct acquisition of karst preserve areas (through purchase, deed and/or conservation easements), operation, management, monitoring, research and public education efforts related to the species. The Foundation's goal is to provide a long-term method for conservation and potential recovery of the species. Ultimately, the Foundation hopes to acquire and manage additional preserve lands sufficient to "down-list" or "de-list" various endangered karst species in Williamson County.

The Balcones Canyonlands Preserve (BCP) is a multi-agency conservation effort which operates under a regional 10(a) permit issued by the U.S. Fish and Wildlife Service (USFWS). Though this permit was issued to the BCP's two managing partners, the City of Austin and Travis County, several other organizations own and manage Preserves dedicated to the BCP. These organizations include the Travis Audubon Society, the Lower Colorado River Authority, the Nature Conservancy of Texas and numerous private land owners. The BCP's goal is the acquisition and management of at least 30,428 acres. At this time (summer, 2002), acreage dedicated to the Preserve totals 26,323 acres. The City of Austin's holdings total 13,034 acres and Travis County's BCP acreage totals 2,289 acres.

(http://www.ci.austin.tx.us/preserves/bcl.htm; accessed January 2005). Because the purpose of the BCP is endangered species conservation, allowable activities and public access vary between individual Preserves in the system.

The Balcones Canyonlands Conservation Plan (BCCP), a document accompanying the permit, specifies eight endangered species, two migratory songbirds and six karst invertebrates, to be protected within the Preserve. They include the golden-cheeked warbler, black-capped vireo, Tooth Cave pseudoscorpion, Tooth Cave spider, Tooth Cave ground beetle, Kretschmarr Cave mold beetle, Bone Cave harvestman, and Bee Creek Cave harvestman. An additional list of 27 "species of concern" specifies threatened plants and invertebrates to be protected.

The USFW Service 10(a) permit and its accompanying documents provide a very specific mandate for Preserve Management. Page 2-31 of the Habitat Conservation Plan and Final Environmental Impact Statement (March 1996) states the following:

> "The BCCP preserve system is to be managed to permanently conserve and facilitate the recovery of the populations of target endangered species inhabiting western Travis County. This priority objective will govern preserve management activities to improve target species habitat, while protecting preserves against degradation caused by urbanization of surrounding lands and increased public demand for recreation usage within preserves."

Evaluations of historic water usage, population and water demand projections, current water supplies, and total water availability are provided in this section. The evaluated data come predominantly from the 2002 State Water Plan, *Water For Texas - 2002* (TWDB, 2002). Data from the Brazos G and Region K Regional Water Plans have also been utilized. If not discussed here, the methodologies for development of the evaluated data may be referenced in the state and regional water plans.

Water supplies from existing sources are the amounts of water that can be used if water rights, water quality, infrastructure limitation, 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. Groundwater availability represents the total amount of water available for use from an aquifer under a development scenario selected by regional planning group. Most of the planning groups estimate groundwater availability using either recharge or systematic depletion. Groundwater supplies represent the amount of water that can be accessed with existing infrastructure, such as wells and pipelines. 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.

Water Usage

Table 1 shows area-wide estimated water use for the counties in the study area in 2000. In 1995, approximately 127,819 acre-feet of water was used to meet the needs of the three-county study area. Of this amount, approximately 79 percent was extracted from surface water (101,214 acft), and the remaining 21 percent (26,605 acft) was extracted from groundwater sources.

Water needs throughout the study area are primarily met with surface water, and increased use from 1985-2000 has largely been met by surface water sources. Groundwater use and levels of use have remained fairly consistent over this time period. Burnet County used 2,944 acft of groundwater in 1985 and decreased to 2,320 acft in 1995, and increased to 2,957 acft in 2000. Travis County shows increased use of groundwater by 28 percent (1,438 acft) from 1985 to 2000. The amount of groundwater used in Williamson County did not vary much between 1985 to 2000. In 1995, groundwater accounted for 20 percent of all water used in the study area, and was down from 24 percent in 1985. In 2000, groundwater accounted for 17 percent (27,417 acft), and surface water accounted for 83 percent (137,459 acft) of water used in the study area. Increased use of surface water was observed in the study over this five-year period.

More water is used for municipal needs in the study area than for any other purpose. In 2000, municipal accounted for 141,667 acft (86 percent) of the total amount of water used, up from 107,254 acft (84 percent) in 1995, and up from 93,541 acft (86 percent) in 1990. Of the amount of water used for municipal purposes in 2000, 22,646 acft (16 percent) was supplied by groundwater sources and 119,021 acft (84 percent) was supplied from surface water sources. Sixty-three percent of the water used in 2000 for municipal purposes (89,554 acft) was used in Travis County north of the Colorado River. Williamson County used 15,496 acft (69 percent) of the groundwater used for municipal use in 2000 in the study area.

Table 1. Estimated Water Use, 2000, Williamson, Burnet and Northern Travis Counties Study Area						
USE TYPE	**BURNET COUNTY**		**NORTHERN TRAVIS COUNTY**		**WILLIAMSON COUNTY**	
	GW	**SW**	**GW**	**SW**	**GW**	**SW**
MUNICIPAL	1,798	3,709	5,352	84,202	15,496	31,110
MANUFACTURING	23	720	404	8,817	518	653
POWER	0	0	4	4,269	0	0
IRRIGATION	78	25	680	17	0	80
MINING	641	1,084	0	732	1,672	215
LIVESTOCK	417	417	200	200	134	1,209
2000 USE	**2,957**	**5,955**	**6,640**	**98,237**	**17,820**	**33,267**
PREVIOUS WILLIAMSON, BURNET AND NORTHERN TRAVIS COUNTIES PGMA STUDY AREA WATER USE BY SOURCE						
USE TYPE	**BURNET COUNTY**		**NORTHERN TRAVIS COUNTY**		**WILLIAMSON COUNTY**	
	GW	**SW**	**GW**	**SW**	**GW**	**SW**
1985 USE	2,944	2,878	5,202	70,484	17,872	9,108
1990 USE	1,946	4,752	5,501	68,252	16,842	11,347
1995 USE	2,320	4,687	6,467	75,972	17,818	20,555
Notes: **Water quantity in acre-feet**; GW - groundwater; SW - surface water. Adapted from TWDB, 2004.						

Manufacturing use accounted for 11,135 acft (seven percent) of the total water used in 2000. Eight percent of this water use was from groundwater. As a comparison, water used for these purposes in 1990 was 4,999 acft (or 4.6 percent of the total water used), with groundwater constituting ten percent of this amount in the study area. Travis County used 9,221 acft for manufacturing, 83 percent of the water used in 2000.

Mining use accounted for 4,344 acft (three percent) of the total water used in 2000. Out of this amount 53 percent was from groundwater sources. Williamson County used 1,672 acft for mining purposes, 72 percent of groundwater use in 2000 for mining purposes.

Water for power generation accounted for 4,273 acft of water use in Travis County in 2000, representing less than three percent of the total water use in the study area. Groundwater was used to supply 758 acft of water for irrigation purposes (less than one percent of total water use) and 2,313 acft of water for mining purposes (less than two percent of total water use) in 2000. Use of surface and groundwater sources for the watering of livestock accounted for 2,577 acft of use (less than two percent) in 2000; consisting of 29 percent groundwater (751 acft) and 71 percent surface water (1,826 acft).

Population and Water Demand Projections

According to the Brazos G and Region K Regional Water Planning Groups, the total population of the study area was 669,595 in 2000. This report uses the population projections developed for the regional and state water plans in 2002. The U.S. Census Bureau did not outline population projections based on Water User Groups (WUGs) or for the portion of the study area north of the Colorado River; therefore, this report did not use population projections from the Bureau.

The regional and state water plans project that between the years 2000 and 2030, total population within the study area will increase by approximately 91 percent (from 669,595 inhabitants in 2000 to 1,278,831 inhabitants in 2030). During that time period, the population in Austin, Georgetown, Round Rock, Hutto, and Leander are projected to increase most dramatically. Population projection data is shown in Table 2.

The area of Travis County north of the Colorado River was estimated using GIS techniques and compared to the area of southern Travis County. The TWDB estimated that approximately 56 percent of Travis County lies north of the river and about 44 percent south of the river. The TWDB used a similar technique to estimate the area of the City of Austin north and south of the Colorado River. These areas are approximately 57 percent and 43 percent, respectively. Other cities (population greater than 500 and listed in the 2002 State Plan database) within Travis County lie entirely north or south of the Colorado River and either were fully retained (north of the river) or completely eliminated (south of the river).

Table 2. Projected Population, Williamson, Burnet and Northern Travis Counties PGMA Study Area

BURNET

WUG	BASIN	YR1996	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
BERTRAM	BRAZOS	1,051	1,209	1,232	1,231	1,229	1,275	1,325
BURNET	COLORADO	4,290	4,819	6,091	7,015	7,812	8,048	8,292
COTTONWOOD SHORES	COLORADO	750	880	1,060	1,144	1,213	1,261	1,285
GRANITE SHOALS	COLORADO	2,167	2,502	3,426	4,356	5,089	5,396	5,721
MARBLE FALLS	COLORADO	5,228	5,975	7,435	8,995	10,268	10,739	11,231
MEADOWLAKES	COLORADO	799	1,010	1,045	1,058	1,072	1,130	1,202
COUNTY-OTHER	BRAZOS	4,072	4,747	5,732	7,012	8,078	8,402	8,731
COUNTY-OTHER	COLORADO	11,069	12,732	14,973	17,971	20,467	21,263	22,104
		29,426	**33,874**	**40,994**	**48,782**	**55,228**	**57,514**	**59,891**

NORTHERN TRAVIS

WUG	BASIN	YR1996	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
ANDERSON MILL	COLORADO	180	247	251	260	267	268	281
AUSTIN	COLORADO	316,918	364,936	439,857	542,797	639,895	703,062	772,464
JONESTOWN	COLORADO	1,319	1,853	2,396	3,108	3,800	4,251	4,756
LAGO VISTA	COLORADO	2,417	5,586	6,935	8,749	10,484	11,611	12,858
MANOR	COLORADO	1,217	1,424	1,862	2,208	2,523	2,728	2,950
PFLUGERVILLE	COLORADO	8,233	12,968	16,569	21,327	25,927	28,922	32,263
ROUND ROCK	BRAZOS	63	102	154	221	286	330	381
WELLS BRANCH	COLORADO	7,894	8,075	8,264	8,293	8,616	9,057	9,497
COUNTY-OTHER	BRAZOS	580	363	396	454	502	533	564
COUNTY-OTHER	COLORADO	51,919	32,395	35,694	41,336	46,004	48,911	51,927
		390,740	**427,949**	**512,378**	**628,753**	**738,304**	**809,673**	**887,941**

WILLIAMSON

WUG	BASIN	YR1996	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
BARTLETT	BRAZOS	995	840	873	947	973	1,035	1,101
BRUSHY CREEK	BRAZOS	7,735	12,589	20,648	22,798	23,800	23,800	23,800
CEDAR PARK	BRAZOS	10,847	17,439	30,978	39,642	46,915	53,413	56,026
FLORENCE	BRAZOS	1,126	1,060	1,349	1,682	2,097	2,318	2,489
GEORGETOWN	BRAZOS	21,445	33,357	54,419	77,409	100,432	128,994	163,777
GRANGER	BRAZOS	1,521	1,574	2,021	2,548	3,091	3,540	3,947
HUTTO	BRAZOS	821	1,065	1,578	2,280	3,216	4,322	5,532
LEANDER	BRAZOS	5,738	9,381	15,557	20,214	26,478	32,333	39,195
ROUND ROCK	BRAZOS	48,961	58,742	92,430	140,605	165,487	189,521	197,313
TAYLOR	BRAZOS	14,130	16,025	22,028	30,886	35,597	41,021	48,996
THRALL	BRAZOS	745	691	774	976	1,224	1,378	1,532
COUNTY- OTHER	BRAZOS	62,355	55,009	78,886	145,312	179,271	193,494	209,184
		176,419	**207,772**	**321,541**	**485,299**	**588,581**	**675,169**	**752,892**

Note: Water User Group (WUG) population data from 2002 State Water Plan.

The updated population projections from the TWDB for the 2006 Regional Water Plans indicate an increase from the 2002 State Water Plan predications for Burnet and northern Travis counties and also indicate a decreased population projection for Williamson County for the next 25 years. The updated population projections are presented below.

COUNTY NAME	P2000 CENSUS	P2010	P2020	P2030	P2040	P2050	P2060
BURNET	34,147	41,924	51,044	60,382	69,271	79,981	90,263
NORTHERN TRAVIS	469,999	552,874	675,734	789,584	883,806	981,960	1,076,469
WILLIAMSON	211,474	304,154	416,122	550,146	696,412	855,960	1,027,400

Projected water demand data, by county and category for the study area, are presented in Table 3. The Water User Groups (WUGs) have been identified by the Brazos G and Region K Regional Water Planning Groups. The WUG projected water demand data include municipal demands for cities and towns, rural water supply demands for county-others uses, agricultural demands for irrigation and livestock, and other water demands for manufacturing, mining, and steam electric power generation.

Development of the demand projection data is detailed in Brazos G (HDR, 2001) and Region K (Turner, Collie and Braden Inc. et al., 2000). The total projected water demand for the three-county study area is expected to change significantly over the next 30-year period. The total water use for 2000 (Table 1) was 164,876 acft and the total projected demand for 2030 is anticipated to be 298,278 acft, an increase of 133,402 acft, or 81 percent over the 30-year time frame. The year 2000 estimated water use value accounts for only 93 percent of the 2000 water demand projection.

Municipal needs represent the largest demand for water in the study area. Municipal demand for the study area is projected to increase by approximately 124,667 acft over the 30-year planning period. It accounts for 86 percent of the total water use in 2000 and increases to 89 percent of the total water demand for 2030, from 141,667 acft to 266,334 acft. Municipal water demand for Williamson County is projected to increase 97 percent (from 46,606 acft to 91,966 acft), Travis County is projected to increase 77 percent (from 89,554 acft to 158,466 acft), and Burnet County is projected to increase 39 percent (from 5,507 acft to 7,646 acft) between 2000 and 2030.

Demand for manufacturing, the second largest demand for water in the study area, is projected to increase 34 percent (from 11,136 acft to 14,960 acft) between 2000 and 2030. This demand is mainly used by industries in producing end-products, as a cooling agent during manufacturing process, or for cleaning/wash-down of parts and/or products. The projected increase in manufacturing water use in Travis County accounts for 86 percent of the total manufacturing demand in 2030.

Water for mining is the third largest demand in the study area and is projected based on future production of mineral commodities, historic rate of water use, and calculated by water requirements of technological processes. In 2000, mining demand was the third highest use category in the study area and accounted for three percent of the total water demand in the study area (4,344 acft). This demand is projected to increase by 44 percent (to 6,277 acft) by 2030 and accounts for two percent of the total demand in the area. Travis County mainly uses and is projected to use the majority of the mining water demand in the study area.

Steam electric power generation is the fourth largest demand for water in the study area even though this demand is located solely in Travis County. The total steam electric water use in 2000 was 4,271 acft and will increase to 7,695 acft in 2010. This demand is projected to remain the same between 2010 and 2040.

Livestock water demand accounts for about two percent of the total water use in the study area in 2000. This demand is projected to remain almost the same for the next 30-year period, and will decrease to account for one percent of the study area total water demand in 2030.

Irrigated agricultural demand represents the least demand for water in the study area. Water for irrigation accounts for 0.5 percent of the total water demand in 2000 and decreases slightly to 0.3 percent of the total water demand in 2030. Decrease in irrigation water demand is associated with improvements in irrigation efficiency and reductions in irrigated acres due to forecasted unfavorable farming economics.

Table 3. Total Water Demand Projections, Williamson, Burnet and Northern Travis Counties PGMA Study Area

BURNET COUNTY

WUG NAME	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
BERTRAM	207	200	190	184	185	191
BURNET	912	1,078	1,179	1,286	1,307	1,338
COTTONWOOD SHORES	141	160	164	168	170	171
GRANITE SHOALS	286	345	400	456	471	493
MARBLE FALLS	1,372	1,624	1,874	2,105	2,177	2,264
MEADOW LAKES	453	451	440	441	459	486
COUNTY OTHER	2,193	2,412	2,715	3,006	3,057	3,143
MANUFACTURING	1,246	1,377	1,514	1,655	1,800	1,947
IRRIGATION	295	290	285	280	275	271
STEAM ELECTRIC POWER	0	0	0	0	0	0
MINING	1,013	987	1,006	1,028	1,058	1,091
LIVESTOCK	794	794	794	794	794	794
TOTAL	**8,912**	**9,718**	**10,561**	**11,403**	**11,753**	**12,189**

NORTHERN TRAVIS COUNTY

WUG NAME	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
ANDERSON MILL (P)	35	34	34	33	32	34
AUSTIN (P)	87,070	100,511	119,778	139,054	151,206	165,267
JONESTOWN	243	284	334	400	438	485
LAGO VISTA	1,821	2,128	2,519	2,995	3,291	3,630
MANOR	255	313	349	393	419	449
PFLUGERVILLE	2,876	3,378	4,061	4,908	5,410	5,963

WUG NAME	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
ROUND ROCK (P)	25	36	51	63	73	85
WELLS BRANCH	1,113	1,074	1,013	1,013	1,025	1,064
COUNTY OTHER	7,934	8,187	8,930	9,682	10,078	10,642
MANUFACTURING	9,624	10,819	11,672	12,674	13,841	15,487
IRRIGATION	412	379	348	320	295	271
STEAM ELECTRIC POWER	7,560	7,560	7,560	7,560	7,560	9,240
MINING	2,733	2,658	2,938	3,243	3,588	3,985
LIVESTOCK	487	487	487	487	487	487
TOTAL	**122,188**	**137,848**	**160,074**	**182,825**	**197,743**	**217,089**

WILLIAMSON COUNTY

WUG NAME	YR2000	YR2010	YR2020	YR2030	YR2040	YR2050
ANDERSON MILL	1,963	1,975	1,943	1,986	2,031	2,106
AUSTIN	1,779	3,037	4,757	6,092	6,905	7,866
BARTLETT (P)	197	196	203	205	213	227
BRUSHY CREEK	2,538	3,955	4,214	4,345	4,239	4,212
CEDAR PARK	3,516	5,933	7,326	8,916	9,513	9,916
FLORENCE	195	238	290	340	383	416
GEORGETOWN	7,052	10,444	13,826	17,416	21,962	27,800
GRANGER	245	292	311	374	424	469
HUTTO	131	194	281	396	532	681
LEANDER	1,891	2,979	3,736	4,832	5,759	6,934
ROUND ROCK (P)	13,339	19,672	26,345	30,839	35,318	40,225
TAYLOR	3,016	3,874	5,155	5,861	6,663	7,958
THRALL	83	87	102	123	133	146
COUNTY OTHER	7,096	8,778	15,365	18,497	19,614	18,127
MANUFACTURING	368	398	409	405	443	481
IRRIGATION	160	160	160	160	160	160
STEAM ELECTRIC POWER	0	0	0	0	0	0
MINING	1,885	1,845	1,896	1,949	2,007	2,068
LIVESTOCK	1,314	1,314	1,314	1,314	1,314	1,314
TOTAL	**46,768**	**65,371**	**87,633**	**104,050**	**117,613**	**131,106**

Notes: All water demand projections in acre-feet.
(P) Indicates city is in more than one county
Adapted from TWDB, 2003.

The updated water demand projection figures for the 2006 Regional Water Plans from the TWDB, (2004) indicate increased projections in Williamson and Burnet counties and decreased projections in Travis County from the 2002 State Water Plan predictions. Counties' projected demands are in acre-feet per year and are presented below.

COUNTY NAME	2000	2010	2020	2030	2040	2050	2060
BURNET	9,158	10,665	12,190	13,659	15,093	16,625	18,483
NORTHERN TRAVIS	104,013	130,222	156,521	185,186	209,339	233,223	254,396
WILLIAMSON	51,424	71,903	95,177	122,752	152,650	185,431	220,885

Water Supply

Current and projected water supply data by county, water user group, and year for the study area are tabulated in Appendix 2. The projected population and water demand data combined with the estimates of groundwater and surface water availability are critical to project water supply shortfalls or surpluses for the study area. The regional water plan data describe current supplies and water user groups based on existing conditions and limitations. All water supplies that are presently available to a water user group are identified and quantified. Surface water supplies include rivers, streams, creeks, lakes, ponds and tanks. These supplies are under state regulation, and are limited by water rights, contracts, or reservoir yields. Groundwater resources located in the study area also supply water based on developed well fields and aquifer availabilities. The total quantity of water supplied in the study area is estimated to be 345,209 acft estimated in 2000, and is projected to decrease by eight percent between 2000 and 2030. In the study area, groundwater usage is not projected to fluctuate, and is projected to continue accounting for almost 11 percent of total water usage.

In 2000, groundwater supplied an estimated 36,609 acre-feet (acft) of water in the study area. The Edwards and Trinity aquifers are the primary groundwater sources in Travis and Williamson counties. Groundwater supplied in Burnet County is from the Ellenburger-San Saba, Trinity, Hickory and Marble Falls aquifers. Williamson County uses more groundwater than the other counties in the study area. In 2000, groundwater supply was 56 percent, 5 percent and 14 percent of the total water supply in Burnet, Travis and Williamson counties, respectively. Water supply from the Edwards aquifer in Travis and Williamson counties is projected to remain the same through 2030, 10,692 acft. In 2000, the Trinity aquifer supplied 4,051 acft of water in the study area, and is projected to decrease to 3,925 acft in 2030. Groundwater supply from minor aquifers in Burnet County is projected to remain fairly constant through 2030, from 14,034 acft in 2000 decreasing to 13,948 acft in 2030. Generally, the groundwater supply in the study area is projected to remain constant through 2030.

Surface water supplies include any water resource where water is obtained directly from a surface water body. The primary sources of surface water supply in the study area are from the Highland Lakes, Colorado River combined run-of-river, and the Brazos River Authority system. The Highland Lakes system is comprised of two major water storage reservoirs, Lake Buchanan and Lake Travis, and is one of the major supplies of water in the study area. Water supply from the Highland Lakes in Burnet County is mainly used for municipal use. The municipal use is projected to decrease by 15 percent, up to 4,600 acft between 2000 and 2030. The Highland Lakes supply 53 percent of the water supply in Travis County and 10 percent of the water supply in Williamson County. This supply is projected to decrease in Travis County by 25 percent and remain the same in Williamson County between 2000 and 2030. In 2000, Colorado River combined run-of-river supplied 45 percent of the water supply, 102,613 acft in Travis

County and is projected to increase by two percent in 2030. The Brazos River Authority supplied most of the surface water in Williamson County, and accounted for 57 percent, or 39,936 acft, of the water supply in 2000 and is projected to increase by five percent in 2030. These total surface water supplies are projected to decrease by nine percent between 2000 and 2030 in the study area.

Groundwater Availability

Determination of groundwater availability in the study area involves consideration of issues such as groundwater occurrence, demand, water level declines, spring flows, potential water quality deterioration, depletion of aquifer storage, and the availability of alternate surface water supplies. Groundwater availability allows for some increase in groundwater development to meet a portion of future demands, but utilizes available surface water to meet the majority of demands in order to minimize or eliminate negative effects on aquifer systems.

In the Region K Regional Water Plan (Turner, Collie and Braden Inc et. al., 2000), groundwater availability estimates in Edwards aquifer BFZ are based on minimum spring flows and groundwater withdrawals that occurred in the Colorado and Brazos River Basins during the drought of record of the 1950s. In the Colorado River Basin the estimate is based on minimum spring flow at Barton Springs in Travis County during the drought of the 1950s, and by effective recharge to the aquifer. This estimate does not include removal of water in storage. Future groundwater availability in this aquifer involves consideration of issues such as future demand, water level declines, potential water quality deterioration, depletion of aquifer storage, and the availability of alternate surface water supplies.

Current and projected Edwards aquifer groundwater use should be based on utilizing effective recharge only, with little or no mining of recoverable storage (Ridgeway and Petrini, 1999). Due to its highly permeable nature in the fresh water zone, the Edwards aquifer responds quickly to changes and extremes in stress placed upon the system (Turner, Collie and Braden Inc et. al., 2000). This is indicated by the rapid fluctuations in water levels over relatively short periods of time. During times of adequate rainfall and recharge, the Edwards aquifer is able to supply sufficient amounts of water for most of the demands as well as sustain spring flows at many locations throughout its extent. However, when recharge is low, water withdrawn from wells and water discharged at the springs comes mainly from aquifer storage. If these conditions persist, water in storage within the aquifer continues to be depleted with corresponding water-level declines and reduced spring flows.

Groundwater availability in the Trinity aquifer could consists of the annual recharge and mining of the total recoverable storage until the year 2030 (Ridgeway and Petrini, 1999). After 2030, supply from the aquifer would be based on the estimated effective recharge. The availability is also based on the areal extent of the downdip or artesian portion of the aquifer in the study area.

Moderate amounts of groundwater are supplied to Burnet County from the Ellenburger-San Saba, Hickory and Marble Falls minor aquifers. Table 4 summarizes groundwater availability data from the 2002 State Water Plan. The Edwards aquifer accounts for 39 percent of the available groundwater supply in Travis and Williamson counties. The Trinity aquifer in the study area accounts for eight percent, minor aquifers account for 25 percent, the other undifferentiated aquifers account for 46 percent of the available groundwater supply. Specific geologic sources for the other aquifers were not identified in the regional water plans or the state water plan.

Table 4. Groundwater Availability, Williamson, Burnet and Northern Travis Counties PGMA Study Area				
SOURCE	**COUNTY**	**YEAR 2000**	**YEAR 2030**	**YEAR 2050**
EDWARDS- BFZ AQUIFER	BURNET	0	0	0
	TRAVIS	4,480	4,480	4,480
	WILLIAMSON	7,370	7,370	7,370
TRINITY AQUIFER	BURNET	2,170	1,835	1,505
	TRAVIS	478	478	391
	WILLIAMSON	2,197	2,110	2,045
ELLENBURGER-SAN SABA AQUIFER	BURNET	3,148	3,148	3,148
	TRAVIS	0	0	0
	WILLIAMSON	0	0	0
HICKORY AQUIFER	BURNET	5,411	5,411	5,411
	TRAVIS	0	0	0
	WILLIAMSON	0	0	0
MARBLE FALLS AQUIFER	BURNET	5,625	5,625	5,625
	TRAVIS	0	0	0
	WILLIAMSON	0	0	0
OTHER AQUIFER*	BURNET	10,000	10,000	10,000
	TRAVIS	5,553	5,553	5,553
	WILLIAMSON	10,665	10,665	10,665
TOTAL		57,097	56,675	56,193

All values are acre-feet per year. Adapted from 2002 State Water Plan.

Note: * Specific sources were not identified in the 2001 regional water plans or in 2002 State Water Plan.

Surface Water Availability

There are presently nine major reservoirs in the Lower Colorado River and in the Brazos River basins that lie near or within the study area. Lake Georgetown, Granger Lake and Lake Stillhouse Hollow are located in the Brazos River Basin. Lake Stillhouse Hollow is located outside of the study area. The total amount of surface water available for Williamson County from the Brazos River Basin is 113,556 acft. Water users in Williamson County need to construct additional intake and conveyance facilities to fully use the surface water in the Brazos River basin reservoirs.

The majority of the reservoirs located within the Lower Colorado River Basin in the vicinity of the study area are part of the LCRA's Highland Lakes system. These are Lake Buchanan, Inks Lake, Lake LBJ, Lake Marble Falls, Lake Travis, and Lake Austin (Ridgeway and Petrini, 1999). Of these, Lake Buchanan and Lake Travis are the two major water storage reservoirs in the Lower Colorado River Basin. The two lakes system's firm yield is 445,266 acft per year (TWDB, 1998). Lake Austin is owned by the City of Austin and operated by the LCRA through an agreement. Town Lake and Lake Walter E. Long (Decker Lake) are also located in the study area, owned and operated by the City of Austin. The City of Austin uses Decker Lake to supply cooling water for an electric generating plant.

In addition to the LCRA's Highland Lakes system, several ponds and reservoir with capacities less than 5,000 acft exist in the study area and supply local needs. The total annual availability of surface water is estimated to be 564,266 acft as show below in Table 5.

Table 5. Annual Surface Water Availability, Williamson, Burnet and Northern Travis Counties PGMA Study Area

LOWER COLORADO RIVER BASIN	BRAZOS RIVER BASIN	OTHER SURFACE WATER	REUSE	TOTAL ANNUAL AVAILABILITY
445,266	113,600	5,000	400	564,266
All values are acre-feet per year.				

GROUNDWATER AND WATER SUPPLY CONCERNS ✯✯✯

This section summarizes data and information with regard to water quality, water supply and identified needs, and identified water management strategies for the next 25 years. The discussions in this section rely primarily upon the Brazos G Regional Water Plan (HDR et al., 2001); the Region K (Lower Colorado) Regional Water Plan (Turner, Collie and Braden Inc., 2000); *Water for Texas - 2002* (TWDB, 2002); Duffin and Musick, 1991; and Ridgeway and Petrini, 1999.

Groundwater Quality

The quality of water in the Edwards aquifer is directly affected by the total environment of the water, from its origin as rainfall to its ultimate discharge from wells and springs in the aquifer. Most of the dissolved matter in the groundwater is from the solution of substances in the rocks that compose the aquifer (Duffin and Musick, 1991). The dissolved matter varies throughout the study area. Low permeability, restricted water circulation, longer groundwater residence time, and temperature increases cause the groundwater to become more highly mineralized in the downdip portion of aquifers (Ridgeway and Petrini, 1999). Other constituents found in the water from the Edwards aquifer originating outside the aquifer between precipitation upon the recharge zone and its latter entry into the aquifer. During this time, various constituents, possibly including human-related contaminants, are carried by the recharge water into the aquifer (Duffin and Musick, 1991).

Groundwater in the Edwards and associated limestones aquifer may be described as a calcium carbonate, and sometimes magnesium carbonate type water, generally becoming a sodium sulfate water downdip. Still farther downdip, it becomes more highly mineralized. The quality of water from the Edwards aquifer varies throughout the study area. Mineralization of the water increases from the recharge areas on the west to the downdip areas on the east. The dissolved solids concentration typically increases from 200 to 400 mg/l in the recharge zone, to 1,000 mg/l and then 3,000 mg/l at variable distances to the east (Duffin and Musick, 1991).

The increase in mineralization with distance from the recharge area is much more rapid in Travis County than in Williamson County. Intensive faulting of the groundwater reservoir in Travis County has created numerous barriers to groundwater movement. This retardation of groundwater movement has caused the dissolved solids concentration of the water to reach the 1,000 and 3,000 mg/l limits as near as one to two miles east of the Edwards aquifer outcrop near the Colorado River in Travis County. In Williamson County, where faulting is less severe, the Edwards aquifer contains water having less than 3,000 mg/l of dissolved solids greater distances downdip. In Williamson County, water having generally less than 1,000 mg/l dissolved solids concentrations extends as much as 10 miles east of the aquifer outcrop, and water having generally from 1,000 to 3,000 mg/l extends beyond this limit an additional 10 to 12 miles in places (Duffin and Musick, 1991).

Groundwater geochemical compositions also vary downdip from Ca-HCO_3- to Na-SO_4-type waters and Na-Cl-type water (Brune and Duffin, 1983). These hydrochemical patterns indicate hyrdochemical evolution of groundwater along flow paths. In the south of the study area, faults that disrupt groundwater flow may also provide pathways for an influx of deep saline groundwater (Senger and others, 1999).

The spatial distributions of groundwater having different geochemical compositions reflects the interaction of two main flow systems in the aquifer (Jones, 2003). These flow systems involve:

(1) rapid circulation of fresh groundwater from the recharge zone and
(2) a slow influx of saline groundwater from downdip

The Ca-HCO3 -type water that occurs within or adjacent to the recharge zone is characterized by high tritium of 7 to 11 Tritium Units (TU). The slowly circulating groundwater is characterized by low tritium (<1 TU) and mixed-cation-HCO3-, Na-HCO3-, and Na-mixed-anion-type groundwater. The contrasting low and high tritium in confined and unconfined parts of the aquifer, respectively, indicate that most rapid groundwater circulation in the aquifer occurs in the unconfined part of the aquifer. The boundary between low- and high-tritium groundwater coincides with the bad-water line, indicating relatively little circulation of recently recharged groundwater in the saline parts of the aquifer (Jones, 2003).

The geochemistry of the Trinity group aquifer in the western portion of the study can be characterized as a calcium carbonate type water. This water becomes a sodium sulfate or sodium chloride type downdip. It is usually of neutral pH and very hard and its quality ranges from fresh to slightly saline in most cases (Duffin and Musick, 1991). Down dip to the southeast of the study area, the water quality tends to deteriorate. Low permeability, restricted water circulation, and increase in temperature cause the groundwater to become more highly mineralized in the downdip portion of the aquifer.

Groundwater from the Trinity aquifer is used primarily for domestic and public water supply, although generally the ranges for fluoride and total dissolved solids exceed the drinking water standards especially in the eastern parts of Williamson County. Most public water supplies in the eastern part of the study blend the elevated constituents of the Trinity groundwater with fresh water to meet the drinking water standards. Manufacturing use of groundwater in this area is minimal since the water is generally unsuitable for its high iron, hardness, and sodium bicarbonate contents (Duffin and Musick, 1991).

The potential for man induced groundwater contamination in the Edwards aquifer is a major concern in the study area. The cavernous, highly permeable nature of the aquifer and the thin soil characteristics of the recharge zone pose a significant potential for contamination of the aquifer from surface sources of pollutants. There have been localized instances of groundwater contamination resulting from human activities. Groundwater contamination from nitrate, fecal colliform, or leaking petroleum storage tanks have been recorded in the study area.

Perchlorate contamination was detected in the City of Georgetown public water supply wells in November 2003. A total of 46 private and public water wells were sampled in December 2004 in Williamson County; out of these, 40 samples had detection of perchlorate below 4.0 parts per billion (ppb). Five private wells had detections above the TCEQ interim action level of 4.0 ppb. Four surface water (spring) samples had detections ranging from 6.3 to 9.25 ppb.

The source of the perchlorate contamination is still under investigation. Rock quarries along Interstate Highway 35 (IH-35) are potential sources for perchlorate contamination. Perchlorate can be naturally-occurring, but it is also used in the manufacture of rockets, matches, explosives, and air bags. Levels of perchlorate measured in the City of Georgetown's public water supply wells ranged from non-detect to 4.3 ppb. The TCEQ's interim action level for perchlorate, the level which triggers an investigation but which is well below levels of health concern, is 4 ppb. Level of concern may be at rates at least ten times greater than the interim action. The health implication of perchlorate ingestion is also under investigation. The National Academy of Science (NAS) study on health effects of perchlorate reported that the chemical, in high doses, can decrease thyroid function in humans, and that the chemical is present in many public drinking water supplies (http://www.nas.edu/). The report also said daily ingestion of up to 0.0007 milligrams per kilogram of body weight can occur without adversely affecting the health of even the most sensitive populations. That amount is more than 20 times the "reference dose" proposed by USEPA in recent draft risk assessment (http://www.epa.gov/).

In response to citizens concern about sediment loading from the mining operations along the upper Brazos River, TCEQ conducted an inventory of rock quarries in 2004. Out of the TCEQ inventoried quarries statewide, 40 quarry sites were inventoried in Burnet, Travis and Williamson counties. More than half of these sites in the study area had no permit or were violating the minium standards of their permits either by an unauthorized discharge of sediment or by air quality violation.

Data provided from the City of Austin showed U.S. Geological Survey sampling results from Schlumberg, Tanglewood, and Stillhouse springs discharging from the Edwards aquifer in the Bull Creek watershed in northern Travis County. Samples from all three springs indicated low concentrations of dissolved pesticides and solvents in addition to elevated concentrations of nutrients, ions and certain metals.

Water Supply Shortages and Identified Water Management Strategies

Table 6 summarizes and compares projected water demand and current water supply in the study area. The last column in Table 6 identifies unmet water needs for year 2030 that are not solidly addressed by Brazos G and Lower Colorado Regional Water Planning Groups recommended water management strategies. The following discussion regarding water supply concerns and identified strategies for each county, and regional strategies in general are summarized from Brazos G (HDR et al., 2001) and Region K (Turner, Collie and Braden Inc et al., 2000) Water Plans, and TWDB, 2002.

Table 6. Comparison of Water Demand and Current Supply, and Identified Needs in Williamson, Burnet, and Northern Travis Counties.

COUNTY & YEAR	PROJECTED DEMAND	CURRENT SUPPLY			IDENTIFIED NEEDS
		GW	SW	TOTAL	
BURNET					
2000	8,826	14,034	11,171	25,205	No unmet need identified by Region K Water Plan
2010	9,718	14,027	11,193	25,220	
2020	10,561	14,017	9,058	23,075	
2030	11,403	13,948	8,334	22,282	
NORTHERN TRAVIS					
2000	121,075	11,256	227,664	238,920	No unmet need identified by Region K Water Plan
2010	136,774	11,256	228,311	239,567	
2020	159,061	11,256	224,098	235,354	
2030	181,812	11,256	202,836	214,092	
WILLIAMSON					
2000	46,768	11,319	69,765	81,084	Municipal need identified in year 2010, Mining need identified throughout the planning period.
2010	65,371	11,319	64,562	75,881	
2020	87,633	11,319	69,647	80,966	
2030	104,050	11,256	69,688	80,944	

Notes: **Water demand and supply in acre-feet, availability in acre-feet per year**; GW - groundwater; SW - surface water. For comparison purposes, surface water supply and availability assumed to be the same.

Burnet County

In 2000, groundwater from the Trinity, Ellenburger-San Saba, Marble Falls and Hickory aquifers provided 56 percent of the total supply in Burnet County. Surface water accounted for 44 percent of the total supply, primarily water from the Highland Lakes through contracts with the LCRA. Municipal water demands account for over one-half of the total water demands in Burnet County, and no water shortages are expected for the county in the irrigation, mining, manufacturing, or livestock water user groups (WUGs) through 2050. Burnet County water shortages have been identified in the next 30-year period for municipal user groups and the county-other user group in the Colorado River Basin. Several of these shortages have been identified due to wholesale contract expirations. Water management strategies have been adopted to address all of the projected water supply shortages.

The cities of Marble Falls and Cottonwood Shores are expected to have water supply deficits due to contractual expirations over the study period. The City of Marble Falls is expected to have a water supply shortfall of 1,874 acft/yr by 2020 that increases to 2,105 acft/yr in 2030. The recommended water management strategy to address this need is contract renewal with the LCRA. A contract renewal of 2,264 acft/yr will meet the City of Marble Falls projected water demand through 2030. The City of Cottonwood Shores is projected to have a water supply deficit of 164 acft/yr starting in 2020 that increases to 168 acft/yr in 2030. The recommended water management strategy to address this need is also contract renewal with the LCRA. A contract renewal of 171 acft/yr will meet the City of Cottonwood Shores projected water demand through 2030 (Turner, Collie and Braden Inc., 2000).

The City of Burnet is not expected to have water supply deficits during the study period. The city gets most of its water supply from a Highland Lakes system contract with the LCRA that expires in 2040. With the recommended water management strategy to renew a contract of 4,100 acft/yr, the city is projected to have a surplus through 2030. The City of Granite Shoals is not expected to have water supply deficits even though their LCRA contract of 830 acft/yr will expire in 2030. The city receives most of its water supplies from groundwater. With the recommended water management strategy to renew a contract of 493 acft/yr with the LCRA, the city is projected to have a surplus through 2030. The cities of Bertram and Meadowlakes are not expected to have water supply shortfalls during the study period and no water management strategies are recommended for these WUGs (Turner, Collie and Braden Inc., 2000).

The county-other water user group in the Colorado River Basin is also expected to have deficits of 1,102 acft/yr by 2010 that increase to 1,652 acft/yr in 2030. The recommended water management strategy for this water user group is a contract renewal with the LCRA. A contract renewal of 1,779 acft/yr will meet the projected water demand through 2050 (Turner, Collie and Braden Inc., 2000).

Northern Travis County

In northern Travis County, surface water supplies 95 percent of the total supply and the rest is from the Edwards, Trinity, and undifferentiated aquifers. Surface water is available through the LCRA and City of Austin (COA) run-of-river water rights. Municipal water demands account for more than 80 percent of the total demand in the county and manufacturing and steam electric generation account for most of the remaining demands. The manufacturing, mining, irrigation and livestock WUGs are projected to have enough water to meet their demands through 2050. Travis County water shortages have been identified in the next 30-year period for municipal user groups and the county-other user group. Several of these shortages have been identified due to wholesale contract expirations. Water management strategies have been adopted to address all of the projected water supply shortages.

The largest WUG, the COA, receives its water supply from the Colorado River thorough its run-of-river rights and from LCRA water in the Highland Lakes system. A 1999 amended agreement with the LCRA provides the city with a firm water supply for municipal, industrial, and wholesale water needs totaling 325,000 acft/yr. In addition, the COA has run-of-river rights, and an agreement with the LCRA for water to be used at its steam electric plants sufficient to meet this need through 2050. The COA has sufficient water supplies to meet its municipal, industrial, and wholesale water needs through 2030. Even though there was no water shortage projected for the city, a water management strategy for water reuse of 17,442 acft/yr through the year 2030 has been recommended (Turner, Collie and Braden Inc., 2000).

The City of Pflugerville is expected to have water supply deficits over the study period. The city is expected to have a water supply shortfall of 793 acft/yr in 2010 that increases to 2,323 acft/yr in 2030. The city currently receives its water supply mainly from the Edwards aquifer to meet its water demands. The city has executed a wholesale contract with the COA for the supply of up to 10 mgd (31 acft/day) in order to secure a firm supply of water through 2050. The City of Pflugerville is also looking at other supplemental sources to meet future water demands. The recommended water management strategies from other sources include aquifer storage and recovery, surface water from the Colorado River, and import of Carrizo-Wilcox aquifer groundwater from other counties (Turner, Collie and Braden Inc., 2000).

The cities of Lago Vista and Jonestown are expected to have water supply deficits by 2030. The City of Lago Vista is expected to have water supply deficits in 2030 due to contract expirations of 6,500 acft/yr. The city receives most of its water supplies from the Highland Lakes system. The recommended water management strategy is for renewal of a LCRA contract of 3,630 acft/yr. The City of Lago Vista will be able to meet its projected 2030 water demand with this amount of water. The City of Jonestown is expected to have a water shortage of 40 acft/yr in 2030 that increases to 438 acft/yr in 2040. The recommended water management strategy to address this shortage is to renew a contract of 485 acft/yr with the LCRA by 2030 (Turner, Collie and Braden Inc., 2000).

The municipal Wells Branch and Anderson Mill WUGs are also expected to have water supply deficits by 2030 due to their contractual expirations with the COA and the LCRA, respectively. Wells Branch is expected to have a water supply shortfall of 1,013 acft/yr in 2030 that increases to 1,064 acft/yr in 2050. Contract renewal with the COA is the recommended water management strategy for Wells Branch to address the identified need. Anderson Mill is projected to have a water deficit of 2,009 acft/yr in 2010. The recommended water management strategy to address this need is contract renewal with the LCRA (Turner, Collie and Braden Inc., 2000).

The county-other WUG is also expected to have water deficits over the study period. The expected deficit is 51 acft/yr in 2010, increasing to 7,408 acft/yr in 2030. The deficit is associated with the contractual expirations. The recommended water management strategy to address the identified need is to renew a contract of 8,758 acft/yr either with the LCRA or the COA in 2030 (Turner, Collie and Braden Inc., 2000).

Williamson County

Williamson County receives about 14 percent of its total water supply from Edwards and Trinity aquifers. Surface water is primarily from the Brazos River Basin through the BRA; however, some of the county receives water from Colorado River sources through the LCRA and the COA. Municipal water demand accounts for more than 84 percent of the total water demands in the county. Mining and livestock water demands account for most of the remaining demands. The cities of Georgetown, Round Rock, Granger, Florence, Hutto, and Thrall, and the Brushy Creek Municipal Utility District (MUD) are projected to have water shortages within the next 30-year period. Most of these municipal shortages are associated with the infrastructure expansion or capacity constraints, lack of infrastructure, or contract expirations. The county-other and mining WUGs are also projected to have water shortages over the study period.

The City of Georgetown purchases Lake Georgetown and Lake Stillhouse Hollow water from BRA. The city also uses groundwater from the Edwards aquifer and the estimated reliable supply is about 921 acft/yr. The City of Georgetown also implements wastewater reuse projects where appropriate to meet demands with non-potable water. The city is projected to have a water supply shortage of 8,151 acft/yr in 2030 as a result of infrastructure constraints related to intake and conveyance facilities. The City of Georgetown has a water purchase contract of 22,168 acft/yr from BRA. This water supply is sufficient to meet the city's needs beyond 2040. However, the city's estimated diversion capacity at Lake Georgetown is about 8,344 acft/yr. The City of Georgetown will need to construct additional intake and conveyance facilities to fully use the remaining 13,824 acft/yr under contract. Other long-term strategies recommended to meet the city's water needs beyond 2030 are to participate in the Little River Reservoir project, to develop a groundwater supply from the Carrizo-Wilcox aquifer, and/or purchase water from BRA/LCRA Alliance water availability up to 25,000 acft/yr (HDR et al., 2001). According to the 2005 Brazos G Initially Prepared Plan (IPP), the City of Georgetown is projected to have a surplus of 9,500 acft/yr in year 2030.

The City of Round Rock also purchases Lake Georgetown and Lake Stillhouse Hollow water from BRA. The city also uses groundwater from the Edwards aquifer and the estimated reliable supply is about 921 acft/yr. In addition, the city implements wastewater reuse projects. The City of Round Rock is expected to have a shortage of 12,157 acft/yr in 2030, increasing to 21,543 acft/yr in 2050. About 7,000 acft/yr of this shortage results from intake and conveyance constraints at Lake Georgetown. The city has a water purchase contract of 24,854 acft/yr from BRA. This water supply is sufficient to meet the City of Round Rock's needs until about 2015; however, the city's estimated diversion capacity at Lake Georgetown is limited to about 17,800 acft/yr. The City of Round Rock will need to construct additional intake and conveyance facilities to fully use the remaining 7,000 acft/yr under contract. Other recommended water management strategies are for the city to participate in a regional Carrizo-Wilcox aquifer supply project, to purchase Lake Travis water from the BRA/LCRA Alliance, and to continue implementing wastewater reuse. The other long-term strategy recommended to meet the city's water needs beyond 2030 is to participate in the Little River Reservoir project (HDR et al., 2001). The 2005 Brazos G IPP projects the City of Round Rock will have a 2030 supply deficit of 10,566 acft/yr and increasing to 42, 548 acft/yr by 2060. The recommended strategies are largely the same.

The Brushy Creek MUD presently has a contract for water supply from the City of Round Rock which expires in 2006, and is further projected to have a shortage of 4,020 acft/yr in 2030. In 1994, the Brushy Creek MUD entered into an agreement with the BRA to purchase 4,000 acft/yr of water from Lake Stillhouse Hollow, and became part of the Williamson County Regional Project (other participants include - City of Georgetown, City of Round Rock, Chisholm Trail Special Utility District (SUD), and Jonah SUD). Presently, the Brushy Creek MUD is working to complete construction of its own water treatment plant and transmission line from Lake Georgetown. The recommended water management strategy for Brushy Creek MUD to meet the projected 2030 shortage is for construction of diversion and treatment facilities to use Lake Stillhouse Hollow water delivered to Lake Georgetown (HDR et al., 2001). The 2005 Brazos G IPP projects the Brushy Creek MUD to have supply surplus of 109 acft/yr by 2030, and a surplus of 87 acft/yr by 2060.

The City of Granger is projected to have a water shortage of 129 acft/yr in 2030 that increases to 224 acft/yr by 2050. The expected shortage in 2030 is about 34 percent of demand. The city receives its water supply from the Trinity aquifer. Identified water management strategies to address the projected shortage include participation in a regional water supply project with the City of Taylor and obtaining water from either the BRA (Lake Granger) or from the Carrizo-Wilcox aquifer (HDR et al., 2001). The 2005 Brazos G IPP projects the City of Granger will have a 2030 supply surplus of 130 acft/yr.

The City of Florence is projected to have water deficits of 136 acft/yr in 2030, and increasing to 212 acft/yr in 2050. The expected shortage in 2030 is about 40 percent of demand. The city receives its water supply from the Trinity aquifer. The identified water management strategies to address the projected shortages in 2030 are voluntary redistribution from the BRA, and transmission and treatment through existing Central Texas Water Supply Corporation (WSC) and Chisholm Trail SUD facilities. The City of Florence will need to negotiate for about 250 acft/yr of water from either the BRA or an existing contract holder (HDR et al., 2001). The 2005 Brazos G IPP projects that the city of Florence will have a 2030 supply deficit of only 63 acft/yr and recommends constructing three new Trinity aquifer wells to meet this need.

The City of Hutto is projected to have water deficits of 265 acft/yr in 2030, and increasing to 550 acft/yr by 2050. The expected shortage in 2030 is about 67 percent of total demand. The city receives its water supply from the Trinity and Edwards aquifers. Identified water management strategies to address the projected 2030 shortage are to participate in a regional water supply project with the City of Taylor and to obtain water either from the BRA (Lake Granger) or from Carrizo-Wilcox aquifer sources (HDR et al., 2001). The 2005 Brazos G IPP projects a 2030 supply deficit of 407 acft/yr and recommends buying groundwater from a private out-of-county supplier to meet the need.

The City of Thrall is projected to have a water shortage of 40 acft/yr in 2030, that increases to 63 acft/yr in 2050. The city obtains its water supply from the Trinity aquifer and through the Noack WSC from the City of Taylor. The identified strategy to address the projected shortage is to continue buying water from the City of Taylor and to negotiate a contract to receive additional water sufficient to meet needs (HDR et al., 2001). The 2005 Brazos G IPP projects a 2030 supply deficit of 144 acft/yr and recommends purchasing water from the BRA as the primary strategy.

Entities in the county-other category in Williamson County obtain their water supply from the Edwards and Trinity aquifers, the BRA from Lake Georgetown and Lake Stillhouse Hollow, and by purchases from nearby cities. Water from Lake Stillhouse Hollow is delivered to Lake Georgetown through the Williamson County Raw Waterline. According to the Brazos G Water Plan, the county-other category is shown to have a current water supply shortage. This shortage is based primarily on the conservatively low groundwater supply values in the projections. The projected shortages increase to 11,750 acft/yr in 2030 and then stay relatively the same through 2050. The Brazos G Water Plan identified similar shortages and presented similar strategies as these demands are closely linked to what is occurring in the cities. The water management strategies identified to address the county-other projected shortages include participation in a regional Carrizo-Wilcox aquifer supply project (6,000 acft/yr; year to implemented 2010), purchasing Lake Travis water from the BRA/LCRA Alliance (6,000 acft/yr; year to be implemented 2020), and continued to implementation of wastewater reuse (5,000 acft/yr; year to be implemented 2030) (HDR et al., 2001). According to the 2005 Brazos G IPP, the county-other water user group is projected to have a surplus of 1,165 acft/yr of supply in year 2030.

The mining WUD is also projected to have water deficits over the study period. The projections show a shortage of 1,543 acft/yr in 2030, and increasing to 1,663 acft/yr in 2050. The deficit is due largely, if not completely, to the conservatively low groundwater supply figures used for Williamson County. The Brazos G Water Plan (1) anticipates that mining use will continue to be from locally available groundwater supplies; (2) does not identify any water management strategy to meet the mining needs of the projected supplies from any sources through the year 2030; and (3) notes that if groundwater becomes unavailable due to drought or overpumpage, the mining demand will either purchase new supplies from nearby water utilities, or will cease operations until groundwater (Edwards aquifer) returns

(HDR et al., 2001). The 2005 Brazos G IPP projects the mining user group will have a supply deficit of 1,576 acft/yr in 2030 and recommends conservation to address the shortage.

In addition to those noted above, the 2005 Brazos G IPP identifies the following water user groups having supply shortage for the year 2030: City of Bartlett (146 acft/yr), City of Cedar Park (6,650 acft/yr), Chisholm Trail SUD (941 acft/yr), Jarrel-Schwertner WSC (329 acft/yr), Liberty Hill (788 acft/yr), City of Weir (277 acft/yr), and manufacturing (1,583 acft/yr). The recommended strategies in the 2005 Brazos G IPP for all of these water user groups rely on obtaining additional supplies from surface water sources and conservation.

Other Generally Recommended Strategies

The Brazos G and Lower Colorado Regional Water Plans identified several water management strategies that may be implemented to reduce or offset unmet needs. These general strategies include interbasin transfer of water, wastewater reuse, voluntary redistribution, aquifer storage and recovery, new reservoirs, and Carrizo-Wilcox aquifer development.

At the request of the City of Round Rock and Williamson County, the 76th Texas Legislature passed House Bill 1437 in 1999, authorizing the LCRA to transfer up to 25,000 acft/yr of water to Williamson County under certain conditions. This transfer of water should result in "no net loss" of water to the Colorado River watershed. The Act requires that an additional charge be added to the base water rate to pay the costs of mitigating any adverse effects of the transfer of water to Williamson County from the lower Colorado River watershed. Water resources developed or conserved through the additional charge may be acquired from any source inside or outside the boundaries of the Colorado River watershed and must be used for the benefit of water services areas of the LCRA's irrigation operations.

Under the provisions of HB 1437, the supply of water and cost to irrigation customers will be protected. Before water is transferred, the LCRA must offset the transferred water by the development of an additional water resource or other water-reuse strategies to replace or offset the amount of surface water transferred. This may include the development of groundwater resources, reuse, conservation and other opportunities to reduce reliance on surface water for agricultural irrigation. These strategies must take into consideration the surface water and groundwater needs of the affected Colorado River basin users. Any additional costs for implementing this system will be paid for by Williamson County customers by a mitigation surcharge added to the base water rate.
(source:http://www.utexas.edu/lbj/research/no_net_loss/, accessed in December 2004)

The LCRA had several meetings in and outside the study area to solicit comments regarding the interbasin transfer of water from Lake Travis to meet demands in Williamson County. This interbasin transfer of water may not be amenable to shareholders (Parsons et al., 2003). Similarly, it may not be cost-effective as the cost to the consumer of LCRA water per 1,000 gallons is currently higher than the BRA water (Parsons et al., 2003). Before water can be transferred, "no net loss" must be defined and a plan to mitigate the effect of the transferred water developed and approved by the LCRA board of directors. Thus, a date for water delivery will depend on LCRA board approval and the time it takes to implement the water make-up system. No firm date has been set as of September 2005.

Wastewater reuse is the intentional use of treated wastewater effluent for a beneficial purpose. It takes the place of potable or raw water to reduce the overall demand for fresh water supply. Wastewater reuse typically involves a capital project connecting treatment plant and discharges facilities to an individual entity that has a relatively high, localized use that can be met with non-potable water. Examples most frequently include the irrigation of golf courses and other public lands and specific industries or industrial use areas. This strategy cannot impact the downstream needs for water rights holders and environmental instream uses. Generally, reuse of wastewater can provide a drought resistant source, increases with economic and population growth, and provides an alternative source when high-quality water is not required. In the study area, many municipalities use indirect or direct reuse of wastewater as source supply to meet increasing water demands. These entities include the cities of Austin, Georgetown, Round Rock, and Taylor.

Voluntary redistribution is defined as an entity in possession of water rights or water purchase contracts freely selling, leasing, giving, or otherwise providing water to another entity. Typically, the entity providing the water has determined that it does not need the water for the duration of the transfer. The transfer of water could be for a set period of years or a permanent transfer. Voluntary redistribution is not new to Texas or to the study area–it is essentially a water purchase. Typical examples of voluntary redistribution occurring in the region are the sale of water by entities such as the BRA and the LCRA. The most common water sales occur when cities, such as Austin or Georgetown, sell water to surrounding WUGs. Voluntary redistribution has many benefits over other supply options including the facts that it can be much easier than implementing a new reservoir project, typically cost less than large capital projects, and avoids implementation issues of new reservoir projects such as environmental and local impacts. Most importantly, redistribution of water makes use of existing resources and provides a more immediate source of water (HDR et al., 2001).

Aquifer storage and recovery (ASR) is a process wherein an aquifer is used as an underground reservoir for water storage and recovery. Surface or groundwater is conveyed, via infiltration basins or injection wells, into subsurface space in an aquifer for storage. The water is pumped back out when needed during periods of high demand or drought. This alternative would involve the construction of an aquifer storage and recovery well. In the study area, the City of Pflugerville would purchase treated water from the COA and store this water in the aquifer during low demand periods. This stored water would be recovered during the peak demand period (summer). The probable cost to implement this ASR project is estimated to be about $4.7 million. The unit cost of operating this system, including purchasing the treated water from the COA, would be about $710/acft (HDR et al., 2001).

New reservoirs have been the source of the state's surface water supply resources as well as planning for future supplies. Most of the sites in the state that are readily amenable to reservoir development have already been utilized. Many other sites that are amenable to reservoir development from a technical, or water supply point-of-view have not been developed even though they have been studied for many years. One potential new reservoir could greatly impact the study area. The potential Little River Reservoir site is located on the Little River downstream of the City of Cameron (Milam County) and just upstream of its confluence with the Brazos River. Two different conservation storage levels for this proposed reservoir have been evaluated by the Brazos G Water Plan. One conservation storage level would provide a yield primarily to meet the estimated water supply deficits in Williamson County. The other is at an approximate full development level. The primary water short entities in the study area that could benefit from the construction of the reservoir are the Williamson County municipal, mining, and manufacturing WUGs through 2050. The fully developed Little River Reservoir site would have a yield of about 129,000 acft/yr (HDR et al., 2001).

Carrizo-Wilcox aquifer development involves transporting groundwater to municipal and industrial users in Williamson and northern Travis counties. The required facilities for each of the areas are well fields, pipelines, pump stations, and storage facilities. Water treatment to remove possible iron and manganese constituents may be needed. The Carrizo-Wilcox aquifer system in central Texas is capable of producing large quantities of fresh water from the Simsboro and Carrizo Formations. The aquifer is primarily used for domestic, livestock, public supplies, and some industrial purposes. This alternative addresses the Williamson County shortfalls that begin in 2030 and reach 36,514 acft/yr by year 2050. Groundwater from the Carrizo-Wilcox aquifer could be supplied to the cities of Georgetown, Round Rock, Hutto, Taylor, and Pflugerville and to the Jonah and Chisholm Trail SUDs. The contemplated well fields (in Bastrop, Burleson, Lee, or Milam counties) would be located southeast of the Mexia-Talco Fault Zone and about midway between the outcrop of the Carrizo-Wilcox aquifer and the downdip extent of fresh water (HDR et al., 2001). No infrastructure have been constructed to develop this water supply source.

On July 26, 2004, TCEQ mailed a stakeholder notice to solicit comments and to request data on water supply; groundwater quality, availability, and water level trends; and actions to address identified water management strategies. Approximately 280 stakeholders were identified in the study area. The majority of the stakeholders were county officials, municipalities, water supply corporations, river authorities, planning entities, groundwater conservation districts, and other entities that supply public drinking water. Other identified stakeholders included state legislators, selected federal and state agencies, and other environmental interest groups.

Stakeholder comments about the condition of study area water supplies and actions to meet future demands are summarized here. Burnet and Williamson county water stakeholder groups provided consolidated and concurred comments and information. Stakeholder comments regarding the creation of groundwater conservation districts are presented in a later chapter although some mention may be made here.

Burnet Water Council

The Burnet Water Council (BWC) submitted comments on behalf of the interests of Burnet County. The BWC noted the Region K December 2000 data (Turner, Collie and Braden Inc., 2000) projected the county's population would grow by 76 percent over the next 50 years, and the updated 2004 TWDB data (Appendix 3) projects a population increase of about 75 percent by the year 2030. The BWC also commented the predicted pattern of growth, and anecdotal evidence observed by BWC members, indicate this explosive growth will be from high-density bedroom communities in previously rural areas. They commented that such areas would be reliant on groundwater sources and that groundwater availability may become a "critical" issue in Burnet County over the next 25-year period due to localized groundwater declines. The Burnet Water Council (BWC) noted that localized groundwater level declines can be expected in areas of heavy pumpage, and suggested that localized declines can be managed best at the local level.

The BWC also noted that the western two-thirds of Burnet County were underlain by the Paleozoic Marble Falls, Ellenburger-San Saba, and Hickory aquifers. They commented that the City of Bertram is served by high-capacity wells completed in these aquifers, and the City of Burnet has back-up supply wells drilled in the aquifers. Based on work by Preston et al. (1996), the BWC commented the immediate management issue for these highly faulted and compartmentalized aquifers is not region-wide decline but localized declines. The BWC noted the Paleozoic aquifers were highly important to the economic future of Burnet County, but were not found in Williamson County and northern Travis County. Similarly, they noted the northern Edwards aquifer which supplies significant amounts of groundwater to northern Travis and Williamson counties is not found in Burnet County.

The BWC commented the Trinity Group aquifer in the eastern one-third of Burnet County is the area where most of the anticipated growth is expected to occur. In referencing the two groundwater availability models for the Trinity aquifer, the BWC noted that regional groundwater availability in the Trinity aquifer may not be a pressing issue in the near future; however, localized groundwater declines would likely occur in the Trinity aquifer under heavy pumpage.

The BWC noted it has actively sought to educate Burnet County citizens about the purpose and advantage of a groundwater conservation district. The BWC also stated that Burnet County has a core group of citizens who are committed to effective groundwater management for Burnet County and who strongly support a Burnet-County-only district. The BWC commented that effective groundwater management in Burnet County would be accomplished best by combining an informed citizenry that fully supports the goals of a single-county groundwater conservation district and a citizens group and district board of directors that can anticipate the population growth issues facing the county and can, therefore, respond in a timely and knowledgeable manner to the resulting problems affecting groundwater in the county.

Williamson County Water Visionary Committee

The Honorable John Doerfler, Williamson County Judge, provided consolidated comments and documentation on behalf of the Commissioners Court of Williamson County and the Williamson County Water Visionary Committee composed of county residents, public and city officials, and county water providers. In summarizing information from the Water Visionary Committee (WVC), Judge Doerfler commented that (1) only a small percentage of the county's existing water demand is supplied by groundwater; (2) in the past several years significant additional surface water sources from outside of the county have been obtained through the BRA and the LCRA to replace groundwater; (3) forecasted use of groundwater will continue to decrease with no additional groundwater demands anticipated; (4) conservation programs established by groundwater providers continue in place with emphasis on restricted use of groundwater during drought periods; and (5) the commissioners court is actively reviewing additional means to meet the county's growing water needs. Judge Doerfler also commented that the commissioners court was considering the creation of a strategic master plan addressing the supply, treatment, and distribution of water throughout Williamson County to insure that both rural and urban areas are efficiently and adequately supplied with water. He noted this effort would be similar in focus and execution to the current Williamson County Wastewater Master Plan. To date, a formal rural water supply master plan has not been adopted by the commissioner court or by WVC of Williamson County (personal communication, October 25, 2005).

The provided documentation included resolutions opposing the designation of a PGMA and creation of groundwater conservation district(s) from the Commissioners Court of Williamson County, the City of Round Rock, the City of Georgetown, the Chisholm Trail SUD, and the Brushy Creek MUD. In part, the commissioners court and two city resolutions note that: Williamson County has adequately planned for future surface water sources; dependence on local groundwater is a very small percentage of total water usage in the county; and subsidence, water quality problems, or groundwater shortages are not major issues in Williamson County. The resolutions from the two utility districts note that Williamson County water purveyors recognize the limitations associated with the Edwards aquifer and have developed or are in the process of developing alternative surface water supplies from the Colorado and Brazos River basins and groundwater supplies from the Carrizo-Wilcox aquifer outside of the county. Because of these efforts, the two district resolutions note that Williamson County water purveyors have not experienced and are not expected to experience critical groundwater problems. The two district resolutions note that Williamson County water purveyors have not experienced and are not expected to experience shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, or contamination of groundwater supplies in a manner that justifies the designation of a PGMA or the creation of a groundwater conservation district.

The provided documentation also included WVC information from the Thornhill Group, Inc. This information notes that, based on hydrogeologic conditions and distribution of water needs, the Edwards and Trinity aquifers in Williamson County are relatively "self-regulated" with respect to water availability and production distribution. Among many items, this information notes the following for the Edwards aquifer: (1) the aquifer has relatively low storativity and high transmissivity characteristics; (2) water levels, spring flows, well yields, and total groundwater availability are controlled predominantly by wet-dry cycles and are less impacted by pumping; and (3) primary discharge occurs from pumping near the cities of Pflugerville, Round Rock, and Georgetown, and from flows at Berry Springs near the City of Georgetown and Salado Spring in Bell County about seven miles north of the Williamson–Bell County line. The Thornhill information notes that relatively small sustained water-level declines have occurred in deeper artesian portions of the Edwards aquifer; however, they do not significantly affect overall groundwater availability in Williamson County. The Thornhill information also notes: that short- and long-term water demands far exceed estimated groundwater availability from the Edwards and Trinity aquifers within Williamson County; that dependence on groundwater will likely decrease; and that the existing entities are presently taking actions and developing plans to address future demands.

Brazos River Authority

The Brazos River Authority submitted documentation on water supply and planning issues and provided two recent reports: *Williamson County Water Supply Facilities Plan*, September 2001, prepared by HDR Engineering, Inc.; and *Evaluation of Water Supply Options to Meet Williamson County Needs, Draft Conceptual Master Plan*, February 2003, prepared by Parsons Brinckerhoff Quade and Douglas, Inc. The BRA noted that they have worked with Williamson County entities for over 25 years to evaluate and meet the county's water needs. They commented that the BRA manages the surface water resources of Lakes Georgetown and Granger located in Williamson County and Lake Stillhouse Hollow in Bell County. The BRA commented that they supply approximately 67,000 acft of raw water to Williamson County entities. The BRA noted they also have an agreement with the LCRA to provide 25,000 acft of Colorado River Basin water to Williamson County. Of this, 22,460 acft is presently under contract with water providers in Williamson County. With this water factored in, BRA comments that approximately 89,000 acft of surface water is supplied by the BRA to Williamson County water providers.

The BRA commented that they own a 4.8 million gallon per day (MGD) water treatment plant located near Lake Granger that provides treated water to the City of Taylor and several other entities in eastern Williamson County. The BRA also operates a 4 MGD surface water treatment plant owned by the LCRA and located near Lake Travis that provides treated water to the City of Leander. Further, the BRA noted that water from Lake Travis (Colorado River Basin) is presently being supplied to Williamson County through the City of Austin, and through water treatment plants operated by the City of Cedar Park and the BRA.

The BRA also commented that it operates the Williamson County Raw Water Line. This water line is owned by five Williamson County water providers–the City of Georgetown, the City of Round Rock, the Brushy Creek MUD, the Chisholm Trail SUD, and the Jonah SUD. The water line provides connectivity between Lake Stillhouse Hollow and Lake Georgetown and allows these customers to access the raw Lake Stillhouse Hollow water they have under contract with the BRA.

The BRA commented that it is presently evaluating ways to increase delivery of water to Williamson County from existing reservoirs and facilities, both through their policies and management practices. The BRA noted that it will continue to work with Williamson County entities in the development of new groundwater supplies outside of Williamson County from the Carrizo-Wilcox aquifer, and reuse of effluent from regional wastewater treatment facilities operated by the BRA in Williamson County.

Municipalities and Water Purveyors

The City of Round Rock commented it has conducted several planning studies to assist in developing a long-range plan for water supply to include groundwater from the Edwards aquifer in Williamson County. In addition to groundwater supplies, the city has 36,298 acft of surface water under contract with BRA. When combined with groundwater and wastewater reuse, the City of Round Rock projects adequate supplies until the year 2038. Beyond 2038, the city anticipates receiving groundwater from the Carrizo-Wilcox aquifer. The city noted it has initiated discussions with several water suppliers, including with the BRA, to secure Carrizo-Wilcox groundwater.

The City of Round Rock also noted that it manages groundwater supply by using an average of four to five MGD of groundwater from the Edwards aquifer. The city noted the Edwards aquifer declines in summer months, but recovers very quickly if managed properly. The city noted they also inspect and certify wastewater lines every seven years to prevent ex-filtration of wastewater to protect the aquifer.

The Brushy Creek MUD noted that it is presently constructing a new membrane water treatment facility designed to treat both surface water and groundwater. They commented that their wells have been determined to be under the influence of surface water, and the treatment facility must be on line for them to use the wells. They also commented they were making improvements to be able to direct the groundwater supplies to the treatment facility. The Brushy Creek MUD noted their wells presently produce 1.8 MGD, and they produce at least 1.7 MGD even under extended drought conditions. They noted ongoing efforts to purchase an old Aquasource Company well that produces about 0.7 MGD. The Brushy Creek MUD commented that most of the major entities using groundwater have already determined what they believe to be the maximum pumpage they can sustain, and have shifted or are planning to shift to surface water or other groundwater sources outside of Williamson County for the remainder of their needs.

The Aqua WSC commented that a portion of their certificated service area located in Travis and Williamson counties is deemed as one of several high-growth corridors. The Aqua WSC noted this area's water supplies are not in Travis or Williamson counties. They noted that they have been unable to find any economically reliable groundwater resources within their service area in Travis County and the entirety of the present supply for this area is being produced and treated from groundwater resources within Bastrop County.

The Aqua WSC noted their responsibility to provide a continuous and adequate water service in their certificated area, and stated they have expended considerable time and resources to enable Aqua WSC to plan for and maintain the ability to provide an adequate water supply in the future. The Aqua WSC commented that it was concerned with the future demands the increasing population will place on the natural resources of this and surrounding areas. They noted their plans for growth in the area mirror high-density urban subdivision growth and associated water demands. The Aqua WSC commented they are developing the water supplies needed to meet the future demands of their service area from several potential sources, none of which are in Travis or Williamson counties.

The City of Austin submitted water quality data from three sites/springs in the Bull Creek watershed. The samples were collected and analyzed by the U.S. Geological Survey using the National Water Quality Assessment (NAWQA) protocols for very low detection limits. Samples from all three springs indicated low concentrations of dissolved pesticides and solvents in addition to elevated concentrations of nutrients, ions and certain metals. The results indicate marked differences in water quality between springs in urbanized settings and those in rural settings. The COA also submitted chemical analysis data for wells completed in Edwards aquifer and springs discharging from the Edwards.

Others

The Clearwater Underground Water Conservation District (UWCD) commented that it manages the Trinity and Edwards aquifers in Bell County. They noted the district had registered over 4,000 wells since 2002 and were presently collecting information on production from approximately 50 non-exempt wells and taking biannual water level measurements from selected wells to monitor changes. The Clearwater UWCD noted that Turner Collie & Braden, Inc. and LBG Guyton Associates completed a January 2002 study for the district–*Groundwater Resources Management Information*. This study provides general information on the Edwards and Trinity aquifers in Bell County and includes some Williamson County data.

The Clearwater UWCD noted that data from the TWDB's northern Edwards aquifer groundwater availability model (GAM) indicates the general direction of groundwater flow trends northward from Williamson County into Bell County. The district noted concerns about the potential impact that increased groundwater use in Williamson County could have on the availability of groundwater in Bell County. Turner Collie & Braden, Inc., the district's consultant, provided data involving a series of predictive pumping scenarios using the northern Edwards aquifer GAM.

The Lone Star Chapter of the Sierra Club (Sierra Club) noted that there is a potential for critical groundwater problems to exist in the study area and supported the designation of the area as a PGMA. The Sierra Club noted that significant population growth has occurred since 1990 in study-area cities, and noted the infrastructure to deliver all of the needed water supplies is not completely in place. The Sierra Club commented that most municipalities continue to rely on water wells for backup supply, especially during periods of drought when the aquifers are most susceptible to drawdown. They noted without any groundwater management district in place, the City of Pflugerville, for example, has the potential to pump over 9,000 acft/yr from six wells.

The Sierra Club also noted that the rural domestic users continuing to rely on groundwater could be seriously impacted by depleted aquifers, and noted that groundwater shortages currently exist for mining water users. The Sierra Club commented that the Brazos G water plan states that during periods of drought, many mining facilities will temporarily cease operations because of lack of groundwater supplies. The Sierra Club commented that this management strategy creates the potential for significant stresses to the aquifer as users attempt to remain in operation as long as possible. The Sierra Club also questioned the accuracy regarding of the Brazos G industrial demand projections.

The Sierra Club also commented on the northern segment of Edwards aquifer GAM parameters, including average recharge, recharge from septic tanks, and interaction of surface and groundwater. The Sierra Club acknowledged the state water-quality protection rules for the Edwards Aquifer, but noted that none of the other aquifers are currently protected. Based on the number of septic tanks in the area, the current and projected level of development, and TWDB studies showing slight westward shift of the "bad water", the Sierra Club recommended that water quality concerns are evident in the study area.

One mining company, Capital Aggregate, indicated that the company did not expect any increased use or demands on groundwater resources over the next 25 years. The mining company anticipated using its existing surface water and groundwater supplies and continuous recycling of water (personal communication, October 25, 2005).

In evaluating the need for groundwater management, it is important to examine the efficiency of existing institutions in managing, planning, and regulating groundwater use. If existing entities can effectively develop and implement groundwater management and protection strategies, or if they can secure alternative supplies to decrease dependence or competing interests for groundwater, new entities may neither be necessary nor desirable. However, if such entities do not exist, or if an existing entity does not implement its programs consistently or have sufficient authority, then alternatives may need to be considered.

Several major groups of entities can be considered in the evaluation of groundwater management. These include government entities, authorities and planning groups, water suppliers and water users. Entities that may be involved with groundwater management activities include local municipalities; counties; state and federal government; regional planning authorities and commissions; regional surface water and groundwater management authorities; regional, municipal, and private water suppliers; and major agricultural, industrial and commercial water users.

Federal Agencies

The U.S. Environmental Protection Agency (USEPA) and the U.S. Nuclear Regulatory Commission are federal agencies responsible for enforcing numerous federal laws for protecting groundwater resources. Generally, these agencies have delegated the administration of federal regulatory programs to individual states, or occasionally to local authorities. For example, the USEPA which has authority over the federal Resource Conservation and Recovery Act; the Comprehensive Environmental Response, Compensation and Liability Act; the Clean Water Act; the Safe Drinking Water Act; and the Federal Insecticide, Fungicide and Rodenticide Act has delegated administration of these programs in Texas to the TCEQ.

The USFWS is a bureau within the Department of the Interior that works with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people. Among its key functions, the USFWS enforces federal wildlife laws, protects endangered species, manages migratory birds, restores nationally significant fisheries, and conserves and restores wildlife habitat.

The U.S. Department of Agriculture (USDA) administers numerous programs at the local level to protect and conserve water resources. The USDA Farm Service Agency's Conservation Reserve Program (CRP) undertakes to reduce soil erosion and sedimentation in streams and lakes, improve water quality, establish wildlife habitats, and enhance wetland resources. The CRP encourages farmers to convert highly erodible cropland or other environmentally sensitive areas to vegetative cover such as native grasses. The USDA Natural Resource Conservation Service (NRCS) provides technical assistance to landowners, communities, and local governments in planning and implementing conservation programs. The USDA/NRCS's national Farm*A*Syst and Home*A*Syst programs promote voluntary assessments to prevent pollution. Step-by-step worksheets allow individuals to apply site-specific management practices to their property.

State Water Planning and Regulatory Programs

State agencies do not have authority to manage or regulate groundwater resources. The roles of state agencies in addressing the problems and concerns identified in the study area are limited to water quality protection primarily through the regulation of waste management or implementation of best management practices (BMPs), water resource planning and project funding, and facilitation of groundwater management activities through the creation and limited oversight of groundwater conservation districts.

State law, however, does not provide any state agency the authority to control groundwater pumpage and use.

Water planning efforts at the state level are the responsibility of the TWDB which prepares a statewide water plan using information provided by regional stakeholders and other state water agencies. The TWDB has established 16 regional water planning areas covering the entire state, and a regional water planning group (RWPG) in each of these areas. Each regional water planning area, through its RWPG, is responsible for obtaining local input and developing a regional water plan. The study area is in the 37-county Brazos G Regional Water Planning Area and 14-county Lower Colorado Regional Water Planning Area (Region K). The Brazos G Regional Water Plan (HDR., 2001) and Region K Regional Water Plan (Turner, Collie and Braden, 2000) were adopted and submitted to the TWDB prior to January 5, 2001, and incorporated into the 2002 State Water Plan, adopted by the TWDB on December 12, 2001 (TWDB, 2002). The 2005 Initially Prepared Regional Water Plans (IPPs) are under review by the regional planning groups and the TWDB, and should be completed by early 2006.

In addition to its water planning responsibilities, the TWDB collects and analyzes data to support its planning functions, and administers water development funds under state and federal programs. Water development funds generally are available as low interest loans and some as grants to local and regional governments for water supply and wastewater planning, feasibility studies, and infrastructure development. TWDB financial assistance may be provided only to water supply projects that meet needs in a manner that is consistent with an approved regional water plan. In addition, the TCEQ cannot issue a water right for municipal purposes unless it is consistent with an approved regional water plan.

The TCEQ is the state's primary environmental regulatory agency. TCEQ administers the supervision program for public drinking water systems and has primary responsibility for public water system aspects of the federal Safe Drinking Water Act. TCEQ also implements state and federally delegated programs. Among its other regulatory authorities are surface water rights permitting; creation and supervision of water districts; industrial, municipal and hazardous waste management; and water quality protection.

The TCEQ also administers the Edward Aquifer Protection Program. Anyone who plans to build on the recharge, transition, or contributing zones of the Edwards aquifer must have an application with construction plans approved by the TCEQ. The rules for this program (Title 30, Texas Administrative Code, Chapter 213) address activities that could pose a threat to water quality in the Edwards aquifer and the surface streams that feed it. The rules apply specifically to the Edwards aquifer in Bexar, Comal, Hays, Kinney, Medina, Travis, Uvalde and Williamson counties, and are not intended for any other aquifers in Texas.

The USFWS and TCEQ responsibilities for natural resource protection overlap in some cases regarding water quality and endangered species that are dependent upon high quality water in the Edwards aquifer. The USFWS has determined the optional water quality measures which serve as guidance for complying with TCEQ's Edwards aquifer rules will also protect several federally-listed endangered and threatened species, such as the Georgetown salamander. The USFWS has indicated that if these voluntary enhanced water quality measures are used by non-Federal landowners and other non-Federal managers, "no take" of these species would occur, with some exceptions. Starting February 14, 2005, the use of these optional measures is voluntary under the TCEQ's Edwards Program; however, the water quality measures will protect certain species from potential water quality impacts that could result from development over the Edwards aquifer region. The optional measures include site planning best management practices (BMPs) such as providing stream buffers, providing natural buffers around sensitive features, and providing cave gates. Capture volumes for temporary sediment basins used during construction must be large enough to capture runoff from the 2-year, 24-hour storm. Hazardous material traps are required for new roadways that will convey at least 5,000 vehicles a day. Enhanced stormwater detention requirements are also specified. The optional measures also require permanent BMPs to treat Storm water runoff regardless of the amount of impervious cover that is proposed. When sites are redeveloped, the permanent BMPs must be sized for the entire project area. Each permanent BMP that is constructed must have a sign indication who is responsible for maintenance placed at the facility and maintenance records are required to be kept.

Other state agencies such as the TPWD, Railroad Commission of Texas, Department of State Health Services, Texas Department of Agriculture, Texas Department of Licencing and Regulation, and the Texas State Soil and Water Conservation Board (TSSWCB) have management or regulatory responsibilities for some activities related to environmental protection. The TPWD is the state agency with primary responsibility for protecting the state's fish and wildlife resources. The TSSWCB administers the Texas Soil Conservation Law and offers a technical assistance program to the state's 216 soil and water conservation districts (SWCDs). The TSSWCB is the lead agency for the planning, management and abatement of agricultural and silvicultural (forestry) nonpoint source pollution (Texas Groundwater Protection Committe, 2003).

Regional Groups and Authorities

The study area is within both the Brazos G Regional Water Planning Area and the Lower Colorado Regional Water Planning Area. Northern Travis County, Burnet County, and the metropolitan portion of southern Williamson County are located in Region K, and the remaining portion of Williamson County is located in Brazos G. The Brazos G and Lower Colorado Regional Water Planning Groups (BRWPG and LCRWPG, respectively) consist of members representing the public, counties, municipalities, industry, agriculture, environmental groups, small business, electric generating utilities, river authorities, water districts, and water utilities. The BRWPG and LCRWPG are required to develop a regional water plan, establish policies, make decisions, and consider interest groups in the development of the plans consistent with Texas Water Code requirements. The development of a regional water plan includes studies, decisions, and recommendations on water supply needs. The purpose of the plan is to identify and recommend methods or strategies to conserve water supplies, meet future water supply needs, and respond to future droughts in the region. Both the BRWPG and LCRWPG have identified a number of water supply options in the development of their 2001 regional water plans. The 2005 Initially Prepared Regional Water Plans (IPPs) are under review by the regional planning groups and the TWDB, and should be completed by early 2006.

The Lower Colorado River Authority (LCRA) is a conservation and reclamation district created by the Texas legislature in 1934. It has no taxing authority and operates solely on utility revenues and fees generated from supplying energy, water and community services. The LCRA supplies low-cost electricity for Central Texas, manages water supplies and floods in the lower Colorado River basin, develops water and wastewater utilities, provides public parks, and supports community and economic development in 58 Texas counties. The LCRA sells wholesale electricity to more than 40 retail utilities, including cities and electric cooperatives that serve more than one million people in 53 counties. The LCRA manages water supplies for cities, farmers and industries along a 600-mile stretch of the Texas Colorado River between San Saba and the Gulf Coast. It operates six dams on the Colorado River that form the scenic Highland Lakes: Buchanan, Inks, LBJ, Marble Falls, Travis and Lake Austin. The LCRA regulates water discharges to manage floods, and releases water for sale to municipal, agricultural and industrial users. The organization helps communities plan and coordinate their water and wastewater needs. It also operates an environmental laboratory and monitors the water quality of the lower Colorado River. The LCRA also enforces ordinances that control illegal dumps, regulates on-site sewage systems, and reduces the impact of major new construction along and near the lakes. The LCRA owns about 16,000 acres of recreational lands along the Highland Lakes and Colorado River, with more than 40 parks, natural science centers and nature preserves (www.lcra.org).

The Brazos River Authority (BRA) was created by the Texas legislature in 1929 and was the first state agency in the United States created specifically for the purpose of developing and managing the water resources of an entire river basin. Today, the BRA's purpose is to develop and distribute water supplies, provide water and wastewater treatment, monitor water quality, and pursue water conservation through public education programs. Except for occasional governmental grants to help pay the costs of specific projects, the BRA is entirely self-funded. The BRA maintains and operates its reservoirs and treatment systems using revenues from the customers it serves. The Brazos River basin provides some 6.75 billion gallons of water each year for cities, agriculture, industry and mining. Recreational opportunities such as boating, swimming and fishing are abundant (www.brazos.org).

Three Soil and Water Conservation Districts (SWCDs) are located in the study area: the Little River-San Gabriel SWCD #508 in southern Bell, northern Williamson, and northern Milam counties; the Taylor SWCD #513 in northern Travis, southern Williamson, and southern Milam counties; and, the Hill Country SWCD #534 in Burnet and Lampasas counties. The TSSWCB Water Quality Management Plan Program provides agricultural and silvicultural producers an opportunity to comply with state water quality laws through traditional, voluntary, incentive-based programs. Landowners and operators may request the development of a site-specific water quality management plan through local SWCDs. Plans include appropriate land treatment practices, production practices, and management and technology measures to achieve a level of pollution prevention or abatement consistent with state water quality standards (Texas State Soil and Water Conservation Board, 2004).

The study area is also part of the 10-county Capital Area Council of Governments (CACOG). The CACOG was created June 26, 1970 and includes Bastrop, Blanco, Burnet, Caldwell, Fayette, Hays, Lee, Llano, Travis, and Williamson counties. The CACOG members meet at regular intervals to discuss and study community challenges of mutual interest and concern, and to develop plans, policies, and recommendations for action for approval and implementation by member local governments and other levels of government within the region. The CACOG members encourage and facilitate local governments in the region to cooperate with one another, with other levels of government, and with the private sector to plan for the future development of the region and thereby improve the health, safety, and general welfare of their citizens. Such councils of government (COGs) are political subdivisions of the state and are basically planning and funding distribution agencies with no independent regulatory authority. Among numerous other responsibilities, COGs may make recommendations concerning recreational sites, public utilities, and water supplies. State law mandates that COGs have primary responsibility for the development of regional municipal solid waste plans. Regional solid waste plans must conform with the state plans and are adopted by TCEQ rule (www.capco.state.tx.us/?articleid=12).

Local Government and Water Purveyors

Counties and municipalities typically carry out public health programs such as disposal of municipal solid waste; production, distribution, and protection of public drinking water supplies; and treatment and discharge of municipal wastewater. The Local Government Code, §§212.0101 and 232.0032 provide groundwater availability certification authority to all municipal and county platting authorities in the state. Under this statute, a municipal platting authority or county commissioners court may require a person submitting a plat for the subdivision of a tract of land for which the intended source of water supply is groundwater under that land to demonstrate adequate groundwater is available for the proposed subdivision. If groundwater availability certification is required by the local platting authority under the Local Government Code, the plat applicant must evaluate groundwater resources and prepare the availability certification pursuant to TCEQ rules. The rules in Title 30, Texas Administrative Code, Chapter 230 establish the appropriate form and content of a groundwater availability certification.

Local water suppliers are also important water management entities and can include municipalities, water supply corporations, water supply districts, and water conservation and irrigation districts. A TCEQ issued certificate of convenience and necessity (CCN) defines a water purveyor's service area. The purveyor's system might not extend to the limits of this service area, but other utility service providers generally may not encroach upon the service area. If anyone in this area applies for service, the supplier generally must serve them. Water purveyors may use one or more systems to serve their area. An affected county, investor-owned utility, or water supply corporation must obtain a CCN, but a city, district, or other county does not need one. TCEQ rules regarding CCNs are in Title 30 Texas Administrative Code, Chapter 291. A January 2005 query of the TCEQ water utilities database indicates there are 105 active public water supply systems using groundwater sources in the three-county study area: 24 in northern Travis County, 34 in Williamson County, and 47 in Burnet County.

The purpose of the City of Austin (COA) Water Utility (CCN #11322) is to provide effective management of water resources for the community in order to protect the public health and environment. The mission of the COA is to optimize the use of available water resources, provide a safe and reliable supply of water for community purposes and public safety, and provide quality wastewater collection and treatment services. The COA also has a mission to practice cost efficiency, continuous improvement, environmental responsibility, and customer service. The COA service area covers most of the central part of Travis County in the study area (City of Austin, 2004).

The service areas for the Manville Water Supply Corporation (WSC; CNN #11144) and the Aqua WSC (CNN #10294) cover most of rural eastern Travis County in the study area. The Manville WSC generally extends from the Colorado River east of Farm to Market (FM) FM 973, around the City of Manor and to the City of Pflugerville in Travis County, and to the cities of Round Rock, Hutto, and Taylor in Williamson County. The Aqua WCS in the study area covers an area in the northeastern extreme of Travis County. In the eastern parts of the county, other significant service areas have been issued for the City of Manor (CCN #10947), the City of Pflugerville (CNN #11303), and the Windemere Utility Company, Inc. (CCN #12064).

Scattered parts of northwestern Travis County, north of the Colorado River and west of the COA, are covered by the service areas for the cities of Cedar Park (CCN #10160) and Leander (CCN #10302), the Jonestown WSC (CCN #11115), the Lago Vista Water System (CCN 312813), the Lohman's Ford Water Company (CCN #11894), the Aquasource Utility, Inc. (CCN #11157), the Travis County Water Control and Improvement District (WCID) No. 17 (CCN #11670), and other small service areas.

North of Austin in Williamson County, the cities of Cedar Park, Leander, Georgetown (CCN #12369), and Round Rock (CCN #11047), and the Brushy Creek Municipal Utility District (MUD; CCN #11773) have water service areas that cover most of the Interstate HW 35 (I-35) corridor and the area generally west of I-35 and south of State HW 29. Other smaller service areas in this area have also been issued to the Liberty Hill WSC (CCN #10324), the Durham Park WSC (CCN #10432), and the Anderson Mill MUD (CCN #10301). The area of Williamson County generally north of State HW 29 and the City of Georgetown, and west of I-35, is within the service area of the Chisholm Trail Special Utility District (SUD; CCN #11590). The Chisholm Trail SUD service area also extends into a small part of northeastern Burnet County and into Bell County.

In the eastern part of Williamson County, water service areas have also been issued for the cities of Bartlett (CCN #11232), Granger (CCN #11060), Hutto (CCN #10321), and Taylor (CCN #10319). From the area generally around the City of Hutto and north of U.S. HW 79 to the Williamson–Bell County line, and generally between I-35 and State HW 95, service areas have been issued for the Jonah Water SUD (CCN #10970) and the Jarrell-Schwertner WSC (CCN #10002). East of State HW 95, the area generally north of Lake Granger is in the service area for the Bell Milam Falls WSC (CCN #10051), the area generally southeast of Lake Granger and north of U.S. HW 79 is in the service area for the Southwest Milam WSC (CCN #10027), and the area generally south of U.S. HW 79 is in the Noack WSC (CCN #12359).

The vast majority of Burnet County is not within a TCEQ certificated service area. Burnet County only has certificated service areas for the cities of Bertram (CCN #10442), Burnet (CCN #20158), and Marble Falls (CCN #11137); multiple developed areas along the Colorado River for such entities as the Kingsland WSC (CCN #12217), the Highland Utilities, Inc. (CCN #12334), and the LCRA (CCN #11670); the Kempner WSC (CCN #10456) in the northeastern portion of the county generally north of U.S. HW 183 and FM HW 963; and, the Chisholm Trail SUD in the extreme eastern corner of the county northeast of U.S. HW 183 and south of FM HW 2657.

All wholesale and retail water suppliers are required to prepare and adopt drought contingency plans under TCEQ rules (Title 30, Texas Administrative Code, Chapter 288). These plans are to be implemented during times of water shortage or drought and usually address a variety of measures to reduce peak demands and to extend water supplies. Each drought contingency plan for a retail water utility should include: specific and quantified targets for water use reductions, drought response stages and triggers to begin and end each stage, supply and demand management measures, descriptions of drought indicators, notification and enforcement procedures and procedures for granting exceptions, public input to the plan and ongoing public education, and adoption of plan and coordination with regional water planning groups.

The TCEQ rules require adopted drought contingency plans to be submitted to the TCEQ no later than May 1, 2005. Thereafter, the next revision of the drought contingency plans for retail public water suppliers serving 3,300 or more connections, wholesale public water suppliers, and irrigation districts must be submitted no later than May 1, 2009, and every five years thereafter to coincide with the regional water planning group process. For all retail public water suppliers serving less than 3,300 connections, the drought contingency plans must be prepared and adopted no later than May 1, 2005, and must be available for inspection upon request. Privately-owned water suppliers, called investor-owned utilities (IOUs), are required to complete a drought contingency plan and amend the plan into their tariff. IOUs must submit a letter requesting a tariff amendment with the drought contingency plan to the TCEQ by May 1, 2005.

A January 2005 query of the TCEQ water utilities database indicates there are presently 238 active and operational public water supply (PWS) wells in the study area. Of these, 68 are in northern Travis County, 76 are in Burnet County, and 94 are in Williamson County. In northern Travis County, the Manville WSC presently has 15 operating PWS wells. The Windemere Utility Company, Inc. and the Sandy Creek Ranches are supplied by Aquasource Utilities, Inc., each having seven operating wells. Thirteen of the PWS wells in Burnet County are for supplies to different summer camps. The LCRA presently has nine operating wells supplying water to several developments in Burnet County. In Williamson County, the Jonah SUD has nine operating PWS wells, the City of Georgetown has seven operating PWS wells, and the City of Round Rock and the Jarrell-Schwertner WSC each have six operating PWS wells. Figure 13 shows most of the major water purveyor service areas and PWS well locations in the study area.

TCEQ CCN and public drinking water rules require adequate storage, conveyance and treatment facilities for customer-supplied drinking water. These rules do not address the availability of groundwater locally or regionally for use by water suppliers. The rules do not empower water utilities to regulate or manage groundwater withdrawals. Municipal and county groundwater availability land platting authority under the Local Government Code can be an effective groundwater management tool and can address certain wells outside of a groundwater conservation district's management jurisdiction. However, this management tool is limited because it only addresses site-specific cases of land subdivision and does not allow for aquifer-wide or regional considerations.

Summary

The TCEQ implements a water quality protection program for the recharge, transition, and contributing zones of the Edwards aquifer in Travis and Williamson counties. If desired by developers, this program works in conjunction with the USFWS requirements to protect federally listed threatened or endangered species. The LCRA, the BRA, the COA, and Williamson County also administer natural resource conservation programs such as the Balcones Canyonlands Preserve and setting aside recreational lands for parks and endangered species preserves.

Most of the major water purveyors in the area, including the cities, the LCRA and the BRA, are active participants in regional water planning processes. The water purveyors use both surface water and groundwater to serve customers and they are required to adopt and implement drought contingency plans. Nearly all of northern Travis and Williamson counties, and the municipal areas and developed areas along the Colorado River in Burnet County are within certificated water purveyor service areas. Through conservation programs and efforts to meet new demands with surface water sources, these entities can largely maintain their present groundwater systems. However, these types of entities do not have authority to control large-scale groundwater pumpage for private purposes that could potentially impact a shared groundwater supply.

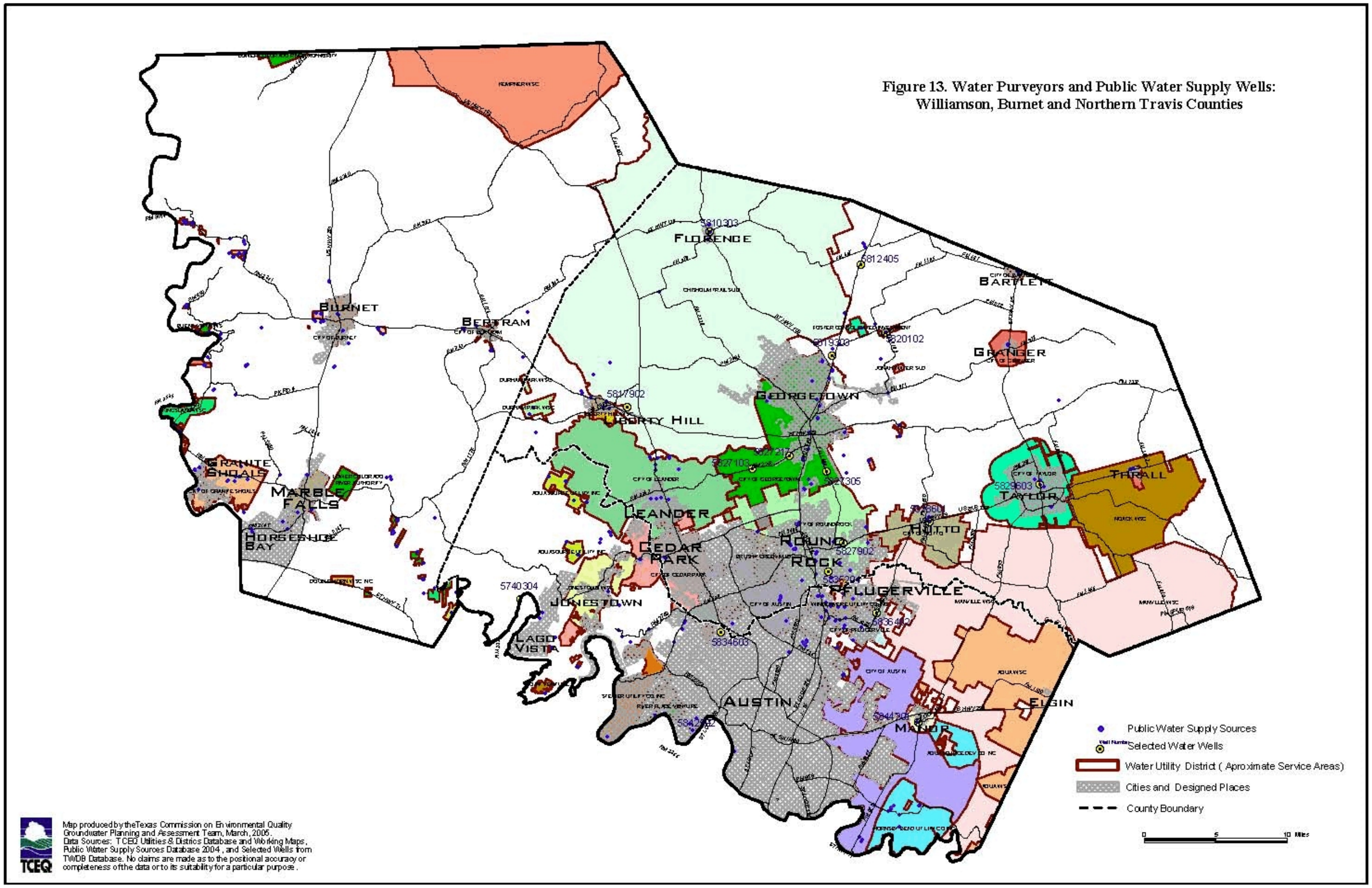

Figure 13. Water Purveyors and Public Water Supply Wells in Williamson, Burnet and Northern Travis Counties

The feasibility of managing groundwater resources within the study area is presented within this section, and groundwater management approaches that can be utilized by groundwater conservation districts are evaluated. Area-specific groundwater management strategies, economic and financial considerations, and available district-creation options are discussed below. At present, there is one groundwater conservation district in the three-county study area.

Groundwater Management Approaches

Various mechanisms are available for protecting groundwater resources in an area. They range from imposing restrictions on groundwater withdrawals to developing alternate supplies, to conjunctively using both surface water and groundwater. The study area water suppliers are actively implementing the latter two measures.

Local or regional groundwater conservation districts (GCDs) are the state's preferred method of managing groundwater resources, and are the only entities in Texas explicitly granted the power to regulate groundwater withdrawals. These districts are charged with managing groundwater by conserving, preserving, protecting, recharging, and preventing wastage of the groundwater resources within their jurisdiction. The GCD approaches or techniques for managing groundwater include:

- water resource planning;
- groundwater resource assessment and research;
- monitoring of water levels, water quality and land subsidence;
- well inventory, registration, permitting and closure;
- limiting withdrawals and well interference through well spacing or setback requirements;
- well pumpage or use limitations; and
- use of engineered structures or injection wells to enhance natural recharge or artificially recharge groundwater aquifers.

Through groundwater monitoring (both quantity and quality) and assessment functions, a GCD can quantify groundwater resources, study and investigate aquifer characteristics, and identify groundwater problems that need to be addressed. Planning functions outline appropriate management objectives and goals for the district to preserve and protect groundwater resources and GCD rules are adopted to achieve the management planning objectives and goals. Texas Water Code, Chapter 36 outlines the general contents of a GCD's locally developed and adopted management plan and requires coordination to develop the plan with surface water entities on a regional basis. Chapter 36 also requires that a groundwater district's management plan must be submitted to and considered by a regional water planning group in development of the region's water plan.

Groundwater conservation districts are required to establish a water well permitting and registration program, and through this program can quantify aquifer impacts from pumpage. They may also adopt rules and permit requirements to regulate the export of groundwater out of the district. An efficient water well inventory, permitting, and registration program allows a GCD to establish an overall understanding of groundwater use and production within the district. Permits must be obtained from the district to drill, equip or complete wells, or to substantially alter the size of wells or well pumps. However, certain types of water wells are exempted from GCD permitting. These exempted wells generally include wells incapable of producing 25,000 gallons per day on tracts of land larger than 10 acres and wells supplying water for exploration, production, and other activities permitted by the Railroad Commission of Texas. Wells exempted from regulation by a district must, however, be completed and maintained in accordance with the district's rules regarding prevention of waste and pollution of the groundwater, and must be registered with the district before being installed.

Groundwater conservation districts may also adopt rules to regulate the spacing and production of water wells. Spacing regulations are generally adopted by a district to minimize drawdown of water levels (both water table and artesian pressure), control subsidence, prevent waste, and prevent interference from other nearby wells. Spacing and production regulations are commonly based on minimum distances from other wells or property lines, a maximum number of wells in a specified area of land (e.g., ¼-section, ½-section, or full-section), or a maximum allowable production per a given unit of land (e.g., 5 gallons per minute per acre or 1 acre-foot of production per year per acre of land).

Groundwater conservation district management activities can include protecting water quality by regulating water well construction, ensuring proper well closure, and actively identifying and closing abandoned wells. Districts also administer activities such as weather modification or recharge enhancement projects to enhance natural recharge and increase groundwater supplies. Other important GCD management programs include water conservation and public education efforts and providing conservation assistance through loan and grant programs.

Other types of regional or local entities do not have the statutory authority to regulate groundwater production, but can indirectly limit groundwater withdrawals by implementing and enforcing water conservation programs and developing alternative supplies. Public water suppliers are required to prepare drought contingency plans and to implement the plans during times of water shortages and drought. These drought contingency plans generally call for mandatory water conservation and address options for alternate supplies during times of shortage.

The Region K Water Plan supports the creation of local groundwater conservation districts and notes such districts are the state's preferred approach to groundwater management. The Region K Planning Group has adopted a resolution regarding the creation of groundwater districts which addresses groundwater management by GCDs and states "....the Lower Colorado Regional Water Planning Group resolves to recommend the creation of Groundwater Conservation Districts as soon as possible giving considerations to developing multi-county districts, or single-county districts with shared management and costs, and with consideration to adjacent hydrological impacts, consistent with local control and local political considerations in order that they may provide for the conservation, preservation, protection, recharging, and prevention of waste of groundwater and to prevent and control subsidence in their areas of the state consistent with the objectives of Section 59, Article XVI, Texas Constitution, or single-county districts with shared management and with consideration to adjacent hydrological impacts."

The regional water plans are required to consider current water availability and use, existing water supply plans, and drought contingency plans during the development of their regional water plans. The regional water planning groups are charged to include potentially feasible water management strategies, including groundwater strategies, within their regional water plans. The regional water planning groups are also designed to involve the stakeholders and the public in water issues both at a local and regional level. Such participation should improve the development of management, conservation, and reclamation practices for those lives and livelihoods that depend on protection of their common water resources.

Identified Groundwater Management Strategies

The water supply problems identified in the study area include lack of drought-reliable groundwater supplies for both short-term drought and long-term economic development, lack of firm supplies for municipal and mining use, localized water-level declines in Edwards aquifer wells due to low area-wide storage and in Trinity aquifer wells due to low permeability, potential groundwater impacts from new mining or industrial well development, and mining of groundwater from aquifer storage to meet future demands. Opportunities for the study area include continued participation in regional water planning and cooperation with local water supply, conservation and education entities. The following management strategies are recommended for the area to address identified problems and issues:

- quantify groundwater availability and quality, understand aquifer characteristics, and identify groundwater problems that should be addressed (both quantity and quality) through aquifer- and area-specific research, monitoring, data collection, and assessment programs;

- quantify aquifer impacts from pumpage and establish an overall understanding of groundwater use through a comprehensive water well inventory, registration, and permitting program;

- establish programs that encourage conservation of fresh groundwater and the use of poorer-quality groundwater when feasible and practicable and facilitate such transitions;

- evaluate and understand aquifers sufficiently to establish spacing regulations to minimize drawdown of water levels and to prevent interference from neighboring wells;

- establish educational programs, for school children and for the general public, to increase awareness of the limited water resources and actions that can be taken to conserve the resources;

- protect water quality by requiring water well construction to be protective of fresh-water zones and by administering a program to locate and plug abandoned water wells; and,

- actively participate in the regional water planning process, groundwater availability model refinements, and regional groundwater management and protection programs with other central Texas groundwater conservation districts and existing water supply entities.

The study area could benefit from GCD monitoring, assessment, planning, and permitting programs as well as water well spacing and well closure programs for the Edwards and Trinity aquifers. Well and well test data is the best data that can be used to understand subsurface geology and hydrology, and the collection and understanding of this type of information is a core GCD responsibility. After existing wells have been located, inventoried, registered, and permitted as necessary, a GCD program to limit the proximity of new wells to existing wells would provide protection to permitted public water supply and industrial wells, and to registered domestic wells. This fundamental GCD function can provide a safeguard from well interference from new groundwater users. A study area GCD could also work closely and provide expertise to municipal and county platting authorities regarding potential groundwater issues associated with rural or suburban subdivision developments. The protection of groundwater quality is also of great importance since the aquifers in the study area are vulnerable to human-induced contamination, especially the Edwards aquifer. An active GCD abandoned-well plugging program to locate and seal such wells would help protect groundwater quality. Lastly, a GCD management program geared toward sustainability would potentially enhance both groundwater quantity and quality and maintain spring flows and riparian habitats within and proximal to the study area.

Economic Consideration and Impacts

Obtaining alternative sources of water for an area is often cost prohibitive because either new or additional surface water rights must be acquired or infrastructure constructed to deliver surface water or groundwater from outside sources. The economic impacts of managing groundwater resources through a groundwater conservation district are both positive and negative. For example, managing an area's groundwater resources can increase the value of land in the area by extending the economic life of the aquifer(s), limiting the possible encroachment of salt-water, and reducing other water quality impacts. One of the greatest benefits a GCD can take is a proactive approach through its assessment and monitoring, planning, permitting, and other conservation programs to equitably extend groundwater supplies for future use and economic development. GCDs also benefit the area by developing and implementing regulations for adequate well spacing, water well construction, pollution prevention through the plugging of abandoned wells, and also by providing public education outreach programs.

While a district may provide many benefits to those living within its boundaries, there is a cost for the groundwater management programs and activities that are provided. To finance its operations, a GCD must generate revenue which is generally done either through property taxes collected from all residents within the district or from well production fees collected from major water users. Collection of taxes to operate a district places an additional financial burden on all property owners within the district, and the collection of well production fees adds a financial burden to the users of water with permitted wells. The scale of cost for residents is dependent upon many factors including the size and total tax base of the district or the quantity of water that is subject to production fees, and the scale and scope of the programs undertaken by the district. Additionally, because a GCD is a political subdivision, it is an additional layer of local government that may not be welcomed by all residents.

Financing Groundwater Management Activities

Groundwater conservation districts are required to operate from an annual budget with spending limited to budgeted items. Present budgets for existing, operational GCDs range from slightly over $100,000 for some single-county districts with limited permitting and monitoring programs to over several million dollars for special-law type, multi-county districts with specific statutory responsibilities and mandates such as restricting production to protect spring-flow or to cease subsidence cause by groundwater withdrawal. Present budgets for GCDs that include three- to four-counties range from about $150,000 to about $425,000 (TCEQ personnel communication, August 27, 2003).

Under Texas Water Code, Chapter 36, a GCD may levy an ad valorem tax at a rate not to exceed 50 cents per $100 assessed valuation to pay for maintenance and operating expenses. In fact, most GCDs have lower ad valorem tax caps established either by their enabling legislation or by voters. After a tax cap has been approved by the voters, a GCD may not exceed the cap unless the voters subsequently authorize the GCD to do so at election. Most existing groundwater conservation districts currently have tax rates ranging from $0.004 to $0.0775 per $100 assessed valuation (or, $4.00 to $77.50 annual tax paid on property valued at $100,000) (TAGD, 2003). Single-county districts generally tend to have higher tax rates than multi-county districts which typically have tax rates averaging around $0.01 per $100 assessed valuation. One partial-county GCD with a small tax base presently has a tax rate of $0.231 per $100 (TCEQ personal communication, January 27, 2005). This is most likely the highest GCD tax rate in the state. (TCEQ personal communication, Hudspeth County UWCD No. 1)

The total appraised value for county taxation in each of the three counties in the study area is as follows: Williamson–$19,824,347,055, Burnet–$2,333,002,487, and northern Travis–$33,891,302,190 (Texas Association of Counties, 2003). For the three-county study area, the total appraised value is approximately $56,048,651,732. If a GCD was created that covered all three counties, a tax rate of $0.0005 per $100 (or fifty cents annual tax on $100,000 of property) would annually generate around $280,243, and a tax rate of $0.001 per $100 (or one dollar on $100,000 of property) would annually generate about $560,486.

Groundwater conservation districts may also generate revenue through the assessment and collection of well production fees on permitted wells. Unless otherwise addressed by a district's enabling legislation, the production fees are capped by state law at $1 per acre-foot/year for agricultural use, and $10 per acre-foot/year for other uses. Based on year 2000 supply data provided in Appendix 2, and assuming that county-other, livestock, and mining uses would be exempt from potential regulation and fees, about 5,262 acre-feet of water was produced for irrigation and about 12,447 acre-feet of water was produced for other purposes (municipal, manufacturing, steam electric) in the three-county study area. Making the same assumption that a GCD was created that included all three counties, and utilizing the maximum statutory well production fee rates ($1 per acre-foot/year for agricultural use and $10 per acre-foot/year for other uses), it is estimated that about $129,732 of revenue could be generated through this method of financing district operation and maintenance.

To a lesser extent, GCDs may also generate revenue by assessing fees for administrative services such as processing permit or groundwater transport applications, performing water quality analysis, providing services outside of the district, and capping or plugging abandoned wells. These fees must not unreasonably exceed the cost of providing these services. GCDs can also impose export fees (see below) and apply for and receive grants, loans and donations from governmental agencies, individuals, companies or corporations for specific conservation projects or research.

In addition, GCDs can issue and sell tax bonds for capital improvements such as building dams, draining lakes and depressions, installing pumps and equipment, and providing facilities for the recharge of aquifers. Such tax bonds are subject to voter authorization, TCEQ review, and the State Attorney General's approval. The taxing rate is not capped for the repayment of bond indebtedness.

GCDs may impose an export fee on water transferred out of the district. Unless specified in the legislation creating the district, the export fee is based on the district's existing tax or production fee rates or is negotiated with the transporter. GCDs are allowed to charge a 50 percent export surcharge in addition to the production fee charged for in-district use.

Conversely, a few groundwater conservation districts have been created without the authority to impose ad valorem taxes or water use fees. These districts have generally been funded by county government and are limited, by the amount of funding received, in the scope of programs they can implement.

Management Options

Water management and management planning can be considered at various scales of oversight and authority. On a state-wide scale, no federal or state entity has authority to regulate groundwater withdrawal or use. However, state-level water planning responsibilities and groundwater conservation district management plan oversight responsibilities are well defined, as previously discussed. Assessment and planning by the regional water planning groups can identify groundwater problem areas and appropriate management options for use by regional and local entities, but these planning entities are not authorized to manage and regulate groundwater resources or implement water conservation programs. County and municipal authorities can require plat applicants to evaluate and demonstrate that site-specific groundwater resources are available and sufficient for new subdivisions, and cities, utilities, and water suppliers can implement programs to discourage groundwater waste and seek alternative supplies. However, none of these local entities are directly authorized to manage groundwater pumpage.

Several groundwater management options are available for the study area. In one scenario, local leadership, landowners, and citizens can opt not to take any action. If an area does not have any demonstrated or anticipated groundwater problems or issues, this may be an appropriate choice. If this is not the case, however, this choice would not offer any resource protection to landowners and would allow existing or anticipated groundwater problems to persist or worsen.

A groundwater conservation district created within the study area would have the necessary authority to address groundwater issues and accomplish groundwater management objectives identified in the preceding text. Such a district would have the best available regulatory authority to manage and protect groundwater resources in the area. A GCD could benefit the study area by implementing groundwater management strategies as authorized under Texas Water Code, Chapter 36. The study area could benefit from monitoring, assessment, planning, and permitting programs to protect existing public and private water wells. A GCD could also benefit the area by implementing programs to prevent long-term water level drawdowns and well interference, to actively identify and plug abandoned wells that serve as a conduit to contaminate groundwater supplies, to construct and maintain aquifer recharge enhancement features, and to maintain spring discharges for the protection of natural resources.

If groundwater management is desired, the local leadership and concerned citizens must consider several methods for the creation of a groundwater conservation district. Most GCDs are created by special Acts of the Texas Legislature. In other general law procedures, statute allows landowners to petition the TCEQ for the creation of a GCD, or allows landowners to petition another district to have property be added into that district. Lastly, if an area is designated as a PGMA, landowners are provided a two-year period to accomplish one of the above district creation actions. If they do not, TCEQ is required to create a GCD or recommend the area be added to an existing GCD. (Methods of, and procedures for GCD creation are discussed in significant detail in TCE, 2002a and 2002b.)

District size must also be considered. Historically, single-county groundwater conservation districts have been the predominant choice of Texas citizens. However, multi-county GCDs covering larger portions of aquifers have increased in popularity over the past half-dozen years. Such districts can exercise consistent regulation and effective conservation and management planning on a larger or even aquifer-wide scale. Generally, multiple single-county GCDs or a few multi-county GCDs are created within the same groundwater management area and each district operates under its own rules and regulations to manage the groundwater resource. However, because these GCDs share common groundwater resources, it is imperative that their efforts to manage the resource be coordinated. Regional GCD alliances to facilitate like management goals have been established over some of the major aquifers, and the state laws requiring such joint planning have recently been strengthened.

Under Texas Water Code, §36.108, the presiding officer or the presiding officer's designee of each district located in whole or in part in a groundwater management area must meet at least annually to conduct joint planning with the other districts in the management area and to review the management plans and accomplishments for the management area. The districts are required to consider the goals and effectiveness of each management plan and each management plan's impact on planning throughout the management area. After 2010 the state law requires these districts to consider the degree to which each management plan achieves the desired future conditions established during the joint planning process. Through these cooperative efforts, local GCDs can effectively provide coordinated regional management of a shared groundwater resource. The three-county study area, and other counties to the north of the study area are included in Groundwater Management Area 8 for the northern segment of Edwards aquifer and Trinity aquifer as designated by the TWDB in November 2002 (Figure 14).

The following text describing different scenarios for the creation of GCDs in the study area was prepared before the June 17, 2005 creation, and the September 24, 2005 confirmation election for the Central Texas Groundwater Conservation District in Burnet County. The full discussion has generally been retained to illustrate all of the GCD creation options for the three-county study area.

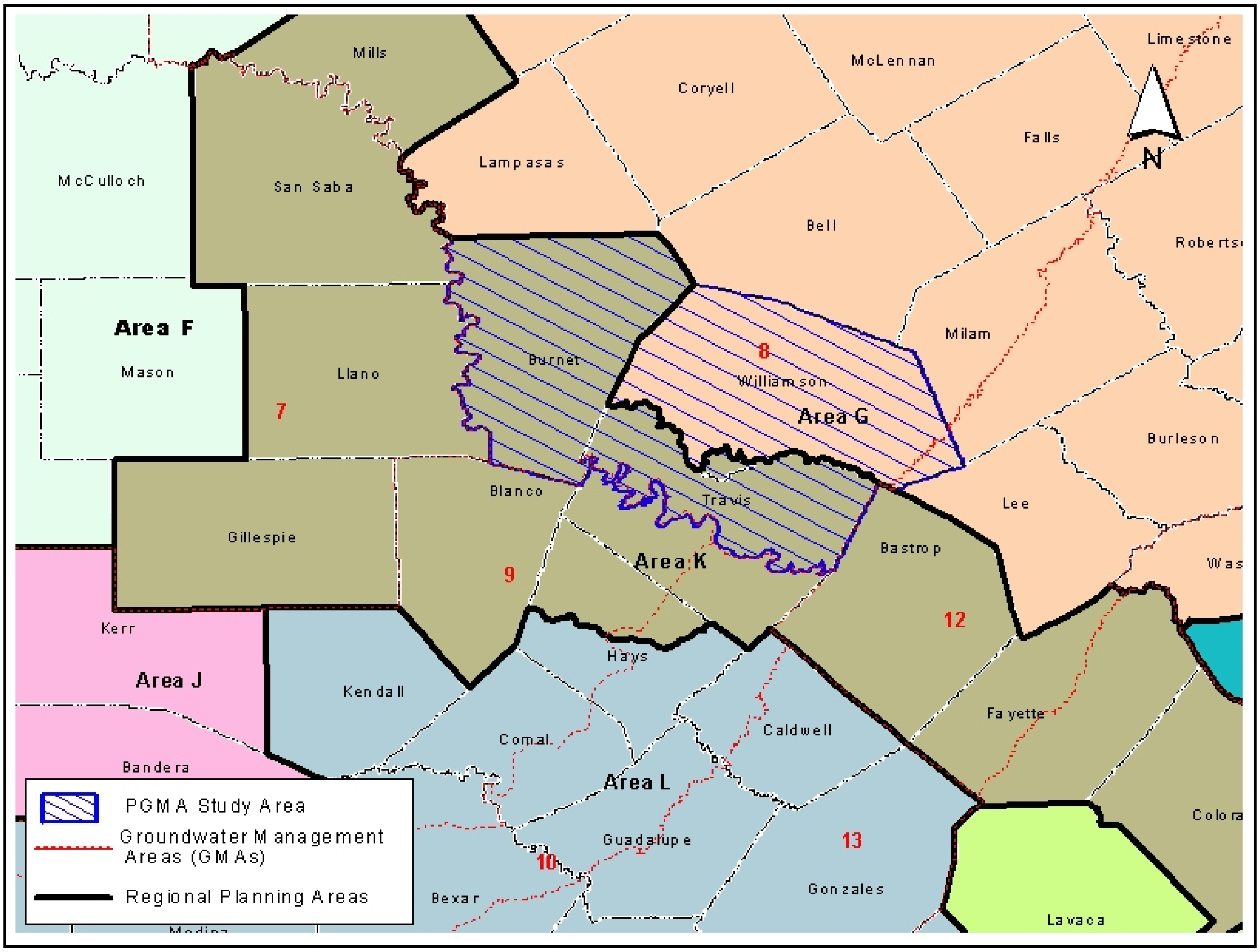

Figure 14. Map Showing Groundwater Management Area and Regional Water Planning Group Boundaries.

Multi-County Groundwater Conservation District

Besides considering the different groundwater conservation district creation methods, citizens must also consider several different GCD creation options and the implications for each. The most reasonable option would be a multi-county GCD consisting of all three counties in the study area. Because of the broader tax base that this option provides, sufficient revenue could be generated to finance district operation and maintenance at an extremely low tax rate. As discussed above, a tax rate of $0.0005 per $100 (or fifty cents annual tax on $100,000 of property) would annually generate around $280,243, and a tax rate of $0.001 per $100 (or one dollar on $100,000 of property) would annually generate about $560,486. These revenue estimates are in line with existing GCDs of the same size and would be practical to finance groundwater management activity through a GCD for the study area. An even lower tax rate may be practicable to finance the initial operations of a new GCD.

Alternatively, a three-county GCD could finance operations and maintenance through the assessment of well production fees and it is estimated (see above) that about $129,732 could be generated annually at the maximum fee rates authorized by Texas Water Code, Chapter 36. Although Chapter 36 authorizes GCDs to generate revenue through the levy of taxes and the assessment of well production fees, TCEQ is unaware of any districts that do both simultaneously. Frequently, the authority for special-law created GCDs requires the generation of revenue through either taxes or fees, but not both. It is doubtful any of the study area counties would be able to finance meaningful single-county district operations through well production fees alone.

Furthermore, since the three-county GCD creation option would include the greatest areal extent of the Edwards and Trinity aquifers, a single GCD management program would also represent the most optimal groundwater management option.

Single-County Groundwater Conservation Districts

Citizens could also consider a combination of single- and bi-county district configurations. The occurrence and condition of aquifers, predominate groundwater and land use types, demographics and population densities, and the public will are usually the defining factors for the consideration of these GCD creation options. TCEQ staff estimate a minimum of about $150,000 in revenue must be generated annually to operate a single-county district and fund meaningful groundwater management programs. All of the counties within the study area are capable of generating sufficient revenue to operate a GCD alone through an ad valorem tax of less than $0.01 per $100 valuation.

Williamson and northern Travis counties would require tax rates of about $0.0008 and $0.0004 per $100 valuation (or, 80 cents and 40 cents per $100,000 valuation), respectively, to generate around $150,000. These tax rates would represent a minimum economic impact on property owners; they are very low compare to tax rates levied by existing GCDs.

A bi-county district of Williamson and northern Travis counties would encompass the remaining part of the northern segment of the Edwards aquifer not presently within the jurisdiction of a GCD. These two counties are also much more urbanized and developed than Burnet County, and have similar aquifer use types and demands. A district composed of these two counties could easily generate more that $250,000 annually with a tax rate of $0.0005 per $100 valuation (50 cents per $100,000 valuation).

Having two or three GCDs would require a like number of individual groundwater management programs. These options provide for the most local control because each director represents a smaller area. However, these options would also require that largely duplicative administrative and management programs be implemented. For example, each GCD would be required to:

- establish and maintain an office;
- establish procedures to address open meetings and open records and records retention;
- annually address financial budgeting and auditing requirements;
- develop and adopt a management plan;
- develop and adopt administrative, well permitting and other regulatory rules; and,
- meet and uphold other statutory requirement relating to policies and district operation.

The creation of single-county districts in the study area is feasible. Nevertheless, citizens should understand that better economic and administrative options do exist. The only apparent trade-off would be the conception that the most-localized form of groundwater management was being forfeited if something other than single-county GCDs were created. However, the creation of GCDs by special law, and Texas Water Code, Chapter 36, allow sufficient flexibility to assure that the number and representation by district directors alleviate this misconception. Under either method, district directors must be accountable to, and responsive to the electorate.

Addition to Existing Groundwater Conservation District

Alternatively, the study area could opt to join an existing groundwater conservation district through the petition and addition procedures outlined in Texas Water Code, Chapter 36, Subchapter J. Under such circumstances, and assuming that a petition to add territory is accepted by the receiving district, landowners in the study area would agree to assume the financial obligations of the district they would join and be provided equitable representation on the receiving district's board of directors. The advantage of joining an existing district include accessibility to the district's established regulations, programs, and infrastructure, and an increased tax base which may be less burdensome on the taxpayers in the study area. All or parts of the study area, down to individually owned tracts of land, could be added to adjacent districts.

Presently, the most feasible GCD (Figure 15) that landowners in the study area could join is the Clearwater Underground Water Conservation District (UWCD). The Clearwater UWCD was created in Bell County in 1989 by HB 3172 (Chapter 524, Acts of the 71st Legislature, Regular Session, 1989). The district was confirmed by election on August 21, 1999 by a vote of 2,272 for; 1,206 against. The voters also approved an operation and maintenance tax to be levied at a rate not to exceed $0.01 per $100 of assessed valuation. The district is currently levying a tax of $0.0059 per $100 and contracts with the Central Texas Council of Governments for administrative services. The district’s initial management program is geared toward controlling groundwater production to protect Salado Springs.

Landowners could also consider joining the Saratoga UWCD in Lampasas County. The Saratoga UWCD was created by Chapter 519, Acts of the 71st Legislature, Regular Session, 1989 (H.B. No. 3122) and confirmed by Lampasas County voters on November 7, 1989. The Saratoga UWCD does not levy ad valorem taxes and is primarily funded by appropriations from the Commissioners Court of Lampasas County. The other GCDs adjacent to the study area, the Post Oak Savannah GCD in Milam and Burleson counties and the Lost Pines GCD in Bastrop and Lee counties, manage the Carrizo-Wilcox aquifer and are predominantly outside of Groundwater Management Area 8.

If any of these GCDs were agreeable to an inclusion-petition from landowners in the study area, the resulting larger GCD would benefit from a larger tax base, would include a larger areal extent of the aquifers, and would be able to develop a more uniform management program for the aquifers. However, the special law for the Clearwater UWCD and the Saratoga UWCD would need to be amended to allow flexibility for board member representation. Primarily because of the aquifer and groundwater management differences for Williamson and northern Travis counties, it would be less practicable to attempt to add the study area to the Saratoga UWCD. For these two counties, it would be more practical to join the Clearwater UWCD as they share the same aquifers.

Under any of the groundwater conservation district creation scenarios outlined above, it will be imperative for a district to understand the water supply options and strategies that have been identified in the Brazos G and Lower Colorado Regional Water Plans and the groundwater data that is built into the State Water Plan (TWDB, 2002) and the TWDB groundwater availability models. This data and these water supply strategies will serve as guides for water planning in the study area, and in the region for the next 50 years. Further, a district should also intimately understand and recognize the drought contingency plans of the wholesale and retail water suppliers in the area and the water demands of areas that are proposed for platting. Through monitoring programs, assessment, research, and cooperation, a district in the study area should be able to institute successful groundwater management programs for the Edwards and Trinity and other aquifers and provide better information and input about the groundwater resources for consideration in future updates to the regional and state water plans.

Stakeholder GCD Creation Issues and Concerns

In response to the study notice mailed in July 2004, most study area water stakeholders have clearly related preferences regarding the creation of groundwater conservation districts. The Burnet Water Council (BWC) submitted comments on behalf of the interests of Burnet County. The BWC reported they have provided over 1,500 signatures to the Honorable Troy Fraser, Texas Senate, petitioning for the creation of the Burnet County Groundwater Conservation District during the 79th Legislature, Regular Session, 2005. The BWC also provided copies of resolutions and other documentation by the cities of Bertram, Marble Falls, and Burnet, and the Chamber of Commerce of Bertram supporting the creation of a Burnet County-only district. The BWC noted the the Edwards aquifer was not present in Burnet County, and the Paleozoic-aged aquifers (Marble Falls, Ellenburger-San Saba, and Hickory) are either not present or are not prominent groundwater resources for the other two counties in the study area. The BWC also rightly commented that broad support of the citizens is crucial for a groundwater conservation district, and notes that such support is presently be built and maintained in Burnet County. The BWC commented that Burnet County residents were strongly against the creation of a multi-county GCD for numerous reasons, and requested they be given the opportunity to proceed with their locally-initiated and supported district creation actions.

The Central Texas Groundwater Conservation District for Burnet County was created by Chapter 855, Acts of the 79th Legislature, Regular Session, 2005 (Senate Bill 967). Burnet County voters confirmed the District's creation on September 24, 2005 by a vote of 2,258 for; 214 against, and authorized the directors to levy an ad valorem tax at a rate not to exceed $0.02 per $100 valuation. Presently five temporary directors govern the district, one appointed from each commissioners precinct and one appointed to represent the county at-large. Two of the five director positions will be up for election in May 2006, and the other three director positions will be up for election in May 2008. Elected directors will serve staggered four-year terms. Chapter 855 authorizes the District with specific powers and duties and with those of Texas Water Code, Chapter 36. The District is prohibited from exercising the power of eminent domain.

The Honorable John Doerfler, Williamson County Judge, provided consolidated comments on behalf of the Commissioners Court of Williamson County and the Williamson County Water Visionary Committee composed of county residents, public and city officials, and various county water providers. He commented the Commissioners Court of Williamson County does not support the creation of a GCD in Williamson County and that it is apparent there is little public support in the county for such a district. Judge Doerfler provided copies of resolutions and other documentation by the Commissioners Court of Williamson County, the City of Georgetown, the City of Round Rock, the City of Taylor, the Chisholm

Trail SUD, the Brushy Creek MUD, and the Williamson County Water Vision Committee all opposing creation of a GCD in Williamson County. The Brushy Creek MUD in Williamson County commented that a GCD would be a solution looking for a problem to solve. They further commented that most of the major entities using groundwater have already determined what they believe to be their maximum sustainable pumpage and have shifted to surface water sources for the remainder of their needs.

The Clearwater UWCD did not comment directly on the GCD creation issue. However, they did comment that groundwater availability modeling data indicates the general direction of groundwater flow in the Edwards aquifer tends to be northward from Williamson County into Bell County. They noted concerns about the impact that increased groundwater use in Williamson County may have on Bell County. The Clearwater UWCD commented the effectiveness of their groundwater management measures may be lessened if surrounding areas are not likewise managing their groundwater. This is especially when they depend upon some of this water entering Bell County. They state unregulated pumping of the Edwards aquifer in Williamson County could have an impact on the availability of groundwater in Bell County. The Brazos River Authority, City of Austin, Lower Colorado River Authority, and Turner Collie & Braden Inc. did not provide direct comment regarding their positions or preferences about GCD creation. The Sierra Club noted their respect for the ongoing Burnet County efforts to create a district, but inferred they would favor a study-area wide GCD.

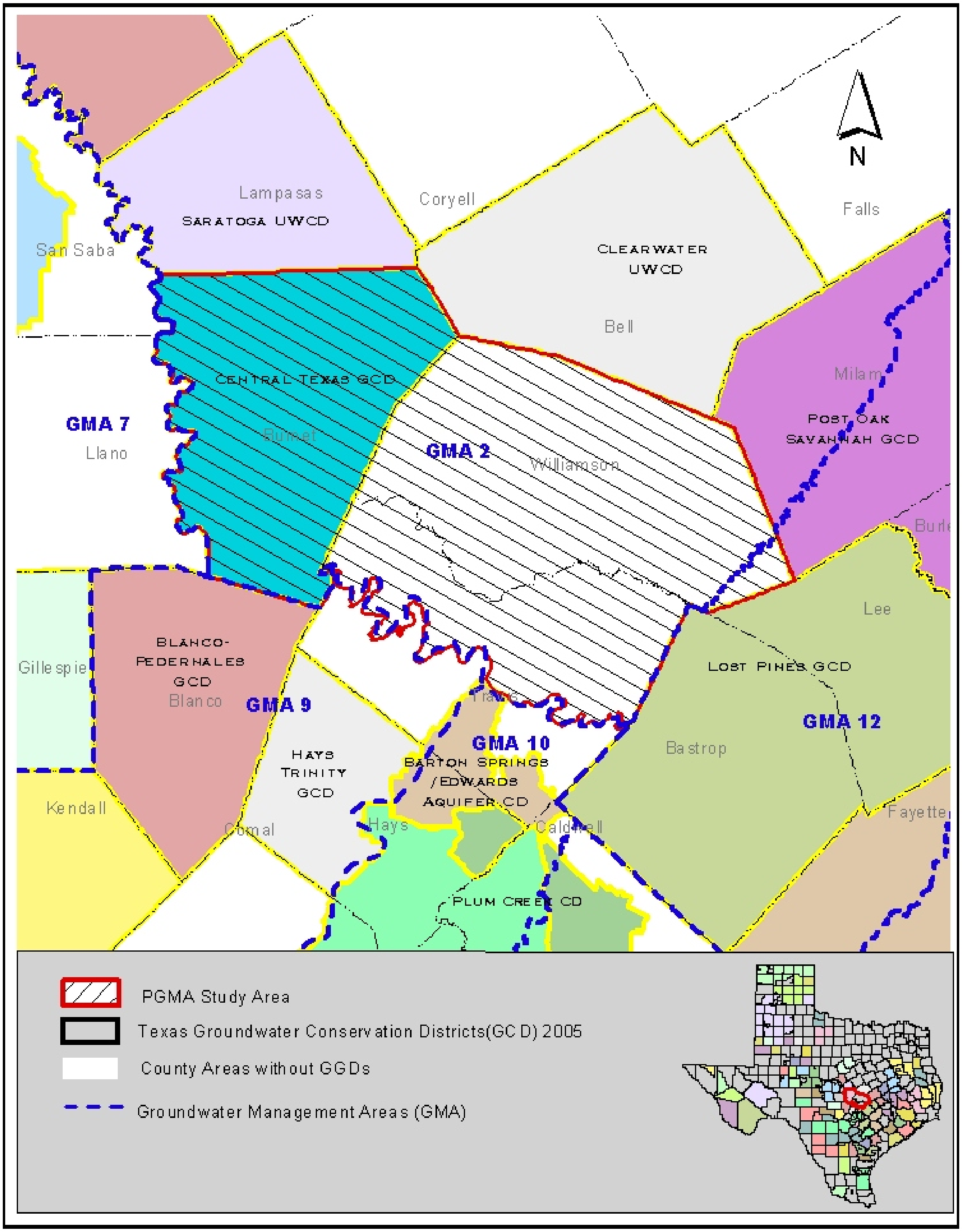

Fig 15. Map showing Groundwater Conservation Districts in Central Texas

SUMMARY ☆☆☆

Texas Water Code, Section 35.007, requires that a TCEQ Priority Groundwater Management Area (PGMA) report: 1) examine the reasons and supporting information for or against designating the study area as a PGMA; 2) recommend the delineation of boundaries if PGMA designation is proposed; 3) provide recommendations regarding groundwater conservation district creation in the study area; 4) recommend actions necessary to conserve natural resources within the study area; and 5) evaluate information or studies submitted by the study area stakeholders.

The Texas Water Code requires the report to identify present critical groundwater problems, or those expected to occur within a 25-year planning horizon. Critical water suplly problems which warrant PGMA designation include shortages of surface water or groundwater, land subsidence resulting from groundwater withdrawal, and contamination of groundwater supplies. This report evaluates the authorities and management practices of existing water management entities and purveyors within the study area and makes recommendations on appropriate strategies necessary to conserve and protect groundwater resources in the area.

TCEQ staff have considered data and information provided by the TWDB, TPWD, stakeholders in the study area, the Brazos G and Lower Colorado Regional Water Plans, and from independent research to support the following conclusions and recommendations regarding the Williamson, Burnet and Northern Travis Counties PGMA Study Area.

Water Use and Supply

The three-county study area gets water from the Colorado and Brazos River Basins and from groundwater sources. In 2000, 164,876 acft of water was used: surface water accounted for 83 percent (137,459 acft), and groundwater accounted for 17 percent (27,417 acft) of the water used in the study area. Increased use of surface water was observed in the study area over the last ten-year period to meet increasing demands and groundwater production levels have remained fairly constant. The Edwards and Trinity aquifers are the primary groundwater sources in Williamson and northern Travis counties, and the Ellenburger-San Saba, Hickory, Marble Falls, and Trinity Group aquifers are the primary groundwater sources for Burnet County. These minor aquifers are not found in Williamson and northern Travis counties. Groundwater from other geological units (undifferentiated aquifers) are also used in the study area. These groundwater sources are not specifically identified in the existing literature.

More water is used for municipal needs in the study area than any other purpose. In 2000, municipal use accounted for 141,667 acft (86 percent) of the total amount of water used, up from 107,254 acft in 1995, and up from 93,541 acft in 1990. Of the amount of water used for municipal purposes in 2000, 22,646 acft (16 percent) was supplied by groundwater sources and 119,021 acft (84 percent) was supplied from surface water sources. Sixty-three percent of the water used in 2000 for municipal purposes (89,554 acft) was used in Travis County north of the Colorado River. Williamson County used 15,496 acft (69 percent) of the groundwater used for municipal purposes in 2000 in the study area.

Manufacturing use accounted for 11,135 acft (seven percent) of the total water used in 2000. Eight percent of this water use was from groundwater. Mining use accounted for 4,344 acft (three percent) of the total water used in 2000. Out of this amount 53 percent was from groundwater sources. Water for power generation accounted for 4,273 acft of water use in Travis County in 2000, representing less than three percent of the total water use in the study area. Groundwater was used to supply 758 acft of water for irrigation purposes (less than one percent of total water use) and 2,313 acft of water for mining purposes (less than two percent of total water use) in 2000. Use of surface and groundwater sources for the watering of livestock accounted for 2,577 acft of use (less than two percent) in 2000; consisting of 29 percent groundwater (751 acft) and 71 percent surface water (1,826 acft).

The total quantity of water available for supply in the study area was estimated to be about 345,209 acft in 2000, and this quantity is projected to decrease by eight percent between 2000 and 2030 mainly due to surface water contract expirations. The primary sources of surface water supply in the study area are from the Highland Lakes, Colorado River, and water supplied through the Brazos River Authority (BRA). In Burnet County, water from the Highland Lakes is mainly used for municipal supply, and is projected to decrease by 15 percent between 2000 and 2030. The Highland Lakes supply 53 percent of the water supply in Travis County and 10 percent of the water supply in Williamson County. Supply is projected to decrease in Travis County by 25 percent, and remain the same in Williamson County, between 2000 and 2030. In 2000, the Colorado River supplied 45 percent of the water supply in Travis County and is projected to increase by two percent through 2030. The BRA supplied most of the surface water in Williamson County, and accounted for 57 percent, or 39,936 acft, of the water supply in 2000. The BRA supplied water is projected to increase by five percent through 2030. These total surface water supplies are projected to decrease by nine percent between 2000 and 2030 in the study area.

Groundwater Supply and Groundwater Quality Concerns

In 2000, groundwater supply was estimated to be 36,609 acft of water in the study area. In the same year, groundwater supply was 56 percent, 5 percent and 14 percent of the total water supply in Burnet, Travis and Williamson counties, respectively. Water supply from the Edwards aquifer in Travis and Williamson counties is projected to remain the same through 2030, at 10,692 acft. In 2000, the Trinity Group aquifer supplied 4,051 acft of water in the study area, and the amount supplied is projected to decrease to 3,925 acft through 2030. Groundwater supply from minor aquifers in Burnet County is projected to remain fairly constant through 2030, from 14,034 acft in 2000 decreasing to 13,948 acft in 2030. Williamson County uses more groundwater than the other counties in the study area. Use of other groundwater sources for import is also projected for some of the eastern Williamson County water user groups before 2030. Generally, the groundwater supply in the study area is projected to remain the same through 2030. The TWDB groundwater availability model runs do not indicate a regional water-level decline in the study area. However, gradual long-term and localized water-level decline is predicted in the Pflugerville, Round Rock, and Georgetown area. Under drought-of-record conditions, the model for the Edwards aquifer predicts water-level declines of greater than 25 feet to occur along the western margin in the outcrop area of the Edwards aquifer.

The groundwater quality in the Edwards aquifer is generally good, however, the aquifer is highly vulnerable to human-induced contamination. The quality of water in the aquifer is directly affected by the total environment of the water, from its origin as rainfall to its ultimate discharge from wells and springs in the aquifer. Within its jurisdiction, the TCEQ Edwards Aquifer Protection rules address activities that could pose a threat to water quality in the Edwards aquifer and the surface streams that feed it in Williamson and northern Travis counties. The groundwater quality of the Trinity Group aquifer in the western portion of the study area can be characterized as a calcium carbonate type water. Downdip to the southeast of the study area, the water quality tends to deteriorate and does not meet drinking water standards for chloride, fluoride, sulfate and hardness.

Natural Resources Concerns

The population of the study area in 2000 was 669,595 and is projected to be 1,278,831 by 2030. Population growth gradually puts a stress on the study area's ecosystems. Stress on the different ecosystems come from the number of people, their location, and the nature and scale of their activities. The TPWD concluded that the selected natural resources mentioned in the report are facing an uncertain future, a future that depends on the quality and quantity of the water resources, both surface and groundwater, within the study area. The five species of Eurycea salamanders found in the study area are all endemic to local springs and caves. Therefore, their fate is tied to groundwater levels.

The TPWD concluded that mitigating the negative impacts of past and current practices, such as grazing, agriculture, industrialization, and urbanization will improve the chances of natural resources recovery, be it surface water, groundwater, or fauna and flora. Fundamental changes in land and water management and resources valuation will be needed for mitigation plans to be effective.

The USFWS and TCEQ responsibilities for natural resource protection overlap in some cases regarding water quality and endangered species that are dependent upon high quality water in the Edwards aquifer. The USFWS has determined the new, optional water quality measures which serve as guidance for complying with TCEQ's Edwards aquifer rules will also protect several federally-listed endangered and threatened species, such as the Georgetown salamander. The USFWS has indicated that if these voluntary, enhanced water quality measures are used by non-Federal landowners and other non-Federal managers, "no take" of these species would occur, with some exceptions. Starting February 14, 2005, the use of these optional measures is voluntary under the TCEQ's Edwards Program; however, the water quality measures will protect certain species from potential water quality impacts that could result from development over the Edwards aquifer region.

Projected Demand, Availability, and Strategies to Meet Needs

The regional and state water plans project that between the years 2000 and 2030, total population within the study area will increase by approximately 91 percent. The total projected water demand for the three-county study area is expected to increase over the next 30-year period. The total water use for 2000 was 164,876 acft and the total projected demand for 2030 is anticipated to be 298,278 acft, an increase of 133,402 acft, or 81 percent over the 30-year time frame. Municipal needs represents the largest demand for water in the study area. Municipal demand for the study area is projected to increase by approximately 124,667 acft over the 30-year planning period. Municipal demand accounts for 86 percent of the total water use in 2000 and increases to 89 percent of the total water demand for 2030, from 141,667 acft to 266,334 acft. Between 2000 and 2030, municipal water demand: for Williamson County is projected to increase by 97 percent from 46,606 acft to 91,966 acft, for northern Travis County is projected to increase 77 percent from 89,554 acft to 158,466 acft, and for Burnet County is projected to increase 39 percent from 5,507 acft to 7,646 acft.

The current and projected Edwards aquifer groundwater use should be based on utilizing effective recharge only, with little or no mining of recoverable storage (Ridgeway and Petrini, 1999). Due to its highly permeable nature in the fresh water zone, the Edwards aquifer responds quickly to changes and extremes in stress placed upon the system. The TWDB also suggests that groundwater availability in the Trinity aquifer could consist of the annual recharge and mining of the total recoverable storage until the year 2030. After 2030, supply from the Trinity aquifer would be based on the estimated effective recharge. The availability is also based on the areal extent of the downdip portion of the aquifer in the study area. The data from the 2002 State Water Plan indicate that 57,097 acft/yr of groundwater is available in the three-county study area. The Edwards and Trinity aquifers account for 21 and 9 percent of the available groundwater supply, respectively. The minor aquifers in Burnet County account for 25 percent of the total groundwater supply in study area. Other aquifers account for 45 percent of the remaining groundwater supply in the study area, primarily from the Colorado River alluvium.

There are nine major reservoirs in the Lower Colorado River and in the Brazos River basins that lie near or within the study area. The majority of the reservoirs located within the Lower Colorado River Basin in the vicinity of the study area are part of the LCRA's Highland Lakes system. These reservoirs are Lake

Buchanan, Inks Lake, Lake LBJ, Lake Marble Falls, Lake Travis, and Lake Austin. The Highland Lakes system firm yield is 445,266 acft. Lake Georgetown, Granger Lake and Lake Stillhouse Hollow are located in the Brazos River Basin. The 2001 Brazos G Water Plan notes the total amount of surface water available for Williamson County from the Brazos River Basin is 113,556 acft. Including other surface water sources and reuse, the total annual availability of surface water for the study area is estimated to be 564,266 acft.

The Brazos G and Lower Colorado Regional Water Planning Groups recommended different water management strategies to meet the identified needs through the year 2030. These water supply strategies generally include surface water contract renewal, on going and continued infrastructure expansion, and Carrizo-Wilcox aquifer groundwater development for import. With the recommended water management strategies, most of the water user groups (WUGs), except for mining, meet their identified needs. The mining WUG is expected to have water deficits over the study period. The projections show a shortage of 1,543 acft/yr in 2030, and increasing to 1,663 acft/yr in 2050. The deficit is due largely, if not completely, to conservatively low groundwater supply figures used for Williamson County. The Brazos G Regional Water Plan anticipates that mining use will continue to be from locally available groundwater, but did not identify any water management strategy to meet the mining needs. The Brazos G Regional Water Plan recommends that if groundwater becomes unavailable due to drought or overpumpage, the mining WUGs will either purchase new supplies from nearby water utilities, or will cease operations until groundwater (Edwards aquifer) rebounds. Mining stakeholders have commented that they do not anticipate increased demands on groundwater sources and will use surface water and recycling.

Stakeholder Concerns

Evaluating the authority and management practices of existing water management entities and purveyors within and adjacent to a PGMA study area is required for TCEQ to make meaningful conclusions about critical water supply and groundwater conditions. Approximately 280 water stakeholders were identified in this study area, and on July 26, 2004, TCEQ mailed a notice to solicit comments and to request data on water supply; groundwater quality, availability, and water levels; and actions taken to address identified water management strategies.

The Burnet Water Council (BWC) provided consolidated comments for Burnet County interests. Noting that the projected Burnet County population increase of about 75 percent by the year 2030 is anticipated to be manifested as high-density bedroom communities in previously rural areas, the BWC commented that such areas would be reliant on groundwater sources and that groundwater availability may become a critical issue over the next 25-year period due to localized groundwater declines. The BWC commented that the Trinity Group aquifer in the eastern one-third of the county is the area where most of the anticipated growth is expected to occur, and that localized groundwater level declines would likely occur in the Trinity aquifer under heavy pumpage. The BWC also noted that localized declines are also an immediate management issue for the highly faulted and compartmentalized Marble Falls, Ellenburger-San Saba, and Hickory aquifers in the western two-thirds of the county, aquifers that are not present in the other two study area counties. The BWC suggested that localized declines can be managed best at the local level and actions to do so were being initiated in Burnet County. The creation and confirmation of the Central Texas GCD in Burnet County was the result of these actions.

The Honorable John Doerfler, Williamson County Judge, provided consolidated comments and documentation on behalf of the Commissioners Court of Williamson County and the Williamson County Water Visionary Committee (WVC). In summary, they commented that (1) only a small percentage of the county's existing water demand is supplied by groundwater; (2) in the past several years significant additional surface water sources from outside of the county have been obtained through the BRA and the

LCRA to replace groundwater; (3) forecasted use of groundwater will continue to decrease with no additional groundwater demands anticipated; (4) conservation programs established by groundwater providers continue in place with emphasis on restricted use of groundwater during drought periods; and (5) the commissioners court is actively reviewing additional means to meet the county's growing water needs. He commented that the commissioners court was considering the creation of a strategic master plan addressing the supply, treatment, and distribution of water throughout Williamson County to insure that both rural and urban areas are efficiently and adequately supplied with water. Resolutions opposing the designation of a PGMA and creation of groundwater conservation district(s) from the Commissioners Court of Williamson County, the City of Round Rock, the City of Georgetown, the Chisholm Trail Special Utility District, and the Brushy Creek Municipal Utility District were provided.

The BRA noted that they have worked with Williamson County entities for over 25 years to evaluate and meet the county’s water needs, and will continue to work with these entities in the development of new groundwater supplies outside of the county from the Carrizo-Wilcox aquifer and from reuse of effluent from in-county regional wastewater treatment facilities operated by the BRA. The BRA commented that it is presently evaluating ways to increase delivery of water to Williamson County from existing reservoirs and facilities, both through their policies and management practices.

The Aqua Water Supply Corporation noted that they have been unable to find any economically reliable groundwater resources within their service area in Travis County, and the entirety of the present supply for their Travis and Williamson counties service area is from Bastrop County groundwater sources. The Aqua WSC commented they are developing water supplies needed to meet the projected high-density urban subdivision growth for their service area from several sources, none of which are in Travis or Williamson counties. The City of Austin submitted data indicating that low concentrations of dissolved pesticides and solvents in addition to elevated concentrations of nutrients, ions, and certain metals are present in Travis County in the Bull Creek watershed. These results indicate marked differences in water quality between springs in urbanized settings and those in rural settings.

The Clearwater Underground Water Conservation District noted that Edwards aquifer groundwater flowed from Williamson County into Bell County, and noted concerns about the potential impact that increased groundwater use in Williamson County could have on the availability of groundwater in Bell County. The Lone Star Chapter of the Sierra Club noted the infrastructure to deliver all of the needed study area water supplies is not completely in place, that most of the municipalities continue to rely on groundwater for backup supply, and that groundwater shortages presently exist for mining water uses. They noted that rural domestic users continue to rely on groundwater and could be seriously impacted by depleted aquifers. The Sierra Club commented that the potential for these critical groundwater problems to persist support the designation of the study area as a PGMA.

TCEQ staff have considered data and information provided by the Texas Water Development Board, Texas Parks and Wildlife Department, stakeholders in the study area, the 2001 Brazos G and Lower Colorado Regional Water Plans, and from independent research to support the following conclusions and recommendations.

Study Area Designation Recommendation

The water supply problems identified in the study area include lack of drought-reliable groundwater supplies, lack of firm supplies for some municipal use and most mining use, localized water level declines, potential groundwater supply impacts from new mining or industrial wells, and removal of groundwater from aquifer storage to meet future demands. Most water supply concerns in the study area are addressed with surface water contract renewal, on going and continued water supply infrastructure expansion, and Carrizo-Wilcox aquifer groundwater development for import - all management strategies adopted by the 2001 Brazos G and Lower Colorado Regional Water Plans. There are no significant changes to the management strategies identified in the two 2005 Initially Prepared Regional Water Plans for the study area water users.

During the last 15 years, the study area water purveyors have secured and continue to secure additional surface water resources while not increasing the amount of groundwater use. Using the water demand projections developed by the Brazos G and Lower Colorado Regional Water Planning Groups, the TWDB groundwater availability predictive models for the northern Edwards and Trinity/Woodbine aquifers do not project future significant regional water-level decline to occur in the next 25-year period in the study area. Over the 50-year horizon, the model runs do predict that a gradual long-term water-level decline will occur in the Pflugerville-Round Rock-Georgetown area.

The Edwards aquifer is highly vulnerable to surface contamination. Water quality problems in the study area are best solved by coordinated efforts of state and local government, and water supply entities. Within its jurisdiction, the TCEQ Edwards Aquifer Protection Program rules address activities that could pose a threat to water quality in the Edwards aquifer and the surface streams that feed it in Williamson and northern Travis counties. Naturally occurring water quality problems in the Trinity Group aquifer, especially in the eastern side of the study area, are primarily addressed by blending this groundwater with surface water to achieve the drinking water standards.

Most of the identified water supply problems are localized and are not study-area-wide problems. The available data indicates that study area water supplies are of sufficient quality to meet intended and projected uses. Further, study area water purveyors have secured adequate water resources or are presently working to secure adequate water resources to meet water demands for the next 25-year period. Surface and groundwater supplies are sufficient to meet the present needs, and are projected to be sufficient to meet all future needs to 2030.

Based on the presently available information, the Williamson, Burnet, and Northern Travis counties study area is not experiencing and is not expected to experience within the next 25-year planning horizon, critical groundwater problems. Therefore, it is concluded and recommended the Williamson, Burnet and northern Travis counties study area should not be designated as a priority groundwater management area at this time.

Natural Resource Recommendations

Groundwater management strategies to monitor, evaluate, and understand the aquifers sufficiently to establish programs to protect the riparian habitats fringing rivers, streams, and lakes, as well as protecting karst habitats, should be a priority in study area land-use planning processes. Implementing programs to minimize water level declines from concentrated pumping centers, and maintaining the existing spring flows in the study area and in counties adjacent to the study area would also facilitate the protection of natural resources. Cooperating and supporting existing multi-agency efforts such as the Balcones Canyonlands Preserve, Williamson County Karst Conservation Foundation, and TCEQ Edwards aquifer protection rule are also recommended to help conserve natural resources in the study area.

Groundwater Conservation District Considerations

Because the study area's water supply concerns are mostly solved with implementation of water management strategies adopted by the regional water planning groups, PGMA designation is not recommended at this time and any GCD creation action would have to be locally initiated. Most study area stakeholders have made it clear they do not believe a multi-county GCD would be practicable based on both hydrological conditions and other factors such as study area population densities.

Burnet County stakeholders commented that they greatly preferred a Burnet County-only GCD, and in fact legislatively created and voted to confirm the creation of the Central Texas Groundwater Conservation District during the preparation of this report. The Burnet County stakeholders noted that the importance of the Paleozoic-aged Marble Falls, Ellenburger-San Saba, and Hickory aquifers to the county, the lack of these aquifers in the other two counties, and the population density differences from the other two counties were reasons enough to favor creation of the single-county district. It is concluded that programs to manage the Trinity aquifer will be needed as projected population growth and anticipated new demands on groundwater supplies in the eastern part of Burnet County become reality.

The new Central Texas Groundwater Conservation District is sufficiently authorized to manage and protect the groundwater resources in Burnet County. Groundwater monitoring, assessment, planning, education, and permitting programs, as well as water well spacing and well closure programs are recommended for the district to manage the Trinity and Paleozoic-aged aquifers for the present citizens of the county and for future generations. Implementation of these types of programs will allow the district to identify and address water-level declines in localized areas of heavy pumpage, provide safeguards from well interference from new groundwater users, and protect groundwater quality.

Nearly all of northern Travis and Williamson counties are within certificated water purveyor service areas. Through conservation programs and efforts to meet new demands with surface water sources, these entities can largely maintain their present groundwater systems. However, these types of entities do not have authority to control large-scale groundwater pumpage for private purposes that could potentially impact a shared groundwater supply. The Clearwater UWCD in Bell County noted the effectiveness of their groundwater management measures may be lessened if surrounding areas are not likewise managing the shared groundwater resource.

A consensus of Williamson County stakeholders commented that they do not believe a GCD is needed in Williamson County at this time. The Williamson County Water Visionary Committee – composed of county residents, public and city officials, and county water providers – does not support the creation of a GCD in Williamson County and noted that it is apparent there is little public support in the county for such a district. Even though most of the major Williamson County entities using groundwater have already determined what they believe to be their maximum sustainable pumpage and have shifted to surface water sources for the remainder of their needs, detrimental impacts from large-capacity, nonmunicipal wells could easily affect the groundwater balances relied upon by these water purveyors.

In absence of a GCD, TCEQ staff suggest that the Commissioner Court of Williamson County should follow through with its intent to adopt a formal Williamson County master water supply plan to address the supply, treatment, and distribution of water throughout the county to insure both rural and urban areas are efficiently and adequately supplied with water.

TCEQ staff suggests that the most practicable method to achieve groundwater management for landowners who are concerned about groundwater quantity or quality impacts from new users or demands may be to petition an adjacent GCD, either individually or collectively, to have their property added to the district. Lastly, TCEQ staff suggest that a GCD consisting of Williamson and northern Travis counties would be a feasible groundwater management entity only if there were public support for it to succeed.

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APPENDIX 1.

1990 CRITICAL AREA REPORT SUMMARY FOR TEXAS WATER COMMISSION

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EVALUATION OF GROUNDWATER RESOURCES WITHIN BELL, BURNET, TRAVIS, WILLIAMSON AND PARTS OF ADJACENT COUNTIES, TEXAS
(A Critical Area Groundwater Study)
Chapter 52, Subchapter C, Texas Water Code

TECHNICAL SUMMARY

The area identified for the critical area groundwater study includes parts of six counties: Bastrop, Bell, Burnet, Milam, Travis, and Williamson. The area was identified as a potential critical area and nominated for a detailed study by the Texas Water Commission and the Texas Water Development Board in a joint press release dated January 13, 1987. The critical area study and report were joint efforts of the Board and Commission. The report recommends that the study area not be designated as a Critical Area and provides information about groundwater problems and water use in the area in support of the recommendations.

A public meeting was held in Austin, Texas on October 9, 1986, to solicit comment regarding critical area designation for the study area. Interviews of members of local government, industry, and concerned citizens were conducted in the spring and summer of 1987. A sixteen-member advisory committee, composed of representatives from throughout the study area, was formed in October, 1987, to assist TWC staff in assessing local groundwater conditions and to provide input and comments on both ground and surface water issues on a local level. The advisory committee provided input to the report and on the recommendations in the report.

Groundwater problems in the study area include a lack of drought-reliable supplies for both short-term drought demand and long-term economic development. Pumpage had historically exceeded recharge, resulting in declining water levels and possibly deteriorating chemical quality in the Hosston and Hensel members of the Trinity Group aquifer in the eastern and western portions of the study area. During late summer dry spells and drought, water levels drop quickly in Edwards aquifer wells due to low area-wide storage and in Trinity Group wells due to low permeabilities.

Overdrafts are occurring in the Trinity Group aquifer in portions of Bell, Williamson, and Travis counties. The estimated groundwater availability for Trinity Group aquifer in the study area, based on average annual effective recharge and a prorated amount of water recoverable from storage is 6,700 acre-feet per year. However, in 1985, 7,705 acre-feet of groundwater was pumped from the Trinity Group aquifer in the study area, resulting a net loss of water from the aquifer in 1985. Water-level declines and associated reduction of artesian pressure caused by deficit-removal of water from storage constitute a regional groundwater problem.

A major problem with the Edwards aquifer is available during drought conditions, especially at its current level of development. In 1985, approximately 15,919 acre-feet of groundwater was pumped from the Edwards aquifer. The amount of water stored in the Edwards aquifer in the study area is not known, but is considered to be small due to the aquifer's low average porosity. The availability for drought conditions is calculated to be 7,464 acre-feet annually based on the amount of springflows plus well pumpage during the drought of record. Recent pumpage in the study area has equaled or exceeded drought-year recharge to the aquifer.

Water quality in both aquifers in the eastern portion of the study area presents problems for public supplies. High concentrations of sulfates, chlorides, fluorides, and dissolved solids often do not meet the Texas Department of Health standards for public water supply systems. The potential for water quality impacts to the Edwards aquifer in the study area from man's activities is judged to be high. No regional contamination problems are known, and current Commission rules protecting the aquifer, with some improvements, should afford the necessary protection.

Current and projected water demand for the area is based on three factors, increased population growth, water use, and current availability of both groundwater and surface water. The Texas Water Development Board projects the population to grow by almost fifty percent between 1985 and 2010. The annual water requirement for the study area is expected to more than double from 1985 to 2010. In 1985, a total of 25,940 acre-feet of groundwater was pumped from all aquifers in study area with 7,705 acre-feet from the Trinity Group and 15,919 acre-feet from the Edwards aquifer. A total of 118,084 acre-feet of water was used for public supply, irrigation, industrial, power, and livestock purposes in the area with groundwater supplying 22 percent of the total and surface water supplying 92,144 acre-feet, the remainder.

Shortage of present and future supplies of groundwater may pose a serious problem for the study area. However, the area is not facing a "critical" water supply problem due to the availability of surface water. Surface water supplies are adequate due to meet current and projected needs beyond 2010. Sufficient water is available in the Highland Lakes system of the Colorado River basin to supply the needs of the City of Austin and a large part of northern Travis County. Sufficient water is available in Lake Georgetown and has become available in Lakes Granger and Stillhouse Hollow, both in the Brazos River basin, to meet area needs to the year 2000 and beyond 2000 for some entities. More surface water development is needed in the basin to free up additional water, currently committed for system use, in Lake Stillhouse Hollow to meet local supply needs to 2010 and beyond. Many large-volume groundwater users, concentrated along the Interstate Highway 35 and State Highway 183 corridors, plan to convert to these surface water sources in near future.

While an underground water conservation district has broad powers to regulate activities that endanger the aquifers either from overpumpage or pollution, protecting of existing groundwater supplies through large-quantity producer conversions to surface water may be the best regional management method for area. However, to convert to surface water supplies, reservoirs, treatment plants, and conveyance systems will have to be built. It is also recognized that an underground water district may not be the best or most appropriate mechanism for facilitating conversion to surface water in the study area.

In general, it is recognized that regional management practices are needed to stabilize groundwater levels and to help preserve the aquifers for future use. Interviews indicated that the area, as a whole, would probably not support the formation of a district created under Chapter 52 Subchapter C, Texas Water Code, mainly due to the ad valorem taxing structure and to varying political interests in the area. There is a large dichotomy in the population distribution and water-supply source, mainly divided between the large population centers, rural, and farming areas on groundwater supplies. As a result, an underground water conservation district would probably be viewed as only benefiting a relative few on groundwater while being financed by the majority of surface water.

Although many cities are currently experiencing problems with groundwater level declines and drought availability in the aquifers that supply their water, they are implementing plans that will alleviate their supply problems in the future. Planning in many areas relies on surface water for future supplies. The groundwater supply in these areas will not be critical if future surface water supply plans are implemented. The major blockage to surface water conversion is the initially large expense to build treatment plants and conveyance systems.

It is recommended that the Texas Water Commission not designate the study area as a Critical Area at this time. Progress towards the conversion from groundwater to surface water usage should be monitored by the Texas Water Commission over the next five years, and if conversion plans are not being implemented or if districts are not being formed, consideration should again be given to "Critical Area" designation.

Prepared by:	Steve Musick, Geologist Groundwater Conservation Section Texas Water Commission	March 30, 1990
Approved by:	Bill Klemt, Chief Groundwater Conservation Section Texas Water Commission	March 30, 1990

APPENDIX 2.

Total Water Supply Projections in the Study Area

Burnet County

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
Bertram	K	G	01	Ellenburger-San Saba Aquifer	207	200	190	184
Burnet	K	K	00	Highland Lakes System	4,100	4,100	4,100	4,100
Burnet	K	K	01	Ellenburger-San Saba Aquifer	1,862	1,862	1,862	1,862
Cottonwood Shores	K	K	00	Highland Lakes System	138	138	0	0
Granite Shoals	K	K	01	Highland Lakes System	830	830	830	0
Granite Shoals	K	K	00	Other Aquifer	963	963	963	963
Marble Falls	K	K	00	Highland Lakes System	2,000	2,000	0	0
Meadowlakes	K	K	00	Other Local Supply	486	486	486	486
County-Other	K	G	01	Trinity Aquifer	1,000	1,000	1,000	1,000
County-Other	K	G	01	Ellenburger-San Saba Aquifer	400	400	400	400
County-Other	K	K	00	Highland Lakes System	184	107	0	0
County-Other	K	K	01	Ellenburger-San Saba Aquifer	65	65	65	65
County-Other	K	K	01	Hickory Aquifer	54	54	54	54
County-Other	K	K	01	Marble Falls Aquifer	21	21	21	21
County-Other	K	K	01	Trinity Aquifer	227	227	227	192
County-Other	K	K	01	Other Aquifer	150	150	150	150
Irrigation	K	G	01	Trinity Aquifer	0	0	0	0
Irrigation	K	K	00	Highland Lakes System	102	91	50	0
Irrigation	K	K	00	Irrigation Local Supply	276	276	276	276
Irrigation	K	K	01	Ellenburger-San Saba Aquifer	25	25	25	25
Irrigation	K	K	01	Hickory Aquifer	2,397	2,397	2,397	2,397
Irrigation	K	K	01	Marble Falls Aquifer	533	533	533	533
Irrigation	K	K	01	Other Aquifer	1,000	1,000	1,000	1,000
Irrigation	K	K	01	Trinity Aquifer	104	104	104	104
Livestock	K	K	00	Livestock Local Supply	210	210	210	210

Burnet County (cont.)

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
Livestock	K	G	0	Livestock Local Supply	341	341	341	341
Livestock	K	G	00	Livestock Local Supply	341	341	341	341
Livestock	K	G	01	Trinity Aquifer	45	45	45	45
Livestock	K	K	01	Trinity Aquifer	71	71	71	60
Livestock	K	K	1	Other Aquifer	10	10	10	10
Livestock	K	K	01	Marble Falls Aquifer	3,115	3,115	3,115	3,115
Livestock	K	K	01	Hickory Aquifer	189	189	189	189
Livestock	K	K	01	Ellenburger-San Saba Aquifer	25	25	25	25
Manufacturing	K	K	00	Highland Lakes System	500	500	500	500
Manufacturing	K	K	00	Other Local Supply	1,237	1,367	1,503	1,643
Manufacturing	K	K	01	Ellenburger-San Saba Aquifer	25	25	25	25
Mining	K	K	01	Hickory Aquifer	315	315	315	315
Mining	K	K	01	Ellenburger-San Saba Aquifer	25	25	25	25
Mining	K	K	00	Other Local Supply	767	747	762	778
Mining	K	G	01	Marble Falls Aquifer	123	123	123	123
Mining	K	K	01	Trinity Aquifer	54	54	54	54
Mining	K	K	01	Other Aquifer	1,000	1,000	1,000	1,000
Mining	K	K	01	Trinity Aquifer	4	4	4	4
Steam Electric Power	K	K	01	Ellenburger-San Saba Aquifer	25	25	25	25
Total Projected Water Supplies (acre-feet per year)					25,205	25,220	23,075	22,282

Basin: K- Lower Colorado — 00, Surface Water
G- Brazos — 01, Groundwater

Source: TWDB, 2002

Northern Travis County

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
Anderson Mill	K	K	00	Highland Lakes System	36	0	0	0
Austin	K	K	00	Colorado River Combined Run-of-River	3,478	3,478	3,478	3,478
Austin	K	K	00	Colorado River Combined Run-of-River	78,115	78,115	78,115	78,115
Austin	K	K	00	Highland Lakes System	70,557	70,557	70,557	70,557
Jonestown	K	K	00	Highland Lakes System	360	360	360	360
Lago Vista	K	K	0	Highland Lakes System	6500	6500	6500	0
Manor	K	K	01	Other Aquifer	2,620	2,620	2,620	2,620
Manor	K	K	01	Other Aquifer	0	0	0	0
Pflugerville	K	K	01	Edwards-BFZ Aquifer	2,585	2,585	2,585	2,585
Pflugerville	K	K	00	Colorado River Combined Run-of-River	0	0	0	0
Round Rock	K	G	00	Colorado River Combined Run-of-River	5,498	5,498	5,498	5,498
Wells Branch	K	K	00	Colorado River Combined Run-of-River	1,113	1,074	1,013	0
County-Other	K	K	01	Trinity Aquifer	332	332	332	332
County-Other	K	K	01	Other Aquifer	1,080	1,080	1,080	1,080
County-Other	K	K	01	Edwards-BFZ Aquifer	1,448	1,448	1,448	1,448
County-Other	K	K	00	Highland Lakes System	23,615	23,207	15,488	0
County-Other	K	K	00	Colorado River Combined Run-of-River	2,176	2,245	2,449	2,656
County-Other	K	G	01	Edwards-BFZ Aquifer	19	19	19	19
Irrigation	K	K	01	Other Aquifer	110	110	110	110
Irrigation	K	K	01	Trinity Aquifer	48	48	48	48
Irrigation	K	K	00	Irrigation Local Supply	493	493	493	493
Irrigation	K	K	01	Edwards-BFZ Aquifer	445	445	445	445
Irrigation	K	G	01	Edwards-BFZ Aquifer	3	3	3	3
Livestock	K	G	01	Edwards-BFZ Aquifer	1	1	1	1
Livestock	K	K	00	Livestock Local Supply	487	487	487	487

Northern Travis County (cont.)

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
Livestock	K	K	01	Edwards-BFZ Aquifer	129	129	129	129
Livestock	K	K	01	Other Aquifer	127	127	127	127
Livestock	K	K	01	Trinity Aquifer	1	1	1	1
Manufacturing	K	K	01	Edwards-BFZ Aquifer	94	94	94	94
Manufacturing	K	K	01	Other Aquifer	122	122	122	122
Manufacturing	K	K	00	Colorado River Combined Run-of-River	9,253	10,415	11,240	12,218
Manufacturing	K	G	00	Colorado River Combined Run-of-River	371	404	404	456
Mining	K	G	01	Edwards-BFZ Aquifer	0	0	0	0
Mining	K	K	00	Other Local Supply	2,733	2,658	5,246	5,791
Mining	K	K	01	Edwards-BFZ Aquifer	891	891	891	891
Mining	K	K	01	Other Aquifer	1,103	1,103	1,103	1,103
Mining	K		01	Trinity Aquifer	96	96	96	96
Steam Electric Power	K	K	00	Colorado River Combined Run-of-River	2,546	2,546	2,546	2,546
Steam Electric Power	K	K	00	Highland Lakes System	19,710	19,710	19,710	19,710
Steam Electric Power	K	K	00	Walter E. Long/Decker Lake	560	560	560	560
Steam Electric Power	K	K	01	Trinity Aquifer	2	2	2	2
Steam Electric Power	K	K	00	Colorado River Combined Run-of-River	63	63	63	63
Total Projected Water Supplies (acre-feet per year)					238,920	239,567	235,354	214,092

Basin: K- Lower Colorado 00, Surface Water
G- Brazos 01, Groundwater

Source: TWDB, 2002

Williamson County

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
Anderson Mill	K	G	00	Colorado River Combined Run-of-River	1,975	0	0	0
Austin	K	K	00	Colorado River Combined Run-of-River	160	160	160	160
Austin	K	K	00	Colorado River Combined Run-of-River	1,147	1,147	1,147	1,147
Austin	K	K	00	Highland Lakes System	6,168	6,168	6,168	6,168
Bartlet	G	G	01	Trinity Aquifer	254	254	254	254
Brushy Creek	G	G	0	Brazos River Authority System	0	0	0	0
Brushy Creek	G	G	00	Brazos River Authority System	3360	0	0	0
Brushy Creek	G	G	01	Edwards-BFZ Aquifer	325	325	325	325
Cedar Park	G	G	00	Highland Lakes System	11,289	11,289	11,289	11,289
Florence	G	G	01	Trinity Aquifer	204	204	204	204
George town	G	G	00	Brazos River Authority System	0	0	0	0
Georgetown	G	G	00	Brazos River Authority System	8,344	8,344	8,344	8,344
Georgetown	G	G	01	Edwards-BFZ Aquifer	921	921	921	921
Granger	G	G	01	Trinity Aquifer	245	245	245	245
Hutto	G	G	01	Trinity Aquifer	131	131	131	131
Leander	G	G	00	Highland Lakes System	6,400	6,400	6,400	6,400
Leander	G	G	01	Trinity Aquifer	363	363	363	363
Leander	G	G	00	Brazos River Authority System	0	0	0	0
Round Rock	G	G	00	Brazos River Authority System	3570	342	427	468
Round Rock	G	G	00	Brazos River Authority System	14,191	17,419	17,334	17,293
Round Rock	G	G	01	Edwards-BFZ Aquifer	921	921	921	921
Taylor	G	G	00	Brazos River Authority System	6,451	6,451	6,451	6,451
Thrall	G	G	01	Trinity Aquifer	83	83	83	83
County-Other	G	G	01	Other Aquifer	305	305	305	305
County-Other	G	G	00	Brazos River Authority System	12	12	12	12

Williamson County (Cont.)

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
County-Other	G	G	00	Brazos River Authority System	3,993	4,125	4,210	4,251
County-Other	G	G	01	Edwards-BFZ Aquifer	1,213	1,213	1,213	1,213
County-Other	G	G	01	Trinity Aquifer	470	470	470	470
County-Other	G	G	00	Highland Lakes System	318	318	318	318
County-Other	K	G	00	Other Aquifer	2,414	2,414	2,414	2,414
County-Other	K	G	01	Edwards-BFZ Aquifer	523	523	523	523
County-Other	K	G	01	Trinity Aquifer	219	219	219	176
County-Other	K	K	01	Edwards-BFZ Aquifer	0	0	0	0
Irrigation	G	G	00	Brazos River Authority System	15	15	15	15
Irrigation	G	G	0	Irrigation Local Supply	942	942	942	942
Irrigation	K	K	01	Other Aquifer	35	35	35	35
Irrigation	K	K	01	Trinity Aquifer	15	15	15	12
Irrigation	K	K	01	Edwards-BFZ Aquifer	13	13	13	13
Irrigation	K	G	01	Trinity Aquifer	29	29	29	29
Irrigation	K	G	01	Other Aquifer	150	150	150	150
Irrigation	K	G	01	Edwards-BFZ Aquifer	355	355	355	355
Livestock	G	G	00	Livestock Local Supply	1,303	1,303	1,303	1,303
Livestock	G	G	01	Other Aquifer	10	10	10	10
Livestock	K	G	01	Edwards-BFZ Aquifer	4	4	4	4
Livestock	K	G	01	Other Aquifer	150	150	150	150
Livestock	K	G	01	Trinity Aquifer	10	10	10	8
Livestock	K	K	00	Livestock Local Supply	1	1	1	1
Livestock	K	K	01	Edwards-BFZ Aquifer	0	0	0	0
Manufacturing	G	G	01	Other Aquifer	200	200	200	200
Manufacturing	G	G	00	Brazos River Authority System	0	0	5,000	5,000
Manufacturing	G	G	01	Edwards-BFZ Aquifer	50	50	50	50
Manufacturing	G	G	00	Brazos River Run-of-River	126	126	126	126

Williamson County (Cont.)

WUG NAME	RWPG	BASIN	SOURCE TYPE	SOURCE NAME	YR2000	YR2010	YR2020	YR2030
Manufacturing	K	G	01	Other Aquifer	150	150	150	150
Manufacturing	K	G	1	Edwards-BFZ Aquifer	78	78	78	78
Mining	G	G	00	Edwards-BFZ Aquifer	255	255	255	255
Mining	G	G	01	Other Aquifer	150	150	150	150
Mining	K	G	01	Edwards-BFZ Aquifer	419	419	419	419
Mining	K	G	01	Trinity Aquifer	29	29	29	29
Mining	K	K	01	Edwards-BFZ Aquifer	0	0	0	0
Mining	K	G	01	Other Aquifer	150	150	150	150
Mining	K	K	01	Trinity Aquifer	15	15	15	12
Mining	K	K	01	Other Aquifer	311	311	311	311
Steam Electric Power	K	G	01	Other Aquifer	150	150	150	150
Total Projected Water Supplies (acre-feet per year)					81,084	75,881	80,966	80,944

Basin: K- Lower Colorado; G- Brazos
00, Surface Water; 01, Groundwater
Source: TWDB, 2002

APPENDIX 3.

Williamson, Burnet and Northern Travis PGMA study, Updated Population Projection (TWDB, 2004)

Burnet County

WATER USER GROUP	P2000	P2010	P2020	P2030	P2040	P2050	P2060
BERTRAM	1122	1307	1524	1746	1958	2189	2458
BURNET	4735	5625	6668	7736	8753	9864	11154
CHISHOLM TRAIL SUD	118	178	249	321	390	465	553
COTTONWOOD SHORES	877	1100	1362	1630	1885	2164	2488
COUNTY-OTHER	17315	21733	26913	32218	37265	42781	49189
GRANITE SHOALS	2040	2489	3015	3554	4067	4627	5278
KEMPNER WSC	666	884	1140	1402	1652	1925	2242
KINGSLAND WSC	315	366	426	487	545	608	682
LAKE LBJ MUD	707	817	946	1078	1204	1341	1500
MARBLE FALLS	4959	5604	6361	7136	7874	8680	9616
MEADOWLAKES	1293	1821	2440	3074	3678	4337	5103
Total Projected Population	**34,147**	**41,924**	**51,044**	**60,382**	**69,271**	**78,981**	**90,263**

Northern Travis County

WATER USER GROUP	P2000	P2010	P2020	P2030	P2040	P2050	P2060
ANDERSON MILL MUD	0	0	0	0	0	0	0
AQUA WSC	6300	7251	8523	9698	10432	11208	12007
AUSTIN	644752	770529	946974	1111996	1258580	1409808	1548275
BARTON CREEK WEST WSC	1456	1456	1456	1456	1456	1456	1456
BEE CAVE VILLAGE	656	948	1339	1700	1926	2165	2411
BRIARCLIFF VILLAGE	895	1289	1817	2305	2609	2931	3263
CEDAR PARK	541	922	1432	1903	2197	2508	2828
COUNTY-OTHER	44016	33665	27853	23127	17213	12127	12636
CREEDMOOR-MAHA WSC	4962	5962	7301	8537	9309	10126	10967

Northern Travis (Cont.)

WATER USER GROUP	P2000	P2010	P2020	P2030	P2040	P2050	P2060
ELGIN	33	56	87	116	134	153	173
GOFORTH WSC	217	288	383	471	526	584	644
HILL COUNTRY WSC	991	1689	2623	3486	4025	4595	5182
JONESTOWN	1681	1985	2391	2766	3000	3248	3503
JONESTOWN WSC	779	926	1123	1305	1419	1539	1663
LAGO VISTA	4507	6132	8307	10316	11571	12898	14265
LAKEWAY	8002	10789	14519	17965	20117	22394	24738
LOOP 360 WSC	1802	2803	2803	2803	2803	2803	2803
LOST CREEK MUD	4354	4372	4372	4372	4372	4372	4372
MANOR	1204	1319	1473	1615	1704	1798	1895
MANVILLE WSC	9293	12987	17931	22498	25350	28367	31474
MUSTANG RIDGE	409	486	590	686	746	809	874
NORTH AUSTIN MUD #1	780	780	780	780	780	780	780
NORTH TRAVIS COUNTY MUD #5	2121	3615	5614	7460	8613	9833	11089
PFLUGERVILLE	16335	24709	35916	46268	52733	59572	66614
RIVER PLACE ON LAKE AUSTIN	2763	4449	5250	5250	5250	5250	5250
ROLLINGWOOD	1403	1414	1428	1441	1449	1458	1467
ROUND ROCK	1076	1806	2782	3684	4247	4843	5456
SHADY HOLLOW MUD	4732	4732	4732	4732	4732	4732	4732
THE HILLS	1492	2301	3000	3000	3000	3000	3000
TRAVIS COUNTY WCID #17	11023	15838	22283	28236	31954	35887	39936
TRAVIS COUNTY WCID #18	4915	6291	8133	9834	10896	12020	13177
TRAVIS COUNTY WCID #19	553	716	716	716	716	716	716
TRAVIS COUNTY WCID #20	990	1140	1140	1140	1140	1140	1140
WELLS BRANCH MUD	8211	8211	8211	8211	8211	8211	8211
WEST LAKE HILLS	3116	3520	4061	4561	4873	5203	5543

Northern Travis (Cont.)

WATER USER GROUP	P2000	P2010	P2020	P2030	P2040	P2050	P2060
WEST TRAVIS COUNTY REGIONAL WS	3260	4881	7051	9055	10307	11631	12994
WILLIAMSON-TRAVIS COUNTY MUD #1	1179	1699	2395	3037	3438	3862	4299
WINDERMERE UTILITY COMPANY	11481	17999	18710	18710	18710	18710	18710
Total Projected Population	**812280**	**969955**	**1185499**	**1385236**	**1550538**	**1722737**	**1888543**

Williamson County

WATER USER GROUP	P2000	P2010	P2020	P2030	P2040	P2050	P2060
AQUA WSC	420	504	603	721	849	989	1139
BARTLETT	857	893	936	987	1043	1103	1168
BELL-MILAM FALLS WSC	274	362	467	592	727	874	1032
BLOCKHOUSE MUD	4452	7197	10452	14322	18530	23108	28018
BRUSHY CREEK MUD	11322	16270	22138	23823	23823	23823	23823
CEDAR PARK	25508	52700	73421	102705	128373	154089	187931
CHISHOLM TRAIL SUD	11202	19019	28290	39312	51297	64336	78320
COUNTY-OTHER	14690	2758	2187	3057	12542	25493	33442
FERN BLUFF MUD	5319	9801	15117	21437	28309	35785	43803
FLORENCE	1054	1263	1511	1806	2127	2476	2850
GEORGETOWN	28339	40888	55770	73463	92702	113633	136082
GRANGER	1299	1400	1520	1663	1818	1987	2168
HUTTO	1250	1826	2510	3323	4207	5168	6199
JARRELL-SCHWERTNER WSC	2720	3795	5070	6585	8233	10026	11949
JONAH WATER SUD	7962	10685	13915	17755	21930	26472	31344
LEANDER	7596	11499	16128	21631	27615	34125	41107
LIBERTY HILL	1409	2440	3663	5117	6698	8418	10263
MANVILLE WSC	5273	7979	11188	15003	19151	23664	28504
ROUND ROCK	60060	87187	119358	157606	199196	244442	292970
SOUTHWEST MILAM WSC	1245	1584	1986	2464	2984	3550	4157

Williamson County (Cont.)

WATER USER GROUP	P2000	P2010	P2020	P2030	P2040	P2050	P2060
TAYLOR	13575	15530	17849	20606	23604	26865	30363
THRALL	710	859	1035	1245	1473	1721	1987
WEIR	591	936	1345	1831	2360	2935	3552
WELLS BRANCH MUD	168	168	168	168	168	168	168
WILLIAMSON-TRAVIS COUNTY MUD #1	4179	6611	9495	12924	16653	20710	25061
Total Projected Population	**211474**	**304154**	**416122**	**550146**	**696412**	**855960**	**1027400**

APPENDIX 4.

Williamson, Burnet and Northern Travis PGMA study, Updated Water Demand Projection (TWDB, 2004)

Burnet County

WUG Name	2000	2010	2020	2030	2040	2050	2060
BERTRAM	226	258	295	334	371	412	463
BURNET	849	983	1,143	1,300	1,461	1,635	1,849
CHISHOLM TRAIL SUD	15	28	40	53	66	79	94
COTTONWOOD SHORES	121	147	177	208	239	271	312
GRANITE SHOALS	327	385	453	525	592	669	763
KEMPNER WSC	228	298	381	466	548	636	741
KINGSLAND WSC	49	55	63	70	77	85	95
LAKE LBJ MUD	200	227	261	293	324	359	402
MARBLE FALLS	1,616	1,795	2,016	2,238	2,452	2,693	2,984
MEADOWLAKES	492	687	916	1,150	1,372	1,618	1,903
COUNTY-OTHER	1,629	1,947	2,352	2,743	3,131	3,546	4,078
IRRIGATION	103	101	100	98	96	95	93
LIVESTOCK	835	835	835	835	835	835	835
MANUFACTURING	743	963	1,109	1,248	1,384	1,502	1,636
MINING	1,725	1,956	2,049	2,098	2,145	2,190	2,235
STEAM-ELECTRIC	0	0	0	0	0	0	0
Total Projected Demand (acft/yr)	**9,158**	**10,665**	**12,190**	**13,659**	**15,093**	**16,625**	**18,483**

Northern Travis County

WUG Name	2000	2010	2020	2030	2040	2050	2060
ANDERSON MILL MUD	0	0	0	0	0	0	0
AQUA WSC	981	1088	1251	1390	1484	1582	1695
AUSTIN	72,041	85,603	104,600	122,118	137,412	153,023	167,064
CEDAR PARK	112	188	290	384	443	506	570

Northern Travis (cont.)

WUG Name	2000	2010	2020	2030	2040	2050	2060
ELGIN	6	9	14	18	21	24	27
JONESTOWN	245	280	329	372	400	429	463
JONESTOWN WSC	107	122	145	164	176	190	205
LAGO VISTA	1,494	2,006	2,698	3,340	3,733	4,161	4,602
MANOR	266	285	312	336	351	369	388
MANVILLE WSC	1,291	1,731	2,350	2,898	3,237	3,622	4,019
NORTH AUSTIN MUD #1	112	109	107	106	103	102	102
NORTH TRAVIS COUNTY MUD #5	314	514	792	1,045	1,196	1,366	1,540
PFLUGERVILLE	2,909	4,318	6,196	7,930	8,978	10,143	11,342
RIVER PLACE ON LAKE AUSTIN	919	1,470	1,723	1,723	1,717	1,717	1,717
ROUND ROCK	242	399	605	792	909	1,036	1,167
WELLS BRANCH MUD	1,527	1,508	1,490	1,472	1,444	1,435	1,435
WILLIAMSON-TRAVIS COUNTY MUD #1	144	198	274	344	385	433	482
WINDERMERE UTILITY COMPANY	1,415	2,157	2,222	2,201	2,180	2,180	2,180
COUNTY-OTHER	4,832	3,674	3,022	2,495	1,846	1,293	1,340
IRRIGATION	685	631	579	533	490	451	415
LIVESTOCK	394	394	394	394	394	394	394
MANUFACTURING	9,060	12,881	15,845	21,564	28,270	32,314	36,205
MINING	720	857	923	967	1,010	1,053	1,084
STEAM-ELECTRIC	4,197	9,800	10,360	12,600	13,160	15,400	15,960
Total Projected Demand (acft/yr)	**104,013**	**130,222**	**156,521**	**185,186**	**209,339**	**233,223**	**254,396**

Williamson County

WUG Name	2000	2010	2020	2030	2040	2050	2060
ANDERSON MILL MUD	1,504	1,464	1,434	1,405	1,375	1,355	1,355
AQUA WSC	65	76	88	103	121	140	161
AUSTIN	2,315	3,993	5,964	8,286	10,786	13,479	16,338
BARTLETT	173	176	181	188	195	205	217

Williamson County (cont.)

WUG Name	2000	2010	2020	2030	2040	2050	2060
BELL-MILAM FALLS WSC	41	53	66	83	101	120	142
BLOCKHOUSE MUD	578	903	1,288	1,749	2,242	2,796	3,389
BRUSHY CREEL MUD	1,902	2,643	3,596	3,869	3,869	3,869	3,869
CEDAR PARK	5,286	10,744	14,886	20,708	25,883	31,068	37,892
CHISHOLM TRAIL SUD	1,380	3,025	4,595	6,473	8,619	10,954	13,335
FERN BLUFF MUD	745	1,339	2,049	2,882	3,805	4,810	5,888
FLORENCE	192	224	262	307	357	413	476
GEORGETOWN	6,127	8,610	11,619	15,141	19,003	23,293	27,895
GRANGER	178	185	196	209	222	240	262
HUTTO	176	247	335	439	551	677	812
JARRELL-SCHWERTNER WSC	567	769	1,017	1,306	1,614	1,965	2,342
JONAH WATER SUD	1,159	1,676	2,229	2,804	3,415	4,092	4,845
LEANDER	1,344	1,971	2,728	3,610	4,578	5,657	6,815
LIBERTY HILL	268	454	673	940	1,223	1,537	1,874
MANVILLE WSC	732	1,064	1,466	1,933	2,446	3,022	3,640
NORTH AUSTIN MUD #1	1,007	983	968	952	928	920	920
ROUND ROCK	13,522	19,239	25,937	33,896	42,617	52,298	62,680
SOUTHWEST MILAM WSC	209	259	318	386	465	549	643
TAYLOR	2,281	2,522	2,839	3,208	3,622	4,093	4,625
THRALL	106	123	145	172	200	231	267
WEIR	101	156	223	301	386	480	581
WELLS BRANCH MUD	31	31	30	30	30	29	29
WILLIAMSON-TRAVIS COUNTY MUD #1	510	770	1,085	1,462	1,865	2,320	2,807
COUNTY-OTHER	2,320	429	333	452	1,812	3,627	4,757
COUNTY-OTHER (CITY OF AUSTIN)	2,123	2,401	2,729	3,118	3,536	3,989	4,469
IRRIGATION	80	80	80	80	80	80	80
IRRIGATION	0	0	0	0	0	0	0
LIVESTOCK	1,344	1,344	1,344	1,344	1,344	1,344	1,344

Williamson County (cont.)

WUG Name	2000	2010	2020	2030	2040	2050	2060
MANUFACTURING	1,171	1,587	1,854	2,120	2,388	2,630	2,856
MANUFACTURING	0	0	0	0	0	0	0
MINING	1,874	2,354	2,615	2,795	2,972	3,149	3,280
MINING	13	9	5	1	0	0	0
STEAM-ELECTRIC	0	0	0	0	0	0	0
Total Projected Demand (acft/yr)	**51,424**	**71,903**	**95,177**	**122,752**	**152,650**	**185,431**	**220,885**

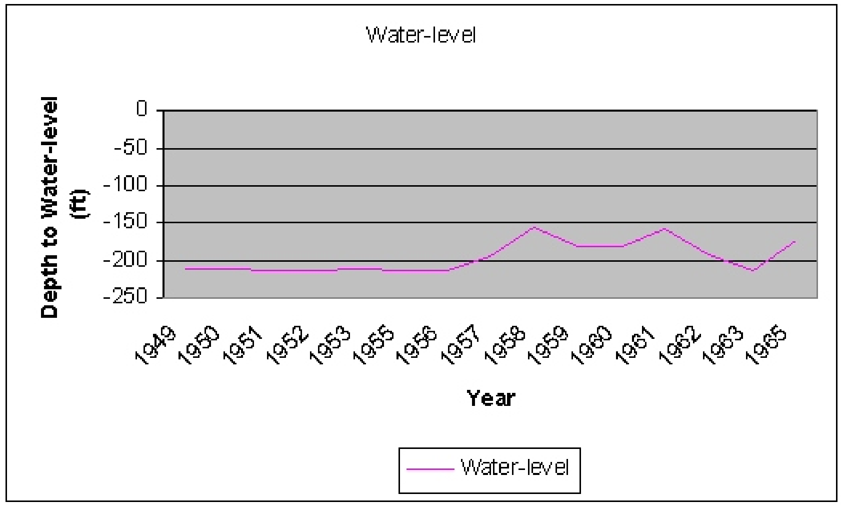
APPENDIX 5.

Selected Hydrographs

Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 54-42-602

Well number 5842602

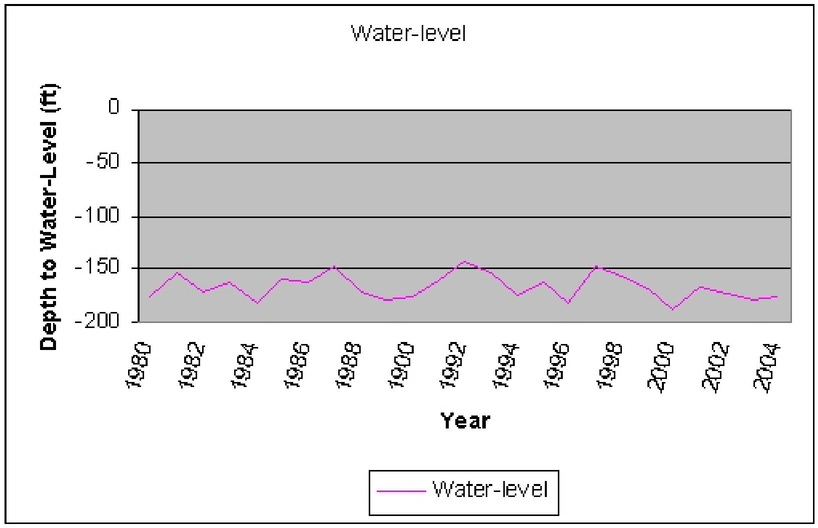
Year	Water-level
1949	-212.42
1950	-211.42
1951	-213.45
1952	-213.65
1953	-211.86
1955	-214.57
1956	-215.01
1957	-193.29
1958	-156.45
1959	-179.96
1960	-180.62
1961	-157.97
1962	-191.81
1963	-212.6
1964	
1965	-172.16



Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-27-305

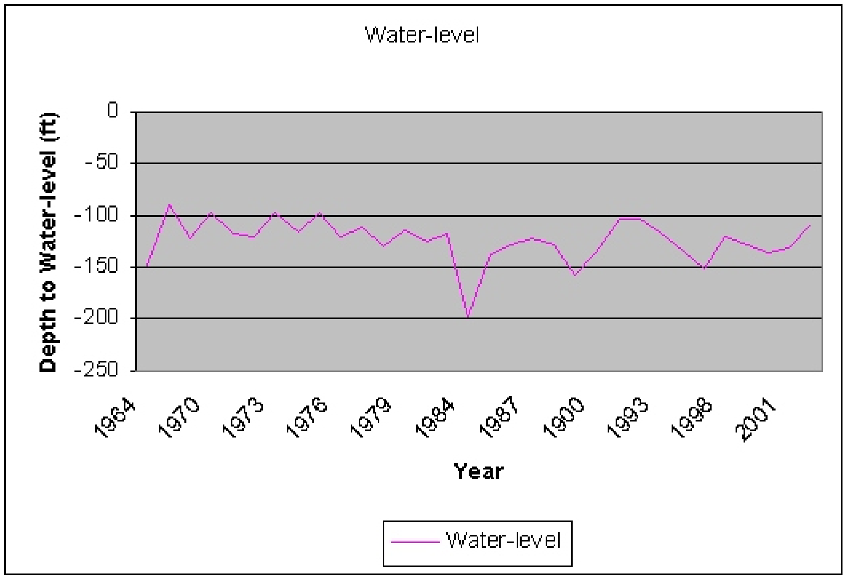
Well no 5827305

Year	Water-level
1980	-177.55
1981	-154.21
1982	-170.41
1983	-163.99
1984	-182.47
1985	-160.06
1986	-163
1987	-146.68
1988	-171.64
1989	-178.12
1990	-176.43
1991	-160.64
1992	-143.69
1993	-154.05
1994	-175.42
1995	-162.48
1996	-181.68
1997	-147.18
1998	-157.79
1999	-169.65
2000	-188.29
2001	-167.2
2002	-173
2003	-179.06
2004	-177.22



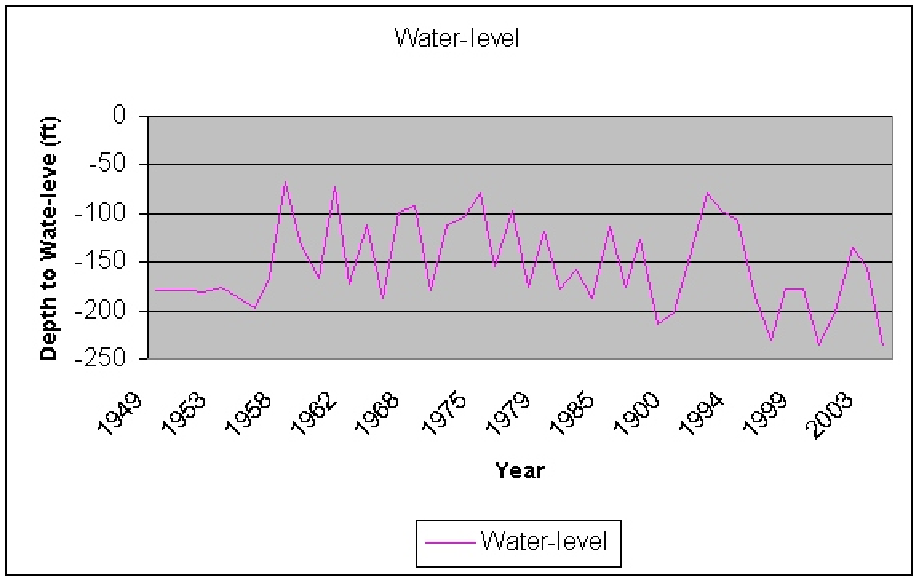
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-35-204

Year	Water-level
1964	-147.8
1965	
1966	
1967	
1968	-90.63
1969	-122.15
1970	-97.8
1971	-117.54
1972	-119.08
1973	-97.6
1974	-115.58
1975	-97.25
1976	-120.38
1977	-111.7
1978	-129.49
1979	-113.25
1980	-126.89
1981	
1982	-118.75
1983	
1984	-198.88
1985	-137.51
1986	-128.66
1987	-121.1
1988	-127
1989	-157.2
1990	-135.7
1991	-103.4
1992	-104.8
1993	-115.5
1994	-134.47
1995	
1996	-151.55
1997	
1998	-120.68
1999	-127.15
2000	-135.4
2001	-131.45
2002	-107.05
2003	
2004	



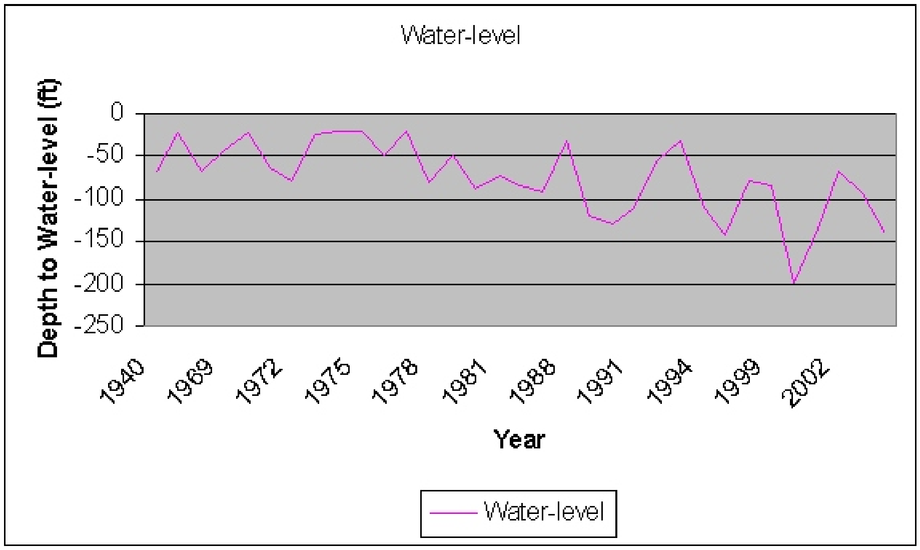
Travis County
Edwards Aquifer, Water-level fluctuations
SWN 58-36-402

Year	Water-level
1949	-178.74
1950	-180.45
1951	-179.99
1952	-181.61
1953	-175.91
1955	-185.74
1956	-197.6
1957	-165.96
1958	-65.54
1959	-133.5
1960	-166.47
1961	-73.64
1962	-173.75
1963	-111.7
1964	-188.57
1965	-98.56
1968	-91.71
1972	-179.56
1973	-111.7
1974	-102.6
1975	-78
1976	-153.66
1977	-97.1
1978	-174.94
1979	-118.4
1980	-177.35
1981	-158.18
1984	-187.09
1985	-113.58
1986	-175.38
1988	-126.35
1989	-212.8
1990	-202
1991	-145
1992	-79.1
1993	-96.5
1994	-106.4
1995	-186.1
1996	-230.6
1997	-177.8
1999	-177.88
2000	-236.1
2001	-200.2
2002	-134.69
2003	-155.86
2004	-237.93



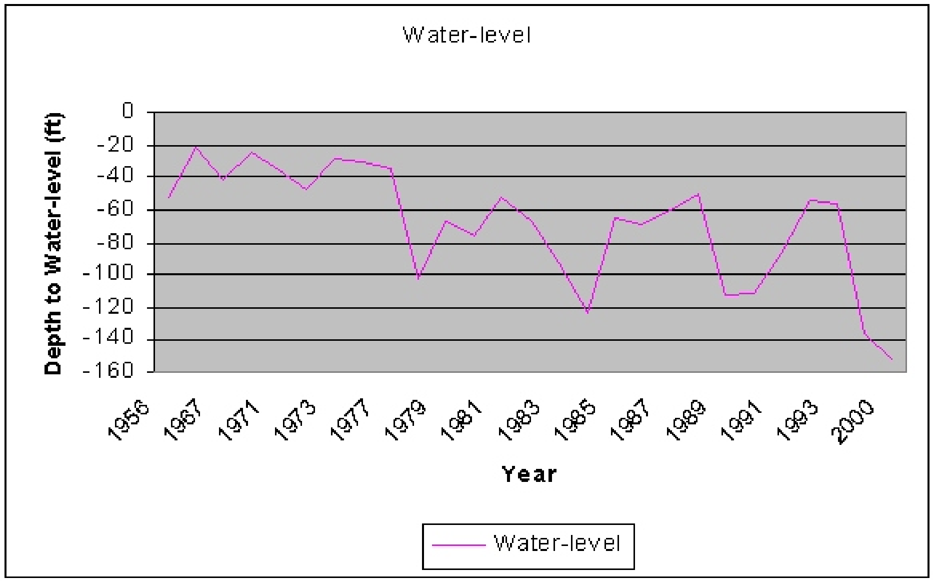
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-28-601

Year	Water-level
1940	-65.51
1966	-21.58
1967	-67.11
1968	
1969	-42.6
1970	-22.16
1971	-63.6
1972	-77.57
1973	-23.38
1974	-19.38
1975	-19.65
1976	-48.33
1977	-20.18
1978	-81.05
1979	-49.2
1980	-89.35
1981	-72.75
1982	
1983	
1984	-82.78
1985	
1986	
1987	-89.9
1988	-32.76
1989	-119.6
1990	-130.2
1991	-111.2
1992	-55.1
1993	-32.2
1994	-110.87
1995	
1996	-143.2
1997	
1998	-77.4
1999	-82.8
2000	-197.7
2001	-134.4
2002	-67.22
2003	-93.18
2004	-138.6



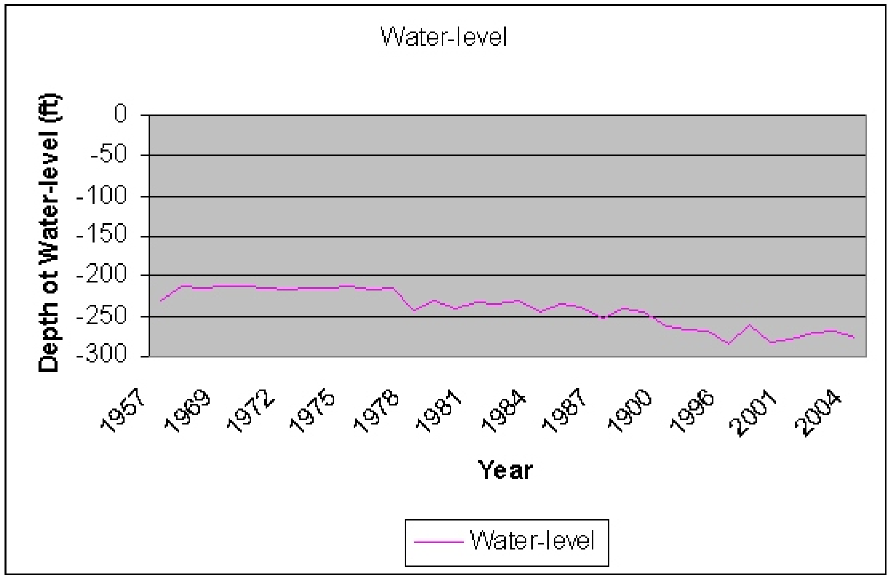
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-27-902

Year	Water-level
1956	-52
1966	-21.41
1967	-41.31
1968	
1969	-24.89
1970	
1971	-36.35
1972	-46.93
1973	-28.4
1974	-30.96
1975	
1976	
1977	-34.72
1978	-103.01
1979	-66.31
1980	-75.07
1981	-52.4
1982	-66.84
1983	-92
1984	-122.76
1985	-65.82
1986	-69.02
1987	-60.44
1988	-49.96
989	-112.5
1990	-111.9
1991	-86.8
1992	-54.2
1993	-55.9
1994	
1995	
1996	-136
1997	
1998	
1999	
2000	-152.3
2001	
2002	
2003	
2004	



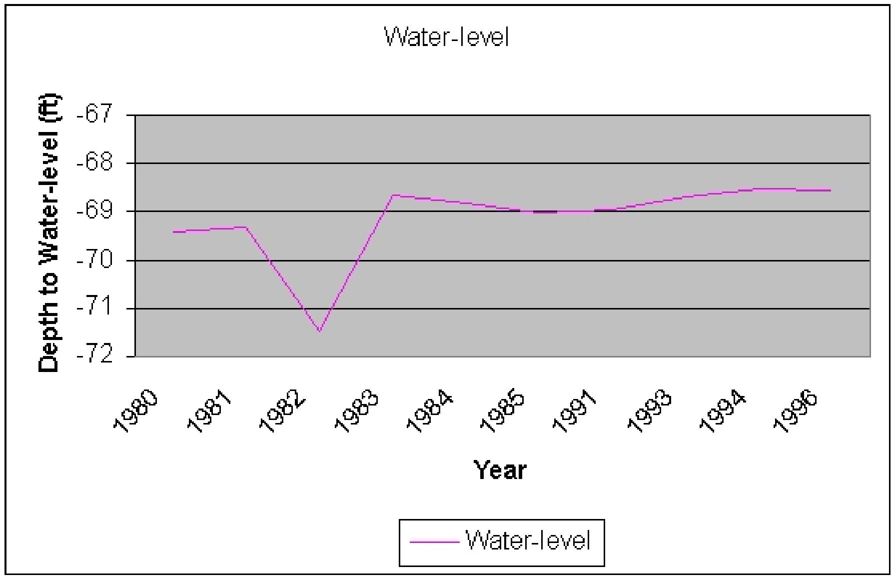
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-20-102

Year	Water-level
1957	-230
1966	-211.03
1967	-215
1968	
1969	-212.14
1970	-212.3
1971	-215.3
1972	-217.18
1973	-213.45
1974	-214.35
1975	-212.87
1976	-216.45
1977	-214.35
1978	-242.76
1979	-230.25
1980	-241.64
1981	-233.93
1982	-236.6
1983	-230.74
1984	-244.94
1985	-235.36
1986	-238.07
1987	-252.51
1988	-240.36
1989	-245.7
1990	-262.6
1991	-266.7
1992	
1993	
1994	-268.9
1995	
1996	-284.6
1997	
1998	-261.15
1999	-282.6
2000	
2001	-278.6
2002	-271.52
2003	-267.8
2004	-275.89



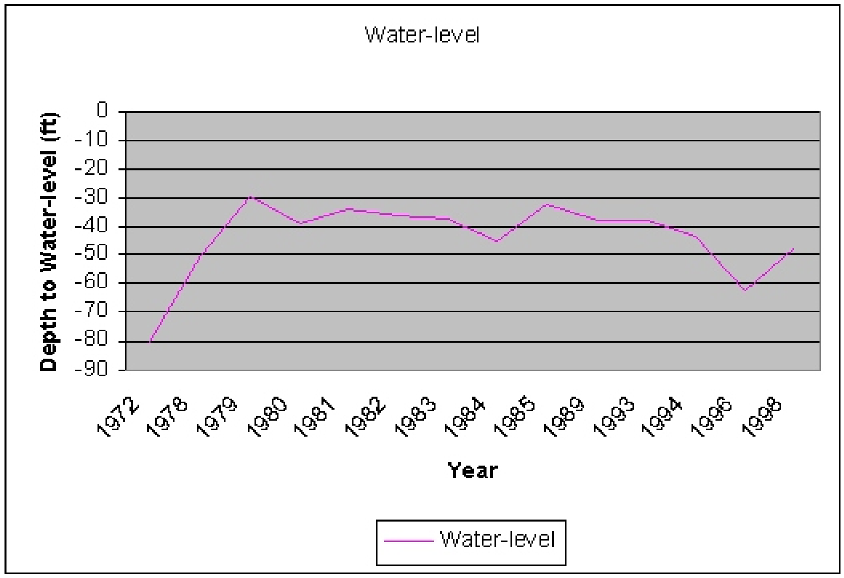
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-27-103

Year	Water-level
1980	-69.43
1981	-69.31
1982	-71.5
1983	-68.62
1984	-68.8
1985	-69.01
1986	
1987	
1988	
1989	
1990	
1991	-68.96
1992	
1993	-68.68
1994	-68.51
1995	
1996	-68.55
1997	
1998	
1999	
2000	
2001	
2002	
2003	
2004	



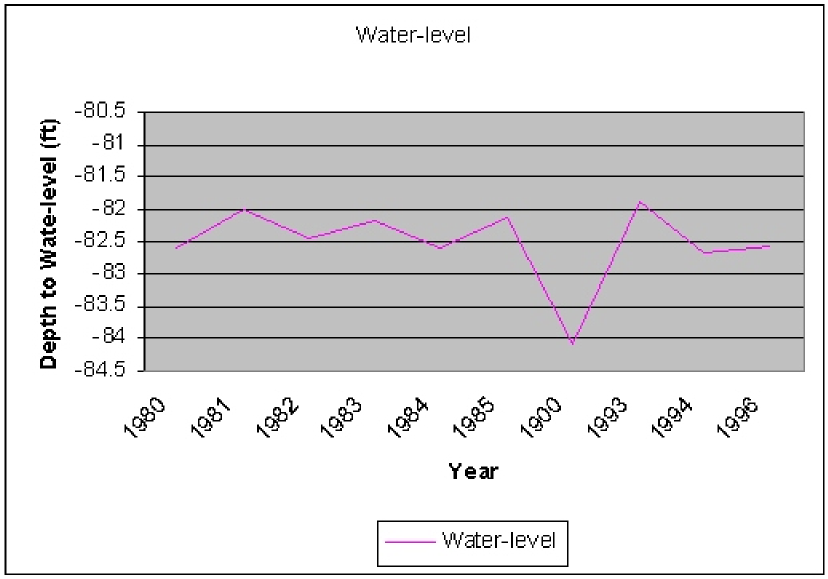
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-19-303

Year	Water-level
1972	-80
1973	
1974	
1975	
1976	
1977	
1978	-50.05
1979	-29.26
1980	-38.62
1981	-33.92
1982	-35.95
1983	-37.09
1984	-45.09
1985	-32.68
1986	
1987	
1988	
1989	-38.32
1990	
1991	
1992	
1993	-38.11
1994	-43
1995	
1996	-62.66
1997	
1998	-47.2
1999	
2000	
2001	
2002	
2003	
2004	



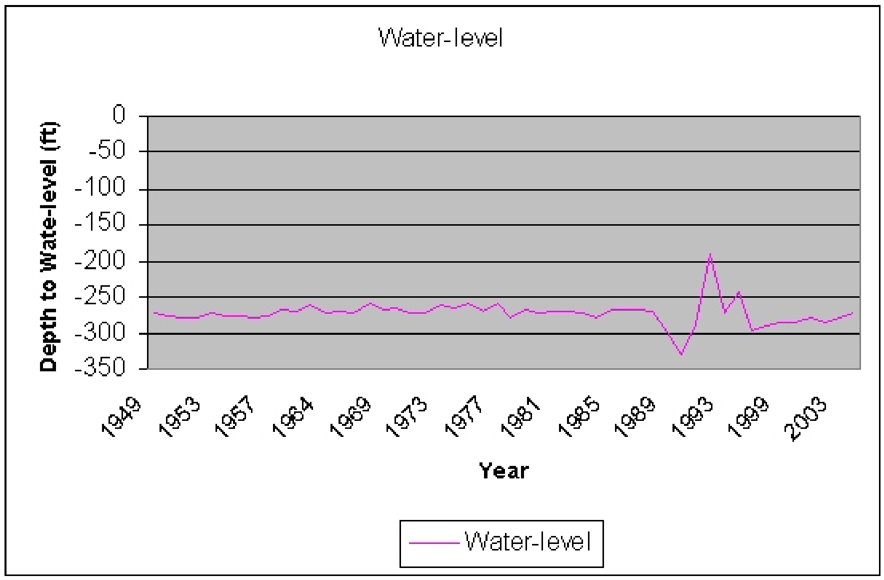
Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-27-217

Year	Water-level
1980	-82.62
1981	-81.99
1982	-82.45
1983	-82.19
1984	-82.6
1985	-82.12
1986	
1987	
1988	
1989	
1990	-84.1
1991	
1992	
1993	-81.87
1994	-82.67
1995	
1996	-82.59
1997	
1998	
1999	
2000	
2001	
2002	
2003	
2004	



Williamson County
Edwards Aquifer, Water-level fluctuations
SWN 58-12-405

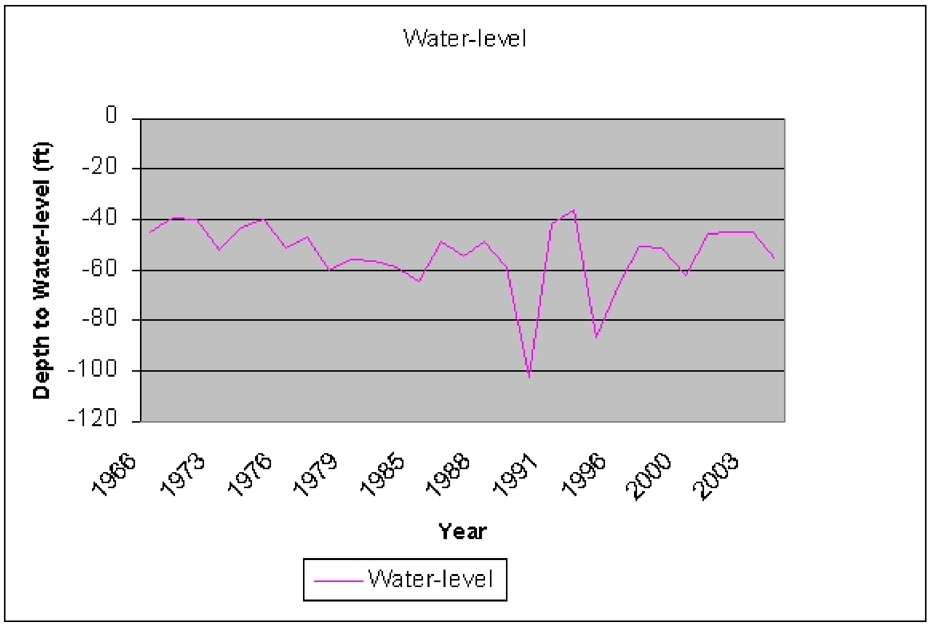
Year	Water-level
1949	-273.33
1950	-275.33
1951	-278.73
1952	-277.62
1953	-272.9
1954	-275.61
1955	-276.5
1956	-279.19
1957	-275.75
1958	-265.77
1959	-269.69
1961	-262.1
1964	-273.07
1966	-269.64
1967	-273.44
1968	-258.81
1969	-266.31
1970	-264.78
1971	-271.28
1972	-272.05
1973	-260.12
1974	-263.1
1975	-257.95
1976	-269.2
1977	-257.8
1978	-278.92
1979	-267.39
1980	-273.02
1981	-270.7
1982	-269.25
1983	-271.31
1984	-279.37
1985	-267.51
1986	-267.37
1987	-268.17
1988	-268.39
1989	-299.6
1990	-330
1991	-287.6
1992	-190.6
1993	-271.6
1994	-243.25
1996	-296.55
1998	-290
1999	-282.6
2000	-285.2
2001	-277.1
2002	-283.62
2003	-278.4



2004	-273.57

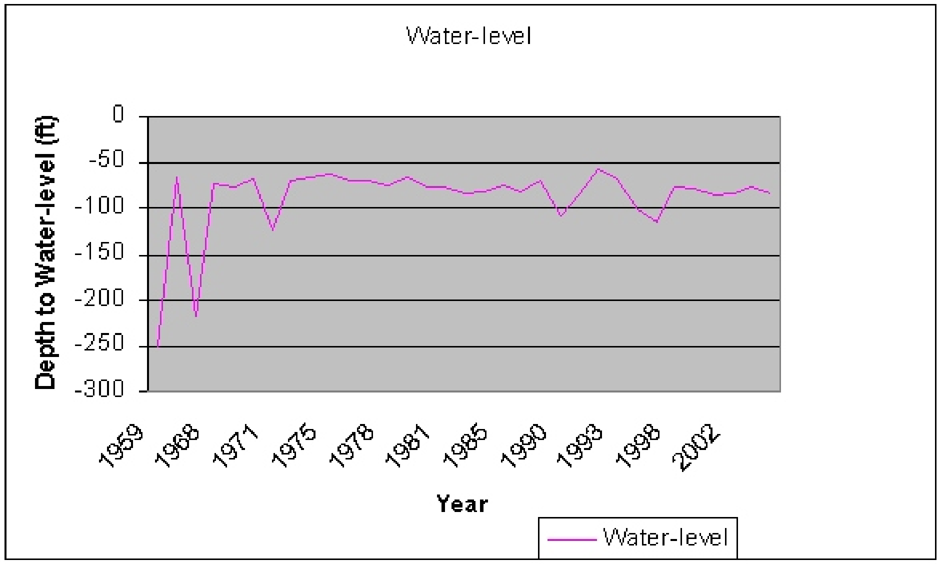
Travis County
Trinity Aquifer, Water-level fluctuations
SWN 58-40-304

Year	Water-level
1966	-45
1967	
1968	-39.22
1969	
1970	-40.67
1971	
1972	
1973	-52.62
1974	-43.2
1975	-40.44
1976	-51.78
1977	-47.09
1978	-60.63
1979	-55.5
1980	
1981	
1982	
1983	-56.46
1984	-59.09
1985	-64.82
1986	-49.33
1987	-55
1988	-48.95
1989	-58.75
1990	-102.5
1991	-41.5
1992	-36
1993	
1994	-87.2
1995	
1996	-64.59
1997	-50.4
1998	
1999	-51.65
2000	-62.2
2001	-46.25
2002	-45.29
2003	-45.17
2004	-55.62



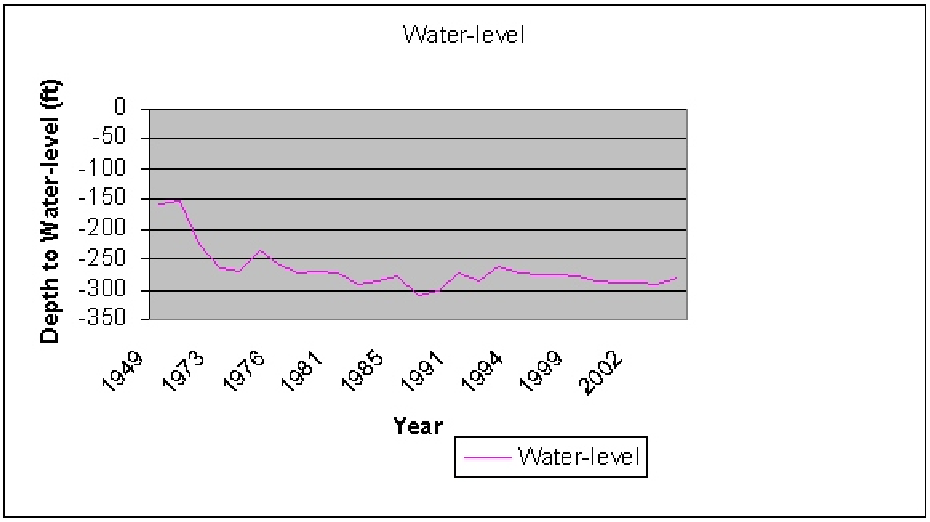
Travis County
Trinity Aquifer, Water-level fluctuations
SWN 58-34-603

Year	Water-level
1959	-250
1960	-65
1966	
1967	-219.3
1968	-71.4
1969	-77
1970	-67.8
1971	-124.79
1972	
1973	-69.82
1974	-65.03
1975	-62.12
1976	-69.55
1977	-70.7
1978	-75.1
1979	-66.4
1980	-77.08
1981	-76.66
1982	
1983	-84.12
1984	-81.16
1985	-73.9
1986	-81.11
1987	
1988	-70.18
1989	
1990	-108
1991	-82.5
1992	-57.5
1993	-68
1994	-101.35
1995	
1996	-114.79
1997	
1998	-76.45
1999	-78.47
2000	
2001	-86.3
2002	-83.39
2003	-75.85
2004	-83.78



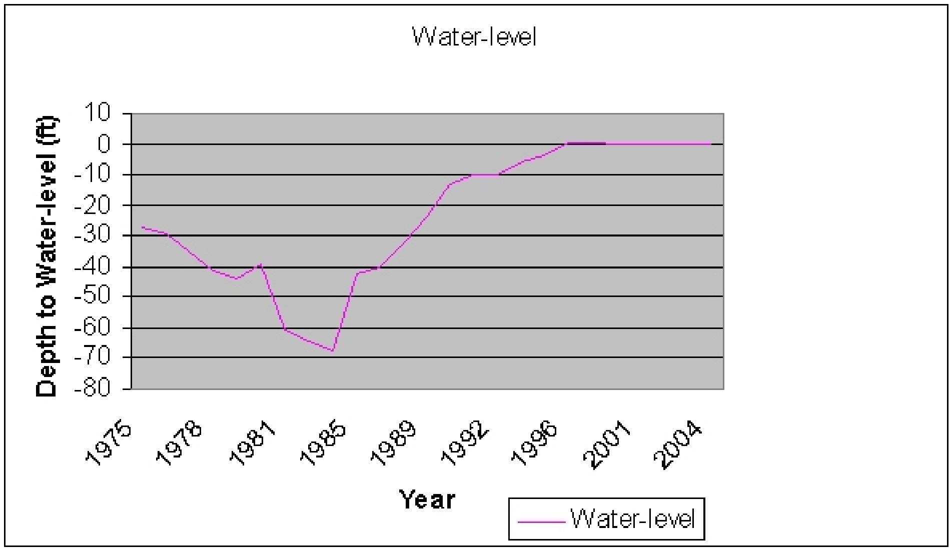
Travis County
Trinity Aquifer, Water-level fluctuations
SWN 58-42-502

Year	Water-level
1949	-158
1950	-152
1966	-223.44
1967	
1968	
1969	
1970	
1971	
1972	
1973	-265.8
1974	-268.32
1975	-235.65
1976	-259
1977	
1978	
1979	-272.1
1980	-267.78
1981	-273.16
1982	
1983	-291.7
1984	-284.93
1985	-277.3
1986	-311.72
1987	-302.9
1988	
1989	
1990	
1991	-273.5
1992	-286.5
1993	-261.6
1994	-271.3
1995	
1996	-275.15
1997	-275.6
1998	
1999	-277.89
2000	-286.1
2001	-289.5
2002	-287.18
2003	-290.85
2004	-281.34



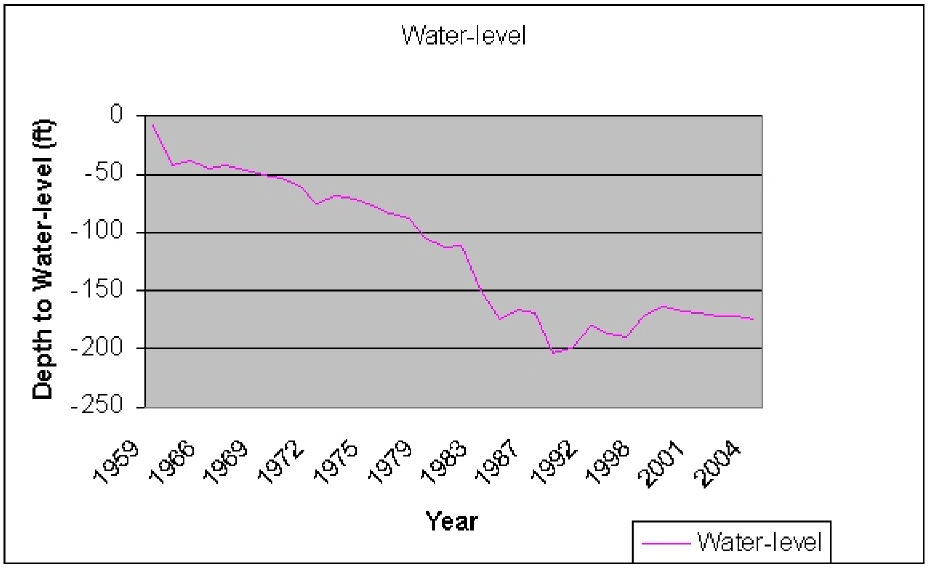
Travis County
Trinity Aquifer, Water-level fluctuations
SWN 58-44-201

Year	Water-level
1975	-27.1
1976	-29.12
1977	-35.1
1978	-41.55
1979	-43.79
1980	-39.5
1981	-60.67
1982	
1983	-64.89
1984	-67.69
1985	-42.7
1986	-40.13
1987	
1988	-32.12
1989	-23.6
1990	-13.2
1991	-10
1992	-9.9
1993	-6.3
1994	-3.68
1995	
1996	0.1
1997	0.1
1998	
1999	0
2000	
2001	0
2002	0
2003	0
2004	0



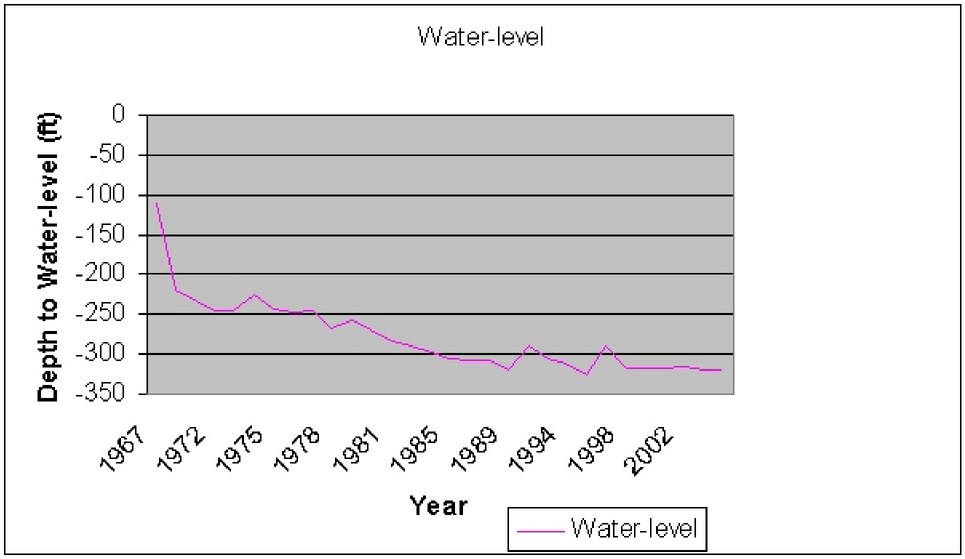
Williamson County
Trinity Aquifer, Water-level fluctuations
SWN 58-29-603

Year	Water-level
1959	-7
1964	-43.5
1965	-37.9
1966	-44.85
1967	-42.3
1968	-45.95
1969	-49.49
1970	-54.27
1971	-61.1
1972	-75.5
1973	-68.04
1974	-72.02
1975	-76.93
1976	-84.3
1977	-87.89
1978	
1979	-105.6
1980	-111.82
1981	-110.43
1982	
1983	-149.7
1984	-174.32
1985	
1986	-165.88
1987	-170.04
1988	
1989	
1990	-203.7
1991	-199.2
1992	-179.65
1993	
1994	-186.92
1995	
1996	-189.73
1997	
1998	-172.26
1999	-164.06
2000	-167.35
2001	-170.01
2002	-171.45
2003	-172.28
2004	-174.28



Williamson County
Trinity Aquifer, Water-level fluctuations
SWN 58-17-902

Year	Water-level
1967	-110
1968	
1969	
1970	-220.4
1971	-232.15
1972	-244.63
1973	-244.2
1974	-223.85
1975	-242.85
1976	-248.15
1977	-245.72
1978	-268.1
1979	-256.75
1980	-269.15
1981	-281.85
1982	
1983	-288.85
1984	-298.37
1985	-306
1986	-307.85
1987	-307.68
1988	
1989	-321.2
1990	
1991	
1992	-290.55
1993	-306
1994	-313.42
1995	
1996	-323.83
1997	-288.78
1998	-317.3
1999	-318.17
2000	
2001	-316.75
2002	-315.75
2003	-321.15
2004	-318.88



Williamson County
Trinity Aquifer, Water-level fluctuations
SWN 58-10-303

Year	Water-level
1966	-292.61
1967	-302.38
1968	-301.76
1969	-302.01
1970	-304.44
1971	-312.47
1972	-313.85
1973	-317.25
1974	-321.01
1975	
1976	
1977	-329.25
1978	-383.5
1979	-341.41
1980	
1981	-376.42
1982	
1983	
1984	-410.05
1985	
1986	-393.47
1987	-409.2
1988	-423.06
1989	
1990	-471.57
1991	
1992	-455.4
1993	
1994	-527
1995	-473.88
1996	-522.4
1997	-531.65
1998	-497
1999	-469
2000	
2001	-474
2002	-492
2003	-492
2004	-470